A Self-Regulatory Model of Behavioral Disinhibition in Late Adolescence: Integrating Personality Traits, Externalizing Psychopathology, and Cognitive Capacity

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ABSTRACT Two samples with heterogeneous prevalence of externalizing psychopathology were used to investigate the structure of self-regulatory models of behavioral disinhibition and cognitive capacity. Consistent with expectations, structural equation modeling in the first sample ($N = 541$) showed a hierarchical model with 3 lower order factors of impulsive sensation seeking, antisociality/unconventionality, and lifetime externalizing problem counts, with a behavioral disinhibition superfactor best accounted for the pattern of covariation among 6 disinhibited personality trait indicators and 4 externalizing problem indicators. The structure was replicated in a second sample ($N = 463$) and showed that the behavioral disinhibition superfactor, and not the lower order impulsive sensation seeking, antisociality/unconventionality, and externalizing problem factors, was associated with lower IQ, reduced short-term memory capacity, and reduced working memory capacity. The results provide a systemic and meaningful integration of major self-regulatory influences during a developmentally important stage of life.

Behavioral disinhibition refers to a pattern of antisocial, impulsive, norm-violating, sensation seeking, and externalizing tendencies and problems (e.g., substance use, attention deficits; Iacono, Carlson, Taylor, Elkins, & McGue, 1999), which has been shown to be a primary psychological substrate of several of the leading behavioral

contributors to mortality (i.e., alcohol, drug, and firearms-related deaths; Bogg & Roberts, 2004; Mokdad, Marks, Stroup, & Gerberding, 2004). Researchers index behavioral disinhibition using a variety of constructs, including personality traits related to impulsivity and socialization (Clark & Watson, 1999; Donovan, Jessor, & Costa, 1991), sensation seeking (Justus, Finn, & Steinmetz, 2000), and externalizing psychopathology (alcohol, marijuana, and other drug problems; Krueger & Markon, 2006) and, less frequently, as cognitive ability variables, such as intelligence, short-term memory, and working memory (Finn, Justus, Mazas, & Steinmetz, 1999). Although these and other indicators of behavioral disinhibition have and continue to be targets of inquiry, a more complete model of the self-regulatory influences fundamental to behavioral disinhibition remains somewhat obscured by a lack of integration across these disparate research traditions (cf. Finn, 2002).

To address the need for a clearer articulation of the relations among disinhibited personality traits, externalizing problems, and cognitive capacity, the current study addresses two major goals: (1) Model the associations among the related domains of disinhibited personality traits and externalizing psychopathology and (2) investigate the resultant model's relations to cognitive capacity outcomes previously found to be associated with various indicators of behavioral disinhibition. Compared to previous research, which has focused on a limited set of personality traits or externalizing problems and has often excluded important cognitive capacity constructs, the approach of the current study attempts to provide a more comprehensive depiction of a self-regulatory model of behavioral disinhibition in late adolescence.

Disinhibited Personality Traits and Externalizing Psychopathology

Recent research demonstrates the presence of an underlying continuum of psychopathology and personality traits related to impulsivity and socialization that can help explain the multimorbidity of externalizing problems (e.g., Kendler, Prescott, Myers, & Neale, 2003; Krueger & Markon, 2006). Specifically, research has shown that adolescent antisocial behavior, conduct disorder, alcohol dependence, drug dependence, and the personality trait of constraint share a common etiologic (primarily genetic) origin (Krueger et al., 2002). In addition, statistical modeling has shown this externalizing factor to

be dimensional rather than categorical in nature (Krueger, Markon, Patrick, & Iacono, 2005; Markon & Krueger, 2005). Taken together, the findings of a common genetic influence and a latent trait model for antisocial behavior and substance use problems indicate a coherence that can be conceptualized as a liability or spectrum for externalizing problems.

Although substantial progress has been made in understanding the meaning of the multimorbidity of various externalizing disorders and their relation to disinhibited personality traits (cf. Krueger, Markon, Patrick, Benning, & Kramer, 2007), it remains unclear how the structure of a more full account of disinhibited factors—a structure that would include multiple personality trait indicators of impulsivity and socialization as well as externalizing disorder problems—might be related to important cognitive capacity outcomes. The structure of these multiple self-regulatory influences on behavioral disinhibition is important given that Krueger et al. (2002) have shown these traits (measured more narrowly as constraint in their work), while sharing a common additive genetic etiology with externalizing disorder problems, also have a significant component of additive genetic variance that is independent of that shared with externalizing problems. That is, there is a meaningful portion of the additive genetic variance of traits related to impulsivity and socialization that is unique to a source other than that which is shared with the externalizing disorder problems. In fact, in behavior genetic research, Krueger et al. (2002) found only 22% of the variance in constraint to be accounted for by the externalizing factor. This finding suggests that traits related to impulsivity and socialization, while sharing meaningful psychological (and biological) space with externalizing problems, are not wholesale components of an externalizing liability. In part, the current research is designed to further elucidate the relations among the components and subsequently examine how these components of behavioral disinhibition are related to multiple indicators of cognitive capacity.

Cognitive Capacity, Self-Regulation, and Behavioral Disinhibition

Working memory is an important component of a system of interrelated executive cognitive functions (Zelazo & Frye, 1998), including attentional capacity, attentional control, and attention shifting (Cowan, 1999), that plays a critical role in self-regulation

and decision making (Barkley, 1997, 2001; Bechara & Martin, 2004; Finn, 2002; Kimberg & Farah, 1993). As it pertains to self-regulation, increased working memory capacity enables fluid shifting of attention during the decision-making process from more salient proximal (immediate) to less salient distal (long-term) outcomes and allows for appropriate weighting and consideration of long-term consequences of decisions (i.e., less impulsive decisions; Finn, 2002; Finn & Hall, 2004; Oberauer, 2002). By contrast, reduced working memory capacity is related to general behavioral disinhibition (Barkley, 1997, 2001; Finn, 2002; Finn & Hall, 2004; Hinson, Jameson, & Whitney, 2003), which reflects the basic dispositional processes underlying externalizing problems (Finn, 2002; Krueger et al., 2002; Slutske et al., 2002). More generally, working memory is required for activated self-directed speech, self-reflection, and maintenance of representations for the purpose of problem solving to guide socially adaptive behavior (Barkley, 2001; Finn, 2002; Oberauer, 2002).

In the present research, multiple measures of working memory capacity are included because working memory is complex, involving several interrelated processes associated with behavioral regulation, including short-term memory capacity, resistance to distraction, mental manipulation, attentional control in divided attention/dual task contexts, and maintenance of memory traces over time (Baddeley & Logie, 1999; Cowan, 1999; Engle, Tuholski, Laughlin, & Conway, 1999; Finn, 2002). Engle et al. and Finn proposed multidimensional models of working memory capacity that distinguish a short-term capacity dimension, indicated by performance on simple span tasks, from a working memory capacity dimension, indicated by performance on complex, dual-task, span tasks requiring attention shifting and maintenance. Engle et al. showed that these two dimensions of working memory were distinct from measures of intelligence. The current research uses this three-dimensional model of short-term memory, working memory, and intelligence and tests its viability using confirmatory factor analyses.

Recent research suggests that diminished executive cognitive capacities involved in working memory, short-term memory, and intelligence contribute to the development and maintenance of externalizing problems (Aytaclar, Tarter, Kirisci, & Lu, 1999; Finn & Hall, 2004; Harden & Pihl, 1995; Pihl, Peterson & Finn, 1990; Poon, Ellis, Fitzgerald, & Zucker, 2000). Diminished capacity in these domains of cognitive ability also is thought to reflect a general

predisposition to disinhibited, poorly regulated behavior rather than a vulnerability to a specific disorder (Finn, 2002; Finn & Hall, 2004; Giancola, Zeichner, Yarnell, & Dickenson, 1996; Harden & Pihl, 1995). In turn, this disinhibited predisposition can be made manifest as externalizing behavior, such as alcohol dependence, childhood conduct problems, adult antisocial behavior, or other substance abuse (Barkley, 1997, 2001; Finn, 2002; Finn & Hall, 2004; Krueger et al., 2002). As such, these indicators of cognitive capacity represent integral components of a systematic approach to modeling self-regulatory influences on behavioral disinhibition. It should be noted that incentive (i.e., reward) structures, delay of reward components, or learning components are absent from these cognitive tasks. The tasks used in the current study assess general cognitive capacity in the absence of contextual manipulations.

Similarly, the current study did not incorporate an appetitive or incentive (i.e., reward) structure or component to the cognitive tasks. Unlike the Iowa gambling task (Bechara, Damasio, Damasio, & Anderson, 1994), for example, the short-term memory and working memory tasks are not designed to assess or account for the influence of appetitive influences that call on self-control for optimal performance. Instead, the tasks are agnostic with regard to such influences and are intended to assess decontextualized cognitive capacity (e.g., performance not influenced by monetary gains or losses).

The Present Study

The primary aim of the present research is to examine the structure of a self-regulatory model of behavioral disinhibition. Although other personality trait domains are relevant to behavioral disinhibition (e.g., agreeableness, hostility, emotional stability), we focus on traits related to impulsivity and socialization, as well as externalizing problems, as important and related components of behavioral disinhibition (e.g., Bogg & Roberts, 2004; Finn, 2002; Iacono et al., 1999; McGue, Iacono, & Krueger, 2006). Two large-scale community samples are used to model the relations among these disinhibited (i.e., related to impulsivity and socialization) personality traits and externalizing problems.

Aside from modeling the relations among disinhibited personality traits and externalizing problems, we examine how the resulting model is related to cognitive capacity (Engle et al., 1999), a set of abilities that research has shown differentiates individuals who meet

diagnostic criteria for externalizing disorders from those who do not (Aytaclar et al., 1999; Finn & Hall, 2004; Harden & Pihl, 1995). Specifically, we attempt to clarify these relations by examining three competing models of the structure of disinhibited traits and externalizing problems in late adolescent/young adult samples. Previous research indicates individuals in late adolescence and emerging adulthood are establishing patterns of behavioral disinhibition while remaining somewhat developmentally and neurologically malleable and are well suited for addressing self-regulatory questions whose answers can provide needed perspective on early intervention and treatment for at-risk individuals (Lubman, Yücel, & Hall, 2007; Monti et al., 2005; Zucker et al., 2006). Based in part on the behavior genetic research of Krueger et al. (2002), we expect the initial structure to yield separable components of disinhibited personality traits and externalizing problems rather than a single factor. Three approaches guided the modeling process.

First, in line with the idea of an underlying dimension of behavioral disinhibition (e.g., Iacono et al., 1999), a measurement model consisting of one latent variable (with 10 indicators—4 consisting of lifetime externalizing problem counts and 6 of disinhibited personality trait scales) was examined. If it best represented the data, then this one-factor model of disinhibited personality traits and externalizing problems would maximize parsimony while indicating that the covariance shared among the 10 indicators did, in fact, represent a single dimension of behavioral disinhibition that accounted for the multimorbidity of externalizing disorders and explained the interrelations of traits related to impulsivity and socialization and externalizing problems.

The second approach to modeling was guided, in part, by research examining the factor structure of personality scales and inventories related to the Big Five personality trait domain of Conscientiousness (Roberts, Chernyshenko, Stark, & Goldberg, 2005). Inherent in the domain of Conscientiousness is a consideration of disinhibition, which Clark and Watson (1999) in their "Big Three" model of personality traits describe as disinhibition versus constraint, wherein "disinhibited individuals are impulsive and somewhat reckless and are oriented primarily toward the feelings and sensations of the immediate moment; conversely, constrained individuals plan carefully, avoid risk or danger, and are controlled more strongly by the longer-term implication of their behavior" (p. 403). This definition maps neatly onto a similar framework outlined by Pickering and Gray (1999; see also Zuckerman, 2003, 2005), who label this constellation of facets impulsive sensation

seeking. Consistent with these conceptions, Roberts et al. factor-analyzed 36 Conscientiousness-related scales from seven personality inventories and found a six-factor structure labeled order, self-control, responsibility, industriousness, traditionalism, and virtue. Based on this six-factor structure, the impulsivity and socialization-related scales included in the current study load onto the factors of self-control and responsibility. In line with the definition of Pickering and Gray, we take a more expansive view of self-control and use the label impulsive sensation seeking for the personality scales aligning with this factor (i.e., the impulsivity subscale of the Eysenck impulsivity/venturesomeness scale, the control subscale of the Multidimensional Personality Questionnaire, and the disinhibition and boredom susceptibility subscales of the Sensation Seeking Scale). Conversely, although there are aspects of irresponsibility in the measures of socialization used in the current study, this factor is more accurately labeled antisociality/unconventionality, reflecting the more heterogeneous content of the scales used to assess this factor (i.e., the socialization subscale of the California Psychological Inventory and the psychopathic deviate scale of the Minnesota Multiphasic Personality Inventory-2). A third factor representing externalizing problems (i.e., lifetime alcohol, marijuana, other drug problem and conduct/antisocial personality disorder problem counts) was examined in conjunction with impulsive sensation seeking and antisociality/unconventionality to provide representation of the subclinical and clinical symptomatic expression of behavioral disinhibition that might be distinguished from disinhibited personality trait tendencies. Finally, in keeping with the idea of an overlying tendency, a latent superfactor, behavioral disinhibition, was modeled and indicated by the impulsive sensation seeking, antisociality/unconventionality, and externalizing problems factors. If it best represented the data, then this hierarchical four-factor model would provide an intuitive dimensional system of disinhibited personality traits and externalizing tendencies made manifest by the expression of impulsive, antisocial, and externalizing tendencies and problems, organized under a general disposition for behavioral disinhibition.

The third approach to modeling was derived from previous research examining the structure of traits related to disinhibition (Justus et al., 2000). The findings of Justus et al. revealed a structure consisting of (1) impulsivity (comprised of the impulsivity subscale of the Eysenck impulsivity/venturesomeness scale and the control subscale of the Multidimensional Personality Question-

naire), (2) social deviance proneness (consisting of the socialization subscale of the California Psychological Inventory, the psychopathic deviate scale of the Minnesota Multiphasic Personality Inventory-2, and a total count of antisocial problems), and (3) excitement seeking (consisting of the disinhibition and boredom susceptibility subscales of the Sensation Seeking Scale). In the current research, a fourth factor related to substance use problems (indicated by lifetime alcohol, marijuana, and other drug problem counts) is examined in conjunction with the three factors described above to provide an account of the covariance among the alcohol, marijuana, and other drug problems that might be distinguishable from antisocial personality and conduct problems (in contrast to the lower order externalizing factor described in the second approach). Similar to the second approach outlined above, a fifth overlying factor, behavioral disinhibition, was modeled and indicated by the impulsivity, social deviance proneness, excitement seeking, and substance use problems subfactors. If it best represented the data, then this hierarchical five-factor model would serve to replicate and extend the research of Justus et al. (2000) and would suggest a more thoroughly segmented framework with multiple related dimensions of disinhibited traits and externalizing problems, organized under a general disposition for behavioral disinhibition.

Assuming replication of one of the above structural models of disinhibited personality traits and externalizing problems from the first sample to the second, the final model including correlations to cognitive capacity should represent a more coherent self-regulatory system of behavioral disinhibition, one that accounts for the interrelations among externalizing problems and personality traits related to impulsivity and socialization while allowing for unique relations from these domains to cognitive capacity outcomes.

METHOD

Participants

Sample 1

We recruited a community sample ($N = 541$) of adolescents and young adults with a mean age of 20.7 ($SD = 1.87$) years. The sample was sex balanced (48.1% women), and most participants were European American/Caucasian (81.9%), followed by Asian/Asian American (9.4%), Af-

rican American (3.5%), Hispanic (2.9%), and Native American (2.2%). At the time of assessment, the sample averaged 14.1 years of education ($SD = 1.66$ years), indicating an overrepresentation of college students in the sample. Nearly half of the Study 1 sample participants met diagnostic criteria for alcohol dependence (47%), 36.2% for marijuana dependence, and 43.1% for other drug dependence. Additionally, 36.9% met diagnostic criteria for conduct disorder and 23.3% for antisocial personality disorder. Slightly more than one third of the sample (34.1%) did not meet diagnostic criteria for any of the above problems.

Sample 2

We recruited a community sample ($N = 463$) of adolescents and young adults with a mean age of 21.98 ($SD = 2.85$) years. The sample was sex balanced (46.4% women), and most participants were European American/Caucasian (76.9%), followed by African American (12.5%), Asian/Asian American (6.5%), Hispanic (3.5%), and other (0.6%). At the time of assessment, the sample averaged 13.81 years of education ($SD = 1.99$ years), indicating an overrepresentation of college students in the sample. More than half of the Study 2 sample participants met diagnostic criteria for alcohol dependence (56.4%), 36.1% for marijuana dependence, and 22.9% for other drug dependence. Additionally, 49% met diagnostic criteria for conduct disorder and 16% for antisocial personality disorder. Slightly less than one third of the sample (30.2%) did not meet diagnostic criteria for any of the above problems.

Assessment Materials

Diagnostic Interviews

Substance dependence (i.e., alcohol, marijuana, and other drugs) diagnoses and problem counts were ascertained from responses on the Semistructured Assessment for the Genetics of Alcoholism (SSAGA: Bucholz et al., 1994) using criteria from the *Diagnostic and Statistical Manual of Mental Disorders*, 4th edition (DSM-IV; American Psychiatric Association, 1994). Histories and lifetime problem counts for childhood conduct and antisocial personality disorders also were ascertained from responses to the SSAGA, also using DSM-IV criteria. In subsequent analyses, lifetime problem counts for conduct disorder and antisocial personality disorder (ASPD) were summed to form a CDASPD variable that reflected a lifetime history of antisocial behavior problems and tendencies. Because of their skewed distributions, all problem counts were Blom transformed

Table 1
Descriptive Statistics for Externalizing Problem Counts and Disinhibited Personality Trait Scale Scores

	Sample 1 Mean (SD)	Sample 2 Mean (SD)
Lifetime alcohol problems	19.67 (16.82)	27.99 (21.70)
Lifetime marijuana problems	3.34 (4.18)	10.04 (11.71)
Lifetime other drug problems	2.66 (6.10)	14.37 (26.37)
Lifetime CDASPD problems	13.13 (8.87)	26.54 (16.33)
CPI Socialization	31.95 (6.80)	28.78 (8.04)
EYS Impulsiveness	9.17 (4.72)	10.28 (4.61)
MMPI-2 Psychopathic Deviate	19.43 (5.49)	21.89 (6.31)
MPQ Control	12.43 (6.36)	11.44 (6.01)
SSS Boredom Susceptibility	3.81 (1.98)	3.71 (2.05)
SSS Disinhibition	4.27 (1.79)	4.42 (1.65)

Note. Problems are lifetime history problem counts from the Semi-structured Assessment for the Genetics of Alcoholism (SSAGA). CDASPD = sum of lifetime history problem counts for conduct disorder and antisocial personality disorder from the SSAGA. CPI = California Psychological Inventory; EYS = Eysenck Impulsiveness-Venturesomeness scales; MMPI = Minnesota Multiphasic Personality Inventory; MPQ = Multidimensional Personality Questionnaire; SSS = Sensation Seeking Scale.

for subsequent analyses.[1] Descriptive statistics for the raw lifetime problem counts are presented in Table 1.

Personality Trait Indicators

Six well-validated personality scales were used to assess traits related to impulsivity and socialization: The Impulsivity scale from the Eysenck Impulsivity-Venturesomeness test (EYS-IMP; Eysenck & Eysenck, 1978), the Control subscale of the Multidimensional Personality Questionnaire (MPQ-Control; Tellegen, 1982), the Disinhibition (DIS) and Boredom Susceptibility (BS) subscales of the Sensation Seeking Scale (SSS; Zuckerman, 1979), the Psychopathic Deviate (Pd) scale of the Minnesota Multiphasic Personality Inventory-2 (MMPI-2-Pd; Hathaway & McKinley,

1. Blom transformations rank order raw scores (settling ties by using the mean of the contested ranks) and then transform the ranks to *z* scores using the normal distribution. Simulation research comparing various transformations has shown that a Blom transformation of psychiatric symptom count data allowed for a more accurate selection of a true model from a set of alternative models (van den Oord et al., 2000).

1989), and the Socialization (So) scale of the California Psychological Inventory (Gough, 1969).[2] The EIV-IMP scale consists of 19 items (e.g., "Do you need to use a lot of self-control to keep out of trouble?") using a dichotomous response scale (i.e., "yes" or "no"; Sample 2, $\alpha = .83$). The MPQ-Control scale consists of 24 items (e.g., "When faced with a decision I usually take time to consider and weigh all aspects.") using a dichotomous response scale (i.e., "true" or "false"; Sample 2, $\alpha = .87$). High EIV-IMP scores and low MPQ-Control scores reflect low self-control, spontaneity, recklessness, and a lack of planning and foresight. The SSS-DIS scale consists of 10 forced-choice items (e.g., "I like 'wild' uninhibited parties" versus "I prefer quiet parties with good conversation"; Sample 2, $\alpha = .53$) and the SSS-BS consists of 10 forced-choice items (e.g., "I enjoy looking at home movies or travel slides" versus "Looking at someone's home movies or travel slides bores me tremendously"; Sample 2, $\alpha = .55$).[3] Three items that directly referred to drinking or drug use were dropped from the DIS scale: "I often like to get high (drinking liquor or smoking marijuana)"; "Keeping drinks full is the key to a good party"; and "I feel best after taking a couple of drinks." The MMPI-2-Pd scale consists of 50 items (e.g., "What others think of me does not bother me," "Sometimes when I was young I stole things," "No one seems to understand me") using a dichotomous response scale (i.e., "true" or "false": Sample 2, $\alpha = .76$). High scores on the MMPI-2-Pd scale indicate impulsivity, problems with authority, antisocial acts, and alienation (Almagor & Koren, 2001). One item ("I have used alcohol excessively") was dropped from the Pd scale because of contamination with the lifetime alcohol problem counts. The CPI-So scale consists of 54 items (e.g., "I often act on

2. The Sample 1 assessment was conducted in the mid-1990s. Subsequently, and as part of the process of culling older data sets, data from the Sample 1 assessment were compiled into a summary database that did not retain individual item responses. This process was implemented without foresight for the emergence of dimensional models of externalizing problems and disinhibited personality traits (and the subsequent desire to conduct reliability analyses). Consequently, alpha coefficients for Sample 1 are not reported.

3. The DIS and BS scales, and not the Experience Seeking (ES) and Thrill and Adventure (TAS) scales, were used because research indicates that the DIS and BS scales reflect an underlying subfactor of sensation seeking with common genetic origins (Koopmans, Boomsma, Heath, & van Doornen, 1995) that better reflects excitement seeking (Finn, Sharkansky, Brandt, & Turcotte, 2000). The TAS scale reflects low harm avoidance rather than excitement seeking (Finn et al., 2000; Finn, Mazas, Justus, & Steinmetz, 2002), and the ES scale reflects a preference for different types of experiences rather than excitement seeking per se (Finn et al., 2000, 2002).

the spur of the moment without stopping to think," "I keep out of trouble at all costs," "As a youngster in school, I used to give the teachers lots of trouble"; Sample 2, $\alpha = .80$). Low scores on the CPI-So scale reflect undersocialized and norm-violating tendencies. All the personality scales have shown relations with behaviors and outcomes related to substance use and antisocial behaviors and problems (Bogg & Roberts, 2004). Descriptive statistics for the six personality scales are presented in Table 1.

Intelligence

Intelligence was measured using the Shipley Institute of Living Scale estimates of IQ (Zachary, 1986). The Shipley is a self-administered measure of intelligence that strongly correlates (median correlation = .79) with the WAIS Full Scale IQ (Zachary, 1986). As with other abbreviated measures of general intelligence, the Shipley does not include a component for testing memory.

Short-Term Memory Capacity

Short-term memory capacity was assessed with the digits forward and backward scales of the Digit Span subtest of the Wechsler Adult Intelligence Scale-Revised (WAIS-R; Wechsler, 1981). Digits forward and backward are commonly used measures of short-term memory capacity and general attentional capacity in working memory system studies (Engle et al., 1999; Finn, 2002). Short-term memory capacity also was assessed with the letter–number sequencing task from the WAIS-III (Wechsler, 1997). The letter–number sequencing task involves the presentation of increasingly larger sets of letters and numbers (e.g., G-6-B-2) to the participant who, at the end of each set, is asked to verbally recall the numbers in numerical order (e.g., 2–6) and the letters in alphabetical order (e.g., B-G). Set sizes vary from two to eight items.

Working Memory Capacity

Working memory functions of dual-task ability, divided attention, and maintenance capacity were assessed with the Operation-Word Span test (OPWS; Conway & Engle, 1994) and a modified version of the Auditory Consonant Trigram test (ACT: Brown, 1958). The OPWS involves competition for attentional resources (divided attention) and the maintenance of activation of mental representations in a dual task context. This task requires the participant to solve a simple mathematical operation while remembering a word ($6/3 + 2 = 4$ DOG). The participant reads the math operation aloud, responds "yes" or "no" to indicate if the answer is correct or not, and then says the word. One half of the mathematical operations are correct. After a

series of operation-word pairs, the participant is asked to recall the words (series vary from two to six operation/word pairs). The total number of correctly recalled words is the variable derived from the OPWS.

The ACT was modified to include four and five nonsensical strings of consonants, in addition to the original three-string (trigram) consonant stimuli, to increase the overall load on the working memory system. The ACT requires the experimenter to read aloud a string of consonants at a rate of one letter per second and, immediately following the string, to read aloud a random two- or three-digit number. The participant is then asked to begin counting aloud backward in increments of three from the random number for an interval of 18 or 36 s, at which time the participant is asked to stop counting and recall the original consonant string. This task taps divided attention and the strength of the maintenance/decay of the contents of working memory over time (Brown, 1958; Stuss, Seethem, & Poirier, 1987). Counting backward is used to prevent rehearsal of the consonant string. The task included four different three-, four-, and five-consonant strings. For each string length, two were followed by 18-s delay intervals and two were followed by 36-s delay intervals. The dependent variable is the total number of correct consonants recalled across all string lengths and delay intervals.

Single-factor and correlated three-factor models of the cognitive capacity variables were compared to assess the appropriateness of the three-factor model indicated by Engle et al. (1999) and Finn (2002). As suggested by a more negative Bayesian Information Criterion (BIC) value and a lower Akaike Information Criterion (AIC) value (the fit indices are described in greater detail below), the three-factor model provided better fit, $\chi^2(7, N = 463) = 13.10$, $p = .07$, Root Mean Square Error of Approximation (RMSEA) = 0.043, BIC $= -42.14$, AIC $= -0.90$, than the one-factor model, $\chi^2(9, N = 463) = 117.56$, $p < .05$, RMSEA = 0.162, BIC = 62.32, AIC = 99.56, and was used in subsequent correlation analyses. The correlated three-factor model consisted of (1) Shipley IQ (IQ), (2) short-term memory (indicated by letter number, digits forward, and digits backward scores), and (3) working memory (indicated by operation word-span and auditory consonant trigram scores).

Procedure

Participants were recruited from the community by screening telephone responses to advertisements placed in local newspapers and around the local community. Advertisements were designed using Widom's (1977) approach to attract responses from individuals varying in terms of the level of disinhibited traits and tendencies. Highly disinhibited participants were targeted with advertisements asking for responses from "adventurous, carefree individuals who have led exciting and impulsive lives," "daring, rebellious, defiant individuals," "individuals on probation or

who have been in trouble with the law," as well as "persons with a drinking problem," and "social drinkers." Participants with average or low levels of disinhibited traits were targeted with advertisements asking for responses from "persons interested in psychological research" or "quiet, reflective and introspective persons."

Participants were excluded if they were not between 18 and 25 years of age, were taking any psychotropic or antihistamine medications, had never consumed alcohol, had a history of heart disease or psychosis, were not able to speak or read English, or had less than a grade six education level.

Participants were asked to refrain from excessive use of alcohol or drugs for the 24-hr period prior to each session, to refrain from any use for at least 12 hr prior to testing, and to eat a meal within 3 hr of testing. Prior to testing, participants were administered a breath-alcohol test using an AlcoSensor-III (Intoximeters, Inc.) to ensure that their breath-alcohol level (BAL) was 0.00%. Participants completed a questionnaire asking about when they had last eaten food, their drug use in the past 24 hr, and their level of fatigue. If a participant had a BAL greater than 0.00%, reported taking any other psychoactive drugs the day of testing, appeared to be high the day of testing, or was extremely fatigued, then the participant was rescheduled. Participants read and signed an informed consent to participate, were free to refuse any procedure, and were paid $7.00 per hour. The diagnostic interview was administered first, followed by an interspersed ordering of the personality trait and cognitive capacity measures. The total time of assessment was approximately 2–3 hr in Sample 1 and 3–4 hr in Sample 2.

Analyses

In Samples 1 and 2, the three measurement models of the covariance among the four problem-count indicators (alcohol, marijuana, other drug, and CDASPD) and the six personality trait indicators were analyzed using structural equation modeling (via AMOS 7). A single latent factor model (i.e., behavioral disinhibition), a hierarchical four-factor model (i.e., impulsive sensation seeking, antisociality/unconventionality, externalizing problems, and behavioral disinhibition superfactor), and a hierarchical five-factor model (i.e., impulsivity, social deviance proneness, excitement seeking, substance use problems, and behavioral disinhibition superfactor) were analyzed.

In the one-factor and four-factor models, residual terms for the substance use problem variables (i.e., alcohol, marijuana, other drugs) were allowed to freely covary to take into account the unique variance of these variables that was not shared with the other indicators. It was anticipated that the residual

variance of the substance use indicators reflected meaningful components of substance use variance that were not captured by covariation with the personality trait indicators or the CDASPD indicator, or both, in the one- and four-factor models. The residual terms for each substance use variable were expected to represent unique components of substance use problems that would correlate with the residual terms of the other substance use variables in the context of other non-substance-use indicators. In the five-factor model, the three substance use variables indicated a separate and "clean" substance-use latent variable, thereby negating the need to allow for their residual terms to freely covary in that model.

The three models were compared using the BIC and the AIC as the primary arbiters of appropriateness in the process of selecting one model over the others. Both BIC and AIC aid in selecting models by identifying which model among competing models reproduces the observed variances and covariances with the fewest estimated parameters (i.e., with the most parsimony). Lower (i.e., more negative) BIC values indicate better comparative fit in terms of the odds of one model being superior to the other (Raftery, 1995). Specifically, a difference of 10 points between two given models indicates that the odds are approximately 150:1 that the model with the lower (i.e., more negative) BIC value provides a better fit than the model with the higher (i.e., less negative) BIC value (Raftery, 1995). Lower AIC scores also indicate better comparative fit (Akaike, 1987) but are not interpreted as odds. The RMSEA also is reported but is not used for comparative purposes. Rather it is used to quantify the closeness of fit of each model in relation to its degrees of freedom (Browne & Cudeck, 1993), with values approaching zero indicating close fit. Browne and Cudeck advised that a RMSEA value of approximately .08 indicates a reasonable error of approximation. Similarly, the CFI (Bentler, 1990) is reported. CFI scores range from 0 to 1, where a score of .85, for example, means that 85% of the covariation in the data is reproduced by a tested model. A CFI score above .90 suggests adequate fit.

Using only Sample 2, correlations were examined between the latent factors of the selected measurement model found in Sample 1 and replicated in Sample 2 and the three-factor model of cognitive capacity.

RESULTS

Intercorrelations Among Trait and Problem Count Indicators

Table 2 displays the intercorrelations among the disinhibited personality trait scales and the lifetime externalizing problem counts for both samples.

Table 2

Intercorrelations Among Lifetime Externalizing Problem Counts and Disinhibited Personality Traits

	ALC Problems	MARJ Problems	Other Drug Problems	CDASPD Problems	CPI-Soc	EYS-Imp	MMPI-PD	MPQ-Contr	SSS-BS	SSS-Dis
ALC problems	—	.55	.55	.56	−.45	.34	.35	−.33	.27	.23
MARJ problems	.64	—	.56	.45	−.44	.24	.36	−.26	.17	.25
Other drug problems	.53	.54	—	.45	−.39	.21	.32	−.19	.15	.12
CDASPD problems	.69	.60	.52	—	−.74	.48	.57	−.43	.38	.32
CPI-Soc	−.56	−.51	−.48	−.66	—	−.53	−.71	.52	−.39	−.32
EYS-Imp	.49	.37	.33	.51	−.54	—	.41	−.74	.41	.33
MMPI-PD	.53	.40	.39	.62	−.73	.46	—	−.33	.28	.21
MPQ-contr	−.45	−.31	−.26	−.39	.46	−.73	−.38	—	−.38	−.32
SSS-BS	.21	.15	.12	.23	−.28	.35	.24	−.40	—	.39
SSS-Dis	.27	.16	.09	.24	−.22	.36	.12	−.37	.37	—

Note. Sample 1 ($N = 541$) correlations above diagonal, Sample 2 ($N = 463$) correlations below diagonal. ALC Problems = sum of alcohol problem counts from the Semi-structured Assessment for the Genetics of Alcoholism (SSAGA), MARJ Problems = sum of marijuana problem counts from the SSAGA, Other Drug Problems = sum of other drug problem counts from the SSAGA, CDASPD = sum of problem counts for conduct disorder and antisocial personality disorder from the SSAGA, CPI-Soc = Socialization scale from California Psychological Inventory, EYS-Imp = Impulsivity scale from Eysenck Impulsivity-Venturesomeness test, MMPI-PD = Psychopathic Deviate scale form Minnesota Multiphasic Personality Inventory-2, MPQ-Contr = Control subscale from Multidimensional Personality Questionnaire, SSS-BS = Boredom Susceptibility scale from the Sensation Seeking Scale, SSS-Dis = Disinhibition scale from the Sensation Seeking Scale. All correlations are statistically significant at $p < .05$.

Sample 1 Model Comparisons

Table 3 displays the fit statistics and indices associated with the one-, four-, and five-factor models in Sample 1. As is indicated by its more negative BIC value and lower AIC value, the hierarchical four-factor model of impulsive sensation seeking, antisociality/unconventionality, externalizing problems, and behavioral disinhibition provided the best comparative fit among the models.[4] In addition, the RMSEA score of the hierarchical four-factor model indicated a reasonable error of approximation. The CFI score also suggested good fit, indicating more than 96% of the covariation in the data was reproduced by the four-factor model.

Figure 1 shows path weights (single arrows) of three sets of endogenous indicators for impulsive sensation seeking, antisociality/unconventionality, and externalizing problems as well as the path weights for the three subfactors from the behavioral disinhibition

4. Although the approach for modeling the disinhibited personality scales and lifetime problem counts was guided by conceptual or theoretical arguments, or both (i.e., confirmatory approach), one could argue that an exploratory approach is an appropriate alternative or complement. To address this concern, two exploratory approaches were used to investigate other possible structures of the personality scales and lifetime problem counts. The first approach used principal components analysis with oblique (Oblimin) rotation to identify two factors (via visual examination of the scree plot and Eigenvalues > 1.0) that explained 60%–64% of the variance across the two samples. The first factor was comprised of lifetime CDASPD, alcohol, marijuana, other drug problem counts, as well as the MMPI-PD and CPI-Soc scales; the second factor was comprised of the MPQ-Control, EIV-Imp, SSS-BS, and SSS-Dis scales. When analyzed in a latent variable framework, this correlated two-factor structure demonstrated poorer model-specific (RMSEA $> .12$, CFI $< .91$) and relative fit (ΔBIC > 10) than the hierarchical four-factor model examined using confirmatory analyses. The second exploratory approach used exploratory two-factor model specification searches (i.e., all possible indicator-factor combinations are analyzed—where 10 indicator variables and two latent variables yield 1,048,576 possible models). The searches produced inconsistent models across the two samples (likely due to sensitivity to smaller effects in these larger samples) as well as poorer model-specific and relative fit than the hierarchical four-factor model analyzed using the confirmatory approach. As a result of the poorer fit and inconsistent pattern of results for the exploratory approaches, and in keeping with the a priori conceptual rationales guiding the approaches to modeling the personality scales and lifetime problem counts, only the results of the confirmatory analyses are presented and discussed in the body of the report. Interested readers are invited to contact the first author regarding the specific findings (e.g., factor loadings) of the exploratory analyses.

Table 3

Four-Factor Hierarchical Model of Disinhibited Personality Traits and Externalizing Problems Provides Best Fit Across Samples 1 and 2

|	χ^2	df	RMSEA	CFI	BIC	AIC
			Fit Statistics and Indices			
Sample 1 ($N = 541$)						
One-factor model	405.14*	32	.147	.854	203.75	341.14
Four-factor model	115.05*	29	.074	.966	− 67.46	57.05
Five-factor model	339.68*	32	.133	.880	138.29	275.68
Sample 2 ($N = 463$)						
One-factor model	434.17*	32	.165	.832	237.76	370.17
Four-factor model	95.85*	29	.071	.972	− 82.14	37.85
Five-factor model	351.76*	32	.147	.867	155.35	287.76

Note. RMSEA = Root Mean Square Error of Approximation; CFI = Comparative Fit Index; BIC = Bayesian Information Criterion; AIC = Akaike Information Criterion. Lower RMSEA indicates better closeness of fit for each model in relation to its own degrees of freedom. CFI above .90 indicates good fit (i.e., covariation in the data is reproduced by the model). Lower (i.e., more negative) BIC scores and lower AIC scores indicate better comparative fit.
*$p < .05$.

superfactor (all $p < .05$). The expected pattern of covariation between the residual terms of the substance use indicators was found. The correlations for the residual terms of the substance use indicators are illustrated by the double arrows among the residual terms (small circles) in Figure 1.

Sample 2 Model Comparisons

Table 3 also displays the fit statistics and indices associated with the one-, four-, and five-factor models in Sample 2. As is indicated by its more negative BIC value and lower AIC value, the hierarchical four-factor model of impulsive sensation seeking, antisociality/unconventionality, externalizing problems, and behavioral disinhibition provided the best comparative fit among the models. In addition, the RMSEA score of the hierarchical four-factor model indicated a reasonable error of approximation. The CFI score also suggested good fit, indicating more than 97% of the covariation in the data was reproduced by the four-factor model. These results replicate
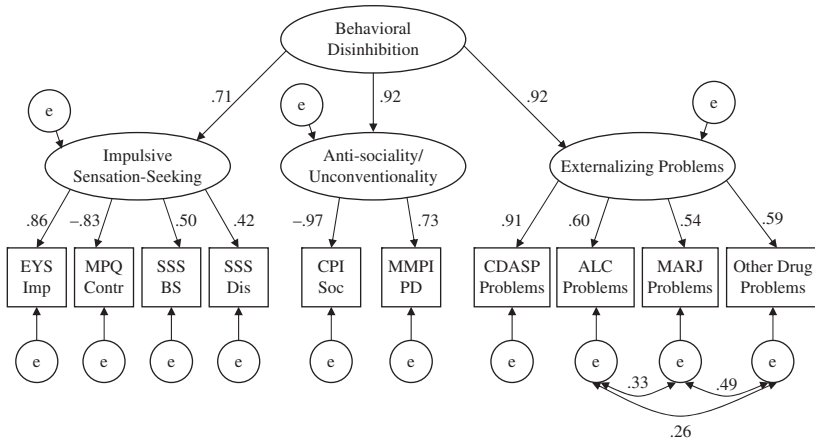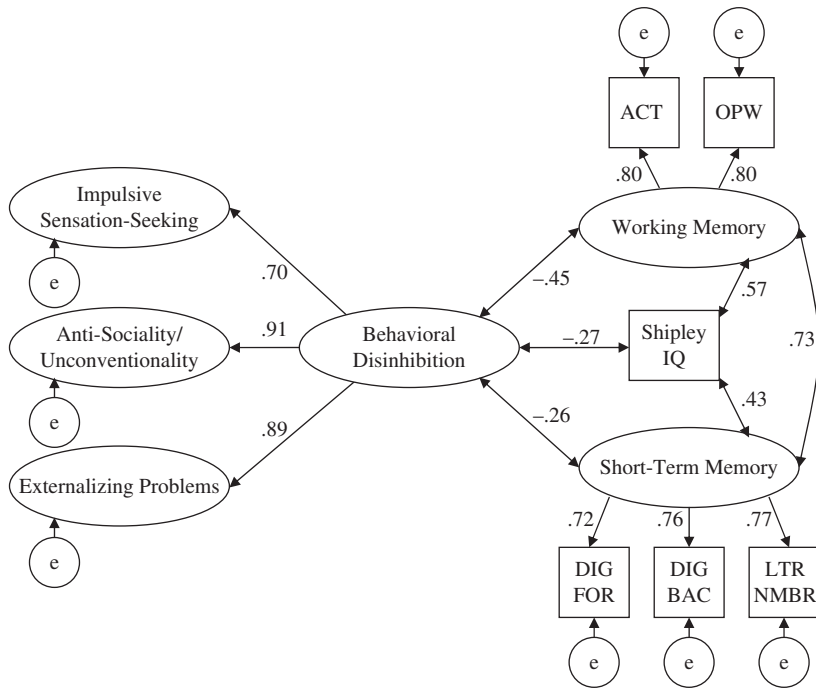
Figure 1

Hierarchical four-factor structure of disinhibited personality traits and externalizing problems for Sample 1 ($N = 541$). EYS-Imp = Impulsivity scale from Eysenck Impulsivity-Venturesomeness test, MPQ-Contr = Control subscale from Multidimensional Personality Questionnaire, SSS-BS = Boredom Susceptibility scale from the Sensation Seeking Scale, SSS-Dis = Disinhibition scale from the Sensation Seeking Scale, CPI-Soc = Socialization scale from California Psychological Inventory, MMPI-PD = Psychopathic Deviate scale form Minnesota Multiphasic Personality Inventory-2, CDASPD = sum of problem counts for conduct disorder and antisocial personality disorder from the Semi-structured Assessment for the Genetics of Alcoholism (SSAGA), ALC problems = sum of alcohol problem counts from the SSAGA, MARJ Problems = sum of marijuana problem counts from the SSAGA, Other Drug Problems = sum of other drug problem counts from the SSAGA. All paths (single-arrowed lines) and correlations (double-arrowed lines) are statistically significant ($p < .05$).

the findings from Sample 1, which also indicated the comparative superiority of the hierarchical four-factor model.

Sample 2 Correlated Model of Behavioral Disinhibition and Cognitive Capacity

Figure 2 shows the path weights of impulsive sensation seeking, antisociality/unconventionality, and externalizing problems from the behavioral disinhibition superfactor (all $p < .05$). The initial correlated model from the hierarchical four-factor model to the cognitive capacity variables designated bidirectional paths from

Figure 2
Final correlated model of Behavioral Disinhibition and the cognitive
capacity constructs for Sample 2 ($N = 463$). ACT = Auditory Consonant
Trigram score, OPW = Operation Word Span score, DIG FOR = WAIS-R
digits forward score, DIG BAC = WAIS-R digits backward score, LTR
NMBR = WAIS-III letter–number sequencing score. All paths (single-
arrowed lines) and correlations (double-arrowed lines) are statistically
significant ($p < .05$).

the higher-order behavioral disinhibition factor to IQ, short-term
memory, and working memory, $\chi^2(93, N = 463) = 195.39$, $p < .05$,
RMSEA $= 0.05$, all of which resulted in significant correlations
($p < .05$). Three subsequent models examined bidirectional paths
from the residual terms of the three subfactors (i.e., impulsive sen-
sation seeking, antisociality/unconventionality, and externalizing
problems) to the cognitive capacity variables. None of these mod-
els resulted in statistically significant correlations ($rs = .01$ to $-.11$,
all $p > .05$). As a result, the final predictive model depicted in Figure
2 excludes these nonsignificant paths. The final model shows that

increased behavioral disinhibition, as indicated by impulsive sensation seeking, antisociality/unconventionality, and externalizing problems, is associated with reduced cognitive capacity in the forms of reduced working memory capacity, lower IQ, and reduced short-term memory capacity.

DISCUSSION

The goal of the present research was to evaluate a self-regulatory model of behavioral disinhibition in late adolescence/early adulthood. Two large samples were administered multiple personality scales assessing impulsive, norm-violating, and sensation-seeking tendencies (i.e., disinhibited personality traits) and were assessed for externalizing problems. Structural modeling identified a hierarchical four-factor structure of impulsive sensation seeking, antisociality/unconventionality, externalizing problems, and a higher-order superfactor of behavioral disinhibition across both samples. Furthermore, a negative association between behavioral disinhibition and multiple domains of cognitive capacity was found, including IQ and indicators of short-term memory and working memory. The approach used in the current study augments the burgeoning literature examining psychopathology using continuous models of problems and symptoms by incorporating components of the larger system of self-regulatory influence that are known to be integrally related to behavioral disinhibition, namely, disinhibited personality traits and executive cognitive capacity.

The hierarchical four-factor structure of disinhibited personality traits and externalizing psychopathology found in the present research conforms to previous research on the etiology of these traits and problems (Krueger et al., 2002). Although these traits and problems have been shown to share a component of additive genetic influence, it also has been shown that the traits (measured as constraint) retain a substantial component of unique additive genetic influence. The modeling of the current research reflects these findings in the parsing of the various indicators as distinguishable factors of impulsive sensation seeking, antisociality/unconventionality, and externalizing problems.

The finding of the divisibility of impulsive/sensation seeking and antisocial traits also supports, in part, previous research on the lower order structure of the personality trait domain of Conscientiousness

(Roberts et al., 2005) as well as theoretical positions and empirical evidence related to the division and content of the scales used in the present study. Specifically, narrative and factor-analytic depictions of the content of the CPI-Socialization and MMPI-2 Psychopathic Deviate scales converge on a description of these scales as assessing a heterogeneous pattern of alienated, antisocial, and norm-violating tendencies (Almagor & Koren, 2001; Gough, 1994), whereas Reinforcement Sensitivity Theory suggests the cluster of approach-oriented, disinhibited, and undercontrolled traits assessed via the MPQ-Control, EIV-Impulsiveness, SSS-Boredom Susceptibility, and SSS-Disinhibition scales represents a coherent domain (Pickering & Gray, 1999). The antisociality/unconventionality and impulsive sensation-seeking factors identified in the current research reflect these perspectives and provide some support for the separation of disinhibited traits along these two dimensions.

Although the structure of the subfactors represents a defensible division of related disinhibited tendencies, the results of the correlation analyses in Sample 2 point to the important role of a behavioral disinhibition superfactor in an account of reduced cognitive capacity in the forms of working memory, short-term memory, and IQ. These results suggest that it is not any of the subfactors per se that is significantly related to the cognitive capacity outcomes, but the covariation among the subfactors. Consistent with Iacono et al.'s (1999) view of behavioral disinhibition as a generalized risk factor for various problems and disorders, the current research shows that it is a broad disposition of behavioral disinhibition that is associated with reduced working memory and short-term memory capacity, as well as lower IQ.

Keeping in mind the self-regulatory influence of working memory, the implication of this relation is that being behaviorally disinhibited means, in part, having a decreased capacity to keep something in mind (e.g., a behavioral norm) while being required to monitor and make decisions about the environment (e.g., a situational distraction that might interfere with keeping a behavioral norm in mind). Greater behavioral disinhibition increases the likelihood of an individual experiencing reduced capacity in his or her ability to retain sufficient attentional control to mitigate the influence of persistent distractions. An individual with greater behavioral disinhibition also is more likely to have reduced attentional capacity as well as lower general cognitive ability.

More generally, the structural and correlated modeling results suggest behavioral disinhibition (1) is a coherent global dispositional tendency, with strongly related components and manifestations; (2) demonstrates a global pattern of relations to three interrelated components of cognitive capacity; and (3), via its pattern of relations to the cognitive capacity constructs, provides a useful depiction of a larger system of self-regulatory influences, one which recognizes that cognitive capacity, disinhibited personality traits, and externalizing psychopathology are mutually informing and reinforcing.

Limitations and Conclusions

The current research is not without limitations and caveats. Primary among them is its cross-sectional design. The analyses in Sample 2, in particular, do nothing to establish the predictive primacy of behavioral disinhibition or cognitive capacity. The predictive status that might be afforded these domains requires a longitudinal design. Such a design would (1) better account for cumulative development and transactions among disinhibited personality traits, externalizing psychopathology, and cognitive capacity and (2) establish the predictive ordering of one or more sets of these constructs—assuming such an issue proves relevant. In addition to the limitation of a cross-sectional design was the targeted sampling scheme used in the current study. Although the sampling procedure was successful in recruiting disinhibited individuals, the resulting samples do not reflect the prevalence of these trait levels or problems in a ''natural'' population. A large-scale, population-based longitudinal design would be better suited to establish a more precise structure as well as better estimates of the magnitude of the relations within that structure.

A second limitation concerns the network of individual difference constructs appropriate for inclusion in a depiction of relevant self-regulatory factors underlying behavioral disinhibition. Although somewhat more comprehensive than most previous research investigating aspects of behavioral disinhibition, the assessment of disinhibited personality traits, externalizing psychopathology, and cognitive capacity in the current research does not provide full coverage of the self-regulatory influences underlying behavioral disinhibition. Additional relevant individual differences factors include

agreeableness, hostility/irritability/trait anger, neuroticism, and negative affect/emotionality, among others (Bettencourt, Talley, Benjamin, & Valentine, 2006; Elkins, King, McGue, & Iacono, 2006; Ohannessian & Hesselbrock, 2008). Similarly, the current study did not incorporate an appetitive or incentive (i.e., reward) structure or component to the cognitive tasks. Unlike the Iowa gambling task (Bechara et al., 1994), for example, the short-term memory and working memory tasks are not designed to assess or account for the influence of appetitive influences that call on self-control for optimal performance. The inclusion of such tasks would undoubtedly aid in a more contextualized understanding of the relationship between cognitive capacity and behavioral disinhibition. Moreover, in any modeling of factors affecting the expression of any observable psychological features, one must also take into account the interplay of genetic and environmental influences. The above concerns do not invalidate the approach or findings of the present research so much as call attention to the array of influences underlying behavioral disinhibition—most of which could not possibly be assessed in a single design but which deserve further integration so as to arrive at a better understanding of the self-regulatory substrata of behavioral disinhibition.

In spite of the limitations, the results of the studies suggest three important trends. First, across two samples, a dimensional approach to behavioral disinhibition yielded a structure of impulsive sensation seeking, antisociality/unconventionality, and externalizing problems, with a behavioral disinhibition superfactor, that reflects the empirical and conceptual rendering of these tendencies found in diagnostic interviews and manuals, the findings of etiologic and factor-analytic research, and long-standing theoretical perspectives. Second, the behavioral disinhibition superfactor, but not the subfactors, was directly associated with reduced cognitive capacity in the forms of IQ, short-term memory, and working memory, revealing the global relations of this broad disposition. This second trend resulted from the finding that it was the covariation among the three lower order latent indicators (represented as the behavioral disinhibition superfactor) that was related to cognitive capacity rather than the indicators themselves. Third, and more broadly, the integration of disinhibited personality traits, externalizing problems, and cognitive capacity illuminates a larger system of interrelated self-regulatory influences underlying behavioral disinhibition—one of the most individually and interpersonally problematic patterns of behavioral expression.

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