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Developing and Validating a Definition of Impulsive/Reactive Aggression in Youth

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Abstract

Objective: To develop a rational, data-driven definition of impulsive/reactive aggression and establish distinctions between impulsive/reactive aggression and other common childhood problems.

Method: Secondary analyses of data from Assessing Bipolar: A Community Academic Blend (ABACAB; $N=636$ ages 5-18; Youngstrom et al., 2005), Stanley Medical Research Institute

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($N=392$ ages 5-17; Findling et al., 2005), and the Longitudinal Assessment of Manic Symptoms (LAMS; $N=679$ ages 6-12) studies, which recruited youths seeking outpatient mental health services in academic medical centers and community clinics. Following Jensen et al.'s (2007) procedure, three judges independently rated items from several widely-used scales in terms of assessing impulsive/reactive aggression. Principal components analyses (PCA) modeled structure of the selected items supplemented by items related to mood symptoms, rule-breaking behavior, and hyperactivity/impulsivity to better define the boundaries between impulsive/reactive aggression and other common childhood symptoms.

Results: In the rational item selection process, there was good agreement among the three experts who rated items as characterizing impulsive/reactive aggression or not. PCA favored five dimension solutions in all three samples. Across all samples, PCA resulted in rule-breaking behavior, aggression-impulsive/reactive (AIR), mania, and depression dimensions; there was an additional hyperactive/impulsive dimension in the LAMS sample and a self-harm dimension in ABACAB and Stanley samples. The dimensions demonstrated good internal consistency; criterion validity coefficients also showed consistency across samples.

Conclusions: This study is a step toward developing an empirically-derived nosology of impulsive aggression/AIR. Findings support the validity of the AIR construct, which can be distinguished from manic and depressive symptoms as well as rule-breaking behavior.

Keywords

aggression; impulsivity; children and adolescents

Aggression is highly impairing: It is distressing to the targets, disruptive in classrooms, and frustrating and stressful to parents. It is the leading cause of referrals to outpatient mental health, as documented by oppositional defiant disorder (ODD; Rettew, Lynch, Achenback, Dumenci, & Ivanova, 2009) and disruptive behavior disorders (DBD) being the most common diagnoses in child and adolescent clinics (Gadow, Sprafkin, & Nolan, 2001; Loeber, Burke, Lahey, Winters, & Zera, 2000; Merikangas et al., 2011), and higher Externalizing problem scores than Internalizing in most clinical settings (De Los Reyes et al., 2011; Youngstrom, Loeber, & Stouthamer-Loeber, 2000). Poorly managed aggressive behavior is also the most costly behavioral health issue; it becomes progressively more treatment resistant, and it is associated with tremendous costs to society in terms of crime, property damage, adjudication, and incarceration (Foster & Jones, 2005; Zagar, Grove, & Busch, 2013).

At the same time, aggression is not specific to a single diagnosis (American Psychiatric Association, 2013; Jensen et al., 2007). Recent research has documented the multiple neural circuits potentially leading to aggression, and suggests distinctions in processes that may differentiate etiology, course, and treatment response (Fairchild et al., 2015; Oades et al., 2008; Raine, 2002; Sterzer, Stadler, Poustka, & Kleinschmidt, 2007; Verona & Bresin, 2015). The Research Domain Criteria (RDoC) (Cuthbert & Insel, 2013; Insel et al., 2010) approach is recasting research on dimensional constructs that have linkages established between different levels of analysis, such as genes, specific brain regions and circuits,

animal models, and measures of human neurocognitive performance as well as behavior and clinical symptoms.

Categorical, diagnosis-oriented approaches to aggression have understandably concentrated on the DBDs – ODD, conduct disorder (CD), and intermittent-explosive disorder (Coccaro, 2012; Foster & Jones, 2005; Pederson & Fite, 2014; Turgay, 2004). In addition, much work has examined the association between attention-deficit/hyperactivity disorder (ADHD) and impulsive aggression (Connor, Chartier, Preen, & Kaplan, 2010; Oades et al., 2008; Turgay, 2004). More recently, considerable attention has been devoted to exploring the boundaries and connections between mood disorder and aggression (Biederman et al., 2003; Leibenluft, 2011; Spencer et al., 2001). The new DSM-5 diagnosis of disruptive mood dysregulation disorder (DMDD; American Psychiatric Association, 2013) and studies using the research definitions of severe mood dysregulation also are efforts to clarify diagnostic boundaries and translate assessment of different aggression phenotypes into clinically actionable formulations. Longitudinal studies suggest a potential trajectory connecting oppositional behavior/ODD with later depression (Burke, 2012; Burke, Hipwell, & Loeber, 2010; Copeland, Shanahan, Costello, & Angold, 2009; Pardini & Fite, 2010; Stringaris & Goodman, 2009a). And factor analyses of ODD symptoms indicate that the symptoms are not unidimensional, but rather linked to two or three distinct components (Burke et al., 2010; Stringaris & Goodman, 2009b). Working within the DSM criteria, Stringaris & Goodman (2009a, 2009b) proposed a three-dimensional model of ODD including irritability, hurtful, and headstrong dimensions, which was supported by confirmatory factor analysis (CFA; Aebi, Plattner, Metzke, Bessler, & Steinhausen, 2013; Stringaris & Goodman, 2009b). Althoff and colleagues (2014) took a slightly different approach conducting a latent class analysis (LCA) on the 5 items of the oppositional defiant problems subscale of the Child Behavior Checklist (CBCL) yielding a no/low symptoms, high symptoms, high defiance/low irritability, and low defiance/high irritability classes. These investigators have found that irritability dimensions of ODD tend to be associated with mood disorders and anxiety, while headstrong/hurtful dimensions are associated with conduct disorder/violence/delinquency concurrently or in adulthood (Aebi et al., 2013; Althoff et al., 2014; Stringaris & Goodman, 2009a; Stringaris, Zavos, Leibenluft, Maughan, & Eley, 2012). Other work has shown that irritability (a commonly identified dimension of ODD) is a sensitive but not diagnostically specific feature of either mood disorders or DBDs (Goldstein et al., 2017). Each of these studies provides support for multiple dimensions of aggression, but limited CFA or LCA analyses to symptoms of ODD. Including symptoms of mood disorders (and conduct problems) in such analyses might allow for clearer delimitation of the boundaries between mood symptoms and disruptive behavior. Further, the necessary reliance on consistent sets of criteria along with backward compatibility with prior definitions militates towards incremental progress, whereas the transdiagnostic perspective might benefit from a more fundamental re-evaluation.

Dimensional approaches to understanding maladaptive behaviors also have a long and fecund history. One of the most extensively studied and well known frameworks is the Achenbach System of Empirically Based Assessment (ASEBA; Achenbach, 2000). Several thousand peer-reviewed papers use versions of the ASEBA (Achenbach, 2000). Its influence is even more extensive in that there are competing measures that often closely correspond in

terms of item content and syndromes assessed (Conners, 2008; Reynolds & Kamphaus, 2015).

The ASEBA and similar frameworks differ fundamentally from the DSM and ICD in that they rely on statistical algorithms for grouping the symptoms based on patterns of covariation, rather than experts organizing the symptoms on the basis of clinical experience or theory (Lengua, Sadowski, Friedrich, & Fisher, 2001). Achenbach used principal components analysis (PCA) with rotation to simplify the structure and help assign items to distinct scales, organizing caregiver, youth, and teacher report of similar symptoms into eight clinical syndrome scales (Achenbach, 1993). PCA differs from factor analysis in that it is a descriptive technique that does not make a strong assertion about the covariation being driven by a latent variable (Fabrigar, Wegener, MacCallum, & Strahan, 1999; James, Witten, Hastie, & Tibshirani, 2013), consistent with the philosophical dustbowl empiricism in which the ASEBA tradition is rooted. Others have rationally carved subsets of items from ASEBA's CBCL, including distinguishing between overt and covert externalizing behaviors (Tiet, Wasserman, Loeber, McReynolds, & Miller, 2001). Further, others have found that the CBCL's empirically defined dimensions do not always align with their nosological categories (Becker & Langberg, 2013; Lengua et al., 2001), highlighting the importance of combining rational and empirical approaches to assessing psychopathology.

Jensen et al. (2007) took such a combined approach to assess the validity of impulsive aggression as a clinical construct. Three experts reviewed the items from the CBCL and other measures of maladaptive behavior including the General Behavior Inventory, the Young Mania Rating Scale, the Aberrant Behavior Checklist, and the Nisonger Child Behavior Rating Form and rated whether they assessed impulsive aggression (interrater agreement ranged from .73 to 1.00; see Jensen et al.'s supplemental materials). The items selected from each measure demonstrated excellent internal consistency and reflected a single latent variable. Key stakeholders (including researchers, clinicians, and patient and family advocates) concluded that impulsive aggression is a significant clinical and public health concern requiring further research.

While impulsive aggression is common and can be highly impairing, it is not well characterized by diagnostic classification systems such as the DSM-5 and ICD-11. The extant literature includes several transdiagnostic approaches to categorizing aggression among youth, some of which categorize aggression by function, into reactive (aggression as a response to a perceived slight) and proactive (in order to achieve a desired aim) aggression. A meta-analysis found that reactive aggression was more strongly associated with internalizing problems, emotional dysregulation and ADHD symptoms, and low prosocial behavior while proactive aggression was more strongly associated with low peer victimization (Card & Little, 2006). The current study builds on Jensen et al. (2007) by employing PCA to define the boundaries of impulsive/reactive aggression (i.e., aggression displayed without premeditation; a construct similar to previous conceptualizations of reactive aggression) and determine whether impulsive/reactive aggression is distinct or an epiphenomenon of mood disorders using data from three samples of youth (recruited from academic medical center- and community-based clinics). These analyses were largely exploratory in nature, but we expected strong agreement among three experts about which

items would be good indicators of impulsive/reactive aggression and that many of these items would load onto a single impulsive/reactive aggression dimension that would be distinct from symptoms of mood disorders. We also expected that this dimension would demonstrate good convergent and discriminant validity (i.e., scores on this dimension would correlate with measures of disruptive behavior and ADHD symptoms but not symptoms of mood disorders).

Method

Participants

This is a secondary analysis of three large de-identified datasets of youth seeking outpatient mental health services. We selected these datasets because they (a) provided detailed diagnostic information derived from semi-structured interviews using highly trained interviewers and methodology that was similar by design; (b) included item-level data on symptoms gathered via widely-used checklists, ensuring linkage to a broad swathe of published literature (Nottelmann, 2001); (c) included rich coverage of mood symptoms by augmenting traditional measures with more detailed questions about mania and depression; and (d) enrolled large numbers of cases with both mood disorders and DBDs, creating sufficient representation to ensure variability in symptoms to improve performance of statistical models grouping items. Supplemental Table 1 provides information about demographics and clinical features across the three samples, as well as effect sizes for differences between them. All three studies were conducted in Midwestern USA.

The Stanley dataset was gathered under the auspices of a grant from the Stanley Medical Research Institute. Families of youths age 5–17 years were recruited by a mix of direct advertising for open clinical trials, local referrals, and referrals of offspring of adults receiving treatment for bipolar disorder at the academic medical center (Findling et al., 2005); the sample was heavily enriched for bipolar disorder both by recruitment for participation in clinical trials, as well as referrals of offspring with bipolar parents from an adult mood disorders program (Findling et al., 2005).

ABACAB (Assessing Bipolar: A Community Academic Blend; NIH R01 MH066647) used the same interviewers and assessment battery to recruit a representative sample of youth (ages 5–18) seeking outpatient mental health services from urban community mental health and from the academic center, at a 3:1 ratio favoring the community. As a result, ABACAB has markedly different demographics, and a referral pattern with less bipolar disorder yet a very high rate of externalizing problems (Youngstrom et al., 2005). The academic sample consisted of families seeking services at Case Western Reserve/University Hospitals of Cleveland; the community sample consisted of families presenting to a large urban community mental health center. Exclusion criteria were not being conversant with spoken English or having a pervasive developmental or cognitive disability. Inclusion criteria were broad to maximize the generalizability of results. The community sample had somewhat lower rates of mood disorders and fewer bipolar spectrum disorders, and high rates of externalizing disorders and ADHD; demographically, it reflected an urban catchment area, with lower SES, and most families being African American (Youngstrom, Halverson, Youngstrom, Lindhiem, & Findling, 2017). Because it formed roughly $\frac{3}{4}$ of the total sample

gathered during that R01, the ABACAB sample includes an exceptional number of low income families.

The third sample, LAMS (Longitudinal Assessment of Manic Symptoms) was a multi-site study (R01MH073967, R01MH073801, R01MH73953, and R01MH073816) which prospectively followed a diagnostically heterogeneous cohort of youths age 6–12 years at study incept recruited from nine clinics affiliated with four different research institutions. The sampling strategy invited all participants showing elevated symptoms of mania (operationally defined as a score of 12+ on the Parent General Behavioral Inventory, 10 Mania items (PGBI-10M)), regardless of current diagnosis. The LAMS sample was augmented by a sample of low scorers matched on demographic characteristics at a 1:10 recruitment rate (Horwitz et al., 2010).

These three projects included interdigitated sets of investigators and used a common core of diagnostic methods, yet they differ substantially in enrollment patterns, geographic coverage, and demographic and clinical characteristics, creating a strong test of external validation (Konig et al., 2007; Youngstrom et al., 2017).

Diagnoses

All diagnoses used versions of the Kiddie Schedule for Affective Disorders and Schizophrenia completed by highly trained raters interviewing the parent and youth sequentially (see Supplement for study specific details).

Measures

The supplemental materials include general details about measures and psychometrics. Specific considerations for the present study are detailed below.

Indicators for Components.—The Stanley and ABACAB samples both used the Achenbach Child Behavior Checklist (CBCL; Achenbach & Rescorla, 2001) as the broad measure of pathology, supplemented with the parent-rated version of the General Behavior Inventory (PGBI; Youngstrom, Findling, Danielson, & Calabrese, 2001) for in-depth coverage of hypomanic and depressive symptoms. We selected subsets of these items as indicators of manic, depressive, and two types of aggressive behavior: impulsive/reactive and rule-breaking (details below). The LAMS protocol used the Child and Adolescent Symptom Inventory (Gadow & Sprafkin, 1994) instead of the CBCL, and used the 10M short form of the PGBI. We rationally selected items for both types of aggression, as well as for hypomania and depression. The CASI also includes all eighteen DSM symptoms of ADHD, making it possible to include indicators for a hyperactive/impulsive component (whereas the CBCL only assesses inattention).

Criterion Validity Indicators.—To evaluate the convergent and discriminant validity of the different components, we selected demographic and clinical characteristics that were available based on similar methods in at least two of the three samples. In addition to age, race, and sex, these included the presence of particular diagnoses (based on the KSADS) as well as severity of manic and depressive symptoms (based on interview), family history of

bipolar disorder, global assessment of functioning, and family functioning and conflict. See supplement and Results for details.

Statistical Analyses

Identification of the items indicating impulsive aggression construct.—

Following the procedure used in Jensen (2007), we pulled together all of the items on the measures available in the archival data sets and had three licensed clinician judges independently rate each item in terms of whether it assessed impulsive aggression, using a four-point scale from 0 – *not at all* to 3 – *definitely, a good indicator*. These ratings became the input for an LCA evaluating a two class solution, grouping the items as relevant or not relevant as indicators of the construct. The approach is an application of the missing gold standard methodology (Pepe, 2003) and represents a class use of LCA (McCutcheon, 1987).

Scale development and psychometrics.—The item set defined by the LCA then underwent exploratory factor analysis (EFA) in each of the datasets, with the goals of identifying whether the items reflected one or more dimensions, as well as examining whether any rationally selected items show weak empirical associations with the dimension.

Of note, the analysis also needed to include indicators of other constructs in order to both (a) define associated features, and (b) to define boundaries and establish distinctions between the newly identified dimension and other dimensions. To this end, we performed additional PCAs and EFAs where we seeded the item set with indicators of other constructs. One of the primary aims of these analyses was to determine the boundaries between impulsive/reactive aggression and depression and mania. The datasets had a rich set of indicators for these, including the mania and depression sections of the CASI, as well as the PGBI. We chose to use the 10 item mania scale, and 10 item depression scale (Youngstrom, Van Meter, Frazier, Youngstrom, & Findling, 2018) to maximize the overlap across samples. Additionally, based on Stringaris's example (2009b) and other's analyses of the symptoms related to ODD, we included items related to *irritability* (including items drawn from the mania and depression sections of the CASI and the PGBI) as well as items related to *headstrong* (see Tables 1S, 1A, 1L for list of items). We also included additional items related to *rule-breaking behavior* (drawing from the conduct problems section of the CASI, the Aggressive Behavior and Rule-Breaking scales of the CBCL) even though we did not consider these items indicators of our target construct. Feeding additional items to the rule-breaking dimension could improve its definition, as well as clarify whether there are groups of cases characterized by elevations in just impulsive aggression, just *rule-breaking behavior*, or both.

The item set supplemented with items related to dimensions described above was also submitted to PCA and EFA, because it was unclear whether three dimensions—as found in Stringaris and Goodman's (2009b)—would suffice when more indicators were available. We used the ensemble of the most accurate methods – scree plot (to visually identify a clear step in the size of the eigenvalue), Glorfeld's extension of parallel analysis (components are interpreted if larger than the 95th percentile of an empirical distribution of simulated junk data with the same number of indicators and cases), and identification of the solution with the minimum average partials (an indication that the solution may account for all of the

reliable covariance among indicators), to establish dimensionality (Ruscio & Roche, 2012). We then evaluated the criterion validity of the dimensions, using correlations with demographics, consensus KSADS diagnoses, and well-characterized checklist scores as the criterion variable. Regressions used the criterion variables to predict each dimensional score to identify which predictors showed significant incremental associations (reported as part correlations). A flow chart of data selection and analysis steps can be found in Supplemental Figure 1.

Missing Data Analyses

For the Stanley sample, 6% of cases had some missing data from the selected items for the PCA. Missingness with these data was unrelated to all other study variables. Overall, 59% of cases had missing data on 1 study variables, with family history (due to families not completing the supplemental interview) and CBQ and FAD (due to protocol changes) being the three main sources of missing data. At the data point level, the Stanley data still were 93.8% complete. Participants who were male or African-American as well as those who had a diagnosis of CD, ODD, or ADHD were more likely to have missing data than others. ABACAB had no missing data on items selected for the PCA. However, 15% of participants were missing data on criterion variables. Participants who were female, older in age, or had a diagnosis of bipolar disorder were more likely to have missing data compared to others. Only 4% of cases in LAMS had missing data on any study variable. Participants with higher scores on the PGBI mania scale or a CD diagnosis were more likely to have missing data than others. Analyses used list-wise deletion. Sensitivity analyses (for criterion and discriminative validity) used propensity scores (Guo & Fraser, 2010) built with clinical and demographic variables as well as study variables to examine whether those that had any missing data differed from those that were used in the analyses.

Results

Demographic and Clinical Descriptive Statistics

All three samples had more male than female youths (see supplemental Table 1). The LAMS sample was markedly younger, with an age range of 6 to 12 years at incept, versus 5 to 18 years for the other two samples. The variance in age was significantly smaller in LAMS, leading to restriction of range that would be expected to attenuate criterion correlations in LAMS. ABACAB families had much lower average income and were much less likely to be white, consistent with the bulk of the families presenting to the urban community health clinic. These differences set up strong tests of generalizability across income and demographic features.

Diagnostically, all three samples had high rates of ADHD (53% to 77%), ODD (24% to 39%), and unipolar depression (18% to 24%). The rate of bipolar disorder was more variable, with Stanley being enriched for it by design (42%), ABACAB having the lowest rate (17% overall), and LAMS having 23% prevalence at baseline. PGBI-10M averages tracked closely with the bipolar disorder rates; family history of bipolar disorder was again highest in the Stanley sample, but the YMRS was higher in LAMS as an artifact of the difference in scoring, with LAMS using the unfiltered, “rate what you see” approach, and

the other two projects only scoring the item if it was in the context of a mood episode. Average CDRS-R scores were around the benchmark for moderate depression (range was $M=31.5$ to 35.4). The average youth was moderately impaired (CGAS $M=53$ to 56) in all three samples. The biggest differences between samples were the Stanley sample tending to have less comorbidity (0.7 to 0.8 fewer diagnoses per youth, $d \sim .5$) and a third of the rate of anxiety disorders found in the other samples. In contrast, ABACAB had higher rates of CD and PTSD, and ABACAB had CBCL Externalizing and Attention Problems scores that were substantially higher than the Internalizing average, whereas in Stanley these averages were all within 2.3 points of each other. The heterogeneity of diagnostic referral patterns and presenting problems creates strong tests of clinical generalizability.

Rational Item Selection

In Jensen et al. (2007), three experts reviewed all of the items in the CBCL and the 73-item version of the GBI, identifying 10 out of 118 items on the CBCL and 7 on the GBI as measuring impulsive aggression (see the Jensen et al. (2007) supplemental materials). We repeated the exercise with three judges in 2018, again using LCA with a two class solution to synthesize the ratings (McCutcheon, 2002) (see supplement for technical details). We then compared the classifications from 2007 and 2018. For the GBI items, two items picked in 2007 were judged extraneous in 2018, and all other items were classified identically, for 97% agreement, $\phi=.83$, $\kappa=.82$. For the CBCL, the initial 2018 ratings added one item (CBCL 15: cruel to animals) and demoted four, agreeing about the rest (96% agreement, $\phi=.70$, $\kappa=.68$). After a consensus meeting, nine of the ten items identified in 2007 were retained, and CBCL item 15 was dropped. For descriptive purposes, this would raise the kappa to .94 between the 2007 and 2018 final pool.

The 2007 ratings did not include the CASI items. The 2018 ratings identified 23 items out of 147 candidates. As a pool, these items tended to be longer than the CBCL items and provide some more sense of context, making the rating process easier and with fewer borderline scores (17 of 23 items receiving the maximum endorsement ratings).

The YMRS also was available across all three data sets, and raters were unanimous in 2007 and 2018 in selecting two of the eleven items as indicators of impulsive aggression (items 5 and 9). However, the YMRS was gathered via interview rather than caregiver report, introducing a source variance factor, and the interviews used different guidelines in LAMS versus the other two protocols, as noted above. Therefore, the YMRS items were not included in the component analyses.

Dimensionality of Rationally Selected Items

Using PCA with a scree plot, MAP, and GHPA, found strong support for a unitary construct within the Stanley and ABACAB rationally selected item pools, which drew from the CBCL and PGBI-10M. The LAMS item pool drew from the ODD, CD, and ADHD sections of the CASI, as well as the PGBI-10M. It had more items selected as conceptually relevant. These items split into two components: rule-breaking behavior and aggression- impulsive/reactive behavior (*AIR*; which included items that Stringaris et al.(2009b) labeled as irritable).

Dimensionality When Rationally Selected Items Were Mixed with Mania and Depression Items

Prior publications have used relatively circumscribed item pools. In order to test the boundaries of the AIR factor with mood symptoms, we augmented the item pool with depression and mania items. We also included the hyperactive/impulsive items, although the CBCL only includes one (its scale is labeled Attention Problems, because the welter of the items is inattentive, not hyperactive), whereas the CASI in the LAMS sample included all nine DSM symptoms. Further, we included rule-breaking behavior items pulled from the Delinquent/Rule Breaking Scale and pathognomonic items on the CBCL, and from the CD section of the CASI.

Analyses in all three samples favored five dimension solutions. Stanley and ABACAB used the same items as inputs and identified highly similar solutions. The LAMS sample used a different set of items, relying on the CASI DSM symptoms instead of the CBCL items. While it also identified five dimensions, one of them (hyperactivity/impulsivity) was clearly different than any obtained from the other two samples using the CBCL items. In LAMS, the five dimensions were rule-breaking behavior, hyperactivity/impulsivity, AIR, mania, and depression. ABACAB and Stanley data yielded very similar solutions each with a depression, AIR, mania, self-harm, and rule-breaking behavior dimension. Tables 1S, 1A, 1L report the item loadings on each dimension after a PROMAX rotation, which we instituted given that these dimensions are likely to be somewhat correlated, in light of the transdiagnostic nature of the constructs and the high observed rates of comorbidity when attempting to classify cases using DSM nosology.

Table 2 displays the correlation between each dimension score and select criterion variables. Of all dimensions, AIR showed the largest correlations with the count of diagnoses for each youth, indicating that it was most associated with comorbidity and a range of diagnoses (all $p < 0.005$ per Steiger's test for dependent correlations, with the exception of the Mania dimension in ABACAB). AIR was also significantly positively correlated with bipolar diagnoses and YMRS ratings, but negatively correlated with unipolar depression in two of three samples, and significantly negatively with CDRS-R scores in ABACAB (though it showed a positive correlation in the unfiltered scoring of the CDRS-R in LAMS). AIR showed medium to large correlations with ODD diagnoses; whereas the rule-breaking dimension showed small and, in ABACAB, non-significant correlations with ODD. The difference in size of correlation with ODD versus CD was highly significant, largest $p < 0.00005$. In contrast, AIR had similar (.15 to .31) correlations with youth CD diagnoses as did the rule-breaking dimension ($r = 0.20$ to 0.37), suggesting that both dimensions play a role in CD, whereas ODD was primarily associated with AIR. AIR was not significantly associated with PTSD, nor with anxiety (showing a small, significant negative correlation in ABACAB); neither was it correlated with substance misuse, albeit the rates of diagnosed substance problems were low in all three samples. AIR showed small but significant correlations with a family history of bipolar disorder across all three samples ($r = 0.08$ to 0.17), but family history consistently showed a significantly stronger correlation with the mania dimension than any other dimension, all $p < 0.05$ except for the depression dimension in LAMS.

In terms of associations with dimensional criteria, AIR showed the largest negative correlations with global functioning of any dimension. It was much more correlated with Externalizing than Internalizing symptoms, but still showed large correlations with Internalizing and Attention Problems, as well as the PGBI10-M (and significantly smaller correlations with the PGBI10-Da). AIR was associated with family functioning and conflict in Stanley, though these did not replicate in ABACAB (which used a different measure of conflict). All of the correlations with dimensional criteria were smaller for the rule-breaking dimension, usually significantly so (but not for the unfiltered administration of the YMRS in LAMS). AIR showed small but significant negative correlations with age, and scores were significantly lower for females in Stanley and ABACAB, but not LAMS.

Regression analyses (see Table 3) found that the combination of age, sex, diagnosis, and mood symptom severity explained 29% to 43% of the variance in AIR scores (versus 20% to 40% in the rule-breaking behavior dimension). Diagnoses of ODD and CD were uniquely and incrementally associated with AIR scores; younger age, bipolar and ADHD diagnoses were also associated with AIR in Stanley and ABACAB, but not LAMS. In contrast, older age was associated with more rule-breaking behavior, with CD being the most strongly associated diagnosis in all three samples. ODD was incrementally associated with rule-breaking in two samples. The mania dimension was most incrementally related to bipolar diagnoses across all three samples, with additional small increments for YMRS scores, and significant residual associations with ODD in ABACAB and Stanley, but not LAMS, as well as unipolar depression, CD, and ADHD in ABACAB, but not in Stanley and LAMS. The depression dimension showed a positive incremental correlation with age and female sex and robust incremental correlations with both unipolar and bipolar diagnoses and CDRS-R scores.

Sensitivity Analyses

A few study variables made significant contributions to the propensity score for the Stanley sample, including any diagnosis of CD, ODD, or PTSD, and lower values on the YMRS and FAD total scores. The only significant predictors of the propensity score for ABACAB included any diagnosis of depression, and for LAMS included any diagnosis of bipolar disorder or CD and higher scores on the PGBI-10M. Covarying the propensity score did not change the direction or size of the criterion correlations in any sample. Propensity scores accounted for an additional 0% to 2.4% of variance across regression models. Simple and part correlations remained similar to two decimal places.

Discussion

This study used rational item selection and secondary data analysis to identify symptoms that characterize impulsive aggression in youth. These analyses expanded upon those described by Jensen et al. (2007) by including mood, hyperactive/impulsive, and conduct items to identify the boundaries between AIR, mood symptoms, and other problems common to youth and by examining such symptoms in samples of youths recruited from both academic medical centers and community clinics. In the rational item selection process, there was good agreement among the three experts who selected items as characterizing AIR

or not. PCA of items identified as characterizing AIR by the experts supplemented by mood, hyperactive/impulsive, and conduct/delinquency items yielded a five-dimension solution in the LAMS, ABACAB, and Stanley samples. Findings support two constructs of aggression/irritability (AIR and rule-breaking behavior), both of which can be distinguished from manic and depressive symptom components, as hypothesized.

Overall, both the PCA results (or corresponding EFA using principal axis factoring extraction) and the criterion validity analyses strongly indicate that AIR is a distinct construct. Its symptoms can be rationally identified *a priori*, and they cohere into a component that is distinct from mania, depression, or rule-breaking behavior. AIR shows consistent and plausible associations with age and sex (consistent with well-established developmental trends; Achenbach & Rescorla, 2001; Steinberg et al., 2008), as well as diagnostic and dimensional criteria. At the same time, it appears to be transdiagnostic, in several senses: (a) the rational item selection and the empirically defined components both pulled items from three or more source scales, (b) AIR showed medium to large correlations with the other dimensions in oblique rotations, (c) AIR showed significant correlations with more diagnoses than did any other dimension, (d) AIR was also the most correlated with the count of diagnoses, an indicator of comorbidity; and (e) AIR showed a large number of significant part correlations – indicating significant incremental associations with each diagnosis or construct—across all three samples. AIR also appears particularly clinically concerning inasmuch as it showed the largest correlations with global impairment, and significant correlations with family functioning and conflict.

All of the rationally selected items loaded on the AIR component in Stanley and ABACAB, pulling items from four different sources: Aggressive Behavior, Rule Breaking Behavior, and Attention Problems on the CBCL, as well as two PGBI10-M items. In LAMS, many of the CD items and most of the augmented research items (CASI category Q) loaded on the rule-breaking behavior component, and the ODD symptoms and a few manic symptoms (e.g., “more irritable or explosive than usual,” “periods of feeling unusually happy when almost everything got on their nerves”) loaded on the AIR component. AIR showed significantly larger correlations with mania than did the rule-breaking behavior component in the Stanley and ABACAB samples, and there was substantial reliable independent variance in each construct across all samples. The criterion validity coefficients also showed consistency across samples.

It is worth noting that these results indicate a strong degree of replication in several respects. First, the analyses span three independent samples that show significant and often large differences in demographics and clinical composition. Thus, the analyses provide a strong test of external validity or geographic transportability (Konig et al., 2007). Second, all three datasets used similar diagnostic interviews to ascertain the same core set of diagnoses. Third, samples were enriched to different degrees to have more bipolar disorder, affording an excellent opportunity to examine associations AIR shared with mood diagnoses and other symptom dimensions. Fourth, we used exploratory methods across all three samples, rather than moving quickly to a confirmatory analytic framework. This choice was motivated by the uncertainty about the composition of the key dimensions, given the diversity of findings in the literature (Jensen et al., 2007; Stringaris & Goodman, 2009a; e.g., whether AIR

symptoms belonged on an irritable mood dimension, a conduct problems dimension, or on a distinct third dimension), as well as the large differences in clinical and demographic characteristics across samples. The fact that such similarity emerged across the three samples when the data were allowed to speak for themselves is striking.

A fifth strength is two-edged. On one hand, the different instrumentation used in LAMS, where the CASI was used instead of the CBCL, provides an opportunity to extend across a larger range of symptoms, and to more directly connect with the DSM nosology. On the other hand, in most instances where results only emerged in two of the three samples, it was Stanley and ABACAB, which both used the CBCL to provide the bulk of the AIR items, that produced consistent results. However, the CASI items map directly to the DSM symptoms, providing a crucial opportunity to extend the nomothetic network of the analyses. The inclusion of the CD and augmented research items clarifies that there are two dimensions of aggressive behavior. Both are important in CD, but the more impulsive one is primarily associated with ODD. The CASI items also were less telegraphic and provided more context than the CBCL items, which made them easier for the judges to rate; that aspect is also likely to influence how caregivers interpret the items when responding. Finally, the CASI was crucial for testing whether AIR is a facet of hyperactive/impulsive behavior, versus being a distinct entity. The CBCL only includes two of the nine DSM hyperactive/impulsive symptoms, consistent with the scale is called “Attention Problems,” with no mention of impulsivity, whereas the CASI includes all of them. This led to differences in the composition of the observed components in LAMS versus the other two samples. It also provided strong evidence that AIR is different than hyperactivity/impulsivity in ADHD.

Limitations and Future Directions

One limitation is that the analyses relied on caregiver report to identify the components and clusters. Future work needs to examine self-report, teacher report, neurocognitive performance, and other sources of information about youth functioning. Caregiver report is a good place to start given its central role in clinical referrals and evaluation, the considerable advantages as a source of information about younger children, and the extensive nomothetic network of validity information accrued for caregiver report on checklists in general and the CBCL in particular. Our analyses also focused on criterion validity markers that were available in at least two of the three samples. Each protocol contains a much more extensive battery of measures, and much can be done to elaborate the validity of the AIR construct; an important next step will be to conduct LCA of AIR scores to empirically define classes of individuals with similar profiles. The value of replication at the outset led to the initial focus on the narrower set of variables. The datasets were all enriched for youth with or at risk for bipolar disorder, which may limit the generalizability of these findings; however, this quality was also a strength in these particular analyses given the primary aim of defining the boundaries between AIR and mood symptoms. Replication in other samples not enriched for bipolar disorder using measures such as the Conners, Vanderbilt, SNAP to augment the CBCL would also likely be informative. Finally, it should be noted that developing a measure of AIR was not the goal of this study and thus the items that loaded onto the AIR dimension should not be taken as such without further psychometric evaluation.

Clinical Implications

This study is a step toward developing an empirically derived nosology of impulsive aggression or AIR, which is not currently captured by established diagnostic frameworks (i.e., DSM and ICD). AIR can be differentiated from mood symptoms as well as rule-breaking behavior. Future analyses will examine whether there are distinct profiles of AIR symptoms. Better characterization of AIR and understanding of its boundaries may lead to improved assessment, treatment, and ultimately outcomes for youth with these symptoms.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1S.

PROMAX rotated loadings in Stanley sample in descending order of size of eigenvalues and loadings (N=392, k=50 items)

Item Content & Scale	1 Depression	2 AIR	3 Mania	4 Self-harm	5 Rule-breaking
<i>Percent Variance (before rotation):</i>	<i>30%</i>	<i>11%</i>	<i>6%</i>	<i>4%</i>	<i>3%</i>
Lacks energy/moves slowly (CBC.102)	.81				
Several days when child was so down that nothing could cheer child up (PGBI.45)	.76				
Several days when child needed more sleep, even having napped (PGBI.05)	.76				
Lost almost all interest in things usually likes to do (PGBI.13)	.75				
Feels depressed/unhappy (CBC.103)	.75				
Days slowed down, couldn't move quickly as usual (PGBI.59)	.74				
Sad/depressed/irritable for several days (PGBI.03)	.74				
Times of sadness/depression when most everything gets on child's nerves or makes child irritable/angry (PGBI.14)	.63				
Long periods when child was down/depressed, with brief periods when mood was normal/slightly happy (PGBI.68)	.62				
Overly tired (CBC.54)	.60				
Long periods when child couldn't enjoy life as easily as other people (PGBI.16)	.59			.39	
Had sad/depressed periods of several days with feeling much more anxious/tense than usual (PGBI.50)	.59				
Periods of several days spending much time brooding about unpleasant things (PGBI.20)	.56				
Assaults people physically (CBC.57)		.93✓			
Unkind/cruel to others (CBC.16)		.86✓			
Makes threats to others (CBC.97)		.85✓			
Fights frequently with others (CBC.37)		.76✓			
Has temper tantrums/short temper (CBC.95)		.75✓			
Damages/wrecks others' property (CBC.21)		.74✓			
Damages/wrecks own property (CBC.20)		.65✓			
Disagrees/bickers (CBC.03)		.64✓			
Extraordinarily loud (CBC.104)		.60✓			
Lack of remorse after acting out/misbehaving (CBC.26)		.55			
Is dishonest/deceives others (CBC.43)		.50			.43
Swears (CBC.90)		.49			.39
Acts impulsively or rash (CBC.41)		.44✓			
Depressed, and struggled to control feelings of rage (PGBI.39)	.41	.43			
Energy generally up or down, rarely in the middle (PGBI.40)		.37	.33		
Periods of feeling unusually happy as well as physically restless (PGBI.04)			.92		
Periods of extreme happiness and intense energy, also more anxious and tense (PGBI.22)			.91		
Periods of extreme happiness where it took >an hour to get to sleep at night (PGBI.31)			.90		
Been told by child's friends that they seem unusually happy/high (PGBI.11)			.88		

Item Content & Scale	1 Depression	2 AIR	3 Mania	4 Self-harm	5 Rule-breaking
<i>Percent Variance (before rotation):</i>	<i>30%</i>	<i>11%</i>	<i>6%</i>	<i>4%</i>	<i>3%</i>
Periods of feeling depressed and other periods of being extremely elated (PGBI.53)			.85		
Periods of feeling unusually happy when almost everything got on their nerves (PGBI.54)			.74		
Times when thoughts came so fast that child couldn't get them all out (PGBI.64)			.64		
Periods feeling unusually happy as well as struggling to control inner feelings of rage (PGBI.27)			.59		
Feelings of restlessness/excessive energy (CBC.10)	-.44		.54		
Mood shifted rapidly from happy to sad or high to low (PGBI.19)			.48		
Guilty (CBC.52)				.68	
Talks about suicide (CBC.91)				.64	
Worthless (CBC.35)				.63	
Several days when felt worthless (PGBI.56)	.50			.52	
Harms self or makes suicide attempt (CBC.18)				.48	
Spends time with others who get into trouble (CBC.39)				.39	.61
Truant (CBC.101)	.34				.61
Steals from places other than home (CBC.82)					.55
Impulsive/disruptive & later knew was poor judgment (PGBI.51)					.39
Enjoys little (CBC.05)					
Cries a lot (CBC.14)					
Breaks rules (CBC.28)					
1 Depression	1.00	.34	.38	.45	.02
2 Aggression – Impulsive/Reactive	.34	1.00	.62	.39	.24
3 Mania	.38	.62	1.00	.40	.15
4 Self-Harm	.45	.39	.40	1.00	.01
5 Rule-breaking	.02	.24	.15	.01	1.00

Note. Loadings <.35 omitted for clarity. Item numbers refer to section on Child Behavior Checklist (CBC) or Parent General Behavior Inventory (PGBI item). AIR=Aggression-Impulsive/Reactive

✓ Indicates an item that the clinical judges selected as a marker of the impulsive aggression/AIR construct.

Table 1A.

PROMAX rotated loadings in ABACAB sample in descending order of size of eigenvalues and loadings (N=636, k=50 items)

Item Content & Scale	1 Mania	2 AIR	3 Depression	4 Self-harm	5 Rule-breaking
<i>Percent Variance (before rotation):</i>	24%	12%	5%	3%	3%
Periods of extreme happiness and intense energy, also more anxious and tense (PGBI.22)	.81				
Periods of feeling depressed and other periods of being extremely elated (PGBI.53)	.78				
Periods feeling unusually happy as well as struggling to control inner feelings of rage (PGBI.27)	.72				
Periods of extreme happiness where it took more than an hour to get to sleep at night (PGBI.31)	.72				
Energy generally up or down, rarely in the middle (PGBI.40)	.72				
Periods of feeling unusually happy when almost everything got on their nerves (PGBI.54)	.72				
Child's mood has shifted rapidly from happy to sad or high to low (PGBI.19)	.72				
Periods of feeling unusually happy as well as physically restless (PGBI.04)	.69				
Times when child felt low/depressed, and had to struggle to control feelings of rage or an urge to smash/destroy things (PGBI.39)	.68				
Been told by child's friends that they seem unusually happy/high (PGBI.11)	.67				
Times when thoughts came so fast that child couldn't get them all out (PGBI.64)	.65				
Had sad/depressed periods of several days with feeling much more anxious/tense than usual (PGBI.50)	.64				
Times of sadness/depression when most everything gets on child's nerves or makes child irritable/angry (PGBI.14)	.56				
Long periods when child was down/depressed, with brief periods when mood was normal/slightly happy (PGBI.68)	.50				
Sad/depressed/irritable for several days without understanding why (PGBI.03)	.44		.35		
Periods of several days spending much time brooding about unpleasant things (PGBI.20)	.40				
Breaks rules (CBC.28)		.76			
Lack of remorse after acting out/misbehaving (CBC.26)		.71			
Is dishonest/deceives others (CBC.43)		.71			
Fights frequently with others (CBC.37)		.70✓			
Damages/wrecks property of others (CBC.21)		.68✓			
Acts impulsively or rash (CBC.41)		.67✓			
Unkind/cruel to others (CBC.16)		.67✓			
Makes threats to others (CBC.97)		.66✓			
Assaults people physically (CBC.57)		.65✓			
Spends time with others who get into trouble (CBC.39)		.63			.40
Steals from places other than home (CBC.82)		.59			
Damages/wrecks own property (CBC.20)		.58✓			
Disagrees/bickers (CBC.03)		.57✓			
Has temper tantrums/short temper (CBC.95)		.51✓			
Feelings of restlessness/excessive energy (CBC.10)		.51			-.36

Item Content & Scale	1 Mania	2 AIR	3 Depression	4 Self-harm	5 Rule-breaking
<i>Percent Variance (before rotation):</i>	24%	12%	5%	3%	3%
Swears (CBC.90)		.49			.45
Extraordinarily loud (CBC.104)		.44✓			
Lacks energy/moves slowly (CBC.102)			.79		
Little enjoyment (CBC.05)			.64		
Overly tired (CBC.54)			.61		
Feels depressed/unhappy (CBC.103)			.55	.38	
Several days when child needed more sleep, even having napped (PGBI.05)			.55		
Days slowed down, couldn't move as quickly as usual (PGBI.59)	.33		.53		
Times couldn't enjoy life as easily as other people (PGBI.16)			.45		
Days when felt worthless (PGBI.56)			.43		
Guilty (CBC.52)			.41		
Times when child lost almost all interest in the things that child usually likes to do (PGBI.13)	.37		.39		
So down that nothing could cheer up (PGBI.45)	.34		.38		
Talks about suicide (CBC.91)				.72	
Harms self or makes suicide attempt (CBC.18)				.60	
Worthless (CBC.35)			.47	.48	
Truant (CBC.101)					.52
Cries a lot (CBC.14)				.35	-.47
Impulsive/disruptive & later knew was poor judgment (PGBI.51)	.37				.44
1 Mania	1.00	.29	.47	.33	.23
2 Aggression – Impulsive/Reactive (AIR)	.29	1.00	-.03	.14	-.09
3 Depression	.47	-.03	1.00	.34	.27
4 Self-Harm	.33	.14	.34	1.00	.36
5 Rule-breaking	.23	-.09	.27	.36	1.00

Note. Loadings <.35 omitted for clarity. AIR=Aggression–Impulsive/Reactive

Item numbers refer to section on Child Behavior Checklist (CBC) or Parent General Behavior Inventory (PGBI item).

✓ Indicates an item that the clinical judges selected as a marker of the impulsive aggression construct.

Table 1L.

PROMAX rotated loadings in LAMS sample, in descending order of size of eigenvalues and loadings (N=634, k=60 items)

	1 Rule- breaking	2 Hyper- impulsive	3 AIR	4 Mania	5 Depression
Item Content & Scale					
Percent Variance (before rotation):	29%	8%	8%	4%	3%
Damages other's ' property (CASI.Q138)	.91✓				
Hits, pushes, or trips (CASI.Q139)	.84✓				
Threatens to hurt others (CASI.Q140)	.82✓				
Engages in physical fights (CASI.Q141)	.81✓				
Throws things at others (CASI.Q134)	.78✓				
Annoys others to provoke them (CASI.Q142)	.76✓				
Curses or teases (CASI.Q137)	.73✓				
Has deliberately destroyed others' property (CASI.C34)	.72✓				
Has been physically cruel to people (CASI.C40)	.72✓				
Smashes/destroys things (CASI.Q135)	.68✓				
Grabs things from others (CASI.Q133)	.66✓				
Starts physical fights (CASI.C31)	.66✓				
Dirty looks or threatening gestures (CASI.Q136)	.63✓				
Used a weapon when fighting (CASI.C38)	.56✓				
Bullies/threatens/intimidates others CASI.C30)	.56✓				
Physically cruel to animals (CASI.C39)	.54✓				
Acts reckless with no concern for safety (CASI.C44)	.44				
Stolen things using physical force (CASI.C36)	.36				
Has difficulty remaining seated (CASI.A11)		.81			
Fidgets with hands, squirms in seat (CASI.A10)		.81			
Seems restless/jittery (CASI.A12b)		.79			
Has difficulty waiting turn (CASI.A17)		.74			
Is on the go/acts as if driven by a motor (CASI.A14)		.74			
Blurts out answers before question completed (CASI.A16)		.72			
Runs about and climbs on things (CASI.A12a)		.71			
Has difficulty playing or doing things quietly (CASI.A13)		.70			
Talks excessively (CASI.A15)		.68			
Is angry/resentful (CASI.B25)			.84✓		
Argues with adults (CASI.B20)			.80✓		
Loses temper (CASI.B19)			.75✓		
Is touchy/easily annoyed by others (CASI.B24)			.74✓		
Defies/refuses what you tell them to do (CASI.B21)			.72		
Blames others for own mistakes (CASI.B23)			.65		
Takes anger out on others/tries to get even (CASI.B26)			.63✓		
Does things to deliberately annoy others (CASI.B22)			.59		

	1 Rule- breaking	2 Hyper- impulsive	3 AIR	4 Mania	5 Depression
Item Content & Scale					
Percent Variance (before rotation):	29%	8%	8%	4%	3%
Periods of feeling unusually happy when almost everything got on their nerves (PGBI.54)			.47	.45	
More irritable/explosive than usual (CASI.L99)			.46✓		
Periods of extreme happiness and intense energy, also more anxious and tense (PGBI.22)				.77	
Been told by child's friends that they seem unusually happy/high (PGBI.11)				.74	
More cheerful than usual (CASI.L98)				.65	
Periods of feeling unusually happy as well as physically restless (PGBI.04)				.62	
Periods feeling unusually happy as well as struggling to control inner feelings of rage (PGBI.27)				.60	
Becomes more active/busy than usual (CASI.L100)				.60	
Periods of extreme happiness where it took > an hour to get to sleep at night (PGBI.31)				.60	
Periods of feeling depressed and other periods of being extremely elated (PGBI.53)				.58	
Child's mood has shifted rapidly from happy to sad or high to low (PGBI.19)			.44	.54	
Change in activity level (CASI.K93)			-.38	.49	
Energy generally up or down, rarely in the middle (PGBI.40)			.41	.48	
Change in ability to concentrate or make decisions (CASI.K94)				.42	
Times when thoughts came so fast that child couldn't get them all out (PGBI.64)		.39		.40	
Change in sleeping habits (CASI.K92)				.38	
Feels worthless/guilty (CASI.K87)					.82
Feels that things never work out (CASI.K90)					.77
Has little confidence (CASI.K89)					.75
Has low energy level (CASI.K88)					.69
Is depressed most of the day (CASI.K84)					.69
Shows little interest in pleasurable activities (CASI.K85)					.67
Talks about death or suicide (CASI.K86)					.60
More sensitive/tearful (CASI.K96)					
Drop in school grades (CASI.K95)					
Rule-Breaking	1.00	.35	.57	.36	.22
Hyper-Impulsive	.35	1.00	.32	.38	.01
Aggression – Impulsive/Reactive (AIR)	.57	.32	1.00	.39	.35
Mania	.36	.38	.39	1.00	.38
Depression	.22	.01	.35	.38	1.00

Note. Loadings <.35 omitted for clarity. AIR=Aggression–Impulsive/Reactive

Item numbers refer to section on CASI or PGBI-10M. In six component solution, five items pull off of the mania factor (decreased need for sleep, cognitive change, change in schoolwork); in 7 component solution, five of the most aggressive items pull off of factor 1.

✓ Indicates an item that the clinical judges selected as a marker of the impulsive aggression construct.

Table 2

Criterion correlations grouped by similar component content for Stanley (S), ABACAB (A), and LAMS (L) samples

Component	AIR	AIR	AIR	Manic	Manic	Manic	Dep	Dep	Self Harm	Self Harm	Hyper	Rule-breaking	Rule-breaking	Rule-breaking
Sample	S	A	L	S	A	L	S	A	S	A	L	S	A	L
Variance (before rotation)	11%	12%	8%	6%	24%	4%	30%	5%	4%	3%	8%	3%	3%	29%
Sex (ref: female)	-.13*	-.17***	.07	-.01	.06	.07	.19***	.22***	-.02	.13**	-.07	-.14*	.13**	-.08
Age	-.23***	-.21***	.07	-.18***	.04	-.01	.31***	.32***	-.02	.18***	-.23***	.27***	.54***	-.04
Race (ref: white)	-.08	-.22***	.11*	-.07	.08*	-.06	-.04	.06	.09	.13**	-.03	-.23***	.08*	-.09*
Number Axis I Diagnoses	.57***	.28***	.27***	.46***	.32***	.18***	.20***	.18***	.31***	.19***	.25***	.17**	.06	.26***
Any mood disorder diagnosis	.43***	-.05	.24***	.39***	.43***	.26***	.59***	.47***	.33***	.36***	.03	.01	.32***	.14***
Unipolar depressive disorder	-.17**	-.18***	.12**	-.28***	.10*	-.02	.42***	.29***	.08	.16***	-.07	.01	.20***	-.05
Bipolar spectrum diagnosis	.57***	.16***	.18***	.62***	.40***	.32***	.21***	.23***	.26***	.19***	.11*	.02	.07	.21***
Any oppositional defiant disorder	.40***	.28***	.36***	.29***	.13**	.03	.00	-.02	.11*	.10*	.15	.11*	-.04	.22***
Any conduct disorder	.24***	.31***	.15***	.08	.14***	.12**	-.10*	-.01	.05	.14***	.13**	.20***	.26***	.37***
Any attention-deficit/hyperactivity	.28***	.45***	.00	.23***	.13**	.06	-.23***	-.15***	.11*	-.18***	.42***	.11*	-.30***	.14***
Any substance misuse	.06	-.01	a	.01	-.02	a	.16**	.00	.00	.05	a	.40***	.17***	a
Any anxiety disorder	.06	-.12**	.00	.02	.11*	.06	.11*	.19***	.15**	.17***	.02	-.12*	.04	-.03
Any posttraumatic stress disorder	.01	.03	.05	.02	.09*	.09*	.13*	.14**	.07	.11**	.07	-.02	.07	.04
GAF/CGAS	-.47***	-.30***	-.24***	-.41***	-.28***	-.23***	-.43***	-.26***	-.36***	-.24***	-.24***	-.17**	-.16***	-.31***
CBCL Externalizing T	.91***	.90***	--	.66***	.40***	--	.37***	.16***	.43***	.29***	--	.37***	.04	--
CBCL Internalizing T	.51***	.28***	--	.44***	.44***	--	.71***	.69***	.62***	.48***	--	.02	.07	--
CBCL Attention T	.52***	.59***	--	.56***	.32***	--	.22***	.29***	.40***	.05	--	.25***	-.22***	--
FAD Total	.13*	.04	--	-.05	.15***	--	.22***	.24***	.17**	.15***	--	.15**	.23***	--

Component	AIR	AIR	AIR	Manic	Manic	Manic	Dep	Dep	Self Harm	Self Harm	Hyper	Rule-breaking	Rule-breaking	Rule-breaking
Sample	S	A	L	A	S	L	A	L	S	A	L	S	A	L
Variance (before rotation)	11%	12%	8%	6%	24%	4%	30%	5%	3%	4%	3%	8%	3%	29%
PGBI 10M	.65***	.38***	.58***	.98***	.96***	.93***	.44***	.36***	.35***	.40***	.23***	.48***	.13*	.42***
PGBI 10Da	.36***	.03***	--	.45***	.80***	--	.96***	.83***	--	.56***	.40***	--	.11*	.42***
YMRS Total	.55***	.19***	.37***	.63***	.46***	.42***	.14*	.24***	.21***	.24***	.23***	.31***	.06***	.36***
CDRS-R Total	.04	-.13**	.30***	.05	.43***	.22***	.69***	.58***	.53***	.30***	.44***	.04	.00	.20***
Family Hx of Bipolar	.17**	.08*	.08*	.27***	.23***	.24***	.09	.10*	.20***	.05	.00	.12**	.05	.07
CBQ Total/Perceived Criticism Scale	.58***	.06	--	.33***	.26***	--	.26***	.23***	--	.29***	.21***	--	.14*	.19***

Note. Coefficients are point-biserial correlations for dummy-coded categorical variables, and Pearson correlations for continuous variables. AIR=Aggression-Impulsive/Reactive; GAF = Global Assessment of Functioning, used in Stanley and ABACAB; CGAS = Children's Global Assessment Scale, used in LAMS; CBCL = Child Behavior Checklist; FAD = Family Assessment Device; PGBI10 = Parent General Behavior Inventory, 10 item short form; CBQ = Conflict Behavior Questionnaire; ABACAB used the Perceived Criticism scale instead.

* $p < .05$,

** $p < .005$,

*** $p < .0005$, two-tailed.

Bold indicates convergent criterion validity correlations, expected to be larger for the indicated component score than the same criterion would show with other component scores.

Table 3

Simple and part correlations looking at unique associations between validating criteria and factor scores across three samples.

	Stanley		ABACAB		LAMS	
Aggression-Impulsive/Reactive	<i>Adj R</i> ² = .43		<i>Adj R</i> ² = .37		<i>Adj R</i> ² = .29	
<i>Predictor</i>	<i>r</i>	<i>r</i> _{part}	<i>r</i>	<i>r</i> _{part}	<i>r</i>	<i>r</i> _{part}
Child age (years)	-.23 ^{****}	-.12 ^{**}	-.21 ^{****}	-.13 ^{****}	.07	.04
Female	-.12 [*]	-.02	-.17 ^{****}	-.01	.08 [*]	.06
Any bipolar spectrum disorder	.57 ^{****}	.49 ^{****}	.16 ^{****}	.10 ^{**}	.18 ^{****}	.03
Any unipolar depressive disorder	-.18 ^{****}	.19 ^{****}	-.18 ^{****}	-.03	.12 ^{**}	.06
ODD as any diagnosis	.41 ^{****}	.21 ^{****}	.28 ^{****}	.25 ^{****}	.36 ^{****}	.34 ^{****}
CD as any diagnosis	.23 ^{****}	.11 ^{**}	.31 ^{****}	.35 ^{****}	.15 ^{****}	.17 ^{****}
ADHD as any diagnosis	.28 ^{****}	.08 [*]	.45 ^{****}	.24 ^{****}	.00	-.07
Anxiety as any diagnosis (most inclusive)	.06	.04	-.12 ^{**}	-.07 [*]	.00	-.05
YMRS Total	.55 ^{****}	.09 [*]	.18 ^{****}	.05	.37 ^{****}	.18 ^{****}
CDRS-R Total	.02	.04	-.13 ^{**}	-.05	.30 ^{****}	.09 [*]
Mania	<i>Adj R</i> ² = .43		<i>Adj R</i> ² = .34		<i>Adj R</i> ² = .19	
<i>Predictor</i>	<i>r</i>	<i>r</i> _{part}	<i>r</i>	<i>r</i> _{part}	<i>r</i>	<i>r</i> _{part}
Child age (years)	-.18 ^{****}	-.07	.04	-.02	.00	-.03
Female	.00	.06	.05	.06	.09 [*]	.06
Any bipolar spectrum disorder	.62 ^{****}	.52 ^{****}	.40 ^{****}	.41 ^{****}	.32 ^{****}	.11 ^{**}
Any unipolar depressive disorder	-.28 ^{****}	.05	.10 [*]	.24 ^{****}	-.02	.02
ODD as any diagnosis	.29 ^{****}	.12 ^{**}	.13 ^{**}	.14 ^{****}	.03	.00
CD as any diagnosis	.07	-.02	.14 ^{****}	.13 ^{****}	.10 [*]	.02
ADHD as any diagnosis	.23 ^{****}	.07	.13 ^{**}	.11 ^{**}	.05	.05
Anxiety as any diagnosis (most inclusive)	.02	.00	.11 ^{**}	.06	.06	.02
YMRS Total	.63 ^{****}	.14 ^{**}	.46 ^{****}	.13 ^{****}	.42 ^{****}	.24 ^{****}
CDRS-R Total	.04	.09 [*]	.43 ^{****}	.19 ^{****}	.22 ^{****}	.03
Depression	<i>Adj R</i> ² = .54		<i>Adj R</i> ² = .36		<i>Adj R</i> ² = .34	
<i>Predictor</i>	<i>r</i>	<i>r</i> _{part}	<i>r</i>	<i>r</i> _{part}	<i>r</i>	<i>r</i> _{part}
Child age (years)	.31 ^{****}	.15 ^{****}	.32 ^{****}	.21 ^{****}	.26 ^{****}	.16 ^{****}
Female	.19 ^{****}	.09 [*]	.21 ^{****}	.10 [*]	.14 ^{****}	.08 [*]
Any bipolar spectrum disorder	.21 ^{****}	.44 ^{****}	.23 ^{****}	.27 ^{****}	.19 ^{****}	.09 [*]

	Stanley		ABACAB		LAMS	
Aggression-Impulsive/Reactive	<i>Adj R</i> ² = .43		<i>Adj R</i> ² = .37		<i>Adj R</i> ² = .29	
<i>Predictor</i>	<i>r</i>	<i>r</i> _{part}	<i>r</i>	<i>r</i> _{part}	<i>r</i>	<i>r</i> _{part}
Any unipolar depressive disorder	.42 ^{****}	.47 ^{****}	.29 ^{****}	.28 ^{****}	.30 ^{****}	.12 ^{****}
ODD as any diagnosis	-.01	.07	-.02	.02	.01	-.01
CD as any diagnosis	-.10 [*]	-.03	-.01	-.06	.03	-.02
ADHD as any diagnosis	-.23 ^{****}	-.09 [*]	-.16 ^{****}	.01	-.09 [*]	-.04
Anxiety as any diagnosis (most inclusive)	.11 [*]	.10 [*]	.19 ^{****}	.10 ^{**}	.21 ^{****}	.09 [*]
YMRS Total	.12 [*]	-.02	.24 ^{****}	.01	.21 ^{****}	-.01
CDRS-R Total	.68 ^{****}	.36 ^{****}	.58 ^{****}	.32 ^{****}	.53 ^{****}	.32 ^{****}
Self Harm (except LAMS = Hyper/Impulsive)	<i>Adj R</i> ² = .18		<i>Adj R</i> ² = .24		Hyper/Impulsive <i>Adj R</i> ² = .30	
	<i>r</i>	<i>r</i> _{part}	<i>r</i>	<i>r</i> _{part}	<i>r</i>	<i>r</i> _{part}
Child age (years)	-.02	-.02	.18 ^{****}	.05	-.23 ^{****}	-.16 ^{****}
Female	-.01	.01	.14 ^{****}	.04	-.06	.00
Any bipolar spectrum disorder	.26 ^{****}	.30 ^{****}	.21 ^{****}	.20 ^{****}	.11 ^{**}	-.02
Any unipolar depressive disorder	.07	.24 ^{****}	.16 ^{****}	.16 ^{****}	-.07	-.03
ODD as any diagnosis	.11 [*]	.03	.10 [*]	.21 ^{****}	.15 ^{***}	.06
CD as any diagnosis	.04	.02	.14 ^{****}	.18 ^{****}	.13 ^{**}	.06
ADHD as any diagnosis	.11 [*]	.10 [*]	-.18 ^{****}	-.16 ^{****}	.42 ^{****}	.36 ^{****}
Anxiety as any diagnosis (most inclusive)	.16 ^{**}	.15 ^{**}	.16 ^{****}	.11 ^{**}	.02	.01
YMRS Total	.24 ^{****}	.03	.23 ^{****}	.02	.31 ^{****}	.24 ^{****}
CDRS-R Total	.29 ^{****}	.27 ^{****}	.44 ^{****}	.24 ^{****}	.05	-.04
Rule-breaking behavior	<i>Adj R</i> ² = .20		<i>Adj R</i> ² = .40		<i>Adj R</i> ² = .30	
	<i>r</i>	<i>r</i> _{part}	<i>r</i>	<i>r</i> _{part}	<i>r</i>	<i>r</i> _{part}
Child age (years)	.27 ^{****}	.33 ^{****}	.55 ^{****}	.41 ^{****}	-.04	-.03
Female	-.13 [*]	-.09 [*]	.14 ^{****}	-.03	-.08 [*]	-.06
Any bipolar spectrum disorder	.01	-.01	.08 [*]	.06	.21 ^{****}	.05
Any unipolar depressive disorder	.01	-.02	.20 ^{****}	.10 ^{**}	-.05	-.05
ODD as any diagnosis	.11	.07	-.04	.14 ^{****}	.22 ^{****}	.25 ^{****}
CD as any diagnosis	.19 ^{****}	.17 ^{****}	.26 ^{****}	.21 ^{****}	.36 ^{****}	.34 ^{****}
ADHD as any diagnosis	.10 [*]	.10 [*]	-.30 ^{****}	-.18 ^{****}	.14 ^{****}	.06
Anxiety as any diagnosis (most inclusive)	-.11 [*]	-.12 [*]	.04	-.02	-.03	-.06

	Stanley		ABACAB		LAMS	
Aggression-Impulsive/Reactive	<i>Adj R</i> ² =.43		<i>Adj R</i> ² =.37		<i>Adj R</i> ² =.29	
Predictor	<i>r</i>	<i>r</i> _{part}	<i>r</i>	<i>r</i> _{part}	<i>r</i>	<i>r</i> _{part}
YMRS Total	.07	.10 [*]	.08	-.05	.36 ^{****}	.15 ^{****}
CDRS-R Total	.00	-.10 [*]	.35 ^{****}	.14 ^{****}	.20 ^{****}	.07

^{*}
p<.05,

^{**}
p<.005,

^{***}
p<.0005,

^{****}
p<.00005, two tailed.

Note. The *p* values attached to the part correlations test the incremental variance explained by the predictor during simultaneous entry in the regression model. Simple bivariate correlations are included as a reference to be able to see the change. If the part correlation is smaller than the bivariate, much of the covariance in the bivariate correlation was shared with other predictors. If the part correlation is larger, that suggests a suppressor system, where other predictors are accounting for non-overlapping variance in the factor score, and are correlated with the predictor (as happens with bipolar diagnosis predicting depression factor scores, and ODD diagnosis predicting the rule-breaking factor scores). *Adj R*² indicates the adjusted *R*², penalized for the number of predictors included in the model.