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Cognitive Abilities, Social Adaptation, and Externalizing Behavior Problems in Childhood and Adolescence: Specific Cascade Effects across Development

Sarah Jensen Racz, Diane L. Putnick, Joan T. D. Suwalsky, Charlene Hendricks, and Marc H. Bornstein

Eunice Kennedy Shriver National Institute of Child Health and Human Development

Abstract

Children's and adolescents' cognitive abilities, social adaptation, and externalizing behaviors are broadly associated with each other at the bivariate level; however, the direction, ordering, and uniqueness of these associations have yet to be identified. Developmental cascade models are particularly well-suited to (1) discern unique pathways among psychological domains and (2) model stability in and covariation among constructs, allowing for conservative tests of longitudinal associations. The current study aimed to identify specific cascade effects among children's cognitive abilities, social adaptation, and externalizing behaviors, beginning in preschool and extending through adolescence. Children (46.2% female) and mothers ($N = 351$ families) provided data when children were 4, 10, and 14 years old. Cascade effects highlighted significant stability in these domains. Unique longitudinal associations were identified between (1) age-10 cognitive abilities and age-14 social adaptation, (2) age-4 social adaptation and age-10 externalizing behavior, and (3) age-10 externalizing behavior and age-14 social adaptation. These findings suggest that children's social adaptation in preschool and externalizing behavior in middle childhood may be ideal intervention targets to enhance adolescent well-being.

Keywords

Cascade models; child and adolescent development; cognitive abilities; social adaptation; externalizing behavior

Introduction

Adolescence is a time of great growth in both cognitive and social abilities, as brain regions associated with these abilities (e.g., prefrontal cortex, limbic regions) continue to mature (Blakemore & Choudhury, 2006; Choudhury, Blakemore, & Charman, 2006; Spear, 2000). Difficulties in behavioral functioning also tend to appear during this time, attributable in part

Correspondence concerning this article should be addressed to Sarah Racz, *Eunice Kennedy Shriver* National Institute of Child Health and Human Development, National Institutes of Health, 6705 Rockledge Dr. Suite 8030, Bethesda, MD 20892-7971. sarah.racz@nih.gov.

Author Note

Sarah Jensen Racz, Diane L. Putnick, Joan T. D. Suwalsky, Charlene Hendricks, and Marc H. Bornstein, *Eunice Kennedy Shriver* National Institute of Child Health and Human Development, National Institutes of Health.

to immaturity in neurobiological mechanisms underlying behavioral control as well as increased affiliation with deviant peer groups (Steinberg, 2005; Steinberg & Morris, 2001; van Goozen, Fairchild, Snoek, & Harold, 2007). As such, adolescence can be a time of great upheaval in cognitive, social, and behavioral functioning. It has also been suggested that some cognitive, social, and behavioral difficulties first emerge during early and middle childhood, thereby laying the foundation for continued and often increasing problems in these domains during adolescence (Compas, Hinden, & Gerhardt, 1995; Hinshaw & Lee, 2003; Lansford, Malone, Dodge, Pettit, & Bates, 2010; Lochman & the Conduct Problems Prevention Research Group [CPPRG], 1995). However, the mechanisms underlying these longitudinal associations - as well as the direction, specificity, and ordering of effects among them - particularly across different developmental periods, are still poorly understood. The goal of the current study, therefore, is to examine unique relations among cognitive abilities (specifically IQ and academic achievement), social adaptation (e.g., interpersonal relationships, play skills, coping abilities), and externalizing behaviors (e.g., reactive aggression, conduct problems, oppositionality) across three different developmental periods (i.e., early childhood/preschool, middle childhood, and adolescence). We specifically aimed to conservatively model these longitudinal associations via cascade modeling to clarify the timing, direction, and uniqueness of effects.

Empirical and Theoretical Links among Cognitive Abilities, Social Adaptation, and Externalizing Behavior in Childhood and Adolescence

Empirical studies demonstrate that strong cognitive skills predict aspects of children's competence across a range of domains, including but not limited to positive social and behavioral functioning (Crick & Dodge, 1994; Emmerich, Cocking, & Sigel, 1979; Masten & Coatsworth, 1998). Conversely, difficulties in both social and behavioral functioning in adolescence are frequently linked with multiple deficits in cognitive functioning, including lower IQ (up to a full standard deviation lower), poor verbal reasoning, difficulties with spatial and perceptual processing, and impaired language abilities (Cook, Greenberg, & Kusche, 1994; Heller, Baker, Henker, & Hinshaw, 1996; Hinshaw & Lee, 2003; Lynam, Moffitt, & Stouthamer-Loeber, 1993; Moffitt, Lynam, & Silva, 1994; Nigg, Quamma, Greenberg, & Kusche, 1999; Raine, Yaralian, Reynolds, Venables, & Mednick, 2002; Toupin, Déry, Pauzé, Mercier, & Fortin, 2000). Several cognitive processes are hypothesized to play a role in these associations, including biased perceptions of the self and others; poor executive functioning; and difficulties with self-regulation, impulse control, and referential communication (Hughes & Ensor, 2011; Oland & Shaw, 2005; Steinberg, 2005). For instance, individuals who are unable to attend to social conversations, inhibit impulsive responses, and engage in perspective taking experience significant difficulties in social interactions and behavioral control (Blakemore & Choudhury, 2006). Indeed, these deficits are so widely documented in the literature that measures of children's cognitive abilities are frequently included as covariates in studies of children's social and behavioral functioning. However, by casting cognitive abilities as a control variable, it is not possible to determine specifically how children's cognitive abilities contribute to the development of child and adolescent social and behavioral functioning.

Most studies examining the links among cognitive, social, and behavioral functioning conceptualize inherent cognitive skills as the antecedent, preceding difficulties in social and behavioral outcomes. However, research also indicates that early externalizing behaviors (e.g., aggression, disruptiveness, poor behavioral control) contribute to later difficulties in both academic and social competence (Fergusson & Horwood, 1995; Masten et al., 2005; McLeod & Kaiser, 2004; Moilanen, Shaw, & Maxwell, 2010; Racz, King, Wu, Witkiewitz, McMahon, & CPPRG, 2013). The trajectory from externalizing problems to academic and social difficulties is most clearly established in studies of early-onset conduct problems (i.e., life-course persistent conduct problems). Children exhibiting this early behavioral pattern evince continued behavioral difficulties across development, leading to many untoward outcomes including poor academic achievement and social rejection (Moffitt, 1993). In addition to these deficits in cognitive and academic performance, children with externalizing problems tend to have poor social competencies (Bornstein, Hahn, & Haynes, 2010; Obradovi , Burt, & Masten, 2010) and experience difficulties navigating interpersonal conflict and peer relationships (Nangle, Erdley, Carpenter, & Newman, 2002; Rudolph & Clark, 2001).

The reverse direction of these effects has also been established, such that poor social understanding in preschool influences aggression in early adolescence (Emond, Ormel, Veenestra, & Oldehinkel, 2007). Overall, there are strong links between poor social adaptation and externalizing behavior problems across childhood and adolescence (Hinshaw & Lee, 2003), but there is also evidence to suggest that children who engage in proactive/interpersonal/indirect aggression actually demonstrate high levels of social adaptation that allow them to engage in socially manipulative tactics (Crick & Dodge, 1996). These links are most commonly observed in the bullying literature, and suggest that children who engage in this type of aggression have high levels of social intelligence and are socially accepted by their peers (Salmivalli, Kaukiainen, & Lagerspetz, 2000; Sutton, Smith, & Swettenham, 1999). There are important differences in these effects depending on the form of aggression (whether proactive or reactive), but these findings highlight that the bivariate relations between cognitive abilities, social adaptation, and externalizing behaviors may not be as straightforward as previously thought. A more theoretical and global view may therefore help clarify the direction of effects among cognitive abilities, social adaptation, and externalizing behaviors.

Social information processing theory asserts a strong connection between child and adolescent cognitive, social, and behavioral functioning. This theory posits that children engage in several cognitive functions during social situations: encoding and interpreting situational cues, evaluating possible responses to the situation, and selecting the best response (Crick & Dodge, 1994). Repeated negative experiences with peers lead children to develop cognitive biases when interpreting social cues (i.e., hostile attribution biases; Dodge et al., 2015), and subsequently, these children respond aggressively even to slight peer provocations. Enduring difficulties with social cognition may therefore contribute to stability in behavior problems over time, as aggressive children are rejected by their peers and subsequently engage in more aggression and antisocial behavior (Dodge et al., 2003; Oland & Shaw, 2005; Trentacosta & Shaw, 2009). For example, longitudinal data from the Child Development Project on 585 children from kindergarten through 3rd grade identified

cascading effects from social information processing problems to aggression through peer rejection (Lansford et al., 2010).

The varied and complex associations among cognitive abilities, social adaptation, and externalizing behavior problems can also be conceptualized within the biopsychosocial model of development (Compas et al., 1995; Dodge & Pettit, 2003). This model postulates that biological factors predispose children to certain risks, and that experiences within the environment (e.g., with parents, peers, teachers, schools) modulate the expression of these risks. Using this framework, deficits in inherent cognitive abilities can be conceptualized as placing children at risk for later social and behavioral difficulties. Coupling this biological predisposition with environmental stressors experienced in the social domain (e.g., poor peer relationships) may lead to the expression of later externalizing behavior problems. Overall, there is both theoretical and empirical support for links among children's cognitive abilities, social adaptation, and externalizing behaviors. However, much of this research has focused only on bivariate relations between pairs of these constructs, and therefore little attention has been paid to the direction, ordering, specificity, and uniqueness of associations across childhood and adolescence within a multivariate framework.

Developmental Cascade Models

A methodological model that may help to explain longitudinal associations among cognitive abilities, social adaptation, and externalizing behaviors is developmental cascades. Many longitudinal relations among different psychological constructs are likely attributable to their stability over time and concurrent associations; however, this potential is frequently ignored in empirical investigations. Developmental cascade models are conservative, multivariate, longitudinal models that allow for the examination of the direction, specificity, and ordering of effects among domains, while simultaneously controlling for stability and covariation (Bornstein et al., 2010; Bornstein, Hahn, & Suwalsky, 2013; Masten & Cicchetti, 2010). Controlling for stability and covariation is crucial in longitudinal studies, given that the strength of these effects likely reduces the availability of unique, predictable variance (Burt, Obradovi, Long, & Masten, 2008). Cascade models isolate and identify specific cross-domain cross-time relations and allow for the prediction of change in the construct over time.

Developmental cascades demonstrate that changes in one domain trigger system-wide, spreading effects into other domains, resulting in dynamic longitudinal interactions (Lansford et al., 2010; Masten et al., 2005). These progressive effects are therefore positioned to identify early pathways that could be targeted to prevent future developmental difficulties. Some evidence of cascade effects between juvenile delinquency and violence (e.g., Dodge, Greenberg, Malone, & Conduct Problems Prevention Research Group [CPPRG], 2008), and among externalizing behaviors, adaptive behaviors, social competence, and academic attainment (e.g., Bornstein et al., 2010; Burt et al., 2008; Obradovi et al., 2010) have been documented, but none has included cognitive, social, and behavioral domains, as we do here. Despite their methodological and theoretical advantages, cascade models remain largely underutilized in psychological research.

Overview of the Current Study

The current study aims to investigate the unique, longitudinal interplay of three central domains of child and adolescent development – cognitive abilities, social adaptation, and externalizing behaviors. Clarifying unique cascading, prospective effects among these three domains - highlighting their direction, specificity, and order - across childhood and adolescence may suggest when, on what, and how to intervene to enhance adolescent cognitive, social, and behavioral functioning (Masten & Cicchetti, 2010). As such, the findings from this study may inform intervention efforts in early and middle childhood to enhance adolescent well-being.

We used a multi-informant, multi-method longitudinal design to examine cascading effects among children's cognitive abilities, social adaptation, and externalizing behavior problems. To better capture a theoretical view of their dynamic interplay, we included broad measures of these constructs. Cascade models generally require, at a minimum, data on three constructs collected at three time points (Masten & Cicchetti, 2010), as we do here. Specifically, all three domains in the current study were measured at three time points (i.e., when children were 4, 10, and 14 years old). These time points were specifically selected to coincide with children's burgeoning cognitive, social, and behavioral development across three important developmental periods (i.e., preschool, middle childhood, and adolescence). Cascade effects may be most pronounced at developmental, school-related transition points (Moilanen et al., 2010), and the timing of the assessments in the current study captures these important milestones (i.e., start of preschool, preparing for the middle school transition, entering high school and pubertal development).

Utilizing cascade models is particularly important in the current study given high levels of stability in children's functioning and behavior (Blandon, Calkins, Grimm, Keane, & O'Brien, 2010; Fergusson, Lynskey, & Horwood, 1996; Heller et al., 1996; Lynam et al., 1993; Masten et al., 2005; Obradović et al., 2010). In fact, stability coefficients for externalizing behaviors in children tend to be as high as those for intelligence (Lansford et al., 2010). Therefore, we expected high levels of stability in all three domains across time. We also expected that the domains would be correlated within each time point, given the bivariate associations reviewed above. Controlling for stability in and covariation among constructs is crucial to determine if cross-lagged, cascading effects are unique or simply reflect the fact that assessed domains are correlated at baseline and are stable across time (Masten & Cicchetti, 2010). After controlling for stability and covariation, we then examined cross-time, cross-domain relations among constructs. Specifically, we expected that better cognitive abilities and fewer externalizing behaviors at one time point would predict better social adaptation at the next time point. We also expected that better cognitive abilities at one time point would predict fewer externalizing behaviors at a subsequent time point. To determine directionality and consider the transactional nature of these constructs, we also considered the reverse order of these effects. We further expected that these cross-lagged paths would combine to create several cascade effects, and would therefore enhance our understanding of the uniqueness, magnitude, ordering, and direction of effects among these three constructs. Lastly, given documented gender differences in social functioning and externalizing disorders among children and adolescents (i.e., females report better social

functioning and fewer externalizing problems than males; Adams, 1983; Hinshaw & Lee, 2003), we tested for any gender differences in these pathways over time. The literature has documented mean differences between males and females on these constructs, but it is not clear how gender may moderate their effects. As such, we did not have any specific hypothesis for this exploratory aim. Our model extends previous literature documenting bivariate links among these constructs by considering their dynamic interplay in a longitudinal, multivariate framework.

Method

Participants

Data came from a longitudinal study of child development and family functioning. European American families with healthy firstborn children were recruited through newspaper advertisements and mass mailings from the mid-Atlantic region of the United States. Data were collected in multiple waves, and a subsample of second children born to the initial set of families was also recruited to the overall sample. The current analyses focused on data collected from children and mothers when the children were 4, 10, and 14 years old.

Children and mothers who contributed data at one or more of the three time points ($N = 351$ children) were included. Fifty-five (15.7%) of these 351 children were second-born children. Approximately half of the children (189; 53.8%) were male. On average, children were 4.04 ($SD = 0.09$, $range = 3.84 - 4.62$), 10.34 ($SD = 0.16$, $range = 10.05 - 10.90$), and 13.87 ($SD = 0.28$, $range = 13.48 - 14.92$) years of age at the three assessments. Mothers were on average 34.42 years old ($SD = 5.90$, $range = 17.53 - 49.63$) when their children participated in the 4-year assessment. At that time, 62.4% of the mothers ($n = 219$) had graduated college, 27.9% ($n = 98$) had not graduated college; 84.6% ($n = 297$) were married, 4.8% ($n = 17$) were not married. At the 4-year assessment, families were of middle to upper socioeconomic status (SES) according to the Hollingshead Four-Factor Index of Social Status (1975; $range = 19 - 66$). A mean Hollingshead score of 53.12 ($SD = 11.44$) indicated that on average families were of upper-middle SES.

Procedure

At the 4-year assessment, children completed several cognitive measures with an administrator while mothers sat in the same or an adjacent room and completed a battery of questionnaires. Packets of questionnaires were mailed to families prior to the 10- and 14-year assessments, with instructions to complete the questionnaires prior to visiting the laboratory. Mothers were interviewed over the telephone by an administrator several weeks after each of the three laboratory visits. Informed consent was obtained from mothers, and assent was obtained from children. All study procedures were approved and monitored by our Institutional Review Board. Families were provided with modest monetary compensation for their participation in the assessments.

Measures

Cognitive abilities—We used the Wechsler Preschool and Primary Scale of Intelligence-Revised (WPPSI-R; Wechsler, 1989) when children were 4 years old and the Woodcock-

Johnson Revised Tests of Achievement (WJ-R; Woodcock & Johnson, 1989) when they were 10 and 14 years old. These measures were administered to the children by trained staff members according to standardized procedures. The WPPSI-R and WJ-R tap into many of the same cognitive abilities and are highly correlated (documented r s ranged from .66 to .77). Studies examining the concurrent validity of the WPPSI-R and WJ-R indicate that these measures are associated with other commonly used measures of cognitive abilities (Harrington, Kimbrell, & Dai, 1992). We administered five subtests of the WPPSI-R (Block Design, Picture Completion, Information, Arithmetic, and Similarities) to reduce time and participant burden. As is common in research settings, these subtests were selected to create a short form of the WPPSI-R due to their high correlations with the Performance, Verbal, and Full Scale IQ scores (documented r s ranged from .58 to .82; Sattler, 1992). Prorated Full Scale IQ scores were used in the current analyses ($\alpha = .78$).

We administered three subtests of the WJ-R at the 10-year assessment (Letter-Word Identification, Passage Comprehension, and Calculation) and four at the 14-year assessment (Letter-Word Identification, Passage Comprehension, Applied Problems, and Dictation), again to reduce time and participant burden. Like the WPPSI-R, this combination of subtests covers age-appropriate aspects of language (reading and writing) and mathematics, and assesses a cluster of abilities important for cognitive development (U. S. Department of Education, Planning and Evaluation Service, Elementary and Secondary Education Division, 2003). Standardized subtest scores were averaged at each time point to create an overall cognitive functioning score ($\alpha_{10 \text{ years}} = .72$; $\alpha_{14 \text{ years}} = .84$).

Social adaptation—We assessed children's social adaptation at ages 4, 10, and 14 with the Socialization domain of the Vineland Adaptive Behavior Scales: Interview Edition (VABS; Sparrow, Balla, & Cicchetti, 1984). The VABS is a widely used measure of children's adaptive behavior with strong psychometric properties as documented by Sparrow and colleagues (i.e., high test-retest, split-half, and inter-rater reliability; strong validity as evidenced by positive correlations with age and additional domains of psychosocial functioning; factor analysis supporting the underlying structure of the measure). Approximately 2 to 3 weeks after their laboratory visit, a trained staff member who had not seen the child at the visit interviewed the child's mother with the VABS; this semi-structured interview lasted approximately 1 hour. The VABS Socialization domain assesses three broad aspects related to children's social adaptation: interpersonal relationships (28 items; e.g., "has a preferred friend of either sex," "initiates conversations on topics of particular interest to others"), play and leisure skills (20 items; e.g., "shares toys or possessions without being told to do so," "has a hobby"), and coping skills (18 items; e.g., "apologizes for unintentional mistakes," "uses appropriate table manners without being told"). Items are rated on a 3-point scale ranging from *yes, usually* to *no, never* to indicate if the child performs the activity or has the characteristic described. Raw scores from these three subdomains are summed and converted to a standard score which was used in the current analyses. Internal consistency alpha is not reported because the socialization domain items are consistent with an index rather a scale, and alpha is not an appropriate measure of reliability (Streiner, 2003).

Externalizing behavior—To measure externalizing behaviors at age 4, we used the parent-reported hostile-aggressive subscale ($\alpha = .76$; 11 items; e.g., “fights with other children,” “is disobedient”) of the Preschool Behavior Questionnaire (PBQ; Behar & Stringfield, 1974). Items on this measure are scored on a 3-point scale ranging from *doesn't apply* to *certainly applies*. Raw scores on relevant items were summed to create the subscale score. At ages 10 and 14 we measured child and adolescent externalizing behavior from the raw score of the Externalizing broad-band scale ($\alpha_{10\&14} = .89$) of the Child Behavior Checklist/4-18 (CBCL; Achenbach, 1991). Mothers rated their children's behavior across several domains on a 3-point scale ranging from *not true* to *very true or often true*. Scores on the CBCL Externalizing broad-band scale were log transformed due to their significant positive skew. We chose to use the PBQ instead of the CBCL at age 4 to reduce participant burden at this time point. However, these two measures are scored on a similar scale and assess many of the same age-appropriate behaviors.

Demographic covariates—We included several demographic covariates due to their documented influence on children's cognitive, social, and behavioral adjustment (e.g., Bornstein, 2010; Bradley & Corwyn, 2002; Hinshaw & Lee, 2003). Specifically, we examined the child's gender, mother's social desirability of responding (to manage any potential bias in the parent-reported measures included in the model), and family socioeconomic status (SES) as covariates at each time point. Maternal social desirability of responding was assessed at ages 10 and 14 with a short version of the Crowne-Marlowe Social Desirability Scale (SDS-SF; Reynolds, 1982; $\alpha_{10} = .71$, $\alpha_{14} = .69$), which includes 13 items to evaluate a participant's tendency to respond to items in a socially desirable manner (e.g., “I am always courteous, even to people who are disagreeable”; “I am always willing to admit when I make a mistake”). Responses are rated *yes/no*, with higher scores indicating that the participant is answering the items in a socially desirable and potentially biased manner (Bornstein et al., 2015). SES was measured according to the Hollingshead Index (1975). All covariates included in the final cascade models were significantly associated with at least three of the study variables (r s ranged from $-.02$, *ns*, to $.38$, p s $< .001$), supporting their inclusion as covariates in analyses.

Analysis Plan

Descriptive analyses were conducted in SPSS 21, and the cascade models were estimated in *Mplus* 7.2 (Muthén & Muthén, 2014). To account for the nested structure of the data from families where two children participated (i.e., first- and secondborns), we clustered based on family and used the Huber-White adjustment of the standard errors to account for non-independence. We used a maximum likelihood estimator that calculated robust standard errors (MLR; Little & Rubin, 2002). As with any longitudinal study, some data are missing due largely to attrition. Specifically, 32 (9.12%) children were missing some data at the 4-year assessment, 85 (24.22%) at the 10-year assessment, and 126 (35.90%) at the 14-year assessment. Overall, we had complete data at all three time points for 177 (50.43%) children. Missing data were handled with full-information maximum likelihood (FIML) in *Mplus*. We examined missing data for evidence of differential missingness by child gender, SES, and scores on the constructs at previous ages; all of these variables informed the FIML procedure. Families who were missing data at the 10-year assessment reported lower SES

than families who were not missing data at that time point, $t(312) = 3.49, p = .001$. As compared to families with complete data at the 14-year assessment, families with missing data at that time point reported lower SES, $t(312) = 3.06, p = .002$, lower age-4 Full Scale IQ WPPSI scores, $t(305) = 2.55, p = .011$, and lower age-4 Vineland socialization scores, $t(288) = 2.42, p = .016$. These findings suggest that families with missing data tended to be of lower SES and to have children with more difficulties in cognitive abilities and social adaptation. There was no further evidence of differential missingness.

Cascade modeling—We conducted a series of path analysis models in *Mplus* to evaluate the hypothesized cascade model. Path modeling was used as all constructs were indicated by one observed variable. This type of model allowed us to examine direct and indirect pathways among the three constructs of interest across the three time points. Specifically, we examined the indirect effects of the age-4 variables on the age-14 variables through the age-10 variables. These models also enabled us to evaluate the significance of the direct and indirect paths, over and above the stability in the constructs between adjacent time points and within-time correlations among the three domains.

Model building proceeded iteratively, with the within-domain stability paths and within-time correlations estimated first; all of these paths, regardless of their significance, were retained in subsequent models to control for stability in and covariation among the constructs. Next, we included the cross-time, cross-domain paths among child and adolescent cognitive abilities, social adaptation, and externalizing behavior, and the reverse order of these effects, such that each construct predicted the other two constructs at a subsequent time point. To consider the unique effects of these three constructs within a multivariate framework, all lag-1 cross-domain paths were included. This modeling approach allowed us to test each hypothesized path in the context of the other variables in the model. This model was tested, and nonsignificant paths were simultaneously removed. Covariates were then added to re-evaluate the cascade model controlling for child gender, mother social desirability of responding, and family SES. Specifically, child gender and family SES at age 4 were entered as time-invariant covariates and were regressed on all domains at all three time points. Mother's social desirability of responding was defined as a time-varying covariate at ages 10 and 14; that is, maternal social desirability of responding at age 10 was regressed on children's social, cognitive, and externalizing behaviors at age 10, and maternal responding at age 14 was regressed on the relevant domains at age 14. To account for stability across time and shared measurement variance, maternal social desirability of responding at ages 10 and 14 were allowed to correlate. We next examined the indirect effect of the identified cascade effects to test for mediation, over and above stability in and covariation among the constructs. Finally, we conducted nested model tests via the Satorra-Bentler scaled χ^2 -difference test (Satorra & Bentler, 2001) to test for gender invariance in our cascade model.

Assessing model fit—Given that the chi-square goodness of fit statistic tends to be sensitive to sample size and the size of the correlations between variables (Bentler & Bonett, 1980), we examined the root-mean-square error of approximation (RMSEA), comparative fit index (CFI), Tucker-Lewis Index (TLI), and standardized root mean square residual (SRMR) to evaluate the fit of all models; these indices are sensitive to model misspecification. For

RMSEA values .06 indicate close fit, for CFI and TLI values .90 indicate adequate fit (although values greater than .95 are preferable), and for SRMR values .08 indicate adequate fit (Hu & Bentler, 1999; Kline, 2010; Marsh, Hau, & Wen, 2004).

Results

Descriptive Statistics

Means, standard deviations, and intercorrelations of the main variables included in the cascade models are presented in Table 1. Correlations indicated significant within-domain stability over time as well as associations between higher cognitive abilities, better social adaptation, and fewer externalizing behaviors.

Cascade Model

The significant standardized path coefficients of the final covariate-controlled cascade model are presented in Figure 1. This model fit the data well, $\chi^2(18) = 25.84$, $p = .103$; CFI = .99, TLI = .95, RMSEA = .04, 90% CI for RMSEA[.00, .07], SRMR = .03. The within-domain paths from ages 4 to 10 and ages 10 to 14 demonstrated significant stability across time, such that higher cognitive abilities, social adaptation, and externalizing behavior at one time point predicted higher cognitive abilities, social adaptation, and externalizing behavior, respectively, at the next time point. Several significant cross-domain, within-time covariation paths also emerged. Specifically, at age 4, better cognitive abilities were related to higher social adaptation and fewer externalizing behavior problems; better social adaptation was also related to fewer externalizing behaviors. At age 10, better cognitive abilities and social adaptation were related to fewer externalizing behaviors. None of the cross-domain, within-time covariation paths was significant at age 14, which may be attributable to limited variance left in the model after accounting for the stability, correlation, and cross-lagged paths at the earlier time points.

Three cross-domain, cross-time paths emerged in the final model, indicating several two-wave cascade effects. Specifically, better cognitive abilities at age 10 predicted increased social adaptation from age 10 to age 14, higher social adaptation at age 4 predicted decreased externalizing behaviors from age 4 to age 10, and fewer externalizing behaviors at age 10 predicted increased social adaptation from age 10 to age 14. These two-wave cascade effects in turn combined to create four three-wave cascades, three of which were significant: (1) age-4 cognitive to age-10 cognitive to age-14 social (standardized indirect effect = .07, $p = .045$, 95% CI[.001, .13]; (2) age-4 social to age-10 externalizing to age-14 externalizing (standardized indirect effect = $-.14$, $p = .003$, 95% CI[$-.22$, $-.05$]; (3) age-4 social to age-10 externalizing to age-14 social (standardized indirect effect = .03, $p = .070$, 95% CI[$-.003$, .07]); and (4) age-4 externalizing to age-10 externalizing to age-14 social (standardized indirect effect = $-.06$, $p = .046$, 95% CI[$-.12$, $-.001$]).

Covariate effects—Covariates tested in the final cascade model included child gender, maternal social desirability of responding, and family SES. Maternal social desirability of responding did not significantly predict any of the domains at any of the ages included in the current study, and so was removed as a covariate from the cascade model. Gender predicted

children's social functioning at age 4 ($\beta = -.14, p = .015, 95\% \text{ CI}[-.25, -.03]$) and externalizing behaviors at ages 4 ($\beta = .14, p = .016, 95\% \text{ CI} [.03, .26]$) and 14 ($\beta = .12, p = .037, 95\% \text{ CI} [.01, .23]$), such that boys exhibited lower social functioning at age 4 as well as more externalizing behaviors (as expected) at age 4 and 14 as compared to girls. Additionally, higher family SES predicted better child cognitive functioning at ages 4 ($\beta = .32, p < .001, 95\% \text{ CI} [.20, .43]$), 10 ($\beta = .27, p < .001, 95\% \text{ CI} [.16, .38]$), and 14 ($\beta = .13, p = .006, 95\% \text{ CI} [.04, .22]$) as well as higher social functioning at age 14 ($\beta = .17, p = .042, 95\% \text{ CI} [.01, .33]$).

Gender differences—No significant gender differences emerged when comparing the final cascade model with no constraints to a cascade model constraining the stability and cross-lagged paths to be equal between boys and girls ($\chi^2(9) = 11.26, p = .258$). The cascade model incorporating these equality constraints fit the data well, $\chi^2(45) = 59.01, p = .079$; CFI = .97, TLI = .96, RMSEA = .04, 90% CI for RMSEA [.00, .07], SRMR = .10, suggesting similarities in the cascade effects for both boys and girls. We also determined that there were no gender differences in the four indirect effects ($z_{\text{indirect1}} = -0.09, p = .167$; $z_{\text{indirect2}} = -0.003, p = .568$; $z_{\text{indirect3}} = -.03, p = .501$; $z_{\text{indirect4}} = 0.09, p = .750$).

Discussion

Much research has documented associations among child and adolescent cognitive abilities, social adaptation, and externalizing behaviors (e.g., Crick & Dodge, 1994; Dodge et al., 2003; Hinshaw & Lee, 2003; Lansford et al., 2010; Masten et al., 2005; Oland & Shaw, 2005; Steinberg, 2005). However, many of these studies have only examined the bivariate relations between these constructs, and have focused on specific aspects of these broader factors (e.g., self-regulation, impulsivity, peer rejection). A broader theoretical, multivariate view is needed to clarify the timing, direction, and uniqueness of these effects. Cascade models are a particularly promising statistical and theoretical methodology as they are suited to examine the dynamic interplay of various constructs across development. These models have several important advantages over other regression-based models (e.g., standard path models, mediation models) as they simultaneously and conservatively control for stability, covariance, and cross-lagged paths among domains (Bornstein et al., 2010, 2013; Burt et al., 2008; Burt & Roisman, 2010; Masten & Cicchetti, 2010; Masten et al., 2005; Obradović et al., 2010). The current study therefore sought to identify cascade effects among child and adolescent cognitive abilities, social adaptation, and externalizing behaviors across development. Such findings may help identify when to intervene and what treatment targets will promote the development of positive outcomes, or prevent the occurrence of negative outcomes, in adolescence.

Consistent with the broader literature (Blandon et al., 2010; Fergusson, et al., 1996; Heller et al., 1996; Lansford et al., 2010; Lynam et al., 1993; Masten et al., 2005; Obradović et al., 2010), our findings indicated significant stability in child and adolescent cognitive abilities, social adaptation, and externalizing behaviors across time. It is important to recognize that the stability coefficients for social adaptation are relatively lower than those for cognitive abilities and externalizing behaviors, likely reflecting changes in children's social functioning across 10 years of development. Additionally, the Vineland items used to assess

social adaptation adjust depending on the age and maturation of the child/adolescent, which likely also reduced the magnitude of the stability coefficients. Regardless, this stability suggests that trajectories of individual differences in children's functioning and behavior through adolescence are established during the preschool years (or earlier), and they highlight the importance of *early* preventive interventions to address emerging difficulties. Poor childhood cognitive abilities, social adaptation, and behavioral adjustment have potential far-reaching impacts into adolescence (and perhaps beyond), including poor school performance, school dropout, antisocial behavior, substance use and abuse, and unemployment (Fergusson & Horwood, 1998; Kellam, Rebok, Ialongo, & Mayer, 1994). Therefore, the early application of prevention and intervention programs for children exhibiting cognitive and social difficulties and problematic behavior is of paramount importance.

Several cross-domain, cross-time associations also emerged in our analyses. Specifically, higher cognitive abilities at age 10 were related to better social adaptation at age 14, supporting the connection between cognitive and social functioning documented in the literature (e.g., Crick & Dodge, 1994). It is important to note that the relation between cognitive abilities and social adaptation was not observed at the earlier time point (i.e., age-4 cognitive abilities to age-10 social adaptation), in the reciprocal direction (i.e., social adaptation to cognitive abilities), or with externalizing behaviors. The timing of this effect may reflect the increasingly important role that peers play in the lives of older children and early adolescents (Bornstein, Jager, & Steinberg, 2012). These associations may therefore not appear until later in child development, when interpersonal and peer relationships become even more central to children's functioning. Consistent with previous research (Emmerich et al., 1979), and perhaps unsurprising given the high level of stability in cognitive functioning (Heller et al., 1996; Lansford et al., 2010), children's social adaptation and behavioral adjustment did not influence their cognitive abilities. Rather, this finding suggests that certain cognitive abilities may help children attend to social cues and understand the perspective of others, thereby enhancing social adaptation in adolescence (Blakemore & Choudhury, 2006).

We also identified reciprocal effects between child social adaptation and externalizing behaviors, such that better child social adaptation at age 4 predicted fewer externalizing behavior problems at age 10, and fewer externalizing behaviors problems at age 10 predicted better social adaptation at age 14. It is important to note that early externalizing behavior (age 4) did not predict social adaptation in middle childhood (age 10), and social adaptation in middle childhood did not predict externalizing behavior in adolescence (age 14). Consistent with social information processing theory (Crick & Dodge, 1994), it appears that children with poor social adaptation in early childhood lack the skills required to interact positively with peers, leading them to respond aggressively to social cues. Additionally, children demonstrating behavioral difficulties in middle childhood experience later difficulties in social adaptation (Dodge et al., 2003, 2015), perhaps due to peer rejection (Lansford et al., 2010). However, this link from externalizing behavior to social adaptation appears to emerge later in development, likely also reflecting the increasing significance of peers in adolescence and highlighting the crucial role that children's behavioral functioning plays during middle childhood. Drawing from transactional models of development

(Sameroff & Mackenzie, 2003), these findings suggest that it is important for future studies to address the interactive nature of these constructs.

These bivariate reciprocal effects combined across time to create several multivariate cascading effects. Specifically, the effect of children's early cognitive abilities on their social adaptation in early adolescence was mediated by their cognitive abilities in middle childhood. Additionally, the effect of social adaptation in preschool on externalizing behavior in adolescence was mediated by externalizing behavior in middle childhood; that is, children with better early social adaptation displayed fewer externalizing behaviors in middle childhood which in turn led to fewer externalizing behaviors and better social adaptation in adolescence. Last, externalizing behaviors in middle childhood mediated the effects of externalizing behaviors in preschool on social adaptation in adolescence such that fewer externalizing behaviors in early childhood predicted fewer externalizing behavior problems in middle childhood which in turn predicted better social adaptation in adolescence. Externalizing behavior in middle childhood did not mediate the effect of children's early social adaptation on their social adaptation in adolescence, suggesting that the effect of early social adaptation on later social adaptation operates largely through stability in this construct.

Our findings confirm the bivariate associations documented between pairs of these domains (e.g., Hinshaw & Lee, 2003; Lansford et al., 2010; Masten & Coatsworth, 1998; Oland & Shaw, 2005), and they extend the literature on these domains in several important ways. First, the current analyses were not bivariate in nature, as each cascade path controlled for no less than six other variables (e.g., stability, within-time associations, child gender, family SES, and social desirability bias). Indeed, these three-wave cascade effects were independent of stability in child and adolescent cognitive abilities, social adaptation, and externalizing behavior. As such, our findings conservatively model longitudinal relations among cognitive abilities, social adaptation, and externalizing behaviors in a multivariate framework across childhood and into adolescence. Second, our findings approach the evaluation of these constructs within a theoretical model, thereby clarifying the timing, direction, and uniqueness of these associations.

Prevention and Intervention Implications

The developmental cascade effects identified in the current study suggest that it may be important to target poor cognitive abilities, difficulties in social adaptation, and high levels of externalizing behaviors in early childhood, as prevention efforts in these domains may disrupt their stability and improve functioning in the other domains into adolescence (Kellam et al., 1994; Lochman & CPPRG, 1995). Externalizing behaviors at age 10 significantly mediated two of the four cascade effects identified in the current study. These findings suggest that middle childhood may be an ideal time to address children's behavior problems with intervention programming. Social adaptation in preschool may be another important treatment target, as better early social adaptation led to decreases in externalizing behaviors in middle childhood which were maintained into adolescence. Several intervention programs designed specifically for externalizing behaviors in childhood (e.g., Problem Solving Skills Training; Kazdin, Siegel, & Bass, 1992; Parent Management Training;

Kazdin, 2003) and social competence in preschool (e.g., Promoting Alternative Thinking Strategies [PATHS]; Domitrovich, Cortes, & Greenberg, 2007) show broad effects on behavior and on overall adjustment later in development.

The cascade effects documented in the current study also suggest that the use of multimodal interventions may help to enhance adolescent adjustment and well-being. For instance, the Coping Power Program (Lochman & Wells, 2002) targets elementary school children's aggressive and disruptive behavior by teaching social skills, emotion regulation, and coping strategies. As an additional example, Linking the Interest of Families and Teachers (LIFT) is a preventive intervention that targets externalizing behaviors in early adolescence through the implementation of behavioral management training with parents and teachers as well as a social and problem-solving modules with children (Eddy, Reid, Stoolmiller, & Fetrow, 2003). Our findings also suggest the need for a sequential approach to preventive intervention programming (i.e., adaptive interventions; Almirall & Chronis-Tuscano, 2016). Specifically, it may be important to target children's social skills in preschool followed by externalizing behavior interventions in middle childhood to promote a healthy transition into adolescence.

Strengths and Limitations

The current study has several strengths, including the implementation of a conservative longitudinal analysis to examine unique cross-domain associations among child and adolescent cognitive abilities, social adaptation, and externalizing behaviors. Cascade models allowed us to test whether cross-time, cross-domain effects were artifacts of the stability in and covariation among different constructs. This modeling technique also enabled us to establish temporal ordering and directionality of effects. Additionally, our multi-method (i.e., experimenter interview, objective assessment, maternal report of self and child) and multi-reporter (i.e., experimenter, child, mother) assessment reduced potential bias due to shared source and method variance. However, it is important to note that the Vineland, PBQ, and CBCL are all mother-reported measures; inclusion of measures from other reporters for the social adaptation and externalizing behaviors domains may have helped to reduce any potential reporter bias. Last, our longitudinal design allowed us to examine cognitive abilities, social adaptation, and externalizing behaviors across multiple developmental periods, beginning in preschool and extending through adolescence.

It is important to note several limitations to the current study as well. Our sample has some sociodemographic diversity but only focuses on one ethnic group (i.e., European Americans). Therefore, our findings may not generalize to other ethnic and sociodemographic populations. Indeed, our sample was relatively affluent and high-functioning (cognitive abilities were on average a standard deviation above an IQ of 100). This study therefore provides a picture of the dynamic relations among these constructs under ideal conditions. Replication of the cascade model presented here with more diverse populations, especially including minority and lower-SES populations, is an important direction for future research, as these effects may be different for families experiencing higher levels of risk and adversities. Furthermore, these cascade effects may be even stronger, perhaps extending into three-wave effects, among a sample demonstrating both

more diversity in demographics and broader variance in the constructs of interest. It is also not clear if the associations and cascading effects documented in the current study would be observed in clinical or at-risk populations. There were also changes in the measurement of cognitive abilities and externalizing behaviors during the course of this study. These measures were significantly correlated at the bivariate level (see Table 1) and demonstrated stability from age 4 to age 10, suggesting their equivalence, but stability may have been even stronger if the same measure had been used at all three time points. However, change in measurement may also be advantageous to the extent that it reduced the potential for inflation of stability coefficients due to practice effects and shared method variance. Measurement changes were also made to adjust for maturation in the participants over time, and as such ensured the developmental appropriateness of the measures at the three time points.

Conclusion

By examining the associations among cognitive functioning, social adaptation, and externalizing behavior across childhood and into adolescence, the results from the current study exposed developmental precursors to adolescent adjustment. Our results extend beyond bivariate relations that have been widely documented in the literature (e.g., Hinshaw & Lee, 2003; Lansford et al., 2010; Masten & Coatsworth, 1998; Oland & Shaw, 2005) in two important ways: (1) by conservatively modeling these effects in a cascading, multivariate framework across different developmental periods and (2) by approaching the evaluation of these constructs in a theoretical manner. Cascade models remain an underutilized analytic approach in the field of adolescent research, and so this study also provides a methodological contribution. Our findings clarify when developmental cascades are initiated and how constructs are related over time, and do so controlling for between-time stabilities and within-time relations in three domains central to child and adolescent development – cognitive abilities, social adaptation, and externalizing behavior. Specifically, it appears that social adaptation in preschool and externalizing behavior in middle childhood play particularly important roles in adolescent cognitive, social, and behavioral functioning. Prevention efforts in these domains may disrupt their persistence and improve functioning in the other domains across adolescent development.

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References

- Achenbach, T.M. Integrative guide for the 1991 CBCL/4- 18, YSR, and TRF profiles. Burlington, VT: University of Vermont, Department of Psychiatry; 1991.
- Adams GR. Social competence during adolescence: Social sensitivity, locus of control, empathy, and peer popularity. *Journal of Youth and Adolescence*. 1983; 12:203–211. DOI: 10.1007/BF02090986 [PubMed: 24306261]

- Almirall D, Chronis-Tuscano A. Adaptive interventions in child and adolescent mental health. *Journal of Clinical Child & Adolescent Psychology*. 2016; 45:383–395. DOI: 10.1080/15374416.2016.1152555 [PubMed: 27310565]
- Behar L, Stringfield S. A behavior rating scale for the preschool child. *Developmental Psychology*. 1974; 10:601–610. DOI: 10.1037/h0037058
- Bentler PM, Bonett DG. Significance tests and goodness of fit in the analysis of covariance structures. *Psychological Bulletin*. 1980; 88:588–606. DOI: 10.1037/00332909.88.3.588
- Blakemore SJ, Choudhury S. Development of the adolescent brain: Implications for executive function and social cognition. *Journal of Child Psychology and Psychiatry*. 2006; 47:296–312. DOI: 10.1111/j.1469-7610.2006.01611.x [PubMed: 16492261]
- Blandon AY, Calkins SD, Grimm KJ, Keane SP, O'Brien M. Testing a developmental cascade model of emotional and social competence and early peer acceptance. *Development and Psychopathology*. 2010; 22:737–748. DOI: 10.1017/S0954579410000428 [PubMed: 20883578]
- Bornstein, MH. Parents' reports about their children's lives. In: Ben-Arieh, A. Cashmore, J. Goodman, G. Kampmann, J., Melton, G., editors. *Handbook of child research*. Thousand Oaks, CA: Sage; 2010. p. 486-533.
- Bornstein MH, Hahn CS, Haynes OM. Social competence, externalizing, and internalizing behavioral adjustment from early childhood through early adolescence: Developmental cascades. *Development and Psychopathology*. 2010; 22:717–735. DOI: 10.1017/S0954579410000416 [PubMed: 20883577]
- Bornstein MH, Hahn CS, Suwalsky JTD. Developmental pathways among adaptive functioning and externalizing and internalizing behavioral problems: Cascades from childhood into adolescence. *Applied Developmental Science*. 2013; 17:76–87. DOI: 10.1080/10888691.2013.774875 [PubMed: 23585713]
- Bornstein, MH., Jager, J., Steinberg, LD. Adolescents, parents, friends/peers: A relationships model. In: Weiner, I., editor. *Handbook of Psychology*. 2nd. Vol. 6. New York: Wiley; 2012. p. 393-433. R. M. Lerner, M. A. Easterbrooks, & J. Mistry (Eds.), *Developmental Psychology*
- Bornstein MH, Putnick DL, Lansford JE, Pastorelli C, Skinner AT, Sorbring E, Oburu P. Mother and father socially desirable responding in nine countries: Two kinds of agreement and relations to parenting self-reports. *International Journal of Psychology*. 2015; 50:174–185. DOI: 10.1002/ijop.12084 [PubMed: 25043708]
- Bradley RH, Corwyn RF. Socioeconomic status and child development. *Annual Review of Psychology*. 2002; 53:371–399. DOI: 10.1146/annurev.psych.53.100901.135233
- Burt KB, Obradović J, Long JD, Masten AS. The interplay of social competence and psychopathology over 20 years: Testing transactional and cascade models. *Child Development*. 2008; 79:359–374. DOI: 10.1111/j.1467-8624.2007.01130.x [PubMed: 18366428]
- Burt KB, Roisman GI. Competence and psychopathology: Cascade effects in the NICHD study of early child care and youth development. *Development and Psychopathology*. 2010; 22:557–567. DOI: 10.1017/S0954579410000271 [PubMed: 20576178]
- Choudhury S, Blakemore SJ, Charman T. Social cognitive development during adolescence. *Social Cognitive and Affective Neuroscience*. 2006; 1:165–174. DOI: 10.1093/scan/nsl024 [PubMed: 18985103]
- Compas BE, Hinden BR, Gerhardt CA. Adolescent development: Pathways and processes of risk and resilience. *Annual Review of Psychology*. 1995; 46:265–293. DOI: 10.1146/annurev.ps.46.020195.001405
- Cook ET, Greenberg MT, Kusche CA. The relations between emotional understanding, intellectual functioning, and disruptive behavior problems in elementary-school-aged children. *Journal of Abnormal Child Psychology*. 1994; 22:205–219. DOI: 10.1007/BF02167900 [PubMed: 8064029]
- Crick NR, Dodge KA. A review and reformulation of social information-processing mechanisms in children's social adjustment. *Psychological Bulletin*. 1994; 115:74–101. DOI: 10.1037/0033-2909.115.1.74
- Crick NR, Dodge KA. Social information-processing mechanisms in reactive and proactive aggression. *Child Development*. 1996; 67:993–1002. DOI: 10.2307/1131875 [PubMed: 8706540]
- Dodge KA, Greenberg MT, Malone PS, Conduct Problems Prevention Research Group. Testing an idealized dynamic cascade model of the development of serious violence in adolescence. *Child*

- Development. 2008; 79:1907–1927. DOI: 10.1111/j.1467-8624.2008.01233.x [PubMed: 19037957]
- Dodge KA, Lansford JE, Burks VS, Bates JE, Pettit GS, Fontaine R, Price JM. Peer rejection and social information-processing factors in the development of aggressive behavior problems in children. *Child Development*. 2003; 74:374–393. DOI: 10.1111/1467-8624.7402004 [PubMed: 12705561]
- Dodge KA, Malone PS, Lansford JE, Sorbring E, Skinner AT, Tapanya S, Pastorelli C. Hostile attributional bias and aggressive behavior in global context. *Proceedings of the National Academy of Science*. 2015; 112:9310–9315. DOI: 10.1073/pnas.1418572112
- Dodge KA, Pettit GS. A biopsychosocial model of the development of chronic conduct problems in adolescence. *Developmental Psychology*. 2003; 39:349–371. DOI: 10.1037/0012-1649.39.2.349 [PubMed: 12661890]
- Domitrovich CE, Cortes RC, Greenberg MT. Improving young children's social and emotional competence: A randomized trial of the preschool "PATHS" curriculum. *The Journal of Primary Prevention*. 2007; 28:67–91. DOI: 10.1007/s10935-007-0081-0 [PubMed: 17265130]
- Eddy JM, Reid JB, Stoolmiller M, Fetrow RA. Outcomes during middle school for an elementary school-based preventive intervention for conduct problems: Follow-up results from a randomized trial. *Behavior Therapy*. 2003; 34:535–552.
- Emmerich W, Cocking RR, Sigel IE. Relationships between cognitive and social functioning in preschool children. *Developmental Psychology*. 1979; 15:495–504. DOI: 10.1037/0012-1649.15.5.495
- Emond A, Ormel J, Veenestra R, Oldehinkel AJ. Preschool behavioral and social-cognitive problems as predictors of (pre)adolescent disruptive behavior. *Child Psychiatry and Human Development*. 2007; 38:221–236. DOI: 10.1007/s10578-007-0058-5 [PubMed: 17476586]
- Fergusson DM, Horwood LJ. Early disruptive behavior, IQ, and later school achievement and delinquent behavior. *Journal of Abnormal Child Psychology*. 1995; 23:183–199. DOI: 10.1007/BF01447088 [PubMed: 7642833]
- Fergusson DM, Horwood LJ. Early conduct problems and later life opportunities. *Journal of Child Psychology and Psychiatry*. 1998; 39:1097–1108. DOI: 10.1111/1469-7610.00414 [PubMed: 9844980]
- Fergusson DM, Lynskey MT, Horwood LJ. Factors associated with continuity and changes in disruptive behavior patterns between childhood and adolescence. *Journal of Abnormal Child Psychology*. 1996; 24:533–553. DOI: 10.1007/BF01670099 [PubMed: 8956083]
- Harrington RO, Kimbrell J, Dai X. The relationship between the Woodcock-Johnson psycho-educational battery-revised (early development) and the Wechsler Preschool and Primary Scale of Intelligence-revised. *Psychology in the Schools*. 1992; 29:116–125. DOI: 10.1002/1520-6807(199204)29:2<116::AID-PITS2310290205>3.0.CO;2-B
- Heller TL, Baker BL, Henker B, Hinshaw SP. Externalizing behavior and cognitive functioning from preschool to first grade: Stability and predictors. *Journal of Clinical Child Psychology*. 1996; 25:376–387. DOI: 10.1207/s15374424jccp2504_3
- Hinshaw SP, Lee SS. Conduct and oppositional defiant disorders. In: Mash, EJ., Barkley, RA., editors. *Child psychopathology*. 2nd. New York: Guilford Press; 2003. p. 144–198.
- Hollingshead, AB. Four-factor index of social status. New Haven, CT: Yale University; 1975. Unpublished manuscript
- Hu LT, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*. 1999; 6:1–55. DOI: 10.1080/10705519909540118
- Hughes C, Ensor R. Individual differences in growth in executive function across the transition to school predict externalizing and internalizing behaviors and self-perceived academic success at 6 years of age. *Journal of Experimental Child Psychology*. 2011; 108:663–676. DOI: 10.1016/j.jecp.2010.06.005 [PubMed: 20673580]
- Kazdin, AE. Parent management training: Treatment for oppositional, aggressive, and antisocial behavior in children and adolescents. New York: Oxford University Press, Inc.; 2005.

- Kazdin AE, Siegel TC, Bass D. Cognitive problem-solving skills training and parent management training in the treatment of antisocial behavior in children. *Journal of Consulting and Clinical Psychology*. 1992; 60:733–747. DOI: 10.1037/0022-006X.60.5.733 [PubMed: 1401389]
- Kellam S, Rebok GW, Ialongo N, Mayer LS. The course and malleability of aggressive behavior from early first grade into middle school: Results of a developmental epidemiologically-based preventive trial. *Journal of Child Psychology and Psychiatry and Allied Disciplines*. 1994; 35:259–281. DOI: 10.1111/j.1469-7610.1994.tb01161.x
- Kline, RB. *Principles and practice of structural equation modeling*. 3rd. New York: Guilford Press; 2010.
- Lansford JE, Malone PS, Dodge KA, Pettit GS, Bates JE. Developmental cascades of peer rejection, social information processing biases, and aggression during middle childhood. *Development and Psychopathology*. 2010; 22:593–602. DOI: 10.1017/S0954579410000301 [PubMed: 20576181]
- Little, RJ., Rubin, DB. *Statistical analysis with missing data*. 2nd. New York: Wiley Interscience; 2002.
- Lochman JE, Conduct Problems Prevention Research Group. Screening of child behavior problems for prevention programs at school entry. *Journal of Consulting and Clinical Psychology*. 1995; 63:549–559. DOI: 10.1037//0022-006X.63.4.549 [PubMed: 7673532]
- Lochman JE, Wells KC. Contextual social-cognitive mediators and child outcome: A test of the theoretical model in the Coping Power program. *Development and Psychopathology*. 2002; 14:945–967. DOI: 10.1017/S0954579402004157 [PubMed: 12549711]
- Lynam D, Moffitt T, Stouthamer-Loeber M. Explaining the relation between IQ and delinquency: Class, race, test motivation, school failure, or self-control? *Journal of Abnormal Psychology*. 1993; 102:187–196. DOI: 10.1037//0021-843X.102.2.187 [PubMed: 8315131]
- Marsh HW, Hau KT, Wen Z. In search of golden rules: Comment on hypothesis-testing approaches to setting cutoff values for fit indexes and dangers in overgeneralizing Hu and Bentler's (1999) findings. *Structural Equation Modeling*. 2004; 11:320–341. DOI: 10.1207/s15328007sem1103_2
- Masten AS, Cicchetti D. Developmental cascades. *Development and Psychopathology*. 2010; 22:491–495. DOI: 10.1017/S0954579410000222 [PubMed: 20576173]
- Masten AS, Coatsworth JD. The development of competence in favorable and unfavorable environments: Lessons from research on successful children. *American Psychologist*. 1998; 53:205–220. DOI: 10.1037/0003-066X.53.2.205 [PubMed: 9491748]
- Masten AS, Roisman GI, Long JD, Burt KB, Obradovi J, Riley JR, Tellegen A. Developmental cascades: Linking academic achievement and externalizing and internalizing symptoms over 20 years. *Developmental Psychology*. 2005; 41:733–746. DOI: 10.1037/0012-1649.41.5.733 [PubMed: 16173871]
- McLeod JD, Kaiser K. Childhood emotional and behavioral problems and educational attainment. *American Sociological Review*. 2004; 69:636–658. DOI: 10.1177/000312240406900502
- Moffitt TE. Adolescence-limited and life-course persistent antisocial behavior: A developmental taxonomy. *Psychological Review*. 1993; 100:674–701. DOI: 10.1037/0033-295X.100.4.674 [PubMed: 8255953]
- Moffitt TE, Lynam DR, Silva PA. Neuropsychological tests predicting persistent male delinquency. *Criminology*. 1994; 32:277–300. DOI: 10.1111/j.1745-9125.1994.tb01155.x
- Moilanen KL, Shaw DS, Maxwell KL. Developmental cascades: Externalizing, internalizing, and academic competence from middle childhood to early adolescence. *Development and Psychopathology*. 2010; 22:635–653. DOI: 10.1017/S0954579410000337 [PubMed: 20576184]
- Muthén, B., Muthén, L. *Mplus (version 7.2)*. Los Angeles, CA: Authors; 2014.
- Nangle DW, Erdley C, Carpenter EM, Newman JE. Social skills training as a treatment for aggressive children and adolescents: A developmental-clinical integration. *Aggression and Violent Behavior*. 2002; 7:169–199. DOI: 10.1016/S1359-1789(00)00040-9
- Nigg JT, Quamma JP, Greenberg MT, Kusche CA. A two-year longitudinal study of neuropsychological and cognitive performance in relation to behavioral problems and competences in elementary school children. *Journal of Abnormal Child Psychology*. 1999; 27:51–63. DOI: 10.1023/A:1022614407893 [PubMed: 10197406]

- Obradovi J, Burt KB, Masten AS. Testing a dual cascade model linking competence and symptoms over 20 years from childhood to adulthood. *Journal of Clinical Child & Adolescent Psychology*. 2010; 39:90–102. DOI: 10.1080/15374410903401120 [PubMed: 20390801]
- Oland AA, Shaw DS. Pure versus co-occurring externalizing and internalizing symptoms in children: The potential role of socio-developmental milestones. *Clinical Child and Family Psychology Review*. 2005; 8:247–270. DOI: 10.1007/s10567-005-8808-z [PubMed: 16362255]
- Racz SJ, King KM, Wu J, Witkiewitz K, McMahon RJ, the Conduct Problems Prevention Research Group. The predictive utility of a brief kindergarten screening measure of child behavior problems. *Journal of Consulting and Clinical Psychology*. 2013; 81:588–599. [PubMed: 23544679]
- Raine A, Yaralian PS, Reynolds C, Venables PH, Mednick SA. Spatial but not verbal cognitive deficits at age 3 years in persistently antisocial individuals. *Development and Psychopathology*. 2002; 14:25–44. DOI: 10.1017/S0954579402001025 [PubMed: 11893093]
- Reynolds WM. Development of reliable and valid short forms of the Marlowe-Crowne Social Desirability Scale. *Journal of Clinical Psychology*. 1982; 38:119–125. DOI: 10.1002/1097-4679(198201)38:13.0.CO;2-I
- Rudolph KD, Clark AG. Conceptions of relationships in children with depressive and aggressive symptoms: Social-cognitive distortion or reality? *Journal of Abnormal Child Psychology*. 2001; 29:41–56. DOI: 10.1023/A:1005299429060 [PubMed: 11316334]
- Salmivalli C, Kaukiainen A, Lagerspetz K. Aggression and sociometric status among peers: Do gender and type of aggression matter? *Scandinavian Journal of Psychology*. 2000; 41:17–24. DOI: 10.1111/1467-9450.00166 [PubMed: 10731839]
- Sameroff AJ, Mackenzie MJ. Research strategies for capturing transactional models of development: The limits of the possible. *Development and Psychopathology*. 2003; 15:613–640. DOI: 10.1017/S0954579403000312 [PubMed: 14582934]
- Satorra A, Bentler PM. A scaled difference chi-square test statistic for moment structure analysis. *Psychometrika*. 2001; 66:333–343. DOI: 10.1007/BF02296192
- Sattler, JM. *Assessment of children: Revised and Updated Third Edition*. San Diego, CA: Jerome M. Sattler, Publisher, Inc; 1992.
- Sparrow, SS., Balla, DA., Cicchetti, DV. *Vineland Adaptive Behavior Scales*. Circle Pines, MN: American Guidance Service, Inc; 1984. (Interview Edition)
- Spear LP. The adolescent brain and age-related behavioral manifestations. *Neuroscience and Biobehavioral Review*. 2000; 24:417–463. DOI: 10.1016/S0149-7634(00)00014-2
- Steinberg L. Cognitive and affective development in adolescence. *TRENDS in Cognitive Sciences*. 2005; 9:69–74. DOI: 10.1016/j.tics.2004.12.005 [PubMed: 15668099]
- Steinberg L, Morris AS. Adolescent development. *Annual Review of Psychology*. 2001; 52:83–110. DOI: 10.1146/annurev.psych.52.1.83
- Streiner DL. Being inconsistent about consistency: When coefficient alpha does and doesn't matter. *Journal of Personality Assessment*. 2003; 80:217–222. DOI: 10.1207/S15327752JPA8003_01 [PubMed: 12763696]
- Sutton J, Smith PK, Swettenham J. Social cognition and bullying: Social inadequacy or skilled manipulation? *British Journal of Developmental Psychology*. 1999; 17:435–450. DOI: 10.1348/026151099165384
- Trentacosta CJ, Shaw DS. Emotional self-regulation, peer rejection, and antisocial behavior: Developmental associations from early childhood to early adolescence. *Journal of Applied Developmental Psychology*. 2009; 30:356–365. DOI: 10.1016/j.appdev.2008.12.016 [PubMed: 20161105]
- Toupin J, Déry M, Pauzé R, Mercier H, Fortin L. Cognitive and familial contributions to conduct disorder in children. *Journal of Child Psychology and Psychiatry*. 2000; 41:333–344. DOI: 10.1111/1469-7610.00617 [PubMed: 10784080]
- U.S. Department of Education, Planning and Evaluation Service, Elementary and Secondary Education Division. *Third national Even Start evaluation: Program impacts and implications for improvement*. Washington, DC: U. S. Department of Education; 2003.

- van Goozen SHM, Fairchild G, Snoek H, Harold GT. The evidence for a neurobiological model of childhood antisocial behavior. *Psychological Bulletin*. 2007; 133:149–182. DOI: 10.1037/0033-2909.133.1.149 [PubMed: 17201574]
- Wechsler, D. Wechsler Preschool and Primary Scale of Intelligence-Revised. San Antonio, TX: Psychological Corporation; 1989.
- Woodcock, RW., Johnson, MB. Woodcock-Johnson Revised Tests of Achievement. Allen, TX: DLM Teaching Resources; 1989.

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Figure 1.

Final covariate-controlled cascade model (covariate effects are not shown here for ease of presentation). Standardized paths are shown; numbers in brackets indicate 95% confidence intervals.

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 1

Means, Standard Deviations, and Correlations of Cascade Model Variables

Variable	1	2	3	4	5	6	7	8	9
<i>Age 4</i>									
1. Vineland	–								
2. WPPSI-R	.26***	–							
3. PBQ agg	-.15*	-.18**	–						
<i>Age 10</i>									
4. Vineland	.21**	.09	-.08	–					
5. WJ-R	.07	.56***	-.05	.04	–				
6. CBCL Ext	-.24**	-.17*	.44***	-.23**	-.22**	–			
<i>Age 14</i>									
7. Vineland	.22**	.18*	-.12	.34***	.22**	-.33***	–		
8. WJ-R	.08	.55***	-.08	-.02	.80***	-.28***	.21**	–	
9. CBCL Ext	-.16	-.06	.35***	-.30***	-.19*	.65***	-.30***	-.21**	–
Mean	99.83	111.61	5.49	98.02	117.47	7.44	99.98	112.51	7.61
(SD)	(11.37)	(15.92)	(2.88)	(12.80)	(12.02)	(6.55)	(15.43)	(13.38)	(6.74)

Note. Vineland = Vineland Socialization domain; WPPSI-R = Wechsler Preschool and Primary Scale of Intelligence-Revised; PBQ agg = Preschool Behavior Questionnaire hostile-aggressive subscale; WJ-R = Woodcock-Johnson Revised Tests of Achievement; CBCL Ext = Child Behavior Checklist Externalizing subscale.

* $p < .05$,

** $p < .01$,

*** $p < .001$.