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Long-Term Effects of the Seattle Social Development Intervention on School Bonding Trajectories

J. David Hawkins, **Jie Guo**, **Karl G. Hill**, **Sara Battin-Pearson**, and **Robert D. Abbott**
University of Washington

Abstract

Bonding to school has been shown to be a protective factor against many problem behaviors. This study examines the effects of intervention during the elementary grades on changes in school bonding from middle school through high school, using hierarchical linear modeling. A full intervention group (Grades 1–6), a late intervention group (interventions in Grades 5 and 6 only), and a control group offered no special intervention were compared. The full intervention group was significantly more bonded to school than the control group at ages 13 and 18. Moreover, the full intervention group showed a curvilinear change in school bonding over time, decreasing to age 16 and then increasing to age 18, whereas bonding to school in both the control and late intervention groups continued to decline from age 13 to age 18. These findings suggest that social development interventions through elementary school can have positive long-term effects on school bonding and demonstrate the importance of long-term follow-up studies of preventive interventions.

Advances in prevention in public health (Farquhar, Fortmann, & Flora, 1990) provide a model for prevention of adolescent problem behaviors by focusing on risk and protective factors predictive of these behaviors (Hawkins, Catalano, & Miller, 1992;Mrazek & Haggerty, 1994). Research on the predictors of school dropout, delinquency, drug abuse, teen pregnancy, and violence has shown that many of the same factors predict these different outcomes (Dryfoos, 1990;Resnick, Bearman, & Udry, 1997). One of these factors—bonding to school—is a protective factor against many serious behavior and health problems in adolescence and young adulthood, including school dropout, delinquency, drug abuse, teen pregnancy, violence, and alcohol abuse or dependence (Abbott et al., 1998;Dryfoos, 1990;Guo, Hawkins, Hill, & Abbott, in press;Hawkins, Catalano, & Miller, 1992;Maguin & Loeber, 1996;Mrazek & Haggerty, 1994;Resnick et al., 1997;Rutter, 1985).

Recently, Hawkins, Catalano, Kosterman, Abott, and Hill (1999) reported significant long-term effects of the preventive interventions of the Seattle Social Development Project (SSDP) during the elementary grades on a variety of serious behavior and health problems at age 18, 6 years after the intervention ended. These effects included reductions in violent delinquency, heavy drinking, lifetime sexual intercourse, multiple sex partners, pregnancy or causing pregnancy, and school misbehavior. The theoretical model guiding the preventive interventions of the SSDP hypothesizes that bonding to school is an important protective factor against health and behavior problems. The interventions tested in the project sought to increase children's bonding to school during the elementary grades. This article first examines whether changes in school bonding during the 6 years following the intervention and levels of school bonding at age 18 were related to the behavioral outcomes observed at age 18. The article next examines whether the preventive intervention during the elementary grades affected changes and levels of school bonding during the secondary grades.

Requests for reprints should be sent to J. David Hawkins, Social Development Research Group, University of Washington, 9725 3rd Avenue NE, Suite 401, Seattle, WA 98115. E-mail: jdh@u.washington.edu

The social development model (SDM; Catalano & Hawkins, 1996) guides the intervention studied here. The SDM hypothesizes that a strong bond to school serves as a protective factor against behaviors that violate socially accepted standards. Attachment, a positive emotional link, and commitment, a personal investment in the group, are the component elements of the social bond. The theory hypothesizes that when social groups produce strong bonds of attachment and commitment in members, and promote clear standards for behavior, these groups increase behavior consistent with those standards and prevent behavior that violates them. The model suggests that early and sustained intervention through the elementary grades should put children on a developmental trajectory leading to more positive outcomes and fewer problem behaviors over the long term (Hawkins et al., 1999). An abundance of research suggests that academic motivation declines from childhood to adolescence (Eccles & Midgley, 1990;Epstein & McPartland, 1976;Hirsch & Rapkin, 1987;Oldfather & Wigfield, 1996;Schulenberg, Asp, & Petersen, 1984;Simmons & Blyth, 1987). It is important to examine whether intervention in the elementary grades can retard this decline in school bonding.

We have found and reported short-term positive effects of the full intervention on school bonding and behavior of children receiving the intervention during Grades 1 through 4 (Hawkins, Catalano, Morrison, et al., 1992;Hawkins, Von Cleve, & Catalano, 1991). We have also found positive effects of the full intervention on school bonding and behavior of children from low-income families at the end of Grade 6 (O'Donnell, Hawkins, Catalano, Abbott, & Day, 1995). This study extends these analyses by investigating the effects of the intervention on school bonding over time, given its theoretical importance as a mediator in the social development model.

This article investigates the following questions: How does the level of school bonding change over the developmental period from Grade 7 through high school in a multiethnic urban sample? Are changes in school bonding and the level of school bonding at age 18 related to behavioral outcomes at age 18? Can intervention in the elementary grades affect changes and levels of school bonding during the secondary grades? Does intervention over the full course of elementary school have greater effects than delivering intervention just prior to adolescence?

Methods

SSDP Design and Intervention

This study of intervention effects is part of a larger ongoing longitudinal study of all consenting fifth-grade students in 18 public schools serving high crime areas of Seattle, Washington. To assess the effects of "full intervention" and "late intervention," a nonrandomized controlled trial with three conditions was created in 1985 by nesting an experimental intervention initiated in 1981 at first-grade entry, within the longitudinal panel study. Schools were assigned nonrandomly to conditions in the fall of 1985, and from that point, all fifth-grade students in each school participated in the same interventions. New schools added for the panel study were matched to the intervention schools with respect to grades served and inclusion of students drawn from high crime neighborhoods of Seattle. Schools added for the panel study were assigned to conditions to achieve balanced numbers across conditions. It should be noted that during this study the Seattle school district used mandatory busing to achieve racial equality in schools. As a result, all schools in this study served a heterogeneous population of students drawn from at least two different neighborhoods of the city. This practice reduced the risk that outcomes observed reflected contextual or neighborhood differences in the populations attending different schools.

The full intervention group consists of all students who were randomly assigned to intervention classrooms in Grades 1 through 4 in eight elementary schools participating in the earlier experimental study and who remained in schools assigned to the intervention condition in

Grades 5 or 6 in this study. The late intervention group consists of students in intervention schools who were in intervention classrooms in Grades 5 and 6 only, some of whom were controls in the earlier intervention study. The control condition consists of students in schools assigned to receive no intervention in Grades 5 and 6 and who were not in intervention classrooms in Grades 1 through 4.

The preventive intervention was a multicomponent package of training for teachers in classroom management and instruction methods, a social-competence promotion curriculum offered to the full intervention condition in Grade 1, and developmentally sequenced parent training curricula. Intervention classroom teachers were trained to use proactive classroom management, interactive teaching, and cooperative learning techniques in their classrooms. In addition, full intervention students received social skills training in Grade 1 using the Interpersonal Cognitive Problem Solving curriculum (Shure & Spivack, 1988). Parents in the intervention conditions were offered developmentally appropriate parent training curricula addressing the importance of monitoring and reinforcement for prosocial behavior, how to help children succeed in school, and skills for reducing risks for early initiation of substance use. The components of the intervention package are elaborated in Table 1.

Sample

The sample studied here included roughly equal proportions of boys and girls. A substantial proportion of participants were from low-income households. Forty-six percent of parents reported a maximum family income under $20,000 per year (in 1985), and over half of the student sample (57%) were from poverty as evidenced by their participation in the National School Lunch and School Breakfast Program at some point in the fifth, sixth, or seventh grade. Forty-two percent of the sample reported only one parent present in the home in 1985. About 44% of the participants were White, 26% percent were African Americans, 22% were Asian Americans, 5% were Native Americans, and 3% classified themselves as from other racial or ethnic groups. The mean California Achievement Test (CAT) score at fifth grade was 502 (national average = 500), with a standard deviation of 48. This study includes all fifth-grade children assigned to the three conditions in 1985 whose parents provided written consent to their involvement in the longitudinal follow-up study (n = 643). Seventy-six percent of the total eligible fifth-grade population in these schools consented. Of these, 143 were in the full intervention group, 243 in the late intervention group, and 206 in the control condition.

Sample selection, attrition, and participation

The consenting sample did not differ significantly from the nonconsenting group in terms of gender, ethnicity, or poverty (as indicated by eligibility for free or reduced price breakfast or lunch). Of the 643 who provided longitudinal consent, 45 participants were not interviewed at age 18. Threats to the internal validity of study conclusions resulting from assignment or attrition appear minimal. Attrition analyses reported elsewhere (Hawkins et al., 1999) showed that the 45 nonrespondents did not differ significantly from those remaining in the study with respect to gender, ethnicity, or poverty. Those missing at follow-up were randomly distributed across the three intervention conditions. After attrition of the 45 nonrespondents, the full intervention and control groups did not differ with respect to residential stability, socioeconomic status, gender, proportion from single-parent families, proportion living in disorganized neighborhoods, or race, indicating the comparability of the full intervention and control groups on variables that might affect the observed outcomes. No evidence of differential attrition by condition was found in tests of interaction of attrition and the intervention condition on fifth grade-measures of outcomes (Hawkins et al., 1999). However, regardless of condition, those lost from the study at age 18 were more likely to have been involved in behavior problems at school and to have had lower academic scores in fifth-grade than those retained in the study (Hawkins et al., 1999).

Parents of 43% of children in the full treatment condition attended parenting classes. Forty-six percent of parents who attended parenting classes were from low-income families.

Teachers of control students did not receive training in instructional or classroom management skills from the project. However, both intervention and control teachers were observed by observers uninformed as to condition of the classrooms for 50 minutes on 2 different days in the fall and spring each year using the interactive teaching map to document the use of the targeted teaching strategies in all conditions (Abbott et al., 1998;Kerr, Kent, & Lam, 1985). Greater use of the experimental instructional and management methods was observed in intervention classrooms.

Measurements

The dependent variable school bonding was measured by the same five items at all years. They include the following items: "I like school," "Most mornings I look forward to going to school," "I do extra school work on my own," "When I have an assignment to do, I keep working on it until it is finished," and "I like my classes this year." All items are measured in the scale of 1 to 4, 1 (*NO!*), 2 (*no*), 3 (*yes*), and 4 (*YES!*). The level of school bonding was assessed at five time-points following the intervention (ages 13, 14, 15, 16, and 18), measured by the mean of all items at each year. A higher score indicates a higher level of school bonding. Results at the end of the intervention period (age 12) have been reported elsewhere (O'Donnell et al., 1995). This article focuses on development during the period following intervention. The question of interest here is whether developmental trajectories in bonding to school in the three intervention groups would remain similar or diverge over a 6-year follow-up period absent additional intervention or boosters. Several possible predictors of school bonding beyond intervention condition were included in the analysis. These included academic achievement in the elementary grades measured by student fifth-grade CAT scores: gender, measured by a dummy variable, which was 1 (*boys*) and 0 (*girls*); ethnicity, measured by three dummy variables, which were 1 (*African American*) or 0 (*not*), 1 (*Asian American*) or 0 (*not*), and 1 (*other races*) or 0 (*not*), and European Americans as the reference group; and poverty, measured by a student's eligibility for the National School Lunch and School Breakfast program, 1 (*eligible*), 0 (*not eligible*).

Measures of school success and failure (self-reported grade point average, GPA; official GPA; number of times repeated a grade by age 18; lifetime prevalence of dropping out of school by age 18; official CAT score at age 17), school misbehavior (cheated on tests, skipped school, sent from class for misbehavior, official disciplinary action reports, and number of times suspended or expelled), crime (10 self-reported nonviolent crimes, 8 self-reported violent crimes, self-reported arrests, 35 officially recorded court charges), substance use (self-reported cigarette, alcohol, and marijuana use; and self reported use of crack or rock cocaine, cocaine, amphetamines, tranquilizers, sedatives, psychedelics, and narcotics), and sexual activity (lifetime prevalence of initiation, lifetime prevalence of having multiple sex partners, lifetime prevalence of pregnancy, lifetime prevalence of natality) at age 18 reported in Hawkins et al. (1999) were included to assess the relation of these outcomes to school bonding.

Dropping out of school is potentially related to school bonding (Hawkins, Catalano, & Miller, 1992;Janosz, LeBlanc, Boulerice, & Tremblay, 1997;Vallerand, Fortier, & Guay, 1997). It is important to ensure that dropping out of school does not confound the observed effect of intervention on changes in school bonding. In this study, each respondent was asked about bonding to school only if he or she had attended school in the past year. Students who had dropped out, but had attended school for some part of the past year, were asked about their bonding to school during that time. At each year's assessment, if a student had dropped out of school and did not answer any questions on school bonding, school bonding was treated as missing for that year. Earlier analyses found a nonsignificant ($p = .45$) trend in dropout by age

18 associated with intervention condition such that the lifetime prevalence of school dropout by age 18 was 21.5% for the control group, 23.3% for the late intervention group, and 18.1% for the full intervention group. This trend toward greater dropout in the control and late intervention groups should make it more difficult to observe effects of the full intervention on school bonding. This is because a greater proportion of respondents likely to express low bonding to school (i.e. dropouts) were missing the school bonding measures from the control and late intervention groups at follow-up than were missing from the full intervention group. Thus, by coding school bonding as missing for each year the respondent had dropped out, the analyses reported here provide a conservative test of the effect of the full intervention on school bonding through age 18.

Analyses

Hierarchical linear modeling (HLM; Bryk & Raudenbush, 1987,1992) was used to analyze the trajectory in school bonding. In the HLM framework, individual change is represented through a 2-level hierarchical model. At Level 1, each person's development is represented by an individual growth trajectory that depends on a set of parameters (intercept, slope, etc.). These individual growth parameters become the outcome variables in a Level-2 Model, where they may depend on some person–level characteristics.[1]

For example, we have the following linear model of school bonding (Model 1):

$$\text{Level 1: } Y_{it} = \pi_{0i} + \pi_{1i} \times (AGE_{it} - 18) + e_{ti} \quad (1.1)$$

$$\text{Level 2: } \pi_{0i} = \beta_{00} + r_{0i}, \quad \pi_{1i} = \beta_{10} + r_{1i} \quad (1.2)$$

In Equation 1.1, Y_{it} represents the level of school bonding for participant i at time t. The variable (AGE_{it} −18) indicates that the analysis is centered at age 18. That is, (AGE_{it} −18) equals to −5, −4, −3, −2, and 0 at ages 13, 14, 15, 16, and 18, respectively, corresponding to t = 1, 2, 3, 4, and 5. Therefore, π_{0i} represents the expected level of bonding for participant i at age 18, and π_{1i} is the expected rate of change per year in the school bonding score for participant i. In addition, e_{ti} is the random within-subjects error of prediction for participant i at time t, conditional on that participant's change parameters π_{0i} and π_{1i}. The within-subjects errors are assumed mutually independent and normally distributed with mean of zero—that is, $e_{ti} \sim N(0, \sigma^2)$.

Growth analyses may center the age variable at the grand mean, group mean, or at an age of substantive interest (Bryk and Raudenbush, 1992). The intercept should be centered at the point that makes it most meaningful. Because we were interested in examining intervention effects at the end of high school, we chose to center the age at the last occasion of measurement (in this case age 18). Centering at the last occasion may increase the correlation between parameter estimates. Thus, it is useful to compare these results with those obtained by centering age at another time-point where the parameter estimates are expected to be less correlated (e.g., at the grand mean, or at the midpoint of the age range).

In the Level-2 Model, β_{00} is the grand mean level of school bonding at age 18, β_{10} is the grand mean rate of change in school bonding, r_{0i} is the random effect of person i on school bonding at age 18, and r_{1i} is the random effect of person i on the rate of change in school bonding. The

[1]These growth curve analyses were conducted at the within and between individual levels after an examination of school effects showed no significant school differences (as indicated by general linear model repeated measures analysis, $F(16) = .640$, $p = .851$, on the level of school bonding.

random effects are assumed bivariate normal with zero means, variances τ_{00}, τ_{11}, and covariance τ_{01}. The regression coefficients β_{00} and β_{10} are called fixed effects.

We further test whether the trajectory of school bonding is curved by adding a new growth parameter π_{2i} to Equation 1.1, a quadratic component which represents the acceleration or deceleration of change in school bonding for participant i (Model 2).

$$\begin{aligned} \text{Level 1: Bonding} &= \pi_{0i} + \pi_{1i} \times (\text{AGE}_{it} - 18) + \\ &\quad \pi_{2i} \times (\text{AGE}_{it} - 18)^2 + e_{ti} \end{aligned} \tag{2.1}$$

$$\begin{aligned} \text{Level 2:} \quad \pi_{0i} &= \beta_{00} + r_{0i} \\ \pi_{1i} &= \beta_{10} + r_{1i} \\ \pi_{2i} &= \beta_{20} + r_{2i} \end{aligned} \tag{2.2}$$

Based on Model 2, the effect of intervention on the trajectory in school bonding is examined by adding intervention variables to the Level-2 Model (Model 3). In Model 3, intervention effects are fixed effects represented by β_{01} and β_{02} (on the mean level of school bonding at age 18), β_{11} and β_{12} (on the rate of change in school bonding at age 18), and β_{21} and β_{22} (on the rate of acceleration):

$$\begin{aligned} \text{Level 1: Bonding} &= \pi_{0i} + \pi_{1i} \times (\text{AGE}_{it} - 18) + \pi_{2i} \times \\ &\quad (\text{AGE}_{it} - 18)^2 + e_{ti} \end{aligned} \tag{3.1}$$

$$\begin{aligned} \text{Level 2:} \quad \pi_{0i} &= \beta_{00} + \beta_{01} \times (\text{Full treatment}) + \beta_{02} \times \\ &\quad (\text{Late treatment}) + r_{0i} \\ \pi_{1i} &= \beta_{10} + \beta_{11} \times (\text{Full treatment}) + \beta_{12} \times \\ &\quad (\text{Late treatment}) + r_{i} \\ \pi_{2i} &= \beta_{20} + \beta_{21} \times (\text{Full treatment}) + \beta_{22} \times \\ &\quad (\text{Late treatment}) + r_{2i} \end{aligned} \tag{3.2}$$

Finally, we examine intervention effects on the trajectory in school bonding when other key covariates such as gender, ethnicity, poverty, and early academic achievement are controlled (Model 4):[2]

$$\begin{aligned} \text{Level 1: Bonding} &= \pi_{0i} + \pi_{1i} \times (\text{AGE}_{it} - 18) + \pi_{2i} \times \\ &\quad (\text{AGE}_{it} - 18)^2 + e_{ti} \end{aligned} \tag{4.1}$$

[2]Ethnicity effects are measured by three dummy coded variables comparing African American, Asian American, and other ethnic groups to European Americans.

$$
\begin{aligned}
\text{Level 2:}\quad \pi_{0i} &= \beta_{00} + \beta_{01} \times (\text{Full treatment}) + \beta_{02} \times (\text{Late treatment}) + \\
&\quad \beta_{03} \times (\text{Gender}) + \beta_{04} \times (\text{Ethnicity}) + \\
&\quad \beta_{05} \times (\text{Poverty}) + \\
&\quad \beta_{06} \times (\text{Baseline academic achievement}) + r_{0i} \\
\pi_{1i} &= \beta_{10} + \beta_{11} \times (\text{Full treatment}) + \beta_{12} \times (\text{Late treatment}) + \\
&\quad \beta_{13} \times (\text{Gender}) + \beta_{14} \times (\text{Ethnicity}) + \\
&\quad \beta_{15} \times (\text{Poverty}) + \\
&\quad \beta_{16} \times (\text{Baseline academic achievement}) + r_{1i} \\
\pi_{2i} &= \beta_{20} + \beta_{21} \times (\text{Full treatment}) + \beta_{22} \times (\text{Late treatment}) + \\
&\quad \beta_{23} \times (\text{Gender}) + \beta_{24} \times (\text{Ethnicity}) + \\
&\quad \beta_{25} \times (\text{Poverty}) + \\
&\quad \beta_{26} \times (\text{Baseline academic achievement}) + r_{2i}
\end{aligned}
\tag{4.2}
$$

There were no missing data on Level 2 predictors (gender, ethnicity, poverty, etc.). To deal with a small amount of Level 1 missing data, the listwise deletion option in HLM was employed as suggested by the HLM manual (Bryk, Raudenbush, & Congdon, 1996). This resulted in analysis sample size of $n = 626$, or 97.4% of the sample in these three conditions.

Results

The first analysis examined the relations of school bonding with behavioral outcomes at age 18. Specifically, we examined whether changes in school bonding in adolescence (controlling for the student's level of school bonding at age 13) were related to behavioral outcomes at age 18, and whether the student's final level of school bonding at age 18 was related to these outcomes. We answered these questions by running the linear growth model of school bonding (Model 1). A residual file containing the empirical Bayes (EB) residuals for each individual, fitted values, and ordinary linear residuals was generated. By adding the EB residuals to the corresponding fitted values, we obtained the EB estimates of the rate of change in school bonding from age 13 to age 18 (the slope π_{1i}), and estimates of the level of school bonding at age 18 (the intercept π_{0I}; Bryk et al., 1996). The first column of Table 2 presents the partial correlation coefficients between individuals' rate of change in school bonding and age 18 behavioral outcomes, controlling for their initial observed level of school bonding at age 13. Also shown in Table 2 are the Pearson correlation coefficients between the estimated level of school bonding at age 18 and behavioral outcomes at age 18.

Table 2 shows that increasing school bonding in adolescence was correlated with higher levels of school achievement and official GPA, and was correlated with less school misbehavior, substance use, and sexual activity. Table 2 also shows that higher levels of school bonding at age 18 were positively correlated with school achievement and official GPA, and negatively correlated with other problem behaviors such as school misbehavior, crime, substance use, and sexual activity at age 18. This pattern of results was maintained after controlling for gender, ethnicity, and poverty in elementary school (not tabled). These results indicate that both the

change in school bonding from age 13 to 18 and the level of school bonding at age 18 were significantly associated with several behavioral outcomes at age 18.

This finding leads to a second analysis examining whether the SSDP intervention affected changes in school bonding from age 13 to age 18. Figure 1 provides the observed mean level of school bonding from age 13 to age 18 (Grade 7 to Grade 12), for the three intervention groups.

As can be seen in Figure 1, at age 13, 1 year after the intervention ended, the full treatment group had the highest mean level of school bonding of the three groups. The mean level of school bonding declined after age 13 for all three groups. However, the mean level of school bonding in the full treatment group began to increase at about age 16, whereas the mean level of school bonding continued to decline to age 18 for the other two groups. As a result, the full treatment group again reported the highest mean level of school bonding among all three groups at age 18. School bonding following intervention appears to have a more curved shape for the full intervention group, and a more linear, monotonically declining shape for the late treatment and control groups.

The next HLM analysis examined whether the change in school bonding from age 13 to age 18 was linear or curved for the combined sample in the three conditions. This question was answered by comparing the linear and quadratic models (Models 1 and 2). The parameter estimates of the fixed and random effects, deviance, and the number of estimated parameters in each model are presented in Table 3. The difference between the deviance statistics of two nested models has a chi-square distribution asymptotically. In this analysis, Ddeviance = 21.066 and DF = 4. Because χ^2 (0.95, N = 4) = 9.5, the quadratic model is significantly better than the linear model. Therefore, we conclude that overall the level of school bonding changed in a quadratic or curvilinear fashion from age 13 to 18 in this combined sample of three conditions.[3]

Although the analyses previously reported suggest a quadratic or curvilinear pattern of change in school bonding for the three conditions taken as a whole, they do not investigate the degree to which patterns of change in school bonding differed across the three conditions of the study. The next analyses examined whether there was a significant intervention effect on the change in school bonding during the period from age 13 to age 18. That is, did students in different intervention groups follow the pattern of quadratic change in school bonding previously described? We examine this question by including intervention as Level 2 predictors (two dummy variables: full treatment vs. control; late treatment vs. control) in the quadratic model, as shown in Model 3. The parameter estimates of Model 3 are presented in Table 4. The pattern of these estimates can be compared to the shapes of the observed changes in school bonding shown in Figure 1.

As can be seen from the coefficients β_{01} and β_{02}, the full intervention group on average had a significantly higher level of school bonding at age 18 than the control group, whereas there was no significant difference in school bonding at age 18 between the late treatment group and the control group.

The coefficients β_{10}, $\beta_{11,}$ and β_{12} indicate that at age 18, the average level of school bonding was decreasing among controls (rate of change = −0.016 per year). The average level of bonding appeared to be slightly increasing in the late treatment group (rate of change = −0.016 + 0.025

[3]Centering the age variable at the last occasion of measurement yielded a correlation between the linear and quadratic terms of .85. To examine the potential effect of this correlation on our parameter estimates, the analysis was repeated centering it at the midpoint of the age range (age 15). In this analysis, the correlation between these two parameter estimates was −.32 and yielded almost identical estimates of the rate of change and rate of acceleration.

= 0.009 per year) at age 18, however, it was not significantly different from that in the control group (*t*-ratio = 0.659). For the full treatment group, the average level of school bonding was clearly increasing at age 18 (rate of change = 0.016 + 0.087 = 0.071 per year), and this increased slope was significantly different from that in the control group (*t*-ratio = 2.053). This pattern of slopes can be seen in the right side of Figure 1 in the age 16 to age 18 transition.

In addition, the comparison of the coefficients β_{20}, $\beta_{21,}$ and β_{22} shows that the average rate of acceleration was significantly higher for the full treatment group than for the control group (*t*-ratio = 2.072). There was no significant difference in the rate of acceleration between the late treatment and the control group (*t*-ratio = 0.780). Thus, the full treatment group had a significantly curved pattern of school bonding (first declining, leveling off, then increasing to age 18), whereas the late treatment and control groups had linearly decreasing levels of school bonding through age 18.

Because school bonding is significantly curved for the full treatment group, we can calculate the point at which its slope is expected to change from negative to positive (the inflection point). For a quadratic growth model, the rate of change at any particular age is the first derivative of growth model evaluated at that age (Bryk & Raudenbush, 1992). Therefore, the rate of change in school bonding for the full treatment group at a particular age equals to (−0.016 + 0.087) + (0.004 + 0.017) × 2 × (AGE −18). Setting this equation equal to zero and solving for AGE shows that the point at which the decline in bonding became zero (the inflection point) was approximately age 16. That is, among the full treatment group, the level of school bonding was decreasing before age 16 and it was increasing after age 16.

We have seen that the full treatment group had a significantly higher level of school bonding at age 18 than the control group, but when did this difference emerge? Was the level of school bonding for the full treatment group different at earlier ages (i.e., at ages 13, 14, 15, and 16)? To answer this question, we centered the time variable at age 16 in Model 3 and examined whether there were significant intervention effects on the mean level of school bonding at age 16. The result (not shown) indicated that there was no significant intervention effect on the mean level of school bonding at age 16. Similarly, there was no significant intervention effect on the mean level of school bonding at ages 14 and 15. However, at age 13, 1 year after the intervention, the full treatment group did have a significantly higher mean level of school bonding than the control group. The difference between the level of school bonding for the late treatment and the control group at age 13 was not significant.[4]

Finally, we examined whether the effect of the intervention on school bonding remained when other factors such as gender, ethnicity, poverty, and academic achievement at the fifth grade were included. We added these four variables as shown in Model 4. It should be noted that ethnicity was represented by three dummy variables: African American versus European American, Asian American versus European American, and other races versus European American. The parameter estimates of Model 4 are presented in Table 5.

Table 5 shows that the effects of SSDP intervention on the mean level of school bonding at age 18, the mean rate of change at age 18, and the rate of acceleration remained significant even after the effects of gender, ethnicity, poverty, and earlier academic achievement were considered. It should be noted that Asian Americans had a significantly higher level of school bonding at age 18 than did European Americans. Furthermore, there were also significant gender differences in the rates of change and acceleration in school bonding at age 18 after

[4]To guard against potential Type 1 errors resulting from multiple comparisons, we reran the analysis with no intercept and used dummy coding for age (i.e., five dummy variables, each representing one time-point) on Level 1. This permits an omnibus test of the intervention effect on the level of school bonding at each age, controlling for constant alpha. This analysis yielded the same pattern of results.

controlling the effects of intervention, ethnicity, poverty, and earlier academic achievement. Although the level of school bonding was decreasing for both boys (−0.149 + 0.085 = −0.064 per year) and girls (−0.149 per year) at age 18, the level of school bonding was decreasing significantly faster for girls than for boys (β_{13} = 0.085, *t*-ratio = 2.633) at age 18.

Discussion

The analyses reported here found that both changes in school bonding during the ages from 13 to 18 and levels of bonding to school at age 18 predicted health and behavior problems at age 18. These findings are consistent with the social development model that guided the intervention, which posits a mediating role of bonding to school in influencing health and behavior outcomes during adolescence. The results suggest that school bonding during the secondary school years was a possible mediating mechanism associated with observed behavioral effects of the intervention reported in Hawkins et al. (1999). Furthermore, we found that the short-term effects of the full SSDP intervention on school bonding reported elsewhere were still present at age 13, 1 year after the intervention ended. Absent additional intervention during the middle school years, levels of school bonding decreased for all three groups to age 16 and did not differ significantly from one another at age 16. However, from age 16 to age 18, the mean level of school bonding among students in the full intervention condition increased, whereas mean level of school bonding among students in the control condition and late intervention continued to decline. School bonding among students in the full intervention group was significantly higher than school bonding in the control group by age 18. Moreover, at age 18, the significant effect of the full intervention on the level of school bonding remained when the effects of other factors, such as gender, ethnicity, poverty, and baseline academic achievement, were considered.

These findings suggest that preventive interventions in elementary school, focusing on teachers, students, and parents, can have a long-term positive effect on changes in and levels of school bonding. It is interesting that the effects of this elementary school intervention on school bonding were no longer significant at age 14 (2 years after intervention ended), but reappeared later in adolescence.

How can we explain these findings? During the elementary grades, SSDP intervention appears to have produced the desired changes in opportunity and reward structures in the full intervention classrooms hypothesized to lead to increased bonding to school. However, these improvements in classroom management and teaching methods were not provided to middle or high school teachers. Absent better teaching and classroom management in their secondary school classrooms, full intervention students' bonding to school decreased as did school bonding of students in the control and late intervention condition. Others have suggested that the transitions to middle school and to high school with their generally larger size and greater anonymity are negative life events that can have traumatic short-term effects before individuals find their way and use the skills they have developed earlier in life (Chou et al., 1998). The results observed here are consistent with this hypothesis. It is possible that as a result of the interventions experienced during the elementary grades, students in the full intervention condition did develop stronger bonds to school that reemerged in the later years of high school as they began to prepare for their futures after secondary school.

Although this explanation of the observed findings is speculative, these data call into question the common assumption that it is only worth looking for long-term effects of preventive interventions if short-term effects are found and maintained. The results suggest that intervention during childhood can change developmental trajectories leading to greater differences at long-term follow-up than at 1-year posttest. These findings parallel those reported by Tremblay and colleagues (Tremblay, Masse, Pagani, & Vitaro, 1996), Pentz and

colleagues (1994), and Botvin and colleagues (Botvin, Baker, Dusenbury, Botvin, & Diaz, 1995). They suggest the importance of long-term follow-up, even when short-term effects are small or seem to disappear. Furthermore, the assumption that effects of preventive intervention deteriorate over time without boosters is not supported by these results. This data suggest that interventions that change the course of development during childhood can have long-term effects, even without boosters, although it may take time for these effects to appear.

Finally, it is noteworthy that late intervention (in Grades 5 and 6) was not enough to significantly affect bonding to school in the secondary grades. These findings suggest that interventions seeking to promote bonding to school as a mechanism for preventing later health and behavior problems should be initiated early in the elementary years and maintained through the elementary grades.

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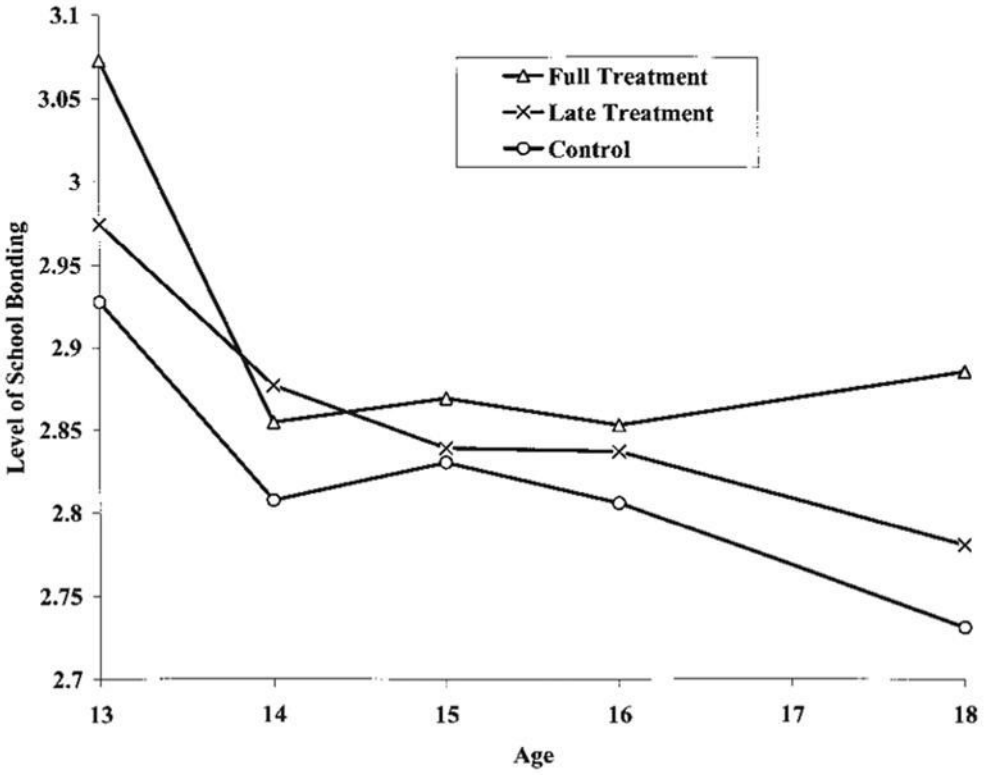

Figure 1.
Observed mean level of school bonding by intervention groups.

Table 1

Seattle Social Development Project Interventions

Teacher Training in Classroom Instruction and Management
Proactive Classroom Management
Establish Consistent Classroom Expectations and Routines at the Beginning of the Year
Give Clear, Explicit Instructions for Behavior
Recognize and Reward Desirable Student Behavior and Efforts to Comply
Use Methods That Keep Minor Classroom Disruptions From Interrupting Instruction
Interactive Teaching
Assess and Activate Foundation Knowledge Before Teaching
Teach to Explicit Learning Objectives
Model Skills to Be Learned
Frequently Monitor Student Comprehension as Material Is Presented
Reteach Material When Necessary
Cooperative Learning
Involve Small Teams of Students of Different Ability Levels and Backgrounds as Learning Partners
Provide Recognition to Teams for Academic Improvement of Individual Members Over Past Performance
Child Social and Emotional Skill Development
Interpersonal Problem-Solving Skills
Communication
Decision Making
Negotiation
Conflict Resolution
Refusal Skills
Recognize Social Influences to Engage in Problem Behaviors
Identify Consequences of Problem Behaviors
Generate and Suggest Alternatives
Invite Peer(s) to Join in Alternatives
Parent Training
Behavior Management Skills
Observe and Pinpoint Desirable and Undesirable Child Behaviors
Teach Expectations for Behaviors
Provide Consistent Positive Reinforcement for Desired Behavior
Provide Consistent and Moderate Consequences for Undesired Behaviors
Academic Support Skills
Initiate Conversation With Teachers About Children’s Learning
Help Children Develop Reading and Math Skills
Create a Home Environment Supportive of Learning
Skills to Reduce Risks for Drug Use
Establish a Family Policy on Drug Use
Practice Refusal Skills With Children
Use Self-Control Skills to Reduce Family Conflict
Create New Opportunities in the Family for Children to Contribute and Learn

Table 2

Correlation Between Change in School Bonding and Behavioral Outcomes in School, Delinquency, and Substance Use at Age 18

Outcome	Rate of Change in Bonding (From Age 13 to 18)		Estimated Level of Bonding at Age 18	
	Partial Correlation[a]	*N*	Pearson Correlation	*N*
School Success or Failure				
School Achievement (Age 17)	0.22****	480	0.22****	597
Official GPA (Age 17)	0.17***	280	0.27****	352
Repeated a Grade (Lifetime Prevalence)	−0.02	480	−0.09**	597
Dropped Out of School (Lifetime Prevalence)	0.00	479	−0.12***	595
Official California Achievement Test Score (Age 17)	0.01	223	−0.04	277
School Misbehavior				
Cheated on Tests, Skipped School and Classes, Sent From Class for Misbehavior (Past Year Frequency)	−0.27****	425	−0.34****	528
Official Disciplinary Action Report (High School Prevalence)	−0.05	339	−0.21****	425
Suspended or Expelled (Lifetime Prevalence)	−0.04	479	−0.13****	596
Crime				
Lifetime Violence	−0.03	480	−0.19****	597
Lifetime Nonviolent Crime	−0.02	480	−0.20****	597
Lifetime Arrested	−0.05	480	−0.18****	597
Lifetime Court Charges From County Records	−0.08*	435	−0.12***	541
Substance Use				
Lifetime Cigarette Use	−0.12***	480	−0.26****	597
Lifetime Alcohol Use	−0.10***	480	−0.27****	597
Lifetime Marijuana Use	−0.08*	480	−0.25****	597
Lifetime Other Drug Use	−0.08*	480	−0.25****	597
Sexual Activity				
Lifetime Sexually Active	−0.12***	474	−0.22****	590
Lifetime Multiple Sex Partners	−0.09**	472	−0.21****	588
Lifetime Been Pregnant or Gotten a Woman Pregnant	−0.05	465	−0.07*	580
Lifetime Had or Fathered a Baby	−0.02	472	−0.04	588

Note: GPA = Grade Point Average.

[a]Partial correlation coefficients were calculated by controlling the observed level of school bonding at the seventh grade (age 13).

*$p < 0.1$.

**$p < 0.05$.

***$p < 0.01$.

****$p < 0.001$.

Table 3

The Trajectory of School Bonding: Linear and Curved Model Comparison

	Model 1: Linear			Model 2: Quadratic (Curved)		
Fixed Effect	**Coefficient**	***SE***	***t*-Ratio**	**Coefficient**	***SE***	***t*-Ratio**
For Base Rate at Age 18, π_{0i}						
Intercept, β_{00}	2.756	0.022	124.700****	2.790	0.024	114.541****
For Rate of Change at Age 18, π_{1i}						
Intercept, β_{10}	−0.035	0.006	−5.998****	0.016	0.016	0.989
For Acceleration, π_{2i}						
Intercept, β_{20}				0.010	0.003	3.384****
Random Effect	**Estimate**	χ^2	***df***	**Estimate**	χ^2	***df***
Var (π_{0i}) = τ_{00}	0.160	1359.659****	620	0.181	1274.885****	604
Var (π_{1i}) = τ_{11}	0.008	1013.495****	620	0.033	778.735****	604
Var (π_{2i}) = τ_{22}				0.001	732.591****	604
Var (e_{ti}) = σ^2	0.160			0.148		
Deviance		4146.434			4125.368	
Number of Estimated Parameters		6			10	

* $p < 0.1$.

** $p < 0.05$.

*** $p < 0.01$.

**** $p < 0.001$.

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Table 4

Intervention Effect on the Trajectory of School Bonding

	Model 3: Intervention as Covariates		
Fixed Effect	**Coefficient**	**SE**	***t*-Ratio**
For Base Rate at Age 18, π_{0i}			
Intercept, β_{00}	2.725	0.041	66.321****
Full Intervention Versus Control, β_{01}	0.153	0.063	2.415**
Late Intervention Versus Control, β_{02}	0.065	0.056	1.147
For Rate of Change at Age 18, π_{1i}			
Intercept, β_{10}	−0.016	0.028	−0.576
Full Intervention Versus Control, β_{11}	0.087	0.042	2.053**
Late Intervention Versus Control, β_{12}	0.025	0.038	0.659
For Acceleration, π_{2i}			
Intercept, β_{20}	0.004	0.005	0.753
Full Intervention Versus Control, β_{21}	0.017	0.008	2.072**
Late Intervention Versus Control, β_{22}	0.006	0.007	0.780
Random Effect	**Estimate**	χ^2	***df***
Var (π_{0i}) = τ_{00}	0.178	1259.577****	602
Var (π_{1i}) = τ_{11}	0.032	772.305****	602
Var (π_{2i}) = τ_{22}	0.001	725.895****	602
Var (e_{ti}) = σ^2	0.148		
Deviance		4116.822	
Number of Estimated Parameters		16	

* $p < 0.1$.

** $p < 0.05$.

*** $p < 0.01$.

**** $p < 0.001$.

Table 5

Intervention Effect on the Trajectory of School Bonding, Controlling for Gender, Ethnicity, Poverty, and Baseline Academic Achievement

	Model 4: Intervention, Gender, Ethnicity, Poverty, and Baseline Academic Achievement as Covariates		
Fixed Effect	**Coefficient**	**SE**	***t*-Ratio**
For Base Rate at Age 18, π_{0i}			
Intercept, β_{00}	2.721	0.306	8.899****
Full Intervention Versus Control, β_{01}	0.149	0.063	2.372**
Late Intervention Versus Control, β_{02}	0.059	0.056	1.059
Boy Versus Girl, β_{03}	0.034	0.049	0.703
African Versus European American, β_{04}	0.031	0.069	0.443
Asian Versus European American, β_{05}	0.137	0.067	2.045**
Others Versus European American, β_{06}	0.115	0.098	1.173
Eligible for Free Lunch Versus Not, β_{07}	0.053	0.054	0.984
Fifth Grade CAT Score × (100), β_{08}	−0.017	0.056	−0.304
For Rate of Change at Age 18, π_{1i}			
Intercept, β_{10}	−0.149	0.203	−0.732
Full Intervention Versus Control, β_{11}	0.093	0.042	2.221**
Late Intervention Versus Control, β_{12}	0.026	0.037	0.705
Boy Versus Girl, β_{13}	0.085	0.032	2.633***
African Versus European American, β_{14}	0.023	0.046	0.509
Asian Versus European American, β_{15}	−0.032	0.045	−0.719
Others Versus European American, β_{16}	0.091	0.065	1.397
Eligible for Free Lunch Versus Not, β_{17}	0.022	0.036	0.599
Fifth Grade CAT Score × (100), β_{18}	0.014	0.038	0.374
For Acceleration, π_{2i}			
Intercept, β_{20}	−0.018	0.038	−0.475
Full Intervention Versus Control, β_{21}	0.018	0.008	2.208**
Late Intervention Versus Control, β_{22}	0.006	0.007	0.782
Boy Versus Girl, β_{23}	0.013	0.006	2.074**
African Versus European American, β_{24}	0.006	0.009	0.721
Asian Versus European American, β_{25}	0.000	0.009	0.036
Others Versus European American, β_{26}	0.022	0.012	1.857*
Eligible for Free Lunch Versus Not, β_{27}	0.002	0.007	0.328
Fifth Grade CAT Score × (100), β_{28}	0.002	0.007	0.313
Random Effect	**Estimate**	χ^2	***df***
$\text{Var}(\pi_{0i}) = \tau_{00}$	0.173	1242.823****	596
$\text{Var}(\pi_{1i}) = \tau_{11}$	0.029	763.899****	596
$\text{Var}(\pi_{2i}) = \tau_{22}$	0.001	721.159****	596
$\text{Var}(e_{ti}) = \sigma^2$	0.148		
Deviance		4065.817	
Number of Estimated Parameters		34	

Note: CAT = California Achievement Test.

* $p < 0.1$.

** $p < 0.05$.

*** $p < 0.01$.

**** $p < 0.001$.