Published in final edited form as:

Psychol Sci. 2010 December ; 21(12): 1802–1810. doi:10.1177/0956797610388047.

The Challenging Pupil in the Classroom: Child Effects on Teachers

Renate M. Houts,
Duke University

Avshalom Caspi,
Duke University & King's College, London

Robert C. Pianta,
University of Virginia

Louise Arseneault, and
King's College, London

Terrie E. Moffitt
Duke University & King's College, London

Abstract

Teaching children requires effort and some children naturally require more effort than others. This study tests whether teacher effort devoted to individual children varies as a function of children's personal characteristics. Using a nation-wide longitudinal study of twins followed between ages 5–12 years, we asked teachers about the effort they invested in each child enrolled in our study. We found that teacher effort was a function of heritable child characteristics; that children's challenging behavior assessed at age 5 predicted teacher effort at age 12; and that challenging child behavior and teacher effort share common etiology in children's genes. While child effects accounted for a significant proportion of variance in teacher effort, we also found variation that could not be attributed to children's behavior. Treating children with challenging behavior and enhancing teachers' skills in behavior management could increase the time and energy teachers have to deliver curriculum in their classrooms.

Relationships with adults have a lasting influence on children's development. These relationships reflect both the socialization efforts made by adults and the characteristics that children bring to them. Forty years ago, developmental and clinical psychologists began investigating how children's characteristics influence interactions with adults (Bell, 1968; Lytton, 1977). Special research designs are needed to disentangle parenting effects on children from children's effects on parenting. Three designs in particular have proven useful (Moffitt, 2005). First, laboratory experiments in which boys were paired with their own and other mothers showed that conduct-disordered boys elicited more negativity than did boys who were not conduct disordered (Anderson, et al., 1986). Second, adoption studies showed that adolescents whose biological mother had a history of antisocial behavior elicited more negativity from their adoptive parents than did adolescents whose biological mother did not have a history of antisocial behavior (O'Connor, et al., 1998). Finally, twin studies showed that children's heritable characteristics partially explained the amount of punishment children received (Jaffee, et al., 2004). Thus, so-called "child effects" research has shown that children who exhibit difficult behavior elicit greater harshness and negativity from parents interacting with them.

Although child effects on parents are now known to be ubiquitous, less work has focused on child effects on teachers. This is surprising, since children spend some 15,000 hours of their

young lives at school and children's school performance has a profound effect on life opportunities and chances (Rutter, et al., 1979). Research shows that children whose relationships with their teachers are characterized by low conflict and dependency and high closeness and warmth have more positive academic and social outcomes (Baker, 2006; Birch & Ladd, 1997; Hamre & Pianta, 2001; Pianta, et al., 1995; Rudasill & Rimm-Kauffman, 2009). Moreover, teachers' interactions with children, in particular the regulatory aspects of those behaviors (timing, contingency, feedback) and their emotional valence, relate strongly to children's learning gains in the classroom (Hamre & Pianta, 2005; Mashburn, et al., 2008) and can mitigate aspects of developmental history that place children at risk for poor performance (Rimm-Kaufman, et al., 2005). However, an unanswered question is the extent to which estimates of teacher or classroom influence are, in part, a function of child effects. That is, how much do children influence their teachers' behavior? In the present study, we examine this question by studying the effort teachers report when interacting with a particular child in their classroom.

Establishing and maintaining positive, productive relationships with children requires significant effort on the part of teachers. This effort involves behaviors similar to those exhibited by effective parents (Wentzel, 2002), such as control, maturity demands, democratic communication and nurturance (Baumrind, 1971; 1991). More importantly, one-on-one teacher effort is a precious commodity – while extra attention may be helpful to an individual child, the time spent giving it may inadvertently undermine instructional time and/or teachers' availability to the class as whole. Given the already limited opportunities to learn in classrooms (Pianta, et al., 2007) and the recognition that "teachers are the most important schooling factors affecting student learning," we need to better understand the factors that shape teachers' behavior (Goldhaber & Hannaway, 2009). Correlational studies provide suggestive evidence that children's cognitive, emotional, and behavioral difficulties are linked to more conflicted relationships with their teachers (Birch & Ladd, 1998; Doumen, et al., 2008; Rudasill, & Rimm-Kaufmann, 2009; Sutherland & Oswald, 2005). But research designs to date have been unable to disentangle the direction of effects in the classroom, as they have in the family home (Plomin, 1994).

The present study tests hypotheses about variation in teacher effort as a function of variation in children's personal characteristics, using a design that has not previously been applied to investigate child effects on teachers. Using the Environmental Risk (E-Risk) Study (Moffitt et al., 2002), we directly asked teachers about the effort required to teach each of the 12-year old children enrolled in our longitudinal twin study as they entered secondary school. In the UK, children move from primary to secondary school between ages 11-12 and we measured teacher effort as children were making a "fresh start" in a new school, but were also establishing a reputation that would likely follow them forward.

In our analysis, we focus on teacher effort, a measure reflecting the effort teachers say they allocate to a particular pupil apart from that required by the class as a whole. Using teacher effort as the outcome, we examine child effects on the environment in two ways. First, by relying on the different levels of relatedness between monozygotic (MZ) and dizygotic (DZ) twin children, we test the relative contribution of genetic and environmental factors to variation in teacher effort. If we find that the measure of teacher effort is influenced by children's genes, then teacher effort is elicited at least in part by personal characteristics of children. Furthermore, we discount alternative methodological explanations by comparing twins rated by the same teacher (in the same classroom) to twins rated by different teachers (in different classrooms). Second, relying on our multi-method/multi-informant longitudinal design, we test whether IQ and challenging behavior of children at 5 years of age contribute to the effort required to teach them 7 years later. If we find that teacher effort is influenced

by these early characteristics, then teacher effort is elicited at least in part by qualities that predate pupils' schooling history.

Method

Sample

Participants were members of the E-Risk Longitudinal Twin Study, which tracks the development of a nationally representative birth cohort of 2,232 British children. The sample was drawn from a larger birth register of twins born in England and Wales in 1994-1995 (Trouton et al. 2002). Details about the sample have been reported previously (Moffitt et al., 2002). Briefly, the E-risk sample was constructed in 1999-2000, when 1,116 families with same-sex 5-year old twins (93% of those eligible) participated in home-visit assessments. Families were recruited to represent the UK population of families with newborns in the 1990's, based on residential location throughout England and Wales and mother's age (i.e., older mothers having twins via assisted reproduction were under-selected and teenage mothers with twins were over-selected). We used this sampling to replace high-risk families who were selectively lost to the register via nonresponse and to ensure sufficient numbers of children growing up in high-risk environments. Follow-up home visits were conducted when the children were aged 7 years (98% participation), 10 years (96% participation), and 12 years (96% participation). At each home visit, parents were asked for permission to send a questionnaire to the twins' teachers. Parents were given an opportunity to view this questionnaire before giving consent.

Zygosity was determined using a standard zygosity questionnaire, which has been shown to have 95% accuracy (Price et al., 2000). Ambiguous cases were zygosity-typed using DNA. The sample includes 55% monozygotic (MZ) twins and 45% dizygotic (DZ) twins. Sex is evenly distributed within zygosity (49% male).

Parents gave informed consent and children gave assent. Ethical approval was granted by the Joint South London and Maudsley and the Institute of Psychiatry Research Ethics Committee.

Measures

Teacher Effort Required by Individual Children—At age 12, questionnaires were mailed to children's teachers; questionnaires were obtained for 80% of the original 2,232 E-risk Study twins (83% of those taking part in the follow-up). The majority of twins were in different classrooms and evaluated by different teachers ($N = 618$ pairs, 70%; MZ = 338, 55%; DZ = 280, 45%), but a substantial minority were in the same classrooms and evaluated by the same teacher ($N = 264$ pairs, 30%; MZ = 143, 56%; DZ = 121, 44%).

To rate the amount of effort each child required, teachers indicated the frequency with which they needed to intervene with the child in the classroom, using a 7-point scale with anchors ranging from "much less" to "much more" compared to typical pupils of the same age (Table 1). All items loaded on one factor, accounting for 64% of the variance. Cronbach's alpha was 0.80. The mean of the items served as the final score used in analyses.

To evaluate inter-rater agreement, we obtained two teacher reports for 300 children in our sample. Agreement between different teachers was acceptable, $r = 0.61$, and comparable to previous studies examining cross-teacher consistency (i.e., $r = .64$; Achenbach, et al., 1987). In subsequent analyses, for children with more than one teacher questionnaire, we included the teacher who reported knowing the child best.

Children's Intelligence Quotient (IQ)—At age 5, children's IQ was individually tested using a short form of the Wechsler Preschool and Primary Scale of Intelligence-Revised (Wechsler, 1990). Using two subtests (Vocabulary and Block Design), children's IQs were prorated following procedures described by Sattler (1992, p.998-1004). Scores ranged from 52 to 145 ($M = 95.79$, $SD = 14.46$).

Children's Challenging Behavior—At age 5, children's challenging behavior was assessed via mother and teacher report and observer ratings. Mothers and teachers each reported on 18 DSM-IV (American Psychiatric Association, 1994) symptoms of hyperactivity/impulsivity and inattention. After the home visit, observers/examiners rated each twin on 25 behavioral characteristics assessing children's style of approach, response to the testing session, and to the home visit more generally. For this study, we focused on two scales (Caspi, et al., 1995): Irritability/Negative Affect included ratings of lability, low frustration tolerance, hostility, roughness, and resistance; Impulsivity/Distractibility included ratings of restlessness, impulsivity, fleeting attention, and lacking persistence.

Results

Is the effort required to teach a child influenced by the child's genetic makeup?

Table 2 documents substantial twin resemblance in the effort required to teach a child. The within-pair MZ correlation was .64 and the within-pair DZ correlation was .40. The higher correlation between MZ twins (who share their entire DNA sequence in common) than between DZ twins (who, on average, share half of their DNA sequence) suggests that children's genetic factors contribute to required teacher effort. To test this hypothesis, we conducted univariate behavioral genetic model-fitting using MPlus v5.21 (Muthén & Muthén, 1998-2009). In behavioral genetic model-fitting, variation in phenotype (e.g., required teacher effort) is assumed to be influenced by latent additive genetic (A), common environmental (C), and non-shared environmental (E) factors. We fit different nested models (ACE vs. CE and ACE vs. AE) to the twin data to account for the observed covariance structure using the most parsimonious number of parameters. To compare the fit of different models, we examined the difference in chi-squares between nested models. When two models are nested (i.e., identical with the exception of constraints placed on the submodel), the difference in fit between them can be evaluated with the chi-square difference, using as its degrees of freedom the df difference between the two models. When the chi-square difference is not statistically significant, the more parsimonious model is selected, as the test indicates that the constrained model does not significantly decrease model fit.

Table 2 shows that the model in which children's genetic factors were constrained to have no influence on teacher effort fit significantly worse than the model that included genetic factors, $\chi^2_{\text{difference}}(1, N = 953) = 24.13$, $p < .001$. The model that constrained the common environmental effect to have no influence on teacher effort fit marginally worse, $\chi^2_{\text{difference}}(1, N = 953) = 3.76$, $p = .052$, and we chose to accept the more complex ACE model because the 95% confidence interval for the C term did not include zero. Thus, the best-fitting ACE model (in bold) indicated that children's genetic factors accounted for 45% of the variance in teacher effort; common environmental factors accounted for 18% of the variance; and unique, child-specific environmental factors accounted for the remaining 37% of the variance in teacher effort.

Before accepting this interpretation, it is important to consider the possibility that teachers might rate MZ twins more similarly than DZ twins on the effort required to teach them simply because MZ twins are more similar in appearance and are more easily mixed up. That is, rather than genetic factors contributing to greater MZ:DZ twin similarity, MZ twins may appear to require more similar teacher effort than DZ twins as a function of rater bias

on the part of teachers. To evaluate this possibility, we compared the within-pair MZ versus DZ correlations among twins who were in the same classroom (and evaluated by the same teacher) with twins who were in different classrooms (and evaluated by different teachers) (shaded part of Table 2). For twins in the same classroom, the within-pair MZ correlation was .80 and the DZ correlation was .56. The best fitting model was an ACE model, suggesting that genetic factors accounted for 51% of variance in teacher effort; common environmental factors accounted for 27% of variance; and unique, child-specific environmental factors accounted for the remaining 19% of variance in teacher effort. For twins in different classrooms, the within-pair MZ correlation was .56 and the DZ correlation was .32. The best-fitting AE model indicated that children's genetic factors accounted for 56% of variance in teacher effort and unique, child-specific environmental factors accounted for the remaining 44% of variance in teacher effort, with no influence of common environmental factors. The increased shared environmental effect in same classrooms as opposed to different classrooms suggests that, in addition to the influence of children's characteristics, teacher characteristics or classroom climate also influence teacher effort.

We also tested a multigroup model that allowed separate estimates of A, C, and E for twins in the same versus different classrooms, in contrast to a reduced model that constrained the estimates of A to be equal for twins in the same and different classrooms. The constrained model did not significantly decrease model fit, $\chi^2_{\text{difference}}(1, N = 885) = 0.14, p = 0.71$, indicating that children's genetic factors exerted an equal influence (56%) on required teacher effort regardless of whether children were in the same classroom and evaluated by the same teacher or in different classrooms and evaluated by different teachers.

Is the effort required to teach a child influenced by the child's challenging behavior and cognitive ability?

Table 3 documents the prospective prediction from children's characteristics at age 5 to required teacher effort at age 12. Whether we look at reports of mothers, teachers, or home-visitors, children whose behavior was irritable, impulsive, hyperactive and inattentive at age 5 required more teacher effort at age 12. We created a composite score representing psychometrically "true" challenging child behavior that was reflected in the ratings by multiple informants in different settings. This was accomplished by removing extraneous variance associated with the perspective and context of the different raters using principal component analysis (Kraemer, et al., 2003). The first component extracted consisted of moderate to strong loadings (range: 0.58 – 0.66) for all variables; this component accounted for approximately 40% of the variance. Standardized scoring coefficients were used to create scores representing "challenging child" behavior.

The challenging child behavior composite at age 5 correlated $r = .33$ with required teacher at age 12 years. Similarly, children's IQ at age 5 correlated $r = -.20$ with required teacher 7 years later. Partialling out the effect of IQ only slightly attenuated the correlation between children's challenging behavior and required teacher effort ($r_p = .28$). Partialling out the effect of children's challenging behavior, on the other hand, reduced the correlation between IQ and teacher effort by half ($r_p = -.10$). Thus, it appears that much of the relationship between low IQ and required teacher effort is accounted for by challenging child behavior, but the relationship between challenging child behavior and teacher effort is less susceptible to variations in children's IQ. Given the statistically weak independent effect of child IQ on teacher effort, we focused our remaining analyses on etiological factors that could influence both challenging child behavior and required teacher effort.

Do genetic factors that influence children's challenging behavior also influence how much teacher effort they require?

Table 2 presents the univariate model-fitting results for challenging child behavior. The AE model provided the best fit to the data with genetic factors accounting for 67% of children's challenging behavior and child-specific environmental factors accounting for the remaining 34% of the variance. We then examined the genetic and environmental influences on the covariation between children's challenging behavior and required teacher effort. In multivariate twin analysis, MZ and DZ correlations are compared across phenotypes—for example, one twin's challenging behavior score is correlated with the co-twin's teacher effort score. If the cross-phenotype twin correlations are greater for MZ twins than for DZ twins, the implication is that genetic factors contribute to the correlation between the two phenotypes. The cross-twin cross-phenotype correlations for challenging behavior and teacher effort were higher for MZ twins than for DZ twins (MZ = .32 and .33; DZ = .18 and .20), suggesting children's genetic background influences the association between challenging behavior and required teacher effort (Table 4).

To test this hypothesis, we constructed a bivariate Cholesky model from the most parsimonious univariate models for challenging child behavior (i.e., AE model) and required teacher effort (i.e., ACE model). A significant path from additive genetic influences on challenging child behavior to teacher effort indicates the degree to which genetic influences on challenging child behavior also influence variation in required teacher effort. Similarly, a significant path from nonshared environmental influences on challenging child behavior to teacher effort indicates the extent to which child-specific environmental influences on challenging child behavior also influence teacher effort. Since the univariate model for challenging child behavior did not include shared environmental influences, this component could not contribute to the explanation of required teacher effort.

Model fit did not deteriorate significantly when the path from nonshared environmental influences on challenging child behavior to teacher effort was set to zero, $\chi^2_{\text{difference}}(1, N = 1102) = 0.13, p = 0.72$. However, when additive genetic influences on challenging child behavior were hypothesized to have no effect on teacher effort, the model fit declined significantly, $\chi^2_{\text{difference}}(1, N = 1102) = 156.34, p < 0.001$. Thus, the final best fitting model consisted of an AE model for challenging child behavior at age 5, an ACE model for required teacher effort at age 12, and a significant genetic pathway from challenging child behavior to teacher effort. This model fit the data well, $\chi^2(20, N = 1102) = 29.86, p = .07$, RMSEA = .030.

Figure 1 illustrates that, in the best fitting model, the only path between challenging child behavior and required teacher effort is that from genetic influences on challenging child behavior at age 5 to required teacher effort at age 12. This indicates that 100% of the relationship between challenging child behavior and required teacher effort can be explained by the child's genes that influence both phenotypes ($\beta = 0.40, p < .001$). When parameter estimates were calculated as proportions of variance (by squaring the standardized parameter estimates), genetic influences on challenging child behavior accounted for 16% of variance in teacher effort. The remaining variance in teacher effort was accounted for by other genetic influences on the child (35%), shared environmental influences (12%), and nonshared environmental influences (37%) unique to required teacher effort. This means that although we found heritable child effects on teacher effort, teacher effort also arises from sources beyond the child.

Discussion

Our findings indicate that there are substantial "child effects" on the effort required to teach individual children. This was demonstrated in three ways. First, variation in teacher effort was shown to be a function of variation among children in heritable child characteristics. Second, children's challenging behavior, assessed at primary school entry, significantly predicted the effort required to teach children in secondary school. Third, such challenging child behavior and the effort required to teach a child appear to share a common genetic etiology. We ruled out two potential methodological artifacts: (1) significant child effects remained even when examining twins rated by different teachers; and (2) the measure of child challenging behavior represented a composite of several raters (early teachers, parents, and researchers) suggesting that this composite likely represents stable aspects of the child's behavior rather than context-specific behavior. Interestingly, child effects on teacher effort were significantly influenced by children's challenging behavior (irritability, negative affect, impulsivity, distractibility, and hyperactivity), and less so by their IQ scores. Consistent with previous research, connections between children's cognitive ability and teacher-child relationships appear to be a function of children's self-regulation and behavioral difficulties (Eisenhower, et al., 2007). This is likely because children with low IQ tend to have co-occurring challenging behaviors, but children exhibiting challenging behavior do not necessarily have low IQ.

While child effects accounted for a significant proportion of the variance in teacher effort, we also found considerable variation in teacher's effort toward individual children that could not be attributed to a child effect. Common environmental factors influenced required teacher effort among children in the same classroom, but not among children in different classrooms. The common environment variance component in behavioral genetic models is usually thought to index environmental experiences in children's families that have made them similar. In the present study, the fact that shared environmental factors create similarities in teacher's effort between children in the same classroom, but not between children in different classrooms suggests three possibilities: (1) classroom climate makes pupils similar in the effort required to teach them, irrespective of their genetic backgrounds; (2) teachers' individual styles lead them to invest similar amounts of effort in all pupils in their classrooms; and/or (3) ratings provided by the same teachers contain bias and create artificial similarities among pupils.

Our study has several limitations. First, the findings are limited to one birth cohort growing up in England and Wales; future research will need to establish whether these findings generalize to school settings in other nations. Second, we studied a cohort of twins, and the findings need to be replicated in singletons. Third, we only studied one age group; factors influencing teacher effort may be different at different ages and stages of school. Fourth, because this was a nationwide cohort, each pair of twins attended a different school, and we were unable to estimate school-level effects on teacher effort. Fifth, our self-report measure of teacher effort was developed for this study and showed very good psychometric properties. However, it should be validated against observational measures of teachers in classrooms.

Teaching children requires effort and some children naturally require more effort than others. The goal of our study was not to blame children (or teachers) for classroom difficulties. Rather, our goal was to test the scope of children's effects on adults beyond the family in order to better understand the factors that shape teachers' behavior in the classroom, which is emerging as one of the most important schooling factors affecting student learning (Goldhaber & Hannaway, 2009). Our findings about child effects on teachers have two implications. First, targeted interventions directed at curbing early-

emerging challenging child behaviors, particularly those associated with ADHD and impulsivity, may improve children's later teaching environments and thereby contribute to their learning; that is, cumulative continuities in children's difficulties may be stalled by actively breaking up gene-environment correlations. Indeed, treatment for ADHD has been shown to improve parenting (Barkley, 1981; Schachar, et al., 1987) and may show similar effects on teachers' behavior. Second, given the powerful role of children in shaping their teachers' behavior, teachers may benefit from learning and mastering cognitive and behavioral management skills for dealing with challenging child behaviors in order to prevent future problems before they arise, consume teachers' efforts and interfere with other students' learning.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

The E-Risk Study is funded by the Medical Research Council (MRC grant: G9806489). Additional support was provided by the Economic and Social Research Council, NICHD grant HD061298, NIMH grant MH077874, and NIDA grant DA023026. Louise Arseneault is supported by the UK Department of Health. Avshalom Caspi is a Royal Society Wolfson Research Merit Award holder.

References

- Achenbach TM, McConaughy SH, Howell CT. Child/adolescent behavioral and emotional problems: Implications of cross-informant correlations for situational specificity. *Psychological Bulletin*. 1987; 101(2):213–232. [PubMed: 3562706]
- American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. Fourth Edition. American Psychiatric Association; Washington, DC: 1994.
- Anderson KE, Lytton H, Romney DM. Mothers' interactions with normal and conduct disordered boys: Who affects whom? *Developmental Psychology*. 1986; 22(5):604–609.
- Baker JA. Contributions of teacher-child relationships to positive school adjustment during elementary school. *Journal of School Psychology*. 2006; 44:211–229.
- Barkley RA. The use of psychopharmacology to study reciprocal influences on parent child interaction. *Journal of Abnormal Child Psychology*. 1981; 9:303–310. [PubMed: 7320347]
- Baumrind D. Current patterns of parental authority. *Developmental Psychology Monographs*. 1971; 4(1, Part2)
- Baumrind, D. Effective parenting during the early adolescent transition. In: Cowan, PA.; Hetherington, M., editors. *Family Transitions*. Earlbaum; Hillsdale, NJ: 1991. p. 111-164.
- Bell RQ. A reinterpretation of the direction of effects of studies of socialization. *Psychological Review*. 1968; 75(2):81–95. [PubMed: 4870552]
- Birch SH, Ladd GW. The teacher-child relationship and children's early school adjustment. *Journal of School Psychology*. 199735(1):61–79.
- Birch SH, Ladd GW. Children's interpersonal behaviors and the teacher-child relationship. *Developmental Psychology*. 1998; 34(5):934–946. [PubMed: 9779740]
- Caspi A, Henry B, McGee R, Moffitt TE, Silva PA. Temperamental origins of child and adolescent behavior problems: From 3 to age 15. *Child Development*. 1995; 66:55–68. [PubMed: 7497829]
- Doumen S, Verschueren K, Buyse E, Germeijs V, Luyckx K, Soenens B. Reciprocal relations between teacher-child conflict and aggressive behavior in Kindergarten: A three-wave longitudinal study. *Journal of Clinical Child and Adolescent Psychology*. 2008; 37(3):588–599. [PubMed: 18645749]
- Eisenhower AS, Baker BL, Blacher J. Early student-teacher relationships of children with and without intellectual disability: Contributions of behavioral, social, and self-regulatory competence. *Journal of School Psychology*. 2007; 45:363–383. [PubMed: 21490876]

- Goldhaber, D.; Hannaway, J., editors. *Creating a New Teaching Profession*. Urban Institute Press; Washington, DC: 2009.
- Hamre BK, Pianta RC. Early teacher-child relationships and the trajectory of children's school outcomes through eighth grade. *Child Development*. 2001; 72(2):625–638. [PubMed: 11333089]
- Hamre B, Pianta RC. Can instructional and emotional support in the first grade classroom make a difference for children at risk of school failure? *Child Development*. 2005; 76(5):949–967. [PubMed: 16149994]
- Jaffee SR, Caspi A, Moffitt TE, Polo-Tomas M, Price T, Taylor A. The limits of child effects: Evidence for genetically mediated child effects on corporal punishment but not physical maltreatment. *Developmental Psychology*. 2004; 40(6):1047–1058. [PubMed: 15535755]
- Kraemer HC, Measelle JR, Ablow JC, Essex MJ, Boyce WT, Kupfer DJ. A new approach to integrating data from multiple informants in psychiatric assessment and research: Mixing and matching contexts and perspectives. *American Journal of Psychiatry*. 2003; 160(9):1566–1577. [PubMed: 12944328]
- Lytton H. Do parents create, or respond to, differences in twins? *Developmental Psychology*. 1977; 13(5):456–459.
- Mashburn A, Pianta R, Hamre B, Downer J, Barbarin O, Bryant D, Burchinal M, Early D, Howes C. Measures of classroom quality in pre-kindergarten and children's development of academic, language and social skills. *Child Development*. 2008; 79(3):732–749. [PubMed: 18489424]
- Moffitt TE. The new look of behavioral genetics in developmental psychopathology: Gene-environment interplay in antisocial behavior. *Psychological Bulletin*. 2005; 131(4):533–554. [PubMed: 16060801]
- Moffitt TE, E-Risk Study Team. Teen-aged mothers in contemporary Britain. *Journal of Child Psychology and Psychiatry*. 2002; 43:1–16.
- Muthén, LK.; Muthén, BO. *MPlus User's Guide*. 5th Edition. Muthén & Muthén; Los Angeles, CA: 1998-2009.
- O'Connor TG, Deater-Deckard K, Fulker D, Rutter M, Plomin R. Genotype-environment correlations in late childhood and early adolescence: Antisocial behavior problems and coercive parenting. *Developmental Psychology*. 1998; 34(5):970–981. [PubMed: 9779743]
- Pianta RC, Belsky J, Houts R, Morrison F, NICHD Early Child Care Research Network. Opportunities to learn in America's elementary classrooms. *Science*. 2007; 315:1795–1796. [PubMed: 17395814]
- Pianta RC, Steinberg MS, Rollins KB. The first two years of school: Teacher-child relationships and deflections in children's classroom adjustment. *Development and Psychopathology*. 1995; 7:295–312.
- Plomin, R. *Genetics and Experience: The Interplay between Nature and Nurture*. Sage; Thousand Oaks, CA: 1994.
- Price TS, Freeman B, Craig I, Petrill SA, Ebersole L, Plomin R. Infant zygosity can be assigned by parental report questionnaire data. *Twin Research*. 2000; 3:129–133. [PubMed: 11035484]
- Rimm-Kaufmann S, La Paro K, Downer J, Pianta R. The contribution of classroom setting and quality of instruction to children's behavior in the kindergarten classroom. *Elementary School Journal*. 2005; 105(4):377–394.
- Rudasill KM, Rimm-Kaufman SE. Teacher-child relationship quality: The roles of child temperament and teacher-child interactions. *Early Childhood Research Quarterly*. 2009; 24:107–120.
- Rutter, M.; Maughan, B.; Mortimore, P.; Ouston, J. *Fifteen thousand hours*. Harvard University Press; Cambridge, MA: 1979.
- Sattler, JM. *Assessment of children: WISC-III and WPPSI-R supplement*. Author; San Diego, CA: 1992.
- Schachar R, Taylor E, Wieselberg M, Thorley G, Rutter M. Changes in family function and relationships in children who respond to methylphenidate. *Journal of the American Academy of Child and Adolescent Psychiatry*. 1987; 26:728–732. [PubMed: 3667503]
- Sutherland KS, Oswald DP. The relationship between teacher and student behavior in classrooms for children with emotional and behavioral disorders: Transactional processes. *Journal of Child and Family Studies*. 2005; 14(1):1–14.

- Trouton A, Spinath FM, Plomin R. Twins Early Development Study (TEDS): A multivariate, longitudinal genetic investigation of language, cognition and behavior problems in childhood. *Behavior Genetics*. 2002; 5:444–448.
- Wechsler, D. Wechsler Preschool and Primary Scale of Intelligence-Revised. The Psychological Corporation, Harcourt Brace and Company; London: 1990.
- Wentzel KR. Are effective teachers like good parents? Teaching styles and student adjustment in early adolescence. *Child Development*. 2002; 73(1):287–301. [PubMed: 14717258]

\$watermark-text

\$watermark-text

\$watermark-text

Figure 1.

Standardized parameter estimates with 95% confidence intervals for bivariate Cholesky model of the association between challenging child behavior at age 5 and required teacher effort at age 12. The letters A, C, and E refer to additive genetic influences, shared environmental influences, and nonshared environmental influences, respectively. The model is displayed for Twin 1 only; the model for Twin 2 would look identical. The variances of the latent variables are fixed at 1. All parameter estimates are statistically significant at $p < .01$.

Table 1

Descriptive statistics for the teacher effort scale

Teacher Effort Items	N	Mean	SD	Alpha
Compared to typical pupils of the same age:				
How frequently must you give this child extra encouragement to get him/her to take part?	1761	2.30	1.76	
How frequently must you act to keep this child's attention on a task?	1759	2.09	1.81	
How frequently must you act to curb disruptive behaviour by this child?	1758	1.36	1.76	
How frequently does this child's behaviour make it rewarding to work with him/her? ^a	1761	3.95	1.46	
How frequently does this child's behaviour make it frustrating to work with him/her?	1759	1.46	1.70	
How frequently does this child need one-to-one interaction from you?	1760	2.40	1.73	
Teacher Effort Total Score	1740	1.94	1.36	0.80

Note: Available response categories are: 0 = Much less; 1 = Somewhat less; 2 = Slightly less; 3 = About average; 4 = Slightly more; 5 = Somewhat more; 6 = Much more

^aReverse scored prior to creating Teacher Effort Total Score.

Table 2
Within-pair correlations for teacher effort and challenging child and results of behavioral genetic model fitting

	Within-pair <i>r</i>		Variance Components			Model Fit Statistics			
	MZ	DZ	A	C	E	χ^2	df	RMSEA	χ^2 difference
<u>Teacher Effort (Age 12)</u>									
ACE	0.64	0.40	0.45 (0.28 - 0.66)	0.18 (0.05 - 0.40)	0.37 (0.32 - 0.42)	5.72	6	0.000	
CE				0.53 (0.48 - 0.58)	0.47 (0.42 - 0.52)	29.85 *	7	0.083	24.13 *
AE			0.64 (0.59 - 0.69)		0.36 (0.31 - 0.41)	9.48	7	0.027	3.76 +
<u>Same Classroom</u>									
ACE	0.80	0.56	0.51 (0.30 - 0.78)	0.27 (0.08 - 0.57)	0.19 (0.15 - 0.24)	3.24	6	0.000	
CE				0.68 (0.62 - 0.75)	0.32 (0.25 - 0.39)	26.94 *	7	0.146	23.70 *
AE			0.81 (0.76 - 0.86)		0.19 (0.15 - 0.25)	7.28	7	0.017	4.04 *
<u>Different Classroom</u>									
ACE	0.56	0.32	0.43 (0.21 - 0.73)	0.12 (0.00 - 0.46)	0.45 (0.38 - 0.53)	6.85	6	0.021	
CE				0.46 (0.40 - 0.53)	0.54 (0.40 - 0.61)	18.38 *	7	0.073	11.53 *
AE			0.56 (0.49 - 0.63)		0.44 (0.37 - 0.51)	7.80	7	0.019	0.95
<u>Challenging Child (Age 5)</u>									
ACE	0.68	0.21	0.67 (0.60 - 0.75)	0.00 (0.00 - 0.05)	0.34 (0.30 - 0.38)	15.73 *	6	0.056	
CE				0.47 (0.42 - 0.52)	0.53 (0.42 - 0.58)	121.50 *	7	0.176	105.77 *
AE			0.67 (0.60 - 0.75)		0.34 (0.30 - 0.38)	15.73 *	7	0.049	0.00

Note: Models in **bold** indicate the best-fitting models. MZ = monozygotic; DZ = dizygotic. A = additive genetic effect; C = common environmental effect; E = unique environmental effect. Numbers in parentheses represent the 95% confidence intervals. RMSEA = root-mean-square error of approximation. χ^2 difference is the difference in the fit between the full ACE model and the reduced model.

+ $p < .10$;

* $p < .05$.

Table 3

Correlations between children's characteristics at age 5 years and teacher effort at age 12 years

Variable	Correlations with Teacher Effort	
	r	r _p
Mother Rated:		
Inattentive	0.24	0.19
Hyperactive / Impulsive	0.21	0.17
Teacher Rated:		
Inattentive	0.21	0.17
Hyperactive / Impulsive	0.21	0.19
Observer Rated:		
Irritability / Negative Affect	0.18	0.19
Impulsivity / Distractibility	0.21	0.14
Challenging Child Composite	0.33	0.28
Child IQ	-0.20	-0.10

Note: All correlations are significant at $p < 0.01$ (adjusted for clustering of twins within families) r_p = Partial correlation between age 5 risk factors and age 12 teacher effort, removing the effect of Challenging Child (for IQ) or Child IQ (for all others)

\$watermark-text

\$watermark-text

\$watermark-text

Within- and cross-twin correlations between challenging child behavior at age 5 and required teacher effort at age 12

Table 4

		Twin 1		Twin 2	
		Challenging Child	Teacher Effort	Challenging Child	Teacher Effort
Monozygotic Twins					
Twin 1	Challenging Child, Age 5	--			
	Teacher Effort, Age 12	0.34	--		
Twin 2	Challenging Child, Age 5	0.68	0.32	--	
	Teacher Effort, Age 12	0.33	0.64	0.35	--
Dizygotic Twins					
Twin 1	Challenging Child, Age 5	--			
	Teacher Effort, Age 12	0.26	--		
Twin 2	Challenging Child, Age 5	0.21	0.18	--	
	Teacher Effort, Age 12	0.20	0.40	0.37	--

Note: All correlations are significant at $p < 0.01$ MZ ($n = 421$ -599); DZ ($n = 335$ -498)