



## Genetic and environmental influences on the co-occurrence of early academic achievement and externalizing behavior



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### ABSTRACT

**Purpose:** Several studies have observed a relationship between academic achievement and externalizing behaviors, both of which are predictors of delinquency and criminal behavior in adulthood. There is, however, no consensus on an explanation for their co-occurrence. One perspective is that both emerge as a result of a common underlying factor. This study investigates the degree to which the same genetic and environmental factors account for the co-occurrence of these two outcomes.

**Methods:** The sample consists of twins (N = 360) from the Early Childhood Longitudinal Survey-Kindergarten Class of 1998–1999. Bivariate genetic analyses were conducted to assess the genetic and environmental influence on the relationship between academic achievement and externalizing behaviors during kindergarten.

**Results:** The covariation was due primarily to common shared environmental factors (55–87%), followed by common genetic (8–44%) and nonshared environmental factors (1–13%).

**Conclusions:** Both early academic achievement and externalizing behaviors are partially influenced by the same genetic and environmental factors. The large proportion of covariance attributed to shared environmental influences suggests that identifying and targeting shared environmental factors in prevention and intervention strategies may improve both behavior and academic achievement.

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### Introduction

Understanding the nature and developmental trajectory of childhood behavioral problems is imperative for advancing criminological theory and developing appropriate intervention strategies. Previous research has clustered early behavioral problems into two dimensions: internalizing and externalizing (Achenbach, 1978; Achenbach & Edelbrock, 1978; Campbell, Shaw, & Gilliom, 2000; Hinshaw, 1992). Internalizing behaviors include withdrawn, anxious, inhibited, and depressive symptoms that influence an individual's psychological functioning. Externalizing behaviors, on the other hand, include acts that are directed outward and are often characterized as defiant, impulsive, disruptive, and aggressive.

Children with externalizing behavior problems may be at risk for a number of negative outcomes later in life, including adolescent and adult crime (Campbell et al., 2000; Liu, 2004). For example, Nagin and Tremblay (1999) examined externalizing behavior trajectories among a sample of 1,037 boys between 6 and 17 years of age. Although behavioral problems for many children declined over time, the results revealed that boys who are aggressive, oppositional, or hyperactive at age 6 may be on a pathway leading to theft, physical violence, or other serious delinquent

acts during adolescence. Furthermore, a consistent finding derived from previous research is that the most serious and persistent offenders initiate involvement in deviant, aggressive, and antisocial behaviors very early in life (Farrington, 1989, 1991; Loeber, 1982; Moffitt, 1990, 1993; Olweus, 1979; Sampson & Laub, 1993; White, Moffitt, Earls, Robins, & Silva, 1990). The empirical evidence in support of this finding is so robust that Robins (1978) concluded that “adult antisocial behavior virtually requires childhood antisocial behavior” (p. 611).

Individuals that display externalizing behaviors often experience problems in other aspects of their lives, as well (Campbell et al., 2000). One area of difficulty in particular is academic achievement. The relationship between the two has been observed among samples at various developmental stages (Hinshaw, 1992), and prior research indicates that both behavioral and academic problems emerge early in life and are highly stable (Bub, McCartney, & Willett, 2007; Huesmann, Eron, & Yarmel, 1987; McGee, Williams, Share, Anderson, & Silva, 1986; Morgan, Farkas, Tufis, & Sperling, 2008; Reinke, Herman, Petras, & Ialongo, 2008).

Although most of the evidence for the co-occurrence of externalizing behaviors and academic achievement is based on findings from youths during middle childhood or beyond (Hinshaw, 1992), evidence from samples in early childhood has shown similar results. For example, McGee et al. (1986) found that behavioral problems among boys were stable from 5 years of age to 11 years, and reading deficiencies were

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stable from age 7 to 11 years. Furthermore, boys with difficulties in reading displayed more behavioral problems over time. In a sample of 74 boys 3 to 6 years of age, Arnold (1997) examined the relationship between externalizing behaviors and emergent academic skills using standardized tests of language abilities and letter recognition. The correlation between behavioral problems and academic difficulties increased with age from .37 at age 3 to .84 at age 6, indicating that the co-occurrence of these traits is apparent at an early age and may strengthen over time.

Doctoroff, Greer, and Arnold (2006) also found that aggressive behavior was associated with poor literacy skills in a sample of preschoolers, particularly among males ( $r = -.43, p = .001$ ). Dobbs, Doctoroff, Fisher, and Arnold (2006) further examined the relationship between social, emotional, and behavioral problems and early math skills. Their results revealed that externalizing behaviors significantly predicted math skills in preschool ( $\beta = -.62, p < .05$ ), as did independent measures that reflect externalizing behavior problems including: delinquency ( $\beta = -.66, p < .05$ ), aggression ( $\beta = -.57, p < .05$ ), self-control ( $\beta = .61, p < .01$ ), attention problems ( $\beta = -.49, p < .05$ ), and social problems ( $\beta = -.53, p < .05$ ).

Finally, a meta-analysis of academic performance and emotional/behavioral disturbance, characterized by a range of internalizing and externalizing behaviors, indicated a strong relationship between achievement and behavioral outcomes (Reid, Gonzalez, Nordness, Trout, & Epstein, 2004). More specifically, an analysis of 25 studies, including 2,486 youths ages 5 to 14 years, produced a mean effect size of  $-.69$ . Children with emotional/behavioral disturbances performed worse than comparisons across all measures of academic achievement, with the strongest effects being obtained in math ( $-.81$ ) and spelling ( $-.81$ ). Taken together, the empirical evidence clearly demonstrates that a strong and persistent relationship exists between academic achievement and problem behavior. The underlying causal mechanism, however, remains open to investigation.

### Explanations for the co-occurrence

To date, four perspectives have been used to explain the relationship between academic achievement and behavioral problems. First, it has been argued that behavioral problems may result in underachievement because children with behavior problems will have lower motivation and ability to learn new skills (Hinshaw, 1992; Huesmann et al., 1987; Rutter & Yule, 1970; Stipek & Miles, 2008). In other words, individuals with behavioral problems are less likely to get involved in activities that stimulate cognitive development, such as reading and math. This aversion to cognitive stimulation will then reduce opportunities to learn new skills. Stipek and Miles (2008) observed this pattern and found children that exhibited increases in aggressive behavior between kindergarten and fifth grade had significantly lower achievement scores in math and reading ( $\beta = -.09, p \leq .05$ ).

A second possibility is that academic underachievement may lead to behavior problems. Individuals that are struggling in the classroom may have a more difficult time understanding and processing new information, resulting in feelings of frustration and lower self-esteem (Hinshaw, 1992; Morgan et al., 2008; Rutter & Yule, 1970). This may cause them to disengage and act out as a way of coping with the negative emotions they experience. Morgan et al. (2008) examined the relationship between reading performance and behavioral problems from first grade through third. They found that children that were poor readers in first grade were also more likely to engage in externalizing behaviors in third grade ( $OR = 1.39, p < .05$ ).

A third hypothesis combines the two aforementioned perspectives by stating that there is a reciprocal relationship between academic achievement and problem behavior (Arnold, 1997; Arnold et al., 2006, 1999; Hinshaw, 1992; Huesmann et al., 1987; Olweus, 1983; Trzesniewski, Moffitt, Caspi, Taylor, & Maughan, 2006). That is, the

emergence of one problem often results in the emergence of the other. This process creates a cycle in which the two exacerbate each other.

Finally, a fourth possibility is that both cognitive deficiencies and behavior problems may be due to a common underlying factor (Gellert & Elbro, 1999; Rutter & Yule, 1970; Trzesniewski et al., 2006). As an example, language deficits may lead to poor outcomes in both domains. Individuals with poor language skills could struggle to understand new information and find it difficult to effectively convey their own ideas, resulting in poor academic performance. Additionally, language deficits could hinder one's ability to communicate with others in a prosocial manner. Instead, he or she may react to conflict with aggressive behaviors.

Previous research seeking to uncover a common underlying factor has examined a number of individual traits and environmental factors. There are, however, at least three areas of research that suggest genetic factors may account for a portion of the relationship between externalizing behavior and underachievement. First, several studies provide clear evidence of strong genetic influences on academic achievement (Byrne et al., 2002; Knopik & DeFries, 1999; Light & DeFries, 1995; Markowitz, Willemssen, Trumbetta, van Beijsterveldt, & Boomsma, 2005; Petrill, Deater-Deckard, Thompson, DeThorne, & Schatschneider, 2006; Taylor & Schatschneider, 2010; Thompson, Detterman, & Plomin, 1991; Wadsworth, DeFries, Fulker, & Plomin, 1995; Walker, Petrill, Spinath, & Plomin, 2004). Second, prior research has demonstrated that variation in externalizing behaviors is partially due to genetic variation between people (Gjone & Stevenson, 1997; Gjone, Stevenson, Sundet, & Eilertsen, 1996; Schmitz, Fulker, & Mrazek, 1995; Silberg et al., 1994; van den Oord, Verhulst, & Boomsma, 1996; van der Valk, van den Oord, Verhulst, & Boomsma, 2003a; van der Valk, van den Oord, Verhulst, & Boomsma, 2003b). Third, and most important, are the studies that have shown that the relationship between academic achievement and behavioral outcomes may be the result of the same genetic influences operating on both traits (Johnson, McGue, & Iacono, 2005, 2006; Trzesniewski et al., 2006).

### Evidence of genetic influences

Through the study of twin and adoptive siblings, it is possible to assess the degree to which additive genetic ( $a^2$ ), shared environmental factors ( $c^2$ ), and unique environmental factors ( $e^2$ ) are influencing variation in trait (Neale & Cardon, 1992). Additive genetic effects are present when alleles at the same loci share a combined effect.<sup>1</sup> Shared environmental factors are those experiences that are shared by each member of a kinship pair, such as going to the same school. Unique environmental factors, on the other hand, are those things experienced by one twin but not the other. For example, twins may be assigned to different classrooms with different teachers. Behavioral genetic studies have estimated the influence of each of these components on various aspects of academic achievement, externalizing behaviors, and the relationship between the two. The following provides a review of the available evidence from these studies.

#### Genetic influences on academic achievement

A number of studies have demonstrated that genetic and environmental factors contribute to performance in multiple academic areas and across different stages of development. Using samples of preschool-age children from the United States, Australia, and Norway, Byrne et al. (2002) investigated the genetic and environmental contributions to several measures of early reading performance. They found moderate and significant genetic influences in four composite measures: phonological analysis and synthesis ( $a^2 = .52$ ), phoneme identity training ( $a^2 = .50$ ), learning/memory ( $a^2 = .47$ ), and print knowledge ( $a^2 = .28$ ).<sup>2</sup> Taylor and Schatschneider (2010) further examined three different early literacy skills in a sample of twin pairs in kindergarten

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