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Childhood inhibitory control and adolescent impulsivity and novelty seeking as differential predictors of relational and overt aggression

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Abstract

Impulsivity is commonly conflated with novelty seeking, but these traits are conceptually independent and hold different predictive implications. Using a multi-informant, longitudinal design, we examined childhood inhibitory control, as well as adolescent impulsivity and novelty seeking, as predictors of aggression in a sample of 976 twins. Lower childhood inhibitory control and higher adolescent impulsivity predicted both overt and relational aggression in regression analyses that accounted for sex, puberty status, age, and socioeconomic status. As predicted, novelty seeking did not predict aggression, a finding that supports its independence from impulsivity.

Keywords

Impulsivity; Novelty seeking; Inhibitory control; Relational aggression; Overt aggression

1. Introduction

Impulsivity is associated with various forms of psychopathology, ranging from suicidality to antisocial personality disorder (Apter et al., 1990; Fossati et al., 2004; Swann et al., 2014; Winstanley, Eagle, & Robbins, 2006); however, its definition as a construct varies widely (Whiteside & Lynam, 2001). Impulsivity is frequently conflated with novelty seeking, but these constructs have conceptual and practical differences. The relation between novelty seeking, defined as a preference for new or unusual experiences, and impulsivity, defined as a tendency to act without thinking or to respond quickly to a stimulus without considering potential consequences, have been conceptualized in one of three ways: impulsivity as a subset of novelty seeking or novelty seeking as a subset of impulsivity, and impulsivity and novelty seeking as separate factors (White et al., 1994). Cloninger's model of personality includes three main domains: novelty seeking, harm avoidance, and reward dependence, with impulsivity included as a subset of novelty seeking and harm avoidance (Cloninger, Przybeck, & Svrakic, 1991; Cloninger, Svrakic, & Przybeck, 1993). The association of novelty seeking and impulsivity is conceived differently in Tellegen's model of personality,

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which includes constraint as one of three higher order factors; impulsivity and novelty seeking are both subsets of the higher order factor constraint (*i.e.*, control; Tellegen, Unpublished). Eysenck, Eysenck, and Barrett (1985) posit that impulsivity is a separate factor from novelty seeking; they contend that impulsivity is a facet of a higher order venturesomeness and psychoticism factor, while novelty seeking is conceived as part of the separate higher order factor extraversion.

Given that these three personality models all have some conceptual and empirical support (*e.g.*, factor analytic findings), testing the association of impulsivity and novelty seeking with external correlates is one objective way to evaluate the nature of their association. If impulsivity and novelty seeking relate in markedly different ways to an external correlate, then their independence is supported.

Discerning whether novelty seeking and impulsivity are overlapping constructs is useful for at least three reasons. First, if they are not overlapping traits, and only one of them relates to an outcome that is targeted by an intervention (*e.g.*, aggression), spending time attempting to alter both traits would be an ineffective use of resources. Additionally, if they are separate traits that relate in different ways to an outcome of interest (*e.g.*, antisocial behavior), taking an individual's level of both traits into account when deciding on an intervention or treatment plan would be crucial. Finally, objective and conclusive evidence that impulsivity and novelty seeking are separate traits could reduce parallel, yet conceptually incompatible, research (*i.e.*, one line of research that conflates impulsivity and novelty seeking and one that does not). Such conceptual clarity would promote cohesive translational research.

Impulsivity predicts various types of aggression (Barratt, Stanford, Kent, & Alan, 1997; Chen, Coccaro, & Jacobson, 2012; Fite, Goodnight, Bates, Dodge, & Pettit, 2008), but whether novelty seeking is similarly associated with any type of aggression is unclear. When novelty seeking is associated with aggression, it is often operationalized in a way that overlaps with impulsivity (*e.g.*, Stadler et al., 2007). Because impulsivity predicts aggression fairly consistently, while novelty seeking has an understudied and unclear relationship with aggression, aggression is a useful external correlate for validating theoretical relationships between impulsivity and novelty seeking. If novelty seeking relates to aggression in a manner parallel to impulsivity, then we have evidence that impulsivity and novelty seeking are overlapping constructs. If the relationship between novelty seeking and aggression is distinctive, then we have evidence that impulsivity and novelty seeking are separate constructs.

Examining potential developmental precursors of impulsivity and novelty seeking is another way to gain insight into their degree of conceptual relatedness. We elected to examine whether childhood inhibitory control (*i.e.*, ability to suppress an implicit or explicit response; Enticott, Ogloff, & Bradshaw, 2006) relates to impulsivity and novelty seeking in similar or disparate ways. Studying novelty seeking during childhood is challenging because children rarely have sufficient opportunities to express novelty seeking tendencies when supervised by caregivers. Consequently, rather than evaluating whether childhood novelty seeking and impulsivity relate to adolescent aggression in the same way as adolescent

novelty seeking and impulsivity, we decided to use a putative developmental precursor of subsequent impulsivity and examine its association with novelty seeking and aggression.

Inhibitory control is defined as “more active processes of inhibition, effortful or willful control of actions, and self-regulation, capable of regulating both approach and avoidance” and is a widely studied and well validated construct, as well as a commonly cited predictor of aggression (Raijmakers et al., 2008; Rothbart, 1989); however, its relation to impulsivity and novelty seeking is less clear. Evidence suggests that impulsivity is associated with inhibitory control deficits, but whether impulsivity and inhibitory control have shared biological origins is challenging to establish (Enticott et al., 2006). Finding that childhood inhibitory control is associated with either impulsivity or novelty seeking, but not with the other construct, would imply different developmental antecedents and possibly different pathways to adolescent aggression (although, to anticipate our findings, only one pathway will be apparent).

We examined temperament and aggression concurrently in adolescence, but to help clarify whether inhibitory control is a precursor of impulsivity and/or novelty seeking, we studied inhibitory control prior to a significant developmental period: the transition to adolescence. Predictive effects that hold over such a significant transition are more likely to be meaningful than contemporaneous associations.

Consequently, we evaluated whether childhood inhibitory control, as well as adolescent novelty-seeking and impulsivity, predicted overt and relational aggression (*i.e.*, suggesting that impulsivity and novelty-seeking are not conceptually separate), or whether only impulsivity and lower inhibitory control predicted later aggression (*i.e.*, suggesting that impulsivity and novelty-seeking are separate constructs).

We hypothesized that novelty seeking leads to experiences that do not overlap substantially with processes that generate violence, which should make novelty seeking a poor predictor of relational and overt aggression. We predicted that only impulsivity, and the putatively related construct of inhibitory control, would be associated with aggression. We analyzed a large, longitudinal sample that included different reporters of each type of construct. Also, we measured each set of constructs (inhibitory control; novelty seeking and impulsivity; and aggression) with different instruments. Using multiple reporters and different instruments helps avoid associations due to common method variance. Using longitudinal data allows us to examine the relationship between inhibitory control and subsequent impulsivity, novelty seeking, and aggression across different developmental periods.

2. Method

2.1. Participants

The participants included twin pairs ($n = 976$ twins) from the birth record-based Wisconsin Twin Project (Schmidt et al., 2013). All twin participants were born between 1997 and 2002. Families were recruited after their twins' birth, and the twins were assessed at age 7–8 years and contacted again in adolescence (13–18 years). The sample is 50% female and includes similar numbers of identical (35%), same-sex fraternal (33%), and opposite-sex fraternal

(32%) twin pairs. The participants' mothers have an average of 15.2 years of education; fathers have 14.7 years of education, on average. The median income of the families is \$60,000–70,000. The majority of the twin pairs are Caucasian (91%), reflecting the statewide population of Wisconsin.

2.2. Demographics

To assess demographics for the families in the sample, we asked primary caregivers to report numerous family characteristics, including the ethnicity of the twins and their parents, family income, and parental years of education. Response options for years of education range from grade school (6–8 years of education) to a graduate degree (JD, MD, etc.; 20+ years of education). Caregivers reported on family income using seventeen possible increments ranging from \$10,000 or less to over \$200,000. We combined standardized measures of mother years of education and family income to create a composite representing socioeconomic status (SES).

2.3. Measures

2.3.1. Inhibitory control—When the twins were approximately 8 years old ($M = 95$ months, $SD = 9$ months), their mothers completed the Children's Behavior Questionnaire (CBQ; Rothbart, Ahadi, Hershey, & Fisher, 2001). This questionnaire assesses 15 child temperament dimensions that fall under positive emotionality, negative emotionality, and self-regulation domains. The CBQ has a response scale ranging from 1 (“extremely untrue of your child”) to 7 (“extremely true of your child”).

The CBQ does not contain a novelty seeking scale. Novelty seeking is difficult to assess at this age because few children have frequent opportunities to pursue activities that clearly exemplify novelty seeking. Thus, we elected to examine inhibitory control, a well-validated construct that might be a developmental antecedent of impulsive and novelty seeking tendencies (Kochanska, Murray, & Coy, 1997). The CBQ inhibitory control scale is internally consistent (Cronbach's $\alpha = 0.77$).

2.3.2. Impulsivity & novelty seeking—At approximately age 13 years ($M = 163$ months, $SD = 20$ months), twins and their primary caregiver completed a shortened version of the Early Adolescent Temperament Questionnaire (EATQ; Capaldi & Rothbart, 1992), which includes age appropriate items similar to the CBQ. The EATQ assesses major adolescent temperament dimensions and includes scales about shyness, sadness, activity level, attention, etc. The shortened version of the EATQ includes a variety of items that are generally related to impulsivity (*e.g.*, “Blurts out answers before someone finishes asking the question”) and novelty seeking (“Thinks traveling to Africa or India would be exciting and fun”), but it does not include distinct scales for novelty seeking or impulsivity. The EATQ response scale ranges from 1 (“Almost always untrue”) to 5 (“Almost always true”). Reliability scores for EATQ scales were 0.76 for self-reported impulsivity (9 items; Table 1), 0.60 for self-reported novelty seeking (5 items; Table 1), 0.87 for mother reported impulsivity (15 items; Table 2), and 0.76 for mother reported novelty seeking (7 items; Table 2).

2.4. Aggression

Participants and their cotwins also completed the MacArthur Health and Behavior Questionnaire (HBQ; Armstrong, Goldstein, & The MacArthur Working Group on Outcome Assessment, 2003) in early adolescence. The HBQ assesses a wide range of items, including adolescent health, recreational activities, internalizing tendencies, externalizing tendencies, peer relationships, and perspectives on school. The HBQ includes items related to relational (“When I’m mad at a kid, I don’t let them do things with me and my friends”) and overt aggression (“I hit or beat up kids”), so factor analyses were used to form a relational aggression composite and an overt aggression composite.

We used cotwin-report rather than self-report of aggression because cotwins are same-age (*i.e.*, adolescent) reporters who are more likely to be aware of their twin’s range of aggressive behavior than a parent might be. Also, cotwins may be more likely to report socially undesirable aggressive behavior than would be disclosed in self-reports. The HBQ response scale for cotwins ranges from a behavior being “really like my twin” (1) to the opposite of that behavior being “really like my twin” (7). Alpha internal consistency estimates were 0.90 (8 items) for overt aggression and 0.84 (7 items) for relational aggression.

2.5. Pubertal status

We assessed puberty using a composite score derived from mother and self-reports on the Pubertal Development Scale (PDS; Petersen, Crockett, Richards, & Boxer, 1988) and self-report via the Picture-Based Interview About Puberty (PBIP; Dorn & Susman, Unpublished). Ratings from the multiple informants were composited using a method similar to that of Ellis, Shirtcliff, Boyce, Dearthoff, and Essex (2011). The PDS consists of five questions about physical development (*e.g.*, growth of body hair or breast development) scored from 1 (has not begun) to 4 (is complete). Trained interviewers administered the PBIP during an in-home visit. Interviewers used a script and photographs to explain the stages of pubertal development. The interviewer then left the room and the participant rated his or her stage of development. Female interviewers administered the PBIP to both males and females, while male interviewers only administered the instrument to males. Mother and twin reports were averaged to form a continuous score ranging from 1.0 (pre-pubertal) to 5.0 (post-pubertal). Correlations between mother- and twin-reported puberty measures were high for both males and females (r s ranged from 0.66 to 0.72).

2.6. Statistical approach

2.6.1. Power—Given our sample size, the lowest bivariate correlation that we could detect as significant at $p < 0.05$ (2-tailed) between impulsivity or novelty seeking and the aggression measures was $r = 0.088$. Because real correlations lower than 0.088 would be of limited interest, power is judged to be adequate.

2.6.2. Variable derivation—To create the aggression composites, we used an exploratory factor analysis of all HBQ items with aggression related content, as judged by item themes. An overt aggression factor and a relational aggression factor emerged when we used the

criterion of accounting for the most variance. We then formed a mean composite of all items that loaded each of the two factors.

To create the impulsivity and novelty seeking composites, we used a rational selection of items based on content and then conducted extensive exploratory factor analyses to determine which impulsivity and novelty seeking items from the EATQ should be included in composites, as well as how many overall composites should be created (*e.g.*, is it necessary to include factors that represent different facets of impulsivity, or can they be combined?). We conducted separate exploratory factor analyses for each reporter (*i.e.*, mother report EATQ items at age 13 years and self-report EATQ items at age 13 years). Next, we conducted exploratory factor analyses to evaluate the fit of models containing 2 through 5 factors for each of the three questionnaire/reporter combinations. Based on model fit statistics and visual inspection of relevant scree plots, we judged that additional factors beyond two did not add a substantial amount of conceptual clarity. We selected items for the novelty seeking and impulsivity factors using an item loading cutoff of >0.3 in a promax rotated factor matrix. This oblique rotation allows the factors to correlate. We computed the average of the items that had a loading above the cutoff for the novelty seeking factor and the impulsivity factor for each questionnaire/reporter combination (see Tables 1 and 2). The low secondary loadings of each item on the “other” factor (*i.e.*, low secondary loadings of impulsivity items on the novelty seeking factor) indicated good discriminant validity of the two item sets.

2.6.3. Analytical approach—We used linear regression models to evaluate novelty seeking and impulsivity as predictors of subsequent relational and overt aggression. This approach allowed us to test the hypothesized main effects of earlier inhibitory control and concurrent impulsivity and novelty seeking, to add the theoretically relevant interaction between impulsivity and sex, and to control for demographic variables, which have the potential to account for a substantial amount of variance in both overt and relational aggression. We used generalized estimating equations (GEE) in SPSS to account for familial dependency of reports on twins in the regression analyses, such that degrees of freedom are appropriately allocated. Results from the GEE approach and the simpler approach of ignoring cotwin dependency (not shown) were highly similar.

3. Results

3.1. Distribution and correlations of the impulsivity, novelty seeking, and aggression composites with demographic variables, and analyses of sex differences

Sample sizes, means, and standard deviations for all variables are presented in Table 3. Table 4 contains bivariate correlations between the demographic variables (*i.e.*, pubertal status, SES, participant age when the EATQ was collected) and predictor and outcome variables. As expected, males were more impulsive (*i.e.*, as reported by participants and their mothers) than females. Despite relatively low correlations between demographic variables and aggression outcomes, we included demographic variables in all analyses.

We corrected for attenuation in correlations between all combinations of temperament composites and overt or relational aggression composites (Table 4) to evaluate whether the

differential reliability of the impulsivity and novelty seeking composites accounted for their differential correlations with aggression, and this was not the case (analyses not shown). Patterns of varying correlation magnitudes remained essentially the same following correction for differential reliability.

We examined the sex differences in behavioral predictor and outcome measures in Table 3. Males were rated higher on measures of impulsivity, mother reported novelty seeking, and aggression. Females were rated higher on mother reported inhibitory control during childhood. Although nearly all sex differences were significant with our large sample, with the exception of self reported novelty seeking during adolescence, males were notably higher on the impulsivity and overt aggression measures.

3.2. Predicting aggression from impulsivity and novelty seeking

We fit a series of generalized estimating equations. In all cases, the reporter for the outcome variable (overt or relational aggression) was the cotwin, who did not report on any of the predictor variables. The models varied in whether the mother or the adolescents themselves reported on the impulsivity and novelty seeking predictors.

First, we regressed cotwin reported *relational* aggression during adolescence on mother reported childhood inhibitory control, mother reported adolescent novelty seeking and impulsivity, and demographic variables (Model 1, Table 5). Individuals with higher mother reported impulsivity during adolescence were more relationally aggressive, as were older children ($\beta_{\text{impulsivity}} = 0.30, p < 0.05$; $\beta_{\text{age}} = .005, p < .05$).

We repeated these analyses with cotwin reported *overt* aggression during adolescence regressed on mother reported childhood inhibitory control, mother reported adolescent novelty seeking and impulsivity, and demographic variables (Model 2, Table 5). Higher mother reported impulsivity predicted higher concurrent overt aggression ($\beta = 0.40, p < 0.05$). Males, participants from lower SES households, and children with more advanced pubertal development were more overtly aggressive ($\beta_{\text{sex}} = 0.32, p < 0.05$; $\beta_{\text{SES}} = -0.098, p < 0.05$; $\beta_{\text{puberty}} = 0.085, p < .05$).

We then regressed cotwin reported *relational* aggression during adolescence on childhood mother reported inhibitory control, adolescent self-reported impulsivity and novelty seeking, and demographic variables (Model 3, Table 5). Again, individuals whose mothers reported that they had lower childhood inhibitory control were more relationally aggressive during adolescence ($\beta = -0.093, p < 0.05$), and individuals with higher self-reported impulsivity were more relationally aggressive ($\beta = 0.38, p < 0.05$).

Finally, we regressed cotwin reported *overt* aggression during adolescence on mother reported inhibitory control during childhood, self-reported impulsivity and novelty seeking during adolescence, and demographic variables (Model 4, Table 5). Individuals whose mothers reported lower inhibitory control during childhood were significantly more overtly aggressive during adolescence ($\beta = -0.080, p < 0.05$), and higher self-reported impulsivity predicted higher concurrent overt aggression ($\beta = 0.42, p < 0.05$). Males and individuals

with lower household SES were more overtly aggressive ($\beta_{\text{sex}} = 0.32, p < 0.05$; $\beta_{\text{income}} = -0.11, p < 0.05$).

3.3. Sex as a moderator of the relations between impulsivity, novelty seeking, and aggression

Given the sizable sex differences in levels of both overt and relational aggression, we examined whether males were primarily responsible for the main effects of decreased inhibitory control and increased impulsivity across ages and reporters on both types of aggression. We did not include novelty seeking in any models that examined the interaction between sex and impulsivity because novelty seeking was not a predictor of either relational or overt aggression.

First, we examined the interaction between mother reported impulsivity during adolescence and sex when predicting relational aggression, which was not significant, indicating that the link between impulsivity and relational aggression is similar for males and females ($\beta_{\text{interaction}} = -0.059, p > 0.05$; Model 5, Table 6). We also tested the interaction between impulsivity and sex when predicting overt aggression, which was also not significant ($\beta_{\text{interaction}} = 0.068, p > 0.05$; Model 6, Table 6).

We then examined the interaction between adolescent self-reported impulsivity and sex when predicting relational aggression, which was not significant, indicating that males' and females' impulsivity predict relational aggression similarly ($\beta_{\text{interaction}} = 0.099, p > 0.05$; Model 7, Table 6). The interaction between sex and impulsivity was also not significant when predicting overt aggression ($\beta_{\text{interaction}} = 0.19, p > 0.05$; Model 8, Table 6).

4. Discussion

We tested whether childhood inhibitory control, adolescent impulsivity, and adolescent novelty seeking predicted concurrent relational and overt aggression in a large community-based sample of twins. In support of our hypothesis, impulsivity related strongly to inhibitory control and was a clear predictor of concurrent aggression; however, novelty seeking had a nonsignificant relation with concurrent aggression and a nonsignificant relation to earlier inhibitory control.

Neither mother reported nor self-reported novelty seeking during adolescence predicted overt or relational aggression. This pattern of results has three main implications or interpretations: (1) more impulsive individuals display increased relational and overt aggression, regardless of reporter; (2) individuals with more novelty seeking tendencies do not exhibit increased relational or overt aggression; (3) lower childhood inhibitory control is strongly related to subsequent impulsivity, but does not relate to subsequent novelty seeking. Additionally, sex and impulsivity did not interact to predict aggression.

The persistent lack of association between novelty seeking and aggression despite some conceptual variation in the sort of novelty seeking tendencies reported by participants and their mothers highlights the consistency of this finding. Specifically, the items that emerged from factor analyses of self-reported novelty seeking during adolescence related more to

hypothetical situations than the items that emerged from analyses of mother report of novelty seeking. Adolescents who self-reported that they would pursue novel options in situations that, on average, had potential to be dangerous (*e.g.*, rock climbing) may experience novelty seeking tendencies more similar to those conceptualized by Cloninger et al. (1991, 1993; *i.e.*, thrill seeking as a component of novelty seeking). A greater willingness to enter not only benign, but also possibly life-threatening situations with little prior thought (*i.e.*, as endorsed at higher levels by adolescents), may reflect poorer self-regulation abilities than a willingness only to engage in fairly benign, safe forms of novelty seeking.

The lack of association between novelty seeking in realistic and less dangerous situations, as well as in potentially riskier hypothetical scenarios, underscores the stability of this finding across contexts and across reporters. Consequently, it seems that enjoyment and pursuit of novelty, whether that novelty is benign and safe or hypothetical and risky, does not relate to increased relational or overt aggression in early adolescence. The markedly disparate relations of impulsivity and novelty seeking with aggression provide strong evidence of the conceptual separateness of novelty seeking and impulsivity.

4.1. Limitations

Results must be interpreted within the context of the challenging nature of assessing adolescent novelty seeking. Although we assessed a number of putative components of novelty seeking behavior, other important facets of this behavior that could emerge in different contexts, some of which may relate to aggression. Additionally, subsequent studies could examine how the related tendency of sensation seeking relates to aggression, as it may overlap with impulsivity significantly more than novelty seeking does.

Another limitation of the study is the relative lack of ethnic and racial diversity in the sample, which affects the generalization of the findings. On the other hand, heterogeneity due to ethnic and racial variation does not substantially hinder interpretation of our results.

5. Conclusions and Implications

Our findings support previous studies showing a strong link between impulsivity and aggression, but no link between novelty seeking and aggression. We plan to expand our study of novelty seeking and impulsivity using neural measures (*e.g.*, resting state functional magnetic resonance imaging, diffusion tensor imaging) that can elucidate whether impulsivity and novelty seeking have overlapping or separate neural substrates, which would further clarify the relationship between these two important constructs.

Moreover, our findings suggest that treating these constructs as distinct is important, not only in assessments used for research purposes, but also in clinical settings. Interventions targeting aggression should focus on impulsivity, as defined in a way that does not conflate it with novelty seeking because this specific form of impulsivity consistently and strongly relates to relational and overt aggression, while novelty seeking does not. It would most likely be unhelpful to target novelty seeking in a cognitive restructuring intervention for aggression; the cognitive processes leading adolescents to state that they would willingly enter novel, and potentially dangerous, hypothetical situations do not seem to overlap

substantially with cognitive processes that generate aggression. Instead, teaching adolescents ways to manage the facets of impulsivity included in the scales we analyzed, such as difficulty inhibiting a prepotent response and a lack of premeditation, would presumably be a more effective way to decrease aggressive tendencies.

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References

- Apter A, Van Praag HM, Plutchik R, Sevy S, Korn M, Brown SL. Interrelationships among anxiety, aggression, impulsivity, and mood: A serotonergically linked cluster? *Psychiatry Research*. 1990; 32(2):191–199. [http://dx.doi.org/10.1016/0165-1781\(90\)90086-K](http://dx.doi.org/10.1016/0165-1781(90)90086-K). [PubMed: 2367604]
- Armstrong, JM., Goldstein, LH., The MacArthur Working Group on Outcome Assessment. Manual for the MacArthur Health and Behavior Questionnaire (HBQ 1.0). University of Pittsburgh, MacArthur Foundation Research Network on Psychopathology and Development (David J. Kupfer, Chair); PA: 2003.
- Barratt ES, Stanford MS, Kent TA, Alan F. Neuropsychological and cognitive psychophysiological substrates of impulsive aggression. *Biological Psychiatry*. 1997; 41(10):1045–1061. <http://dx.doi.org/10.1016/j.psychres.2006.11.001>. [PubMed: 9129785]
- Capaldi DM, Rothbart MK. Development and validation of an early adolescent temperament measure. *The Journal of Early Adolescence*. 1992; 12(2):153–173. <<http://jea.sagepub.com/>>.
- Chen P, Coccaro EF, Jacobson KC. Hostile attributional bias, negative emotional responding, and aggression in adults: Moderating effects of gender and impulsivity. *Aggressive Behavior*. 2012; 38(1):47–63. <http://dx.doi.org/10.1002/ab.21407>. [PubMed: 24833604]
- Cloninger CR, Przybeck TR, Svrakic DM. The tridimensional personality questionnaire: US normative data. *Psychological Reports*. 1991; 69(3):1047–1057. <http://dx.doi.org/10.2466/PRO.69.7.1047-1057>. [PubMed: 1784653]
- Cloninger CR, Svrakic DM, Przybeck TR. A psychobiological model of temperament and character. *Archives of General Psychiatry*. 1993; 50(12):975–990. <http://archpsyc.jamanetwork.com/journal.aspx>. [PubMed: 8250684]
- Dorn, L., Susman, E. Puberty script: Assessment of physical development in boys and girls. Cincinnati Children's Hospital Medical Center; Cincinnati, OH: Unpublished
- Ellis BJ, Shirtcliff EA, Boyce WT, Deardorff J, Essex MJ. Quality of early family relationships and the timing and tempo of puberty: Effects depend on biological sensitivity to context. *Development and Psychopathology*. 2011; 23(01):85–99. <http://dx.doi.org/10.1017/S0954579410000660>. [PubMed: 21262041]
- Enticott PG, Ogloff JR, Bradshaw JL. Associations between laboratory measures of executive inhibitory control and self-reported impulsivity. *Personality and Individual Differences*. 2006; 41(2):285–294. <http://dx.doi.org/10.1016/j.paid.2006.01.01>.
- Eysenck SB, Eysenck HJ, Barrett P. A revised version of the psychoticism scale. *Personality and Individual Differences*. 1985; 6(1):21–29. [http://dx.doi.org/10.1016/0191-8869\(85\)90026-1](http://dx.doi.org/10.1016/0191-8869(85)90026-1).
- Fite JE, Goodnight JA, Bates JE, Dodge KA, Pettit GS. Adolescent aggression and social cognition in the context of personality: Impulsivity as a moderator of predictions from social information processing. *Aggressive Behavior*. 2008; 34(5):511–520. <http://dx.doi.org/10.1002/ab.20263>. [PubMed: 18459110]
- Fossati A, Barratt ES, Carretta I, Leonardi B, Grazioli F, Maffei C. Predicting borderline and antisocial personality disorder features in nonclinical subjects using measures of impulsivity and

- aggressiveness. *Psychiatry Research*. 2004; 125(2):161–170. <http://dx.doi.org/10.1016/j.psychres.2003.12.001>. [PubMed: 15006439]
- Kochanska G, Murray K, Coy KC. Inhibitory control as a contributor to conscience in childhood: From toddler to early school age. *Child Development*. 1997; 68(2):263–277. <http://dx.doi.org/10.1111/j.1467-8624.1997.tb01939.x>. [PubMed: 9180001]
- Petersen AC, Crockett L, Richards M, Boxer A. A self-report measure of pubertal status: Reliability, validity, and initial norms. *Journal of Youth and Adolescence*. 1988; 17(2):117–133. <http://dx.doi.org/10.1007/BF01537962>. [PubMed: 24277579]
- Raaijmakers MA, Smidts DP, Sergeant JA, Maassen GH, Posthumus JA, Van Engeland H, Matthys W. Executive functions in preschool children with aggressive behavior: Impairments in inhibitory control. *Journal of Abnormal Child Psychology*. 2008; 36(7):1097–1107. <http://dx.doi.org/10.1007/s10802-008-9235-7>. [PubMed: 18437548]
- Rothbart MK, Ahadi SA, Hershey KL, Fisher P. Investigations of temperament at three to seven years: The Children's Behavior Questionnaire. *Child Development*. 2001; 72(5):1394–1408. [http://onlinelibrary.wiley.com/journal/10.1111/\(ISSN\)1467-8624](http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1467-8624). [PubMed: 11699677]
- Rothbart, MK. Temperament in childhood: A framework.. In: Kohnstamm, GA, Bates, JE., Rothbart, MK., editors. *Temperament in childhood*. Wiley; Chichester, England: 1989. p. 59-73.
- Schmidt NL, Van Hulle CA, Brooker RJ, Meyer LR, Lemery-Chalfant K, Goldsmith HH. Wisconsin Twin Research: Early development, childhood psychopathology, autism, and sensory over-responsivity. *Twin Research and Human Genetics*. 2013; 16(01):376–384. <http://dx.doi.org/10.1017/thg.2012.105>. [PubMed: 23200241]
- Stadler C, Sterzer P, Schmeck K, Krebs A, Kleinschmidt A, Poustka F. Reduced anterior cingulate activation in aggressive children and adolescents during affective stimulation: Association with temperament traits. *Journal of Psychiatric Research*. 2007; 41(5):410–417. <http://dx.doi.org/10.1016/j.jpsychires.2006.01.006>. [PubMed: 16516233]
- Swann AC, Dougherty DM, Pazzaglia PJ, Pham M, Steinberg JL, Moeller FG. Increased impulsivity associated with severity of suicide attempt history in patients with bipolar disorder. *American Journal of Psychiatry*. 2014; 162(9):1680–1687. <http://dx.doi.org/10.1176/appi.ajp.162.9.1680> (2005 Sep).
- Tellegen, A. Brief manual for the multidimensional personality questionnaire. University of Minnesota (Unpublished); Minneapolis: Unpublished
- White JL, Moffitt TE, Caspi A, Bartusch DJ, Needles DJ, Stouthamer-Loeber M. Measuring impulsivity and examining its relationship to delinquency. *Journal of Abnormal Psychology*. 1994; 103(2):192–205. <http://dx.doi.org/10.1037/0021-843X.103.2.192>. [PubMed: 8040489]
- Whiteside SP, Lynam DR. The five factor model and impulsivity: Using a structural model of personality to understand impulsivity. *Personality and Individual Differences*. 2001; 30(4):669–689. [http://dx.doi.org/10.1016/S0191-8869\(00\)00064-7](http://dx.doi.org/10.1016/S0191-8869(00)00064-7).
- Winstanley CA, Eagle DM, Robbins TW. Behavioral models of impulsivity in relation to ADHD: Translation between clinical and preclinical studies. *Clinical Psychology Review*. 2006; 26(4): 379–395. <http://dx.doi.org/10.1016/j.cpr.2006.01.001>. [PubMed: 16504359]

Table 1

List of self-reported impulsivity and novelty seeking Early Adolescent Temperament Questionnaire items.

EATQ items (self-report)		
Impulsivity	Impulsivity factor loading	Novelty seeking factor loading
I put off working on projects until right before they're due	0.67	0.12
I do something fun before starting homework, even if I'm not supposed to	0.60	0.15
If I have a hard assignment to do, I get started right away (reverse)	-0.63	0.01
I tend to say the first thing that comes to mind without stopping to think	0.49	0.10
I have a hard time finishing things on time	0.47	-0.09
I finish homework before the due date (reverse)	-0.48	0.00
I blurt out answers in class before the teacher calls on me	0.44	0.10
I can stick with my plans and goals (reverse)	-0.44	0.19
I am good at self-discipline (reverse)	-0.42	0.10
Novelty seeking	Novelty seeking factor loading	Impulsivity factor loading
I wouldn't be afraid to try something like mountain climbing	0.62	0.03
I would not be afraid to try a risky sport	0.62	-0.01
Skiing fast down a steep slope sounds scary to me (reverse)	-0.43	-0.03
I get frightened when riding with a person who likes to speed (reverse)	-0.32	-0.17
I enjoy going places where there are big crowds and lots of excitement	0.38	-0.06

Note: Self-reported behavior when participants were approx. 12–13 years old; loadings from Promax rotated factor matrix.

Table 2

List of mother reported impulsivity and novelty seeking Early Adolescent Temperament Questionnaire items.

EATQ items (mother report)		
Impulsivity	Impulsivity factor loading	Novelty seeking factor loading
Is good at self-discipline (reverse)	-0.82	0.09
Has a hard time finishing things on time	0.72	-0.06
Usually gets started right away with difficult homework (reverse)	-0.73	0.17
Usually puts off working on a project until it's due	0.71	-0.09
When someone tells her/him to stop doing something, it's easy for her/him to stop (reverse)	-0.72	0.03
Usually finishes homework before it's due (reverse)	-0.69	0.11
Usually able to stick with plans and goals (reverse)	-0.69	0.17
Usually does something fun before starting homework, even if she/he is not supposed to	0.68	0.00
Good at keeping a secret (reverse)	-0.45	0.13
When asked to do something, she/he does it right away, even if she/he doesn't want to (reverse)	-0.66	0.09
More likely to do something she/he shouldn't do the more she/he tries to stop	0.61	0.02
Says the first thing that comes to mind without stopping to think	0.53	0.07
Blurts out answers before someone finishes asking a question	0.50	0.10
She/he has a hard time waiting her/his turn to speak when excited	0.45	0.05
Opens presents before she/he is supposed to	0.36	-0.07
Novelty seeking	Novelty seeking factor loading	Impulsivity factor loading
Wouldn't be afraid to try a risky sport, like deep sea diving	0.74	0.01
Expresses a desire to travel to exotic places when she/he hears about them	0.67	-0.07
Thinks traveling to Africa or India would be fun and exciting	0.56	-0.03
Would like to drive a racecar	0.57	0.17
Thinks it would be exciting to move to a new city	0.46	0.06
Frightened by the thought of skiing fast down a steep slope (reverse)	-0.50	0.06
Wouldn't want to go on frightening rides at the fair (reverse)	-0.44	0.06

Note: Behavior reported by mothers when participants were approx. 12–13 years old; loadings from Promax rotated factor matrix.

Table 3

Descriptive statistics for inhibitory control, impulsivity, novelty seeking, demographic, and overt and relational aggression composites.

Variable name	N	Mean	Standard deviation	Effect size ((male mean-female mean)/SD _{pooled})	t-test
Childhood inhibitory control (mother report CBQ)	834	4.8	1.0	-0.44	6.41 [*]
Adolescent impulsivity (self-report EATQ)	708	0	0.59	0.25	-4.41 [*]
Adolescent novelty seeking (self-report EATQ)	726	0	0.67	0.12	-1.91
Adolescent impulsivity (mother EATQ)	671	0	0.64	0.37	-6.35 [*]
Adolescent novelty seeking (mother EATQ)	683	0	0.65	0.15	-3.71 [*]
Avg. of puberty measures	746	3.0	1.0	-0.46	6.26 [*]
Socioeconomic status composite	966	0	0.85	0.067	-1.13
Overt aggression (cotwin report)	975	0	0.78	0.46	-8.22 [*]
Relational aggression (cotwin report)	976	0	0.72	0.20	-3.65 [*]

Note: CBQ = Children's Behavior Questionnaire; completed when participants were approx. 7–8 years old; EATQ = Early Adolescent Temperament Questionnaire; completed when participants were approx. 12–13 years old; overt and relational aggression composites are from the MacArthur Health and Behavior Questionnaire; avg. of puberty measures is a composite of mother and self-reported physical development (breast development, body hair growth, etc.); socioeconomic status is an average of standardized values for family income and mother's number of years of education (reported by mothers); the measure of pubertal development ranges from 1 (has not begun) to 4 (is complete); impulsivity, novelty seeking, overt aggression, relational aggression, and SES composites are means of standardized items.

^{*} $p < 0.05$, 2-tailed (one level of significance used for all tests).

Table 4

Bivariate correlations between demographic variables, inhibitory control, impulsivity, novelty seeking, and aggression outcome variables.

	SES composite	Avg. of puberty measures	Inhibitory control (mother CBQ)	Adol. impuls. (self EATQ)	Adol. novelty seeking (self EATQ)	Adol. impuls. (mother EATQ)	Adol. novelty seeking (mother EATQ)	Overt Aggression (cotwin report)	Relational Aggression (cotwin report)
SES composite (n = 966)									
Avg. of puberty measures	-0.034	(n = 746)							
Inhibitory control (mother CBQ)	0.186 *	0.068	(n = 834)						
Adol. impulsivity. (self-report EATQ *)	-0.128 *	0.098 *	-0.197 *	(n = 708)				<i>0.435</i>	<i>0.382</i>
Adolescent novelty seeking (self-report EATQ *)	0.068	0.097 *	-0.037	-0.019	(n = 726)			<i>0.101</i>	<i>0.072</i>
Adol. impulsivity (mother EATQ *)	-0.227 *	-0.074 *	-0.616 *	0.451 *	0.058	(n = 671)		<i>0.414</i>	<i>0.342</i>
Adolescent novelty seeking (mother EATQ *)	0.010	0.010	0.013	0.050	0.356 *	-0.011	(n = 683)	<i>0.077</i>	<i>0.044</i>
Overt aggression (cotwin report)	-0.170 *	0.073 *	-0.277 *	0.378 *	0.076 *	0.379 *	0.064	(n = 975)	
Relational aggression (cotwin report)	-0.117 *	0.080 *	-0.217 *	0.321 *	0.052	0.302 *	0.035	0.701 *	(n = 976)

Note: CBQ = Children's Behavior Questionnaire; EATQ = Early Adolescent Temperament Questionnaire; avg. of puberty = mean composite of mother and self-reported physical development (breast development, body hair growth, etc.); aggression composites are from the MacArthur Health and Behavior Questionnaire; see Table 3 for Ns; uncorrected correlations are below the diagonal and correlations corrected for differential reliability are above the diagonal in italics; significance levels are not listed for these values.

* $p < 0.05$ (one level of significance used for all tests).

Table 5

Results from linear regression models with inhibitory control, impulsivity, novelty seeking, and demographic variables as predictors of overt or relational aggression (no interaction terms).

	Model 1 (outcome: relational aggression)	Model 2 (outcome: overt aggression)	Model 3 (outcome: relational aggression)	Model 4 (outcome: overt aggression)
Mother CBQ inhibitory control	-0.016 (0.033)	0.020 (0.034)	-0.093* (0.028)	-0.080* (0.029)
Self report EATQ impulsivity	–	–	0.38* (0.046)	0.42* (0.050)
Self report EATQ NS	–	–	0.044 (0.042)	0.063 (0.039)
Mother EATQ impulsivity	0.30* (0.056)	0.40* (0.058)	–	–
Mother EATQ NS	0.006 (0.042)	0.034 (0.039)	–	–
Sex	0.094 (0.061)	0.32 (0.063)*	0.059 (0.063)	0.32* (0.062)
Age	0.005* (0.0025)	0.001 (0.0026)	0.004 (0.0025)	-0.001 (0.0026)
Pubertal status	0.025 (0.040)	0.085* (0.038)	-0.005 (0.041)	0.060 (0.037)
SES composite	-0.035 (0.039)	-0.098* (0.040)	-0.036 (0.036)	-0.11* (0.038)

Note: CBQ = Children's Behavior Questionnaire; EATQ = Early Adolescent Questionnaire; sex was coded as 1 for females and 2 for males; pubertal status is based on a composite of mother and self-report of physical development (breast development, body hair growth, etc.); SES composite is a combination of standardized values for family income and mother's number of years of education; values in the cells are unstandardized partial regression coefficients, with standard errors in parentheses.

* $p < 0.05$.

Table 6

Results from linear regression models with inhibitory control, impulsivity, novelty seeking, and demographic variables as predictors of overt or relational aggression (interaction terms included).

	Model 5 (outcome: relational aggression)	Model 6 (outcome: overt aggression)	Model 7 (outcome: relational aggression)	Model 8 (outcome: overt aggression)
Mother report CBQ inhibitory control	-0.016 (0.033)	0.021 (0.034)	-.094* (0.027)	-0.082* (0.028)
Self-report EATQ impulsivity	-	-	0.23 (0.16)	0.13 (0.15)
Mother report EATQ impulsivity	0.39* (0.14)	0.301* (0.14)	-	-
Sex	0.097 (0.061)	0.33* (0.063)	0.062 (0.063)	0.32* (0.062)
Sex × self-report EATQ impulsivity	-	-	0.099 (0.10)	0.19 (0.10)
Sex × mother report EATQ impulsivity	-0.059 (0.094)	0.068 (0.099)	-	-
Pubertal status	0.024 (0.040)	0.086* (0.038)	-0.007 (0.041)	0.057 (0.036)
SES composite	-0.034 (0.039)	-0.099* (0.041)	-0.035 (0.036)	-0.11* (0.037)
Age	0.005* (0.0025)	0.001 (0.0026)	0.004 (0.0024)	0.00 (0.0025)

Note: CBQ= Children's Behavior Questionnaire; EATQ= Early Adolescent Temperament Questionnaire; sex was coded as 1 for females and 2 for males; pubertal status is based on a mean composite of mother and self-report of physical development (breast development, body hair growth, etc.); family income is on a numerical scale ranging from 1 to 17, with 1 = <\$10,000 and 17 = >\$200,000.

* p < 0.05.