

The influence of perinatal complications and environmental adversity on boys' antisocial behavior

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Background: The purpose of the present study was to test components of Raine's (2002) biosocial model, specifically the interactive effects of perinatal complications, rejecting parenting, and family adversity on the development of early-onset antisocial behavior (ASB). Boys' internalizing problems were also tested to investigate the specificity of the model. **Methods:** Birth records in addition to longitudinal data were collected on 310 low-income boys followed from birth until 10 years of age. **Results:** Findings demonstrated support for a biosocial framework in predicting ASB but not internalizing problems. Family adversity, and to some extent rejecting parenting, consistently predicted youth outcome. Perinatal complications emerged as a predictor of ASB but only in the context of other family risk factors. According to maternal report, boys experiencing high levels of perinatal complications, rejecting parenting, and family adversity showed significantly higher levels of ASB than boys with lower levels of these risk factors. This finding was partially corroborated by youth self-report, such that boys experiencing high levels of perinatal complications and family adversity reported more antisocial activity than boys experiencing no risk or risk in only one domain. **Conclusions:** This study supports the specific prediction of ASB in middle childhood from a biosocial model. Findings also highlight the salience of a negative psychosocial environment on childhood maladjustment. Intervention efforts including parenting skills and coping strategies for mothers of children from multiple risk environments are advocated. **Keywords:** Perinatal complications, antisocial behavior, family adversity, high-risk sample. **Abbreviations:** ASB: antisocial behavior.

Recently there has been an increased interest in antisocial behavior that emerges early in childhood and persists into adulthood. Contributing to this interest is the growing evidence that 5–6% of the most persistent offenders are responsible for 50% of known crimes (Aguilar, Sroufe, Egeland, & Carlson, 2000). Moreover, individuals performing antisocial acts are difficult to rehabilitate and are likely to become recidivistic (Kazdin, 1987; Moffitt, 1993a). Thus, identifying risk factors of early antisocial behavior has important implications for enhancing both intervention and prevention efforts.

Raine (2002) has proposed a biosocial model to account for the contribution of both biologically and environmentally related risk factors on the development of antisocial behavior (ASB). One group of studies testing the biosocial model has focused on perinatal complications and environmental adversity, noting a consistent interaction between the presence of both of these factors and the development of serious antisocial behavior in adulthood (Arseneault, Tremblay, Boulerice, & Saucier, 2002; Piquero & Tibbetts, 1999; Raine, Brennan, Mednick, & Mednick, 1997). Research investigating the biosocial model has illuminated potential

constructs for increasing the prediction of adult antisocial behavior. However, from a developmental perspective, two important linkages in the model have received modest or only superficial attention with respect to childhood-onset ASB. First, few studies have examined whether the biosocial model predicts behavior problems in middle childhood. For the two studies that have investigated childhood outcomes of ASB, the results for an interaction between perinatal complications and family adversity have proven inconsistent (Arseneault et al., 2002; Laucht et al., 2000). Second, the measures of environmental risk used in these studies typically have been distal. In this vein, the main goal of the present study was to test components of the biosocial model on early-onset ASB. It was hypothesized that the association between perinatal complications and child ASB would be moderated by high levels of family risk factors, such that the adverse effects of perinatal complications on boys' ASB would be evident only under conditions of high family adversity. The following sections review literature pertaining to perinatal complications and constructs of environmental adversity used in the present study, namely rejecting parenting and cumulative family adversity.

Perinatal complications

Research has suggested that there are multiple risk factors and pathways associated with the development of antisocial behavior during early and middle childhood (Cicchetti & Rogosch, 1996). One such risk factor is maternal health status which, when compromised during pregnancy, has been associated with impaired functioning of offspring's central nervous system (CNS) and subsequent problems in the child's well-being (Moffitt, 1993a, 1993b). Complications during the prenatal (conception to 7th month of pregnancy) and perinatal (7th month of pregnancy through 28 days after birth) periods are early factors affecting CNS development and have been tested individually as predictors of deviant outcomes (for a review see Brennan & Mednick, 1997). The most consistent relations have been found between complications during the perinatal stage and later ASB (Kandel & Mednick, 1991). Direct relations between perinatal complications and ASB have not typically been demonstrated (Cohen, Velez, Brook, & Smith, 1989; Rantakillio, Koiranen, & Moettoenen, 1992). However, in the context of family adversity, high levels of perinatal complications have been associated with increased risk of child ASB (Broman, Nichols, & Kennedy, 1975; Drillien, 1964; Werner, Bierman, & French, 1971).

Recent empirical research testing the biosocial interaction hypothesis has demonstrated that relations between perinatal complications and later ASB are moderated by environmental adversity (Arseneault et al., 2002; Laucht et al., 2000; Piquero & Tibbetts, 1999; Raine, Brennan, & Mednick, 1994, 1997; Werner, 1987). In a Danish birth cohort of males, Raine and colleagues (1994, 1997) found that boys who suffered both perinatal complications and early maternal rejection were most likely to become violent offenders in adulthood. Arseneault and colleagues (2002) also found support for the biosocial model in a low-income sample of 849 boys. Their results demonstrated that a combination of perinatal complications posing imminent harm to the infant predicted elevated rates of physical aggression at ages 6 and 17 years in boys when children were reared in impoverished environments.

Environmental risk

A substantial amount of research links aspects of a child's environment to the development of ASB. Both proximal and distal factors of the child's environment have been related to ASB, including parenting and the accumulation of less proximal environmental risk factors (e.g., low SES and marital conflict).

Parenting. A number of studies suggest that the quality of early parental care, such as unresponsiveness and rejection, plays a significant role in the

development of early-onset ASB (Campbell, Shaw, & Gilliom, 2000; Shaw, Ingoldsby, Gilliom, & Nagin, 2003). Parental responsiveness, sensitivity to social cues, and emotional availability have all been associated with positive outcomes in young children, such as behavioral regulation and social competence (Bost, Vaughn, Washington, Cielinski, & Bradbard, 1998; Martin, 1981; Wakschlag & Hans, 1999). A lack of parental responsiveness during infancy, however, has been associated with negative outcomes, such as ASB, later in childhood (e.g., Shaw, Keenan, & Vondra, 1994a; Shaw et al., 1998b; Wakschlag & Hans, 1999). Parental rejection, the combination of harsh and controlling parenting practices coupled with unacceptance of the child, also has been linked with the development of later ASB (Campbell, Pierce, Moore, & Marakovitz, 1996; Dishion, 1990; Dodge, Pettit, & Bates, 1994; Younge, Oetting, & Deffenbacher, 1996). The present study investigated a blend of these two parenting factors, which from this point will be referred to as 'rejecting parenting' for the sake of brevity.

Cumulative family adversity. A number of studies support a 'cumulative risk hypothesis,' wherein the number of environmental stressors rather than the particular combination of stressors, has been associated with child behavior problems both concurrently and longitudinally (Deater-Deckard, Dodge, Bates, & Pettit, 1998; Rutter, Cox, Tupling, Berger, & Yule, 1975a; Rutter et al., 1975b; Sameroff, Seifer, Zax, & Barocas, 1987; Sanson, Oberklaid, Pedlow, & Prior, 1991; Shaw, Vondra, Hommerding, Keenan, & Dunn, 1994b; Shaw, Winslow, Owens, & Hood, 1998a). In their classic study, Rutter and colleagues (1975a, 1975b) found a dramatic rise in the probability of child adjustment difficulties as the number of family stressors increased. Sameroff and his colleagues (1987) tested the impact of three sets of variables on children's behavior and found that children with high multiple environmental risk scores had much worse outcomes than children with low multiple risk scores. In two longitudinal studies, Shaw and colleagues (1994b, 1998a) also demonstrated support for the 'family adversity hypothesis' in early childhood by examining its effects on boys starting in infancy. They showed that boys' internalizing and externalizing behavior problems at ages 2 to 3.5 increased in a linear fashion with respect to the number of family stressors present in the first two years.

The goal of the present study was to test components of the biosocial model proposed by Raine (2002), specifically examining the interactive effects of perinatal complications, rejecting parenting, and family adversity on the development of early-onset ASB. This research has the potential to advance the biosocial model because of the examination of

early environmental risk factors, the use of multiple informants and repeated measures, and a test of specificity. Prospective data were collected from birth to 10 years of age on a racially diverse, high-risk sample of boys from a metropolitan area in the United States. Unlike previous studies which have used distal proxies of maternal rejection, such as an attempt to abort the fetus (Raine et al., 1997), the present study measured maternal parenting using observational and interview data when the boys were 2 years old. In previous studies, measures of environmental adversity have been based on indices of socioeconomic status (e.g., Arseneault et al., 2002). Our study improved upon this practice by creating a cumulative family adversity index comprised of several proximal facets of the child's home environment measured prospectively and repeatedly over time. Child internalizing problems were included to explore the specificity of the bio-social model to child ASB (Laucht et al., 2000). Specifically, we hypothesized that data on proximal family processes (parenting and quality of home environment) would increase our understanding of potential mechanisms underlying the interaction between perinatal complications and family adversity, an issue that to date has only examined the quality of the family environment from a distal perspective (e.g., socioeconomic status of family versus having observations of parenting behavior). Three hypotheses were tested in relation to later child ASB. First, based on the evidence reviewed above (e.g., Kandel & Mednick, 1991; Raine et al., 1994, 1997), perinatal risk was not expected to be directly related to later ASB. However, based on previous research (e.g., Sameroff et al., 1987; Shaw et al., 1994a, 1998b), direct relations were anticipated to emerge between rejecting parenting, family adversity, and ASB. Second, in accordance with biosocial theory and previous studies (e.g., Arseneault et al., 2002; Raine et al., 1994, 1997), we predicted that children with risk factors from both biological and environmental domains would be at greater risk for later ASB. Specifically, children who experienced high levels of perinatal complications in addition to high levels of rejecting parenting or family adversity were expected to be at greater risk for later ASB. Third, based on previous research (Rutter et al., 1975a, 1975b; Sameroff et al., 1987; Shaw et al., 1994b, 1998a), we anticipated the effects of perinatal complications on child ASB to be most evident within the context of maximum family adversity. In particular, we expected a significant three-way interaction, such that children who experienced high levels of perinatal complications along with high levels of rejecting parenting *and* family adversity would demonstrate higher levels of later ASB than children with only one or two of these risk factors.

Methods

Participants

Families were selected from the Pitt Mother and Child Project, an ongoing longitudinal study aimed at examining the antecedents of children's antisocial behavior. Initially, 310 families with boys between the ages of 6 and 17 months were recruited from Women, Infant, and Children (WIC) Nutritional Supplement Program clinics in the metropolitan Pittsburgh area. The WIC program provides nutritional resources to income-eligible families. In addition to having a son between the ages of 6 and 17 months, the families were required to have another sibling living at home. Mothers and their sons were formally assessed for the first time when the target child was 1.5 years old. The sample consists of 40% African-American, 54% Caucasian families, and 6% other. At recruitment, the average educational level of mothers was 12.5 years and mean per capita income was \$2,892 per year. Observations of parent-child interaction and maternal- and youth-report data were collected at the lab and/or home when the target child was 1.5, 2, 3.5, 8, and 10 years old (i.e., youth report at age 10 only).

All boys whose birth records were obtained and whose families participated in the age 1.5-, 2-, and/or 3.5-year visits, as well as the age 8- and/or 10-year visit, were selected for inclusion in this study. Based on these criteria, approximately 250 families, or 81% of all families at recruitment, were included in the analyses. Comparisons of boys whose birth records were obtained versus those whose were not available revealed no significant differences on any index of child adjustment at ages 8 and 10 years.

Procedures

During the age 1.5- and 2-year laboratory visits, mothers completed questionnaires, provided demographic information, and engaged in interactive tasks with their sons. A home assessment at age 2, which took place on the same day as the laboratory visit, was conducted to gather observational data on the home environment and parenting. The age-3.5 assessment consisted of one laboratory visit, in which mothers completed questionnaires and participated in several structured tasks with their child. At the age 8 and 10 home assessments, mothers and sons completed questionnaires about the boys' behavior with the examiner. All laboratory visits were videotaped through a one-way mirror.

Measures

Predictor variables

Perinatal complications. Written consent to access birth records was obtained from mothers at the time of the first lab assessment when the boys were 1.5 years old, and admission to medical records was requested directly from hospitals. The first author and research assistants visited hospitals in the metropolitan area and copied pertinent information from the mothers' and/or boys' medical records. Some records were obtained from hospitals via postal mail. Seventy-six

percent of birth records were obtained from nine teaching/university-based hospitals. The remaining 24% were obtained from six community hospitals.

The present study employed the same weighted scale system for perinatal complications used in previous research studies (Kandel & Mednick, 1991; Mednick, Hocevar, Baker, & Teasdale, 1983; Raine et al., 1996, 1997).¹ This weighted-severity scale was developed by the collaboration of American and Danish obstetricians and pediatric neurologists and was derived from a 'logical and clinical approach' as opposed to factor or cluster analysis techniques. The complete list of complications and the severity ratings for this weighted scoring system were obtained from the authors and are presented in the Appendix. Items were weighted on a scale of 0–5 according to the judged severity of the complication or deviance, with the most severe complication score being recorded.

Home Observation for Measurement of the Environment Inventory (HOME; Caldwell & Bradley, 1984) and Early Parenting Coding System (EPCS; Winslow & Shaw, 1995). The infant/toddler version of the HOME was administered as part of the age-2 home assessment. The HOME is a 45-item instrument that assesses the quality and quantity of support and stimulation in the child's home environment through observational and parent interview components and has demonstrated good reliability and validity (Caldwell & Bradley, 1984). Six items tapping parental unresponsiveness were selected from the *Emotional and Verbal Responsivity* subscale and subjected to factor analysis, with factor loadings ranging from .55 to .74 ($\alpha = .69$). Lower scores indicate less responsiveness. The EPCS was designed to measure a range of parenting behaviors typically exhibited in interactions with young children. Molecular and global ratings were recorded from videotaped mother-child interactions during a structured clean-up task at the age-2 laboratory assessment that took place the same day as the HOME assessment. A composite of two molecular ($\kappa = .79-.87$) and three global ($\kappa = .83-.94$) ratings relevant to *rejecting parenting* was employed. Higher scores indicate higher rejection (for more

information about the EPCS, see Shaw and colleagues, 1998b). The abridged 6-item HOME *Responsivity* factor and the EPCS rejecting parenting score were negatively correlated ($r = -.26, p < .001$). To create the single measure of 'rejecting parenting' from the constructs of maternal unresponsiveness and rejection, HOME *Responsivity* standardized scores were subtracted from EPCS *rejecting parenting* standardized scores.

Cumulative family adversity index. The family adversity risk index was comprised of seven constructs: family size, family income, family criminality, neighborhood dangerousness, number of stressful life events, parent daily hassles, and parental conflict. These factors were chosen for their potential effects above and beyond those accounted for by parenting. Information pertaining to family income, parental criminality, and overcrowding was obtained from a demographic questionnaire that was administered at recruitment and at the age 2- and 3.5-year assessments. The number of negative life events (e.g., loss of job) occurring in the last year was measured by the Negative Life Events factor of the *Life Experiences Survey* (LES; Sarason, Johnson, & Siegel, 1978), administered at the age 2 visit. The *Parenting Daily Hassles* (PDH; Crnic & Greenberg, 1990) is a 20-item measure of typical everyday events parents encounter with children. The frequency and intensity of the items were summed and used in the analyses. Mothers completed at the PDH at the age-1.5, -2, and -3.5 visits, and scores were averaged across the available (potentially 3) time points. The *Neighborhood Questionnaire* (NQ; Pittsburgh Youth Study, 1991) is a 17-item measure of problematic and dangerous activities within a family's neighborhood as perceived by the parent at the age-2 visit. The items are summed to create one factor score for neighborhood dangerousness. Parental conflict was measured using the verbal and physical aggression factors of the *Conflict Tactics Scales* (CTS-Form N; Straus, 1979), administered at the age 3.5 visit. There was adequate reliability for the LES, PDH, and CTS ($\alpha = .63$ to $.90$).

To create a cumulative Family Adversity Index (FAI) score, each of the seven measures listed above were assigned a score of one (1) if they met the following criteria (indicating greater adversity), and zero (0) if they did not. The criterion for low income was an annual prorated per capita income equal to or less than \$2,500, averaged over three time points. Overcrowding was defined as families having four or more children living at home or having less than one room per person at any time point (Rutter et al., 1975b; Shaw et al., 1998a). Parental criminality was based on maternal report of criminal behavior committed by the child's family members living in the home during the child's lifetime. For the LES, PDH, NQ, and CTS, the criterion was set at or greater than one standard deviation above the sample mean. The seven scores were summed, with total scores ranging from 0 to 7. In the case of missing data from a repeated measure, data from any of the time points was used on its own. The total summed score was divided by the total number of measures obtained, since some subjects were missing data from a questionnaire administered at only one time point (e.g., LES or CTS).

¹ There have been numerous ways in which perinatal complications have been grouped and used by researchers. Raine and colleagues (1994, 1997) used the same system as the present study but dichotomized the variable into zero versus one or more birth complications. Arseneault and colleagues (2002) ran a principal components analysis to derive three factors. Although both groups of researchers used different systems, they found a significant biosocial interaction predicting to antisocial behavior. We subjected our items to a factor analysis and obtained a factor similar to Arseneault et al.'s Deadly Risk Situation factor. Our weighted-severity perinatal score was significantly correlated with this factor ($r = .23, p < .001$), as well as a weighted-frequency score ($r = .77, p < .001$) and a continuous frequency-of-complications score ($r = .65, p < .001$; Richardson, Hamel, Goldschmidt, & Day, 1999). Since one classification system has not proven consistently superior over another in predicting antisocial behavior and due to the high correlation of the present system with the systems employed in other studies, we preferred to have continuous variable emphasizing potential severity of each complication.

Child outcome variables. *Child Behavior Checklist-Parent Report Form (CBCL; Achenbach, 1991).* The CBCL is a reliable and well-validated 112-item instrument that assesses child behavior problems. Parents rate the items on a three-point scale ranging from 'Not True' to 'Very True' of their child in the past six months. As both aggressive reactive and covert delinquent activities have been linked to perinatal complications and family risk factors (Arseneault et al., 2002; Raine et al., 1994, 1997), the current study used the Externalizing broad-band factor to measure later child ASB at age 8. The Internalizing broad-band factor was also used to investigate specificity effects when boys were 8 years old.

Self-Report of Delinquency (SRD; Elliott, Huizinga, & Ageton, 1985). Ten items ($\alpha = .71$) were adapted from the SRD to measure children's report of antisocial behavior at age 10. The SRD is a semistructured interview that assesses the frequency with which an individual has engaged in delinquent behavior. Using a 3-point rating system (1 = 'never,' 2 = 'once/twice,' 3 = 'more often'), boys rated the extent to which they engaged in different types of antisocial behaviors (e.g., stealing, throwing rocks or bottles at people) within the last year.

Child Depression Inventory (CDI; Kovacs, 1992) and Multidimensional Anxiety Scale for Children (MASC; March et al., 1997). Boys completed 10-item short forms of the CDI ($\alpha = .66$) and MASC ($\alpha = .69$) at age 10. For the items on the CDI, boys were presented with a group of three statements and were asked to choose the sentence that best described their feelings in the past two weeks. These items were summed to generate one measure indicative of child depressive symptomatology. For the items on the MASC, boys were presented with a series of statements indicating anxiety-arousing situations and were asked to rate how true each statement was for him on a 4-point scale. These items were summed to form one factor indicative of anxiety symptoms in children. Both the CDI and MASC have been shown to have adequate reliability and validity (Kazdin, French, Unis, Esveld-Dawson, & Sherick, 1983; March et al., 1997). The total CDI and MASC scores were standardized and then averaged ($r = .30, p < .001$) to create a measure of child internalizing problems.

Results

For all analyses, the CBCL Externalizing and Internalizing broad-band factors at age 8 years and the SRD and child internalizing score at age 10 years served as the dependent variables.

Descriptive statistics and intercorrelations

Descriptive statistics for all study variables are provided in Table 1. The mean severity weight for perinatal complications was 2.25 (median = 3). The sum of individual complications (i.e., unweighted) ranged from 0 to 8, with the median being 2. The assigned severity weight was significantly correlated with the number of perinatal complications ($r = .74, p < .001$). The mean t scores for maternal-rated Externalizing ($M = 51, SD = 10.2$) and Internalizing ($M = 49, SD = 9.8$) were comparable to the normative mean t score of 50 (Achenbach, 1991).

Two-tailed Pearson product intercorrelations were computed among the predictor variables: perinatal complications, rejecting parenting, and the family adversity index (FAI) and among child outcome variables across informants. Rejecting parenting and FAI were modestly but significantly related ($r = .23, p < .001$), but neither was related to perinatal complications. Maternal reports of child adjustment were modestly related to youth-reports ($r = .15$ for Externalizing/Delinquency, and $r = .17$ for Internalizing, $p < .05$). Across informants, reports of Externalizing/Delinquency were not related to reports of Internalizing.

Testing direct relations between perinatal complications, rejecting parenting, family adversity, and later child adjustment

To examine the hypothesis that perinatal complications would not be directly related to later antisocial behavior (ASB) and that rejecting parenting and family adversity would be directly and positively related to later ASB, a series of one-tailed Pearson product correlation coefficients were calculated between these factors and CBCL Externalizing at age

Table 1 Descriptive statistics for predictors and outcome measures of boys' adjustment

Variables	Mean	Standard deviation	Range	Sample size
Predictors				
Perinatal complications	2.25	1.32	0-5	271
Rejecting parenting	.0026	1.34	-2.04-4	286
Family adversity index	.2777	.203	0-1	307
Outcome measures				
<i>Maternal report - age 8</i>				
Externalizing (CBCL)	50.98	10.2	30-82	248
Internalizing (CBCL)	48.59	9.78	34-80	248
<i>Youth report - age 10</i>				
Delinquency (SRD 10-items)	1.74	2.29	0-12	234
Internalizing (CDI/MASC z-score)	-.0004	-.144	-1.4-3.24	234

8 years and the Self-Report of Delinquency at age 10, the results of which are presented in Table 2. The correlations between the predictor variables and Externalizing/Delinquency were generally consistent with expectations. Perinatal complications were unrelated to Externalizing/Delinquency, and relations between the FAI and child adjustment were significant across informants ($r = .22$ and $.20$ for mothers and boys, respectively, $p < .001$), albeit modest in magnitude. Rejecting parenting at age 2 was significantly related to child-reported Delinquency eight years later ($r = .17$, $p < .01$).

To test for the specificity of these effects in relation to child adjustment, one-tailed Pearson product correlations were computed between predictor variables and maternal- and child-rated Internalizing at ages 8 and 10, respectively. As displayed in Table 2, perinatal complications and rejecting parenting were consistently unrelated to Internalizing, whereas FAI was significantly correlated with both maternal- and child-report Internalizing ($r = .21$ and $.12$, $p < .001$ and $.05$, respectively).

Testing for interactive effects of the predictor variables on child adjustment

The second issue of interest was testing the interactive effects of biological and environmental risk

factors on child outcomes. A series of hierarchical regression analyses were computed to examine whether high levels of perinatal complications would interact with high levels of rejecting parenting and/or family adversity to increase risk of later child adjustment problems. For all regression analyses, independent variables were hierarchically entered into regression equations based on chronological order: perinatal complications followed by rejecting parenting, then family adversity, followed by each of the three two-way interaction terms (i.e., perinatal complications \times rejecting parenting, followed by perinatal complications \times family adversity, and then rejecting parenting \times family adversity), and finally the three-way interaction term.

Externalizing/Delinquency

Table 3 displays the summary of the hierarchical regression analyses involving perinatal complications, rejecting parenting, and FAI for maternal-rated Externalizing at age 8. A significant 3-way interaction emerged in relation to Externalizing. To explore the nature of this effect, post hoc analyses using one-way ANOVAs were conducted. Risk groups were generated by parsing the environmental risk variables into 'high' and 'low' scores using the upper quartile as the cutoff. That is, high scores

Table 2 One-tailed Pearson correlations between predictor variables and boys' adjustment by maternal and youth report

Outcome measure		Perinatal complications	Rejecting parenting	Family adversity index
Maternal report – age 8				
CBCL Externalizing	Pearson r	-.004	.064	.218**
	N	216	237	248
CBCL Internalizing	Pearson r	-.016	.040	.211**
	N	216	237	248
Youth report – age 10				
SRD Delinquency	Pearson r	.049	.174**	.202**
	N	207	223	234
CDI/MASC Internalizing	Pearson r	-.087	.037	.124*
	N	207	223	234

* $p < .05$; ** $p < .01$.

Table 3 Summary of regression analyses for perinatal complications and environmental variables predicting to maternal report of boys' externalizing and internalizing at age 8

Variables	Maternal report at age 8 ($n = 206$)					
	CBCL Externalizing			CBCL Internalizing		
	B	Std. E	β	B	Std. E	β
Perinatal complications	.223	.949	.029	.275	.918	.037
Unaccepting parenting	2.18	2.03	.286	-1.59	1.96	-.219
Family adversity index (FAI)	14.4	7.10	.287*	14.1	6.86	.293*
Perinatal \times Parenting	-1.17	.853	-.371	.189	.825	.063
Perinatal \times FAI	-1.55	2.97	-.093	-1.54	2.81	-.096
Parenting \times FAI	9.65	5.55	-.459	3.27	5.37	.163
Perinatal \times Parenting \times FAI	5.48	2.48	.591*	.178	2.39	.020

* $p < .05$.

were set at or above the 75th percentile; low scores were below the 75th percentile. Consistent with previous research (Piquero & Tibbetts, 1999; Raine et al., 1994, 1997), perinatal complications were dichotomized, with zero complications comprising the 'low group' and 1 or more complications comprising the 'high group.' As hypothesized, post hoc ANOVAs revealed that boys with high perinatal complications, high rejecting parenting, and high FAI demonstrated higher Externalizing than boys with high scores on only 2 risk factors (61 vs. 51.33, respectively; $F(1,58) = 6.54, p < .05$), 1 risk factor (50.9; $F(1,59) = 6.07, p < .05$), and no risk factors (50.29; $F(1,113) = 6.58, p < .05$).

Table 4 shows the results for the hierarchical regression analyses for child-reported delinquency at age 10, for which variables were entered into the regression equations as described above. Results indicated a significant 2-way biosocial interaction involving perinatal complications and family adversity. Post hoc contrasts conducted in the manner described above revealed that boys with biosocial risk reported more delinquent behaviors than boys with perinatal risk only (3.39 vs. 1.55, respectively; $F(1,161) = 14.34, p < .001$) and no risk (1.35; $F(1,66) = 11.01, p < .001$). There was also a trend for boys with biosocial risk to report greater delinquency than boys with family risk only; however, detection of such an effect was difficult based on the small number of cases in the family risk group ($n = 4$). Therefore, boys with family risk only were combined with the group of boys demonstrating perinatal risk only. When compared to the combined group of boys with only one risk factor, boys with biosocial risk continued to report significantly higher rates of delinquency (1.52; $F(1, 165) = 15.1, p < .001$) (see Figure 1).

Internalizing

Tables 3 and 4 display the results for the hierarchical regression analyses for maternal- and child-rated Internalizing at ages 8 and 10, respectively. No significant interactions were found for either outcome.

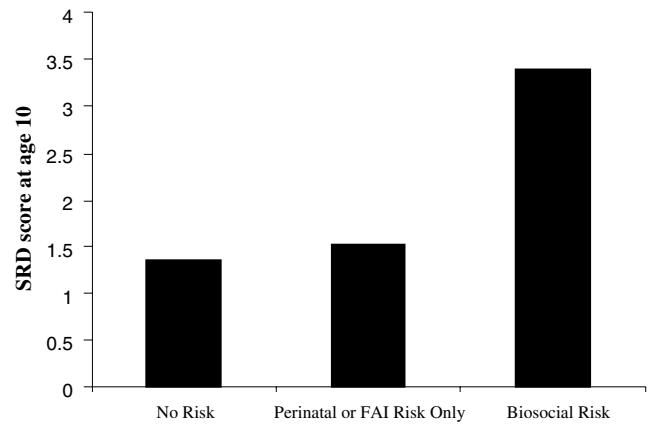


Figure 1 Illustration of the significant interaction detected between perinatal complications and family adversity (FAI) predicting to boys' self-reported delinquency (SRD) at age 10 years

Discussion

The main goal of the present study was to test components of the biosocial model of early antisocial behavior proposed by Raine (2002) in a sample of low-income boys. A second aim was to test the specificity of this model in relation to internalizing problems. Overall, there was broad support for the validity of the biosocial perspective in relation to children's antisocial behavior (ASB). Our findings suggest that perinatal complications are related to ASB in boys but only in the context of compromised family adversity or functioning. Addressing the specificity of the biosocial model, our findings did not support its generalizability to boys' internalizing problems. Across reporters, the cumulative measure of family adversity was a consistent predictor of boys' later adjustment difficulties, supporting previous findings and underscoring the salience of a negative psychosocial environment on childhood maladjustment (Sameroff et al., 1987; Shaw et al., 1994b, 1998a).

The present study sought to replicate the findings and improve upon the methods in previous invest-

Table 4 Summary of regression analyses for perinatal complications and environmental variables predicting to youth self-report of delinquency and internalizing at age 10 years

Variables	Youth self-report at age 10 years ($n = 196$)					
	SRD – Delinquency			CDI/MASC – Internalizing		
	B	Std. E	β	B	Std. E	β
Perinatal complications	-.418	.214	-.240	-.100	.077	-.165
Unaccepting parenting	.390	.456	.228	-.223	.164	-.376
Family adversity index (FAI)	-2.32	1.60	-.206	.022	.576	.006
Perinatal × Parenting	-.018	.192	-.025	.088	.069	.359
Perinatal × FAI	1.93	.655	.516**	.218	.235	.169
Parenting × FAI	-1.10	1.25	-.233	.718	.449	.440
Perinatal × Parenting × FAI	.335	.557	.161	-.294	.200	-.408

* $p < .05$; ** $p < .01$.

igations (Arseneault et al., 2002; Raine et al., 1994, 1997). Both the Raine and Arseneault studies had validated the importance of perinatal complications within a biosocial framework in predicting ASB from early school age through adulthood, and this study corroborates these findings for ASB during middle childhood. In fact, the robustness of the interactional findings is noteworthy, such that boys experiencing high levels of perinatal, parenting, and family risk were described by their mothers as demonstrating ASB at least one standard deviation above that of boys experiencing fewer risk factors ($d = .99-1.08$). Similarly, the effect sizes were high when boys experiencing both perinatal risk and high family adversity were compared to boys experiencing risk in only one domain or no risk at all ($d = .82$ and $.85$, respectively), according to youth report. Across studies there appears to be convergence that boys with early biosocial risk demonstrate higher levels of ASB at various points in childhood, throughout adolescence, and into adulthood.

The present findings also extend our understanding of possible mechanisms underlying interactions between perinatal complications and family adversity in relation to early ASB found in previous studies, by including more proximal family risk factors and evaluating them more intensively. For example, Raine and colleagues (1994, 1997) investigated the interactive effects of maternal rejection and perinatal complications on adult males' violent offending. Rather than using a direct measure of parenting after the child was born, these researchers employed three distal criteria (e.g., an attempt to abort the fetus) to assess maternal rejection. Whereas in the present study, maternal parenting was evaluated using *observational* strategies recorded in the home and the laboratory.

By investigating the moderating effects of multiple environmental factors, our study found a significant three-way interaction involving perinatal complications, rejecting parenting, and family adversity in the prediction of ASB in boys at age 8. However, this finding was only partially replicated at age 10. This may be due, in part, to methodological considerations. First, different informants of child ASB were used at the age-8 and age-10 assessments. Second, child behavior is likely to have been only moderately stable during this period. Third, although modestly correlated ($r = .15$, $p < .05$), different questionnaires were used to assess maternal- and youth-report of ASB (CBCL and SRD, respectively), with only a subset of these items included on both measures (i.e., 60% of SRD items were covered on the CBCL Externalizing factor, whereas only 15% of CBCL Externalizing items were represented on the SRD). Moreover, the CBCL Externalizing factor covers a broader domain of symptoms than the SRD, including emotional control issues (e.g., jealous, stubborn/irritable, sudden mood changes, temper tantrums).

Another possible explanation for the differences in the pattern of the interactions is that maternal rejection is a more salient factor for the emergence of ASB at earlier ages (i.e., age 8 versus 10). In previous research, a two-way biosocial interaction has been found involving perinatal complications and measures of family disadvantage in relation to ASB taking place outside of the home (Arseneault et al., 2002; Raine et al., 1994, 1997). This pattern of results is robust, for it has been corroborated across time (i.e., cohort effect), culture, and SES (Arseneault et al., 2002; Piquero & Tibbetts, 1999; Raine et al., 1994, 1997; Werner et al., 1971); and our study supported these results when boys reported on their ASB at age 10. This is not to suggest that interactions involving parenting per se are not as likely to occur in relation to child ASB during the latter part of prepubescent period, but it may be the case that other components than rejection begin to play a more critical role as children approach adolescence (e.g., monitoring).

The present study demonstrated support for a biosocial framework in predicting ASB but not internalizing problems in childhood. This specificity may be the results of differential consequences of perinatal complications for pathways leading to externalizing versus internalizing problem behavior. For ASB, it is hypothesized that perinatal complications lead to neurological impairment in the frontal lobes, an area of the brain believed to be dedicated primarily to executive functioning (Hawkins & Trobsta, 2000; Raine, 1997). Deficits in executive functioning have been associated with problems in impulsivity, verbal expression, and understanding societal norms, all validated correlates of ASB (Raine, 2002). While children with internalizing problems may experience social problems as a result of deficits in executive functioning (e.g., withdrawing from their peers), social withdrawal may be less impacted by harsh parenting and other types of family adversity. In contrast, for externalizing problems a child who suffers perinatal insult may be especially sensitive to conditions of environmental risk. When reared in a noxious environment that lacks sensitive and involved caregiving or that excludes the shaping and modeling of prosocial behaviors, the child is not likely to develop these abilities. In all probability, coercive and aggressive behaviors will be learned instead, which sets the child up to fail within the school context, be it complying with teachers or socializing with peers (Paterson, DeBaryshe, & Ramsey, 1989).

Limitations

A number of limitations must be considered when interpreting the present results. First, many potentiating factors of perinatal complications, such as lack of prenatal care, may be confounded with aspects of family adversity. However, in this study perinatal complications and family adversity were

unrelated ($r = .02$), indicating that these risk factors reflect largely independent processes. Second, CBCL data and many components of the FAI (e.g., parental conflict, SES, parent criminality) were obtained through maternal report, which raises the issue of informant bias. However, many of the findings were corroborated by child-report, and perinatal complications and maternal parenting were based on objective sources or observation. Fourth, the present study was conducted on a high-risk sample of boys, which limits the generalizability of the findings to nonurban, less socioeconomically deprived populations. Moreover, the results of this study ought to be interpreted with caution in relation to predictors of girls' externalizing behaviors and risk factors associated with other domains of functioning. For example, it is quite possible that results regarding internalizing problems may vary, particularly during early adolescence when sex differences in depression emerge.

Finally, although this longitudinal study has shown some support for the validity of the biosocial perspective in regards to boys' ASB, causality cannot be inferred. Perhaps an uninvestigated third factor, such as genetics, may be responsible for these results (Raine, 2002). Child temperament and child psychopathology are often influenced by genetics. Negative parenting and a predisposition to perinatal complications all contain genetic components, as well. The present study cannot disentangle genetic and environmental effects; twin and adoption studies are needed to address this issue.

Another 'third variable' explanation is ADHD. Inattentiveness, hyperactivity, and impulsivity are behaviors that tend to co-occur at high rates with ASB, and studies have demonstrated that boys with comorbid ADHD and conduct disorder (CD) show a more severe and chronic trajectory of antisocial behavior than CD-only and ADHD-only boys (Moffitt, 1990). Moreover, boys with ADHD show learning and social problems similar to those described in the sections above. To explore the possibility that ADHD symptoms accounted for much of the variance attributed to perinatal complications, we entered ADHD as a covariate into the multiple regression equations and did not find ADHD to affect any of the significant interactions predicting to ASB.

Clinical implications and conclusions

A major implication of this study is the import of early environmental risk factors when considering later adjustment of high-risk children. Most aspects of risk in this study were measured at or before the age of 2. Thus, one implication is that preventative interventions could target toddlers from disadvantaged or chaotic families to maximize benefits on child outcome. Efforts to teach parenting skills, especially for toddlers showing extreme signs of compromised executive functioning (e.g., constant

impulsivity, high reactivity, excessively short attention spans), would be advocated. In addition, parents in such high-risk environments may need assistance in coping with stressors in and outside of the family that affect the quality of the caregiving environment, as suggested by the results from analyses involving family adversity.

In summary, the study provides data that indicate children experiencing severe perinatal complications are the most vulnerable to the effects of an adverse home environment. During prenatal care visits or shortly after delivery, mothers who report an unstable home environment or frustration in caring for their older children would appear to be likely candidates for intervention. Further prospective research of the interactive effects of perinatal insult and home environment on later child adjustment will help to clarify the precursors, reveal potential etiologies, and establish successful preventions of early-onset ASB.

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Appendix

Severity weight	Perinatal complication
1	Induced labor; labor stimulation b/c of primary weak labor
1	Episiotomy
1	Ruptured perineum
2	Induced labor; manual rupture of the membrane; induced labor with artificial rupture alone
2	Augmentation; ARM
2	Drug induced labor; drug induced labor and artificial rupture of the membrane
2	Contracted pelvis (birth complication)
2	Stimulation of labor b/c of secondary weak labor (orifice distended)
2	Other intervention of birth, besides vacuum, forceps
2	Irregular fetal position (occiput posterior)
2	Fetal presentation – transverse position or other lower extremity positions
2	Child's condition at birth – living, mildly affected (cyanotic, sluggish, tonus preserved) including, resuscitation; fetal growth retardation
2	Birth weight = 4550 to 5000 grams
2	Anesthesia (besides local)
3	Umbilical cord complications besides prolapsed cord (e.g., nuchal cord)
3	Stormy labor: dysfunctional labor; fetal distress; secondary arrest of dilation; prolonged 2nd stage
3	Heart sound affected (e.g., bradycardia; tachycardia; prolonged decelerative phase)
3	Forceps/vacuum extraction
3	Caesarian section
3	Other manners of birth (e.g., oxytocia; rupture of membrane)
3	Fetal presentation – fore position brow, face
3	Birth duration > 30 hours

Appendix (continued)

Severity weight	Perinatal complication
3	Mechanical hindrance at birth (e.g., CPD; shoulder dystocia)
3	Precipitous/premature birth
3	Birth weight > 5050 grams
4	Bleeding at beginning of delivery
4	Preeclampsia, severe degree
4	Fetal presentation – transverse lie; breech; breech-foot positions
4	Child's condition at birth – living, heavily affected (pale and limp)
5	Ruptured uterus
5	Umbilical cord prolapse
5	Eclampsia

Highest possible score = 5.