Level and Change in Reading Scores and Attention Problems During Elementary School as Predictors of Problem Behavior in Middle School

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This study examined heterogeneity in change in reading test scores and attention problems during middle childhood and whether heterogeneity in change in these variables predicted later problem behavior. Our sample consisted of 783 students recruited from 10 Pacific Northwest schools. For both reading scores and teacher report of attention problems, latent growth curve models of annual data from Grades 3 to 6 showed statistically significant heterogeneity in initial level and change. Level and change factors for both variables were statistically significant predictors of problem behavior in 7th grade. In a combined model that included growth factors for both reading and attention problems, only level of attention problems had a unique and statistically significant association with problem behavior.

Children who have poor academic outcomes in elementary school, particularly those who have difficulty learning to read, are more likely to engage in delinquency, violence, and substance use during adolescence (for reviews, see Farrington, 1998; Hawkins, Catalano, & Miller, 1992; Hawkins et al., 1998; Hinshaw, 1992b; Maguin & Loeber, 1995). A cluster of behaviors that includes impulsivity, hyperactivity, and poor concentration (referred to here as *attention problems*) has been linked to academic failure (Hinshaw, 1992a; Kellam et al., 1991; Rabiner, Coie, & Conduct Problems Prevention Research Group, 2000) and has also been shown to predict multiple forms of later problem behavior (for reviews, see Farrington, 1998; Hawkins et al., 1992; Hawkins et al., 1998). Although the links between both attention problems and poor reading ability and later problem behavior have been well established and many preventive interventions have been developed to reduce problem behavior by affecting changes in these risk factors, prior studies have not used longitudinal data and growth models that show how changes in these risk factors are associated with problem behavior (Burchinal & Appelbaum, 1991).

In a meta-analysis of survey studies that examined the relationship between academic performance and delinquency, Maguin and Loeber (1995) found consistent support for an association between these variables. They obtained a mean effect size of −.15 for bivariate analyses of longitudinal data in which academic achievement was determined to be a predictor of later delinquency. This relationship varied in degree, but not in direction, across groups based on gender, ethnicity, and age (range of mean effect sizes = −.09 to −.25). Also, academic achievement and delinquency were negatively correlated, even when measured several years apart, regardless of whether academic achievement was assessed by test scores, grades, or teacher reports.

Scores on tests of reading ability have been widely used as indicators of academic achievement during elementary school and have been found to have predictive validity with respect to problem behaviors (Maguin & Loeber, 1995; Maguin, Loeber, & LeMahieu, 1993; Rutter, Tizard, & Whitmore, 1970). The centrality of reading test scores as an indicator of academic performance is due, in part, to the fact that reading test scores are widely available and not as contingent on curriculum content as other academic test scores. Further, because reading skills are perhaps the most important dimension of

academic competence in elementary school, they are a primary focus of many academic interventions that also aim to prevent problem behaviors (e.g., Kellam, Rebok, Ialongo, & Mayer, 1994; Slavin & Madden, 2001).

Reading test scores at different time points during the elementary school period are positively correlated with each other, suggesting that individual differences in reading skills are stable. Early elementary school students who read at lower levels than their peers are likely to still be reading at lower levels later in elementary school. Kowalski-Jones and Duncan (1999) examined reading test scores over four time points using National Longitudinal Survey of Youth data from ages 6 to 13 years and found correlations between adjacent time points that were greater than .6 for both boys and girls and correlations greater than .5 between first and last time points. They also found that in latent growth models that included level and slope factors (and autoregressive adjustments for "shock" effects of deviation above or below expected values at a given time point) there was between-individual variability in slope that was significantly greater than zero. This suggests that there is heterogeneity in the rate of change in reading scores during middle childhood, which raises the question of whether change in reading scores is itself a predictor of later problem behaviors. The importance of the relationship between change in academic performance and later problem behaviors is clear; many preventive interventions attempt to improve academic competency in elementary school and thereby reduce problem behaviors such as substance use, violence, and delinquency during adolescence (e.g., Catalano et al., 2003; Conduct Problems Prevention Research Group, 2000; Hawkins, Catalano, Kosterman, Abbott, & Hill, 1999; Kellam et al., 1994; Slavin & Madden, 2001).

Attention problems and an array of related cognitive and behavioral deficits (e.g., impulsivity, hyperactivity, poor concentration) broadly represent attention-deficit/hyperactivity disorder (ADHD), a classification of disruptive behavior disorders (American Psychiatric Association, 1994) that has been strongly linked to both poor academic performance and problem behaviors such as delinquency, violence, and drug use in adolescence. Although other psychopathologies, such as oppositional defiant disorder, conduct disorder, and depression, have also been found to be associated with poor academic performance and adolescent problem behaviors, the dimensions of externalizing behavior most closely linked to low academic performance are attention problems and hyperactivity (Hinshaw, 1992a; Kellam et al., 1991; Rabiner et al., 2000). Because of considerable debate regarding the distinctions between attention problems and the other dimensions of ADHD (Crystal, Ostrander, Chen, & August, 2001; Hinshaw, 1987; Kaplan, Dewey, Crawford, & Wilson, 2001), we have chosen to focus on a global construct of attention problems that includes impulsivity, hyperactivity, and poor concentration.

Similar to academic performance, attention problems across the elementary school period display a degree of stability. Among early elementary school children, Rabiner et al. (2000) found moderate correlations between teacher ratings of inattention in kindergarten and first grade (.40) and in first grade and second grade (.33). Rebok and colleagues (1997) found moderate to high stability in attentional performance measures between the ages of 8 and 13 years. On one test of ability to focus attention, a correlation of .61 was found between tests administered at ages 8 and 13 years. Other studies have found that there is high probability that children diagnosed with ADHD will maintain that diagnosis over time. For instance, Hart et al. (1995) found that in a sample of 177 boys who were from 7 to 12 years old at baseline and had been diagnosed with ADHD, 77% met the criteria for that diagnosis 4 years later. In comparison, most epidemiological studies have found ADHD prevalence rates of less than 20% for school-age boys (American Psychiatric Association, 1994).

The supposition that there is heterogeneity in change in externalizing behaviors in general, if not specifically in attention problems, is an integral component of theories that posit different developmental pathways in the development of antisocial behavior (e.g., Loeber, Stouthamer-Loeber, Van Kammen, & Farrington, 1991; Moffitt, 1993; Patterson, Capaldi, & Bank, 1991). However, few direct empirical assessments of heterogeneity in change in externalizing behavior during middle childhood have been conducted. Spieker, Larson, Lewis, and Gilchrist (1999), using maternal reports on the *Behavior Problems Index* (BPI; Baker & Mott, 1989) of 185 children between the ages of 3 and 6 years, found between-individual variation in linear change in disruptive behaviors that was greater than would be expected, due to sampling error. As with reading scores, Kowalski-Jones and Duncan (1999) found that for boys, a middle childhood growth model for a problem behaviors construct (of which externalizing behaviors were a major component and based on maternal report on the BPI) had statistically significant heterogeneity in slope, although variability in slope was not statistically significant for girls.

An additional line of inquiry in the investigation of predictors of problem behaviors involves analyses to identify salient risk factors when controlling for potentially confounding variables. Such an approach provides stronger evidence for building theories of causal relationships between predictors and outcomes. The case for academic failure leading to later problem behaviors is that children become discouraged by academic failure, find the school environment less rewarding, and drift away from the prosocial influences of the school environment (Catalano & Hawkins, 1996; Hawkins & Lishner, 1987; Kellam, Mayer, Rebok, & Hawkins, 1998; Rutter et al., 1970). Some support for this perspective comes from randomized control trials of interventions intended to boost academic performance in which improvements in academics were related to improvements in behavioral outcomes (e.g., Hinshaw, 1992a; Kellam et al., 1998). However, as noted by Kellam et al. (1998), academic interventions may address a common underlying cause of academic failure and rule-breaking behavior, such as poor impulse control. The idea that a "common cause" variable gives

rise to both later academic failure and later problem behaviors suggests that academic achievement has no independent association with problem behaviors when this common-cause variable is controlled. (For a discussion of this issue, see Maguin & Loeber, 1995.) Maguin and Loeber, based on analyses from seven longitudinal naturalistic studies, found that conduct problems (measured by peer, teacher, or parent measures of oppositional or disruptive behaviors) accounted for approximately one third of the association between academic achievement and delinquency but that a unique association between the two variables remained when conduct problems were controlled. Although few longitudinal studies have included baseline information on attention problems, evidence from cross-sectional studies, including the analyses of Maguin, Loeber, and LeMahieu (1993), has indicated that including a measure of attention problems based on parent and teacher reports accounted for almost all of the association between academic achievement and delinquency (Maguin & Loeber, 1995). Based on this evidence, we focus on attention problems as a variable that might account for the association between academic failure and later problem behaviors.

Prior studies that have looked at academic failure and attention problems as risk factors for later problem behavior have examined relationships between level of these variables at one time point and later problem behaviors. The present study adds to prior research by assessing heterogeneity in change in these risk factors during middle childhood and then examining how change in these variables is associated with later problem behaviors.

First, we examine whether there is heterogeneity in change over the last 4 years of elementary school in reading test scores and attention problems, as measured by teacher reports of child behavior. Second, we assess the extent to which level of and change in these variables predict early adolescent problem behavior, measured by child self-report in what, for most students in the study, was the first year of middle school. We model problem behavior as a latent factor measured by three indicators: substance use, covert antisocial behavior, and physical aggression. These models test the hypothesis, implicit in the design of many preventive interventions, that positive changes in the risk factors of academic failure and attention problems are associated with reductions in problem behavior. Further, we test the hypothesis that the relationship between academic failure and problem behavior is accounted for by attention problems using a model that includes growth models for both reading and attention problems, thereby assessing the unique association between growth in these two risk factors and later problem behavior.

Method

Participants

Participants were involved in the Raising Healthy Children (RHC) Project, a longitudinal study of students drawn from 10 public schools in a suburban Pacific Northwest school district. RHC is a study of the etiology of problem behaviors as well as a test of a multicomponent preventive intervention. The intervention was delivered at five of the project elementary schools and consisted of instructional staff development for teachers, parenting workshops for parents, summer camps and study clubs for students, and home-based case management services for high-risk students who exhibited academic or behavioral problems. Additional details regarding RHC have been reported by Haggerty, Catalano, Harachi, and Abbott (1998) and Catalano et al. (2003). Nine hundred and thirty-eight students were enrolled in the project in the fall of 1993, when they were in either first or second grade. An additional 102 students, who were from the same grade levels and had transferred to the study schools, were enrolled in the fall of the subsequent year.

To be included in the present study, an RHC participant had to complete at least one of four reading achievement tests administered annually to all district students in Grades 3 through 6. Seven hundred and eighty-three students met this criterion; the 257 students who did not do so lacked test data because they had transferred out of the school district prior to the spring of third grade. The sample size of this study yields sufficient power to detect small effect sizes. For example, using an alpha value of .05, 783 participants yields power of .80 to detect a bivariate correlation of .10. Of the analysis sample, 58% were originally enrolled in an intervention school and 53% were male. The ethnic composition of the analysis sample was as follows: 83% White, 7% Asian or Pacific Islander, 4% Hispanic, 4% Black, and 2% Native American. Based on parent survey data from the spring of the students' third-grade year, 32% came from one-parent families and 31% came from low-income families, as indicated by the child's receiving reduced-price or free lunch at school or the family's receiving public assistance in the form of Aid to Families with Dependent Children (AFDC) or food stamps (see Note 1).

Data Collection

Reading achievement test scores were collected from school district records. Test scores were available for 98% of the analysis sample in third grade, 89% in fourth grade, 80% in fifth grade, and 73% in sixth grade. These numbers generally reflect the percentage of study participants still enrolled in the school district in these years. Surveys were administered to parents, teachers, and students in the spring of each year of the project. For completing surveys, parents received small monetary incentives (between $25 and $50) and children received token gifts (e.g., watch, radio). The surveys included items measuring problem behaviors and social development constructs in family, individual, community, school, and peer domains. Student and parent survey data were collected for all students enrolled in the project, even if they had left their original elementary school or the school district. Teacher survey data used to measure attention problems were available for 99% of the analysis sample in Grade 3, 96% in Grade 4, 94% in Grade 5, and 90% in Grade 6. Parent survey data used to measure low-income status were available for 96% of the sample in Grade 3. Child survey data, which were used to measure child problem behaviors in seventh grade,

were available for 93% of the analysis sample at that time point.

Data from the two cohorts were combined and organized by grade level so that reading scores and attention problems measured from Grades 3 through 6 predict problem behaviors in Grade 7, which was, for most participants, the first year of middle school. Only four students in the sample repeated a grade from Grade 3 to Grade 7. For these four students, the problem behavior measures were based on survey data obtained when they were in sixth grade. All of the elementary schools from which RHC initially drew its sample included sixth grade, after which students moved into middle school. However, 47 of the students who transferred out of the school district began middle school a year earlier, in sixth grade.

Measures

Reading test scores were based on the Northwest Evaluation Association (NWEA; 1997) *Achievement Level Tests,* administered in the spring of Grades 3 through 6. The test provides an assessment of reading skills in word recognition and literal, interpretive, and evaluative comprehension of text. Test items on the *Achievement Level Tests* are weighted according to difficulty and are scaled using a Rasch model (Andrich, 1988). The scale score has a range of 141 to 247. In a norming study carried out during the 1995–1996 school year using students in 37 school districts in 10 states and more than 20,000 students at each grade level, the mean scale score showed monotonic growth across grade levels, with the rate of annual growth decreasing slightly from Grade 3 to Grade 6 (NWEA, 1997). Student scores on the *Achievement Level Tests* are strongly correlated with results of widely used achievement tests. For example, among the 688 participants in the present study who took both the *Achievement Level Tests* and the *Comprehensive Test of Basic Skills* (1990) in fourth grade, reading scores on the two tests were correlated, $r = .81$.

Attention problems were assessed in Grades 3 through 6 with a scale based on five items from the *Teacher Observation of Classroom Adaptation–Revised* (TOCA-R; Werthamer-Larsson, Kellam, & Ovesen-McGregor, 1990). Teachers rated how often the following conditions applied to the student: "can't sit still," "mind wanders," "is easily distracted," "pays attention," and "stays on task." The last two items were reverse-coded. The following response options were given for each item: *rarely or never true* (1), *sometimes true* (2), and *often true* (3). While this scale is not unidimensional, in that some items measure hyperactivity, which some authors choose to distinguish from inattention (see, e.g., Hinshaw, 1987), it is internally consistent with a Cronbach alpha of .88 at Grades 3, 4, and 5 and .87 at Grade 6. It is also similar to measures used in prior studies that have shown predictive validity of combined attention deficit and hyperactivity measures, with respect to conduct problems and adolescent problem behavior (e.g., Maguin et al., 1993).

Problem behavior was measured as a latent variable with three indicators: substance use, covert antisocial behaviors, and physical aggression. Drug use, delinquency, and violence, as well as other forms of problem behavior, are correlated at the individual level, particularly as these behaviors emerge in early adolescence (Loeber, Farrington, Stouthamer-Loeber, & Van Kammen, 1998). This has led some authors (e.g., Donovan & Jessor, 1985; Elliott, Huizinga, & Ageton, 1985; Jessor & Jessor, 1977) to propose that different manifestations of problem behaviors represent one underlying syndrome. Empirical investigations of the structure of adolescent problem behavior have shown that adequate fit of empirical data requires taking into account the independence of distinct forms of problem behavior, although the shared variance among these distinct behaviors can be represented by latent constructs (Ary, Duncan, Duncan, & Hops, 1999; Gillmore, Spencer, Larson, Tran, & Gilchrist, 1998; McGee & Newcomb, 1992; Osgood, Johnston, O'Malley, & Bachman, 1988; Resnicow, Ross Gaddy, & Vaughan, 1995). In the analyses presented here, analytically distinct indicators of the general problem behavior construct were used in a structural equation modeling approach that allows for the testing of structural paths from independent variables to the more general problem behavior factor, as well as paths that point to relationships with specific indicators of problem behavior.

Indicators of problem behavior were created from items on the child survey administered in the spring of seventh grade. The early middle school time point is of interest because it corresponds with a developmental period linked to entry into new school contexts and unsupervised peer groups and reductions in parental monitoring and school involvement (Eccles, 1999). It is also a time of high rates of initiation of new forms of antisocial behavior, such as drug and alcohol use (Johnston, O'Malley, & Bachman, 1999). Three indicators of problem behavior were used. The first indicator was the sum of standardized scores of four items concerning alcohol, cigarette, and marijuana use. The following items were used:

1. In the past year, on how many occasions (if any) have you had more than just a few sips of an alcoholic beverage like beer, wine, or liquor?
2. In the past year, on how many occasions (if any) have you used marijuana?
3. In the past year, on how many occasions (if any) have you used other illegal drugs?
4. In the past 30 days, how frequently (if at all) have you smoked cigarettes?

Cronbach's alpha for the indicator was .76. An indicator of covert antisocial behavior was the sum of standardized scores of five items:

1. In the past year, how often have you drawn graffiti, or written things or drawn pictures on buildings or other property without the owner's permission?
2. In the past year, how often have you gone out at night when your parents told you that you couldn't go?
3. In the past year, how often have you cheated on school tests?

4. Have you ever taken something from a store without paying for it?
5. Have you ever taken something that didn't belong to you, like other kids' clothes, or lunches or money from your parents without their knowing it?

Cronbach's alpha for the indicator was .62. An indicator of physical aggression was based on the sum of standardized scores of four items:

1. In the past year, how often have you started a fight with someone?
2. In the past year, how often have you hit someone with the idea of seriously hurting them?
3. In the past year, how often have you thrown objects such as rocks or bottles at cars or people?
4. How many times in the past 12 months have you hit, kicked, pushed, shoved, or threatened another student?

Cronbach's alpha for the indicator was .84. A limitation of the measurement model for problem behavior is that it assumes a continuous and normal distribution for the observed variable although substantial proportions of the sample reported none of each type of problem behavior (76% for substance use, 46% for covert antisocial behavior, and 33% for physical aggression). After making a log transformation of the substance use indicator, the values of skewness and kurtosis were below 2 and 3, respectively, and thus within the range acceptable for making the assumption of approximate normal distribution of observed indicators in latent variable models (Kline, 1998).

Past research has found gender and income status to be associated with levels of academic achievement, externalizing behaviors, and adolescent problem behavior (Farrington, 1998; Farrington, Loeber, & Van Kammen, 1990; Hawkins et al., 1992; Hawkins et al., 1998; Rutter et al., 1970; Shaywitz, Shaywitz, Fletcher, & Escobar, 1990). Therefore, these variables were included as covariates when examining the relationship of reading scores and attention problems with later problem behavior. Although the relationship of these covariates to reading scores, attention problems, and problem behavior are not the focus of the present study, they were included as variables that might account for associations between reading scores and attention problem growth factors and later problem behavior. Thus, including these covariates provides a more conservative test of the predictive validity of between-individual change in reading scores and attention problems. Low-income status was a dichotomous variable defined by whether the student received free or reduced-price school lunch in third grade or, based on the parent survey conducted in the spring of the student's third-grade year, whether the student's family received AFDC or food stamps. Other plausible covariates that had statistically significant bivariate relationships with reading scores, attention problems, or problem behavior, such as ethnicity and whether children lived in single-parent households, did not add unique variance to the tested models and were dropped from the analysis. Analyses also were run with the experimental condition and the child's original school assignment (represented by dummy coded variables) as covariates, but neither was significantly related to level of problem behavior in seventh grade, nor did including experimental condition or school assignment change the direction or significance level of relationships between other variables in the models.

Missing Data

As noted above, less than 10% of students in the analysis sample were missing data on variables measured with survey data. Missing data on these variables was almost exclusively due to nonparticipation at a given wave of data collection, rather than unwillingness to answer specific questions. However, due to students' transferring out of the school district from which achievement test data were collected, 27% of the analysis sample was missing reading test scores by Grade 6. Listwise and pairwise deletion, in addition to reducing sample sizes and statistical power, often result in biased parameter estimates (Graham, Cumsille, & Elek-Fisk, 2002; Schafer & Graham, 2002). To avoid these problems, the present study used the expectation-maximation (EM) algorithm (Little & Rubin, 1987) and multiple imputation to handle missing data. Data files with complete data were imputed using NORM (2.02; Schafer, 1997). In addition to using information from the measured variables in the analyses, this approach allows use of other correlates of missingness and of model variables that can improve precision of imputed data (Collins, Schafer, & Kam, 2001). Included in the model used to run the EM algorithm was information on residential mobility (based on parent report) during the years students were in third through sixth grades, scores from the *Comprehensive Test of Basic Skills* administered to fourth-grade public school students in the state of Washington in the years of 1995 and 1996, students' age and ethnicity, and a dummy-coded representation of school assignment at the inception of the RHC study. For purposes of hypothesis testing, 20 data sets were created using EM estimates as start values and adding variability between imputed data sets by augmenting these start values with random error drawn from a normal distribution. Analyses were conducted on each data set and results were combined, taking into account the variability in results to provide significance tests of hypothesized relationships based on appropriate estimates of standard errors. This strategy is based on the assumption that data are missing at random, contingent upon data on other variables in the imputation model. Following the recommendations of Graham et al. (2002), computation of descriptive statistics for observed variables, standardized path coefficients, correlations between factors, model fit statistics, and model building were based on analyses of one data set that was created using the EM parameter estimates without being augmented with random error.

Analysis

The analysis strategy followed procedures described by Duncan, Duncan, Strycker, Li, and Alpert (1999) for the use of latent

growth curve models. These models are variants of structural equations models where repeated-measures data are modeled as resulting from latent variables, referred to here as *growth factors,* that describe group mean trajectories while allowing for between-individual differences in trajectories. These between-individual differences can then be made conditional upon explanatory variables and also can be used to predict variation in outcome variables. Analyses were performed with the EQS Structural Equations Program (Bentler & Wu, 1995), using normal theory maximum likelihood estimation that assumes approximate normality of observed indicators of latent variables, while allowing for the use of dichotomous exogenous variables (such as the two covariates representing gender and income status) under the assumption that they are measured without error (Bollen, 1989).

In the first step, we fitted separate unconditional growth models to reading scores and attention problems, based on the four time points of data between third and sixth grade. The repeated measures for reading scores and attention problems are described by latent growth factors that have a mean (M) and variance (D) parameter. The means of the factors represent group growth parameters and the variance of the factors represent variation of individual study participants around the group means. A two-factor model is shown in Figure 1. A linear model of growth was considered first, with loadings across the four time points set at 0 for third grade, 1 for fourth grade, 2 for fifth grade, and 3 for sixth grade. In a second iteration of these models, we examined whether model fit could be improved by freely estimating the factor loadings on the last two time points on the change factor, as recommended by Duncan et al. (1999), so that growth models were fitted to the actual rates of change in group means across time points and could describe change in group means that was not necessarily linear with respect to unit changes in time. Setting the loadings of the change factor to 0 on the first time point results in the level factor (equivalent to what is often referred to as the intercept factor) representing the level of the variable in the spring of third grade. The change factor represents change from this level during the next 3 years. The level and change factors were allowed to covary. Because the specifications for the unconditional models were based on a saturated model, the fit of the unconditional growth models was almost perfect and of no interest. Of primary interest in these unconditional models was whether the variance parameters for the change factors were significantly different from 0 or, in other words, were greater than what would be expected due to sampling error. Statistically significant variance in the change parameter is evidence of heterogeneity in systematic change, with respect to time between third and sixth grade.

After examining the factor loadings and reliability of the measurement model for problem behavior (estimating each factor loading and setting the variance of the latent factor to 1.00; for discussion of estimating reliability with structural equation models, see Raykov, 1997), we examined three models of assessing the relationships between growth factors and problem behavior, controlling for income status and gender. For each of these models, the factor loading of covert antisocial behavior on the latent problem behavior construct was set to 1 and the other two loadings were freely estimated. In the first two models (depicted in Figure 2), the association between growth factors and problem behavior was examined separately for reading scores and attention problems. Of

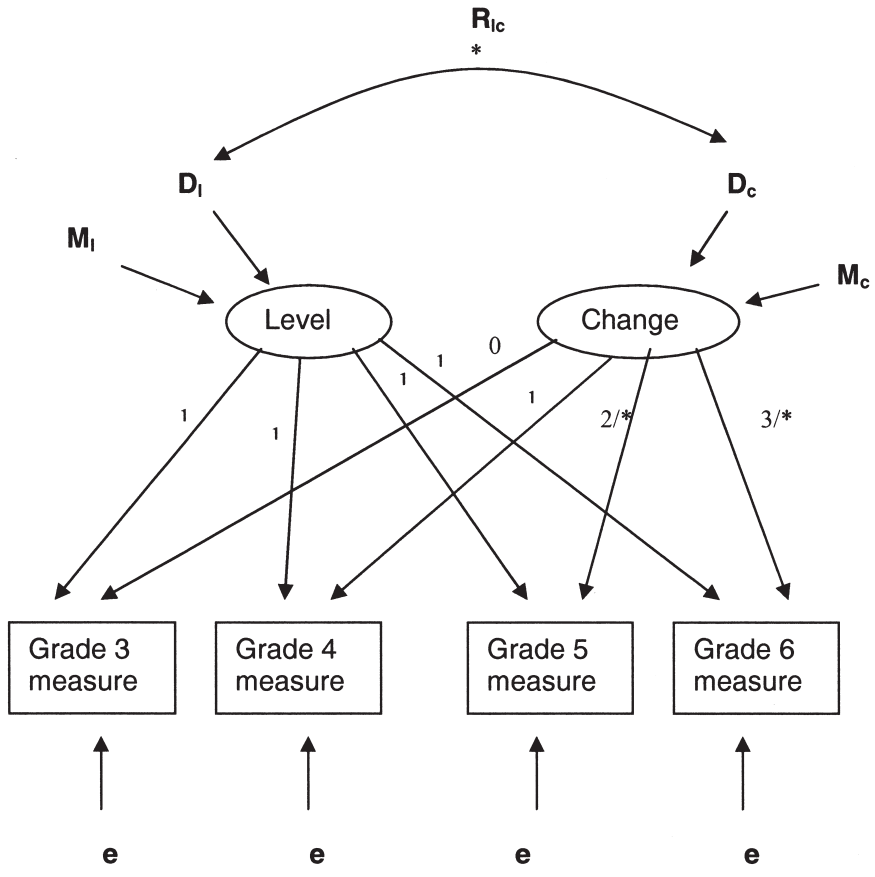

FIGURE 1. Unconditional two-factor growth model with fixed or free loadings of change growth factor on the last two time points. *Note.* M_l = mean of level factor; M_c = mean of change factor; D_l = variance of level factor; D_c = variance of change factor; R_{lc} = covariance of level and change; e = error variance of indicator; * = freely estimated factor loading.

primary interest in these models was whether between-individual variance in change factors had a statistically significant association with variance in problem behavior, which is evidence of predictive validity of heterogeneity in change. In the third model (depicted in Figure 3), the growth factors for reading scores and attention problems were included in the same model predicting problem behavior. Here the focus was on whether reading score and attention problem growth factors had unique associations with problem behavior when they were considered in the same model. For each model, we examined fit indices that evaluate the appropriateness of the specified loadings of the problem behavior indicators on the latent problem behavior construct and the specification of structural paths. In addition to reporting the χ^2 model, we follow Hu and Bentler's recommendations (1998) of providing the *Tucker-Lewis Index* (TLI; Tucker & Lewis, 1973) and the standardized root-mean-square residual (SRMR; Bentler & Wu, 1995) as indicators of model fit. The TLI is sensitive to misspecified factor loadings, while the SRMR is sensitive to misspecification of relationships among latent variables. Lagrange Multiplier (LM) tests (Bentler & Wu, 1995) were used to assess whether specific dimensions of problem behavior had unique associations with growth factors that were not accounted for by the specified paths to the general problem behavior construct.

Results

Descriptive statistics for reading scores and attention problems, as well as the correlation between measures both within and across time points, are shown in Table 1. Mean reading scores increased over time, although the rate of increase diminished across the four time points. Mean scores on the measure of attention problems also increased over the four time points. The correlation between scores at different time points on each of the two measures reflects a degree of stability, particularly with respect to reading scores. Sixty-two percent of the variance in Grade 6 reading scores is explained by Grade 3 reading scores. Twenty-three percent of the variance in attention problems is accounted for by earlier measures of the same variable. The correlations shown in Table 1 also indicate that attention problems were negatively associated with reading scores at each time point and across time points; that is, more attention problems in the classroom correlated with poor reading scores.

Growth Models for Reading Scores and Attention Problems

For reading scores, an unconditional growth model that estimated the factor loadings on the fifth-grade time point at 1.9 and the sixth-grade time point at 2.7 fit the data better than a strictly linear model of growth. This reflects the shape of dimin-

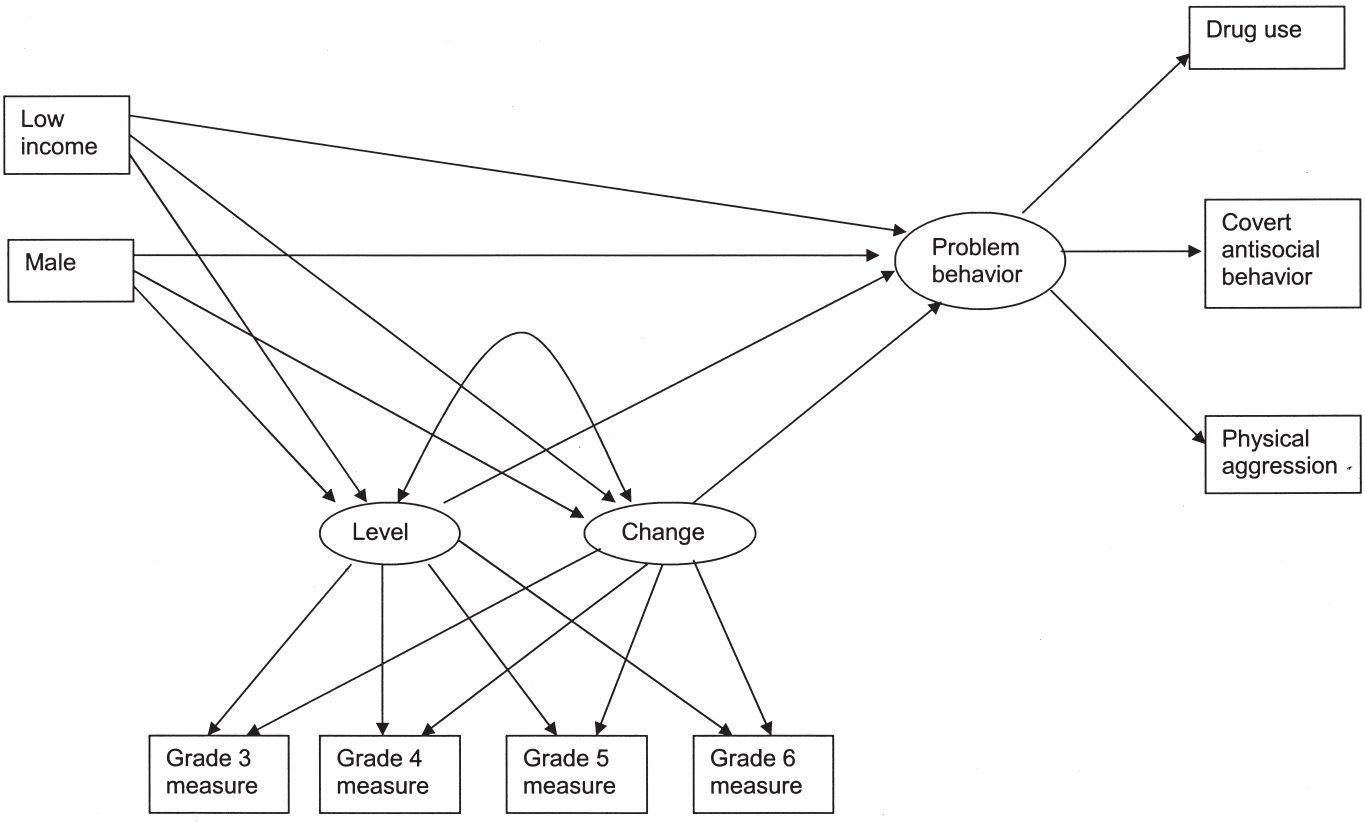

FIGURE 2. Growth model linked to problem behavior, controlling for income status and gender.

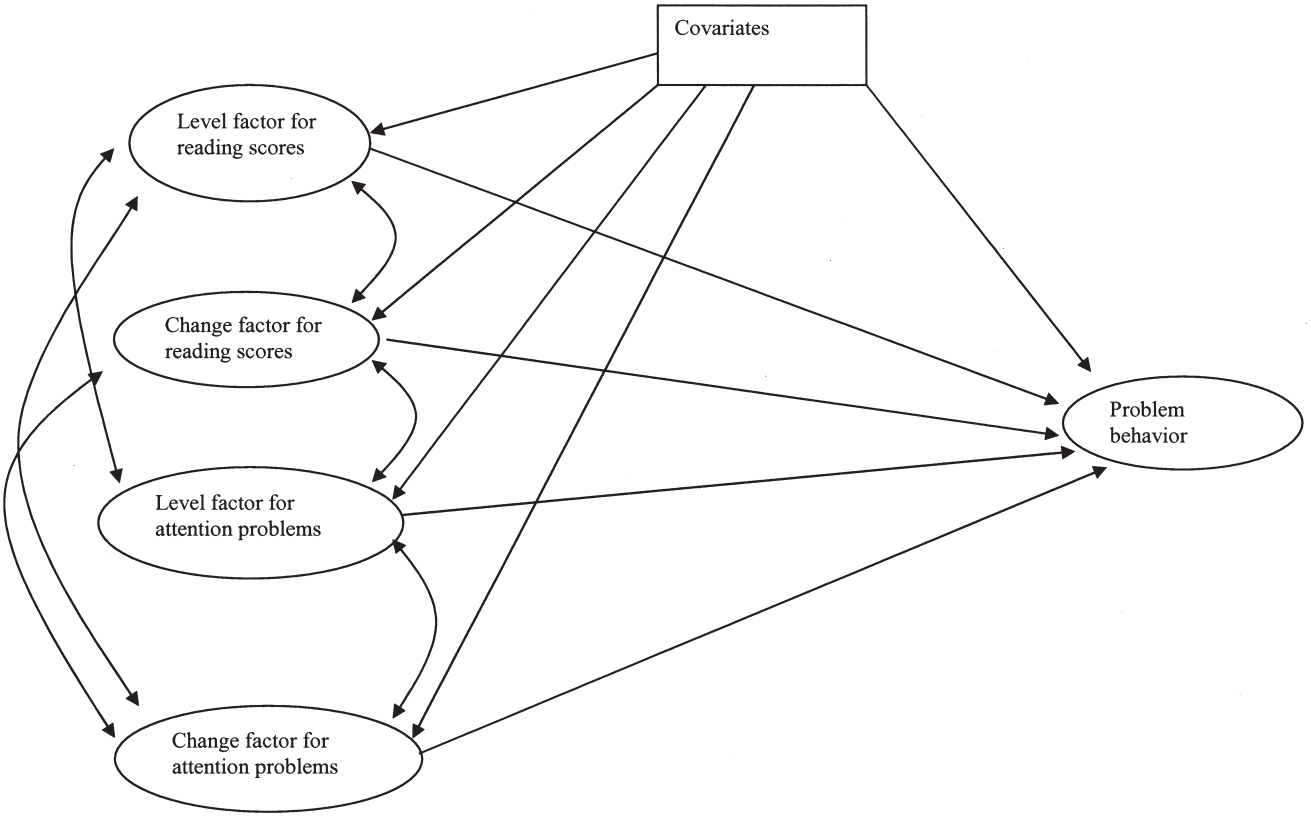

FIGURE 3. Structural paths for combined model with growth factors for reading scores and attention problems linked to problem behavior, controlling for covariate.

TABLE 1
Descriptive Statistics for Reading Scores and Attention Problems and Correlations Between Measures Within and Across Time Points

	Reading scores				Attention problems			
Variable	**Grade 3**	**Grade 4**	**Grade 5**	**Grade 6**	**Grade 3**	**Grade 4**	**Grade 5**	**Grade 6**
Reading scores								
Grade 3	—							
Grade 4	0.84	—						
Grade 5	0.82	0.84	—					
Grade 6	0.79	0.82	0.86	—				
Attention problems								
Grade 3	–0.33	–0.31	–0.34	–0.34	—			
Grade 4	–0.38	–0.37	–0.39	–0.41	0.54	—		
Grade 5	–0.32	–0.37	–0.36	–0.36	0.53	0.56	—	
Grade 6	–0.28	–0.30	–0.33	–0.37	0.48	0.55	0.59	—
M	195.45	202.87	209.67	215.30	1.59	1.60	1.66	1.68
SD	15.12	13.87	12.77	12.03	0.52	0.55	0.56	0.57
Skewness	–0.76	–0.64	–0.66	–0.68	0.45	0.62	0.44	0.37
Kurtosis	0.34	0.52	1.06	0.93	–0.75	–0.54	–0.63	–0.81

ishing growth in mean scores across the four time points. For attention problems, a linear growth model adequately fit the data, and loadings of 0, 1, 2, and 3 were used across the four time points. The parameter estimates for the unconditional models are shown in Table 2. Mirroring the increase in group means across time points, the mean parameters for change for both reading scores and attention problems were significantly greater than zero. Both growth models showed variation in intercept and change that was also significantly greater than zero. Also of note in Table 2 is the covariance between level and change factors. For reading scores, the covariance between growth and initial level is negative (factor correlation = –.60), indicating that children who started out with lower scores showed greater increases in test scores. The covariance between change and intercept was nonsignificant for attention problems (factor correlation = –.03).

TABLE 2
Parameter Estimates for Growth Models for Reading Scores and Attention Problems

Parameter	Reading scores	Attention problems
Level factor		
M	195.52* (.53)	1.59* (.02)
Variance	193.79* (11.48)	0.16* (.02)
Change factor		
M	7.33* (.13)	0.031* (.0066)
Variance	4.40* (.92)	0.0077* (.0025)
Covariance between level and change	–18.18* (2.60)	–0.0024 (.0046)

Note. Standard errors are in parentheses.
*$p < .05$.

TABLE 3
Problem Behavior Indicators' Descriptive Statistics, Intercorrelations, and Correlations with Reading Scores and Attention Problems

	Problem behavior indicator		
Variable	Substance use	Physical aggression	Covert antisocial behavior
Substance use	—		
Physical aggression	.57	—	
Covert antisocial behavior	.65	.70	—
Reading scores			
Grade 3	–.12	–.07	–.06
Grade 4	–.15	–.11	–.12
Grade 5	–.18	–.13	–.11
Grade 6	–.15	–.15	–.13
Attention problems			
Grade 3	.09	.14	.11
Grade 4	.12	.19	.14
Grade 5	.18	.22	.19
Grade 6	.16	.22	.17
M	–.00034	.0090	.00066
SD	1.00	0.84	0.70
Skewness	1.78	1.59	1.54
Kurtosis	2.76	2.53	2.36

Separate Models of Reading and Attention Problems Predicting Problem Behavior

Descriptive statistics for the three indicators of problem behavior and the correlations among these indicators are shown in Table 3. Reflecting the positive correlation among problem behavior indicators, a one-factor measurement model for the problem behavior construct indicated reliability of .83 for a congeneric measures model. The factor loadings were positive and statistically significant for each indicator. The standardized loadings were .72 for substance use, .79 for physical aggression, and .89 for covert antisocial behavior. Table 3 also shows the correlations between the indicators of problem behavior and measures of reading scores and attention problems across time points. The hypothesized model in Figure 2 was used to describe these relationships for both reading scores and attention problems, independently.

The model linking level and change in reading scores with problem behavior explained 7% of the variance in problem behavior, and the model with level and change in attention problems explained 11% of the variance in problem behavior. The standardized and unstandardized structural path coefficients and fit indices for these two models are shown in Table 4. Both level and change factors for reading scores and attention problems predicted problem behavior in the expected direction. Children with higher reading scores in the middle of elementary school and those whose scores in-

TABLE 4
Models Linking Reading Scores and Attention Problems with Problem Behavior

Coefficient	Reading scores		Attention problems	
	Unstand. (*SE*)	Stand.	Unstand. (*SE*)	Stand.
Growth factors on problem behavior				
Level → problem behavior	–0.011* (.0032)	–.25	0.29* (.081)	.18
Change → problem behavior	–0.078* (.031)	–.30	1.58* (.67)	.25
Covariates on growth factors				
Male → level factor	–2.60* (1.03)	–.09	0.23 (.034)	.30
Male → change factor	0.12 (.25)	.04	0.028* (.013)	.15
Low income → level factor	–6.79* (1.12)	–.23	0.19* (.037)	.22
Low income → change factor	0.46 (.29)	.10	0.0052 (.015)	.03
Covariates on problem behavior				
Male → problem behavior	0.17* (.050)	.15	0.083 (.054)	.06
Low income → problem behavior	0.063 (.055)	.05	0.042 (.056)	.03
Covariance/correlation between growth factors				
Level ↔ Change	–17.50* (2.49)	–.60	–0.0044 (.0045)	–.09
Fit indices				
χ^2	91.17		53.56	
df	26		26	
TLI	.98		.98	
SRMR	.03		.03	

*$p < .05$.

creased between third and sixth grade reported engaging in significantly less problem behavior in seventh grade, controlling for gender and income status. The results for attention problems indicate that the children who displayed greater attention problems in the middle of elementary school and those whose attention problems increased, relative to changes in the attention problems of other children, were more likely to engage in problem behavior in seventh grade.

The two covariates had bivariate associations with observed variables that were in the expected direction. Boys had lower reading scores (range of correlations –.08 to –.09 over the four time points), higher scores on attention problem measures (range of correlations .23 to .28, with the differences growing stronger between third and sixth grade), and higher values on the indicators of problem behavior (.07 for substance use, .23 for physical aggression, and .09 for covert antisocial behavior). Children from low-income families also had lower reading scores (range –.19 to –.22), higher attention problems (range .16 to .17), and more problem behavior (.03 for substance use, .08 for physical aggression, and .07 for covert antisocial behavior). In each model, the two covariates had statistically significant associations with the level factor, with boys and low-income students having lower reading test scores and displaying higher levels of attention problems. The covariates were not related to change, with the exception of an association between gender and change in attention problems, reflecting the fact that the difference in attention problems between boys and girls increased between the third and sixth grades. In the model linking reading scores to later problem behavior, gender had an independent, direct effect on problem behavior, with boys displaying more problem behavior in seventh grade than girls. However, the relationship between gender and problem behavior was nonsignificant in the model that included growth factors for attention problems, suggesting that attention problems play a mediating role in this relationship. There was no unique association between low-income status and problem behavior in models that took growth factors for reading scores or attention problems into account.

Although the fit of both of these models was good (TLI = .98 and SRMR = .03, for both models), the LM tests suggested that fit for the model linking attention problems with problem behavior could be improved by adding a specific path from change in attention problems to the physical aggression indicator. Adding this path resulted in a change in chi square of 7.80 and the loss of one degree of freedom when using the data set created directly from EM estimates. The unique relationship between change in attention problems and physical aggression mirrors the slightly higher correlation, shown in Ta-

ble 3, between attention problems in the later grades of elementary school with this indicator, relative to correlations with the other two indicators of problem behavior.

Combined Model of Reading and Attention Problems Predicting Problem Behavior

The estimates for structural paths of a combined model linking the growth factors of both reading scores and attention problems to later problem behavior are shown in Table 5. Fourteen percent of the variance in the problem behavior factor was explained in the combined model and the model fit was good (TLI = .98; SRMR = .03). The direction of the unique associations between each of the growth factors in the model and the problem behavior factor was as expected, although in each case the size of the association was less than in the models that looked at attention problems and reading scores separately. The only factor that had a statistically significant unique association with problem behavior was level of attention problems. The covariances among growth factors in the combined model indicate that children who displayed more attention problems in the classroom had lower reading scores and that those who showed reductions in attention problems improved their reading scores. The positive correlation between level of attention problems and change in reading is due to the fact that children with higher initial attention problems had lower initial reading scores, and is thus a reflection of the strong negative covariance between the reading intercept and reading growth.

TABLE 5
Combined Model Linking Reading Scores and Attention Problems with Problem Behavior

Coefficient	Unstand. (SE)	Stand.
Growth factors on problem behavior		
Level of reading → problem behavior	–0.0064 (.0037)	–.13
Change in reading → problem behavior	–0.048 (.035)	–.20
Level of attention problems → problem behavior	0.22* (.10)	.15
Change in attention problems → problem behavior	1.31 (.82)	.20
Covariates on growth factors		
Male → level of reading	–2.59* (1.03)	–.09
Male → change in reading	0.12 (.25)	.04
Male → level of attention problems	0.23* (.034)	.30
Male → change in attention problems	0.028* (.013)	.22
Low income → level of reading	–6.79* (1.12)	–.23
Low income → change in reading	0.46 (.29)	.10
Low income → level of attention problems	0.19* (.037)	.22
Low income → change in attention problems	0.0052 (.015)	.04
Covariates on problem behavior		
Male → problem behavior	0.097 (.054)	.08
Low income → problem behavior	0.035 (.056)	.02
Covariances/correlations among growth factors		
Level of reading ↔ change in reading	–17.65* (2.50)	–.60
Level of attention problems ↔ change in attention problems	–0.0033 (.0044)	–.06
Level of reading ↔ level of attention problems	–2.35* (.26)	–.47
Change in reading ↔ change in attention problems	–0.057* (.024)	–.29
Level of reading ↔ change in attention problems	0.088 (.096)	.04
Level of attention problems ↔ change in reading	0.15* (.062)	.23
Fit indices		
χ^2	131.28	
df	57	
TLI	.98	
SRMR	.03	

*$p < .05$.

DISCUSSION

This study first assessed the properties of growth, particularly individual differences in growth, for reading and attention problems during middle to late elementary school. The results indicate that there was heterogeneity in change for both reading and attention problems that was greater than expected due to sampling error. Between-individual variation in change in reading scores during this time period has been found by other researchers (e.g., Belmont & Belmont, 1978; Kowalski-Jones & Duncan, 1999). Prior research also has found variability in change in externalizing behaviors such as disruptive behavior during the early childhood and elementary school period (Kowalski-Jones & Duncan, 1999; Spieker, Larson, Lewis, Keller, & Gilchrist, 1999). The statistically significant variation in change in attention problems among children is noteworthy. In contrast to the idea that attention regulation is a trait-like characteristic and fluctuations in attention problems are episodic or random, our findings indicate discernible differences in the rate at which children increase or decrease in their ability to focus on tasks in the classroom during this developmental time period.

Second, this study assessed whether heterogeneity in level and change in reading and attention problems predicted later problem behavior. Of particular interest was testing the hypothesis that changes in these risk factors are associated with level of problem behavior. In models that looked at reading and attention problems separately, variation in level and change for both variables predicted level of early adolescent problem behavior. A key find-

ing is that change between third and sixth grades was predictive of problem behavior after accounting for level of these risk factors in third grade as well as gender and income status. This finding provides empirical support for the theoretical models underlying preventive interventions that attempt to reduce problem behavior in adolescence by affecting change in academic performance and attention problems during middle childhood. The amount of variance in problem behavior explained by these models (7% and 11%) is modest. Also, the standardized path coefficients from growth factors to the problem behavior construct, which can be considered measures of effect sizes for unique associations, are below absolute values of .3. On the other hand, we found statistically significant associations between growth factors for test scores and teacher reports of child behavior in the elementary school developmental time period and child self-report of problem behaviors after participants had transitioned to the middle school developmental time period. This is a more conservative test of predictive validity than cross-sectional studies or studies that link variables measured from the same source.

Third, this study assessed the unique associations between growth factors for reading scores and attention problems with later problem behavior in a model that included growth factors for both variables. This model tests the hypothesis that the relationship between academic failure and problem behavior is accounted for by an overlap between academic failure and attention problems. We found that when growth factors for reading scores and attention problems were considered together, slightly more variance in problem behavior could be explained (14%) and all growth factors had associations with problem behavior of similar size (i.e., standardized path coefficients ranging in absolute value from .13 to .20). However, only level of attention problems had a statistically significant association with problem behavior. This corroborates findings from cross-sectional studies summarized by Maguin and Loeber (1995) that attention problems may account for much of the relationship between academic achievement and delinquency. These findings do not discount the more general, theoretical argument (e.g., Catalano & Hawkins, 1996; Hawkins & Lishner, 1987; Kellam et al., 1998; Rutter et al., 1970) that academic failure may set in motion a chain of events that leads to more problem behavior. Such a relationship may be indirect, with a variable such as attention problems being the more proximal predictor of problem behavior but also being influenced, in part, by academic achievement. The covariances we found among growth factors for reading and attention problems point to the interconnectedness of these two variables during the elementary school period. Various attempts have been made to disentangle this relationship (e.g., Fergusson & Horwood, 1992; Pennington, Groisser, & Welsh, 1993; Rabiner et al., 2000; Rowe & Rowe, 1992; Wood & Felton, 1994). In the present study we did not examine the direction of the relationship between reading and attention problems; our results emphasize simply that children who read poorly display attention problems and those who improve their reading ability relative to their peers also show improvements in attention relative to their peers. As noted by Hinshaw (1992b) and Tremblay and LeMarquand (2000), the association between academic skills and externalizing behaviors is present in early childhood, prior to the start of elementary school, and full understanding of the relationships among these variables requires data on these early years.

Consistent with prior studies on the structure of problem behavior in early adolescence (Ary et al., 1999; Gillmore et al., 1998; McGee & Newcomb, 1992; Osgood et al., 1988; Resnicow et al., 1995), we modeled the different types of problem behavior as indicators of a latent construct. It could be argued that our indicators are not unidimensional. The indicator of covert antisocial behavior had moderate internal consistency, suggesting different patterns of nonviolent antisocial behavior that were not adequately captured by summing across the component items. The measure of substance used contains items related to cigarettes, alcohol, and marijuana, which may have different etiological antecedents. Further, the LM modification index shows some evidence that change in attention problems had a unique association with physical aggression that was not accounted for by the relationship with the shared variance among physical aggression, covert antisocial behavior, and substance use. This suggests an additional unique connection between attention problems, which may reflect underlying lack of physical, cognitive, and emotional self-control, and physical aggression. Our findings also suggest that attention problems are related, if to a slightly lesser degree, to covert antisocial behavior and substance use and that the relationship between attention problems in elementary school and problem behavior in seventh grade could be adequately described with one latent problem behavior construct. An additional limitation of our measurement of problem behavior is that, while our findings should be robust (Kline, 1998), the three types of problem behavior were treated as continuous, normally distributed variables, despite the fact that a substantial percentage of youth in early adolescence abstain completely from these types of behaviors.

While prior studies have found relationships between problem behavior and both academic achievement and attention problems, this study used data collected annually on a sample of Northwest public school students to model growth in these two risk factors and examine how this growth was associated with later problem behavior. One implication of this study is to broaden the risk factor paradigm beyond looking at predictors of poor outcomes as static variables. This study demonstrates a strategy for examining change in behavioral risk factors as predictors of later problem behavior, beyond what is accounted for by level of these factors at a given time point. With respect to prevention programs, heterogeneity in change in reading and attention problems during mid- to late elementary school suggests that both academic achievement and attention problems are promising targets for developmental interventions during this time period. The association between change in these variables and later prob-

lem behavior provides support for interventions that attempt to address these variables as a means of improving later behavioral outcomes. The findings presented here suggest that improving academic skills and achievement and increasing focus and on-task behavior in the classroom may lead to reductions in drug use, delinquency, and violence during early adolescence.

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Authors' Notes

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Notes

1. There were no statistically significant differences between the analysis sample and the 257 students dropped from the original sample due to missing test data with respect to ethnicity, gender, income status, or single-parent status. The 257 excluded students were less likely to have originally been in schools in the experimental condition (42% vs. 58%; $\chi^2 = 18.58$, $p < .05$).
2. Multiple-group models were run for each model examined in this study to compare results for children in the experimental and control conditions of the RHC study. Also, in light of studies that examined growth models separately by gender (e.g., Kowalski-Jones & Duncan, 1999) and studies that have found differences in magnitude of association between academic achievement and delinquency across gender and income groups (Maguin & Loeber, 1995), multiple-group analyses were conducted by gender and income status. In each set of multiple-group analyses, unconstrained models in which parameters were freely estimated for the different groups showed the size and directionality of model parameters to be similar across groups. Models that placed equality constraints (on covariances and paths among variables, on loadings of indicators on the problem behavior construct, and, in the unconditional growth models, on variances of growth factors) had good fit (TLI > .96 and SRMR < .06). Based on the results of these comparisons, students in experimental and control conditions, boys and girls, and poor and nonpoor participants, were pooled and included in the same analyses.

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