



# A prospective investigation of neurodevelopmental risk factors for adult antisocial behavior combining official arrest records and self-reports



Angela D. Paradis<sup>a, \*</sup>, Garrett M. Fitzmaurice<sup>b, c</sup>, Karestan C. Koenen<sup>d</sup>, Stephen L. Buka<sup>a</sup>

<sup>a</sup> Brown University School of Public Health, Providence, RI, USA

<sup>b</sup> Harvard T. H. Chan School of Public Health, Boston, MA, USA

<sup>c</sup> McLean Hospital, Belmont, MA, USA

<sup>d</sup> Mailman School of Public Health, Columbia University, New York, NY, USA

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## ABSTRACT

Neurodevelopmental deficits are postulated to play an important role in the etiology of persistent antisocial behavior (ASB). Yet it remains uncertain as to which particular deficits are most closely associated with ASB. We seek to advance this understanding using prospectively collected data from a birth cohort in which multiple indices of neurodevelopmental functioning and ASB were assessed. Participants ( $n = 2776$ ) were members of the Providence, Rhode Island cohort of the Collaborative Perinatal Project. Information on demographic and neurodevelopmental variables was collected from pregnancy through age 7. When all offspring had reached 33 years of age an adult criminal record check was conducted. A subset of subjects also self-reported on their engagement in serious ASB. Bivariate logistic regression was used to examine the relationship between each neurodevelopmental factor and adult ASB and test whether associations varied depending on how ASB was ascertained. After controlling for background and contextual characteristics, maternal smoking during pregnancy, lower childhood verbal and performance IQ, and age 7 aggressive/impulsive behavior all significantly increased the odds of adult ASB. Associations were not modified by sex and did not depend on how ASB was assessed. However, while both males and Black participants were more likely to engage in ASB than their respective female and White counterparts, relationships were significantly stronger for official records than for self-reports. Results point to a particular subset of early neurodevelopmental risks for antisocial outcomes in adulthood. Findings also suggest that prior contradictory results are not due to the use of official records versus self-reported outcomes.

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## 1. Introduction

Early neurodevelopmental deficits have been postulated to play an important role in the initiation and maintenance of persistent antisocial behavior (ASB) into adulthood (Moffitt, 1993). Factors from the prenatal period to early childhood have been investigated, including maternal smoking during pregnancy (D'Onofrio et al., 2010; Paradis et al., 2011; Wakschlag et al., 2002), pregnancy/delivery complications (PDCs) (Arseneault et al., 2002; Hodgins et al.,

2001; Murray et al., 2010; Raine et al., 1997), low birth weight (Hack et al., 2004; Murray et al., 2010; Tibbetts and Piquero, 1999; Vaske et al., 2015), aggressive and impulsive behavior (Caspi, 2000; Dubow et al., 2014; Farrington, 1995), and indices of cognitive functioning such as IQ (Dubow et al., 2014; Raine et al., 2005; Sampson and Laub, 1993). Although some factors have shown robust associations with antisocial outcomes (e.g., lower verbal IQ), support for other early neurodevelopmental deficits (e.g., PDCs, low birth weight) has been equivocal. Identifying the neurodevelopmental factors most closely associated with persistent ASB is necessary to enhance our understanding of the etiology of such behavior.

To further our knowledge of the possible neurodevelopmental underpinnings of ASB, it is important to consider

\* Corresponding author. Brown University, Department of Epidemiology, 121 South Main Street, GS-121-2, Providence, RI 02912, USA.

E-mail address: [angela\\_paradis@brown.edu](mailto:angela_paradis@brown.edu) (A.D. Paradis).

how methodological variations across studies may impact observed associations, including differences in outcome assessment. Adult ASB is frequently assessed using either official arrest records or self-reports of engagement in such behavior. Some researchers have suggested that differences in the measurement of ASB across investigations may (partially) explain previous inconsistent findings of the relationship between risk factors, including indices of neurodevelopmental functioning, and antisocial outcomes (Arseneault et al., 2002; Kirk, 2006; Maxfield et al., 2000; Moffitt et al., 1994; Moffitt and Silva, 1988). For instance, it is well-established that official records underestimate criminal activity since only a small fraction of criminal behavior comes to the attention of law enforcement, police use discretion in deciding who to arrest, and not all arrests are officially recorded (Blumstein et al., 1986; Worden and Myers, 1999). Furthermore, not all types of ASB are criminal in nature. It is therefore possible that the relationships between particular neurodevelopmental deficits and adult ASB have been underestimated in studies using official records. Biases in self-reports have also been noted; the potential for significant under-reporting of ASB as well as over-reporting in particular subgroups has been documented (Kirk, 2006; Maxfield et al., 2000). However, researchers have rarely examined how measurement of ASB may impact observed associations between neurodevelopmental deficits and antisocial outcomes.

Other methodological variations have been cited as potential explanations for discrepant results. For example, it has been suggested that differences in how information on neurodevelopmental deficits is collected (e.g., prospective vs. retrospective reports) may influence findings (Arseneault et al., 2002). Aggregating different types of antisocial problems (e.g., violent and nonviolent behaviors) into a single outcome may also possibly attenuate or mask meaningful associations (Barker et al., 2007). In some studies, neurodevelopmental factors have been found to be predictive of only those subtypes of ASB characterized by violence and aggression (Raine et al., 1994).

Finally, many previous investigations examining associations between indices of neurodevelopmental functioning and ASB have focused exclusively on males. Studies that have included both sexes have sometimes found evidence that the association between neurodevelopmental factors and ASB is stronger for males than females (e.g., Murray et al., 2010; Wakschlag et al., 2002). Yet further investigations of large mixed sex samples are needed to determine whether sex modifies the relationship between compromised neurodevelopmental functioning and ASB, or whether neurodevelopmental deficits play a similar role in the initiation and maintenance of behavior problems in both females and males.

### 1.1. Current study

Our major objective was to advance the understanding of the true impact of deficits in early neurodevelopmental functioning on adult ASB. To this end, we were particularly interested in whether inferences differed depending on whether adult ASB was defined based on official arrest records or self-reported engagement in serious ASB. We also tested whether associations were stronger for violent versus nonviolent behavior and examined possible sex differences. An additional strength of the current research is that all data on neurodevelopmental characteristics were collected prospectively using valid and reliable methods. Unlike many previous studies following subjects only through childhood or adolescence, we were able to trace the impact of multiple indices

of neurodevelopmental functioning on antisocial outcomes into adulthood.

## 2. Methods

### 2.1. Participants

Participants were offspring of mothers enrolled in the Providence, Rhode Island site of the Collaborative Perinatal Project (CPP) (Niswander and Gordon, 1972). The CPP was a multicenter study of pre- and perinatal antecedents of childhood mental, neurological, and physical abilities. Over 50,000 pregnancies were enrolled between 1959 and 1966 at several affiliated medical schools throughout the U.S. In Providence, approximately 50% of obstetric patients at participating hospitals were randomly selected for inclusion in the study and a total of 4140 pregnancies were enrolled. Extensive obstetric, neurologic, psychologic, and sociodemographic information from the perinatal period through age 7 was collected prospectively using standardized procedures.

Of the survivors from the original cohort, 81.9% ( $n = 3138$ ) completed the age 7 assessment. (See Fig. 1.) Somewhat more Black (87.6%) as compared to White (80.6%) participants completed the evaluation, but the difference was not substantial. Those seen at age 7 were comparable to those not assessed on other key background factors and putative neurodevelopmental risks. The current study is limited to the 2776 Black and White participants who completed this assessment and had complete covariate information. (Because of the heterogeneity and small number of non-Black minorities these individuals were excluded.) Most subjects excluded from the analysis were omitted due to missing data on childhood socioeconomic status (SES). Excluded participants ( $n = 362$ ) were not found to significantly differ from those who were included on background characteristics, such as sex and SES, and neurodevelopmental factors, including maternal smoking during pregnancy and PDCs.

In 1999–2000, an adult criminal history record check was performed in Rhode Island for each known surviving member of the sample (mean age = 37, range = 33–40). A subset of these subjects also participated in adult follow-up studies, occurring when subjects were ages 30–42 (Buka et al., 1998; Gilman et al., 2008; Kahler et al., 2008), and self-reported on their engagement in ASB during standardized structured clinical interviews. All participants had valid outcome information on adult ASB from at least one data source: 1848 had information from official arrest records only; an additional 928 subjects also provided self-reports during the follow-up interviews. Institutional review boards at Brown and Harvard Universities approved the follow-up studies and written informed consent was provided by participants.

### 2.2. Measures

#### 2.2.1. Background/contextual characteristics

The sex distribution of the sample was roughly equal (49.3% male) and the majority of subjects were White (77.6% White, 22.4% Black). Data on sociodemographic characteristics were collected at the first prenatal visit and reassessed when the children were age 7. An index of SES was calculated based on methods developed by the U.S. Census Bureau (Myriantopoulos and French, 1968). Study parents were compared to national data and assigned a percentile rank for education and occupation of the head of household and household income. The composite measure represents an average of these percentiles; higher percentiles indicate higher relative socioeconomic standing (range = 0–99). SES was dichotomized at the median percentile (43.0), creating a binary indicator of high vs. low socioeconomic standing. Lifetime parental mental illness was

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