
DEVELOPMENTAL TRAJECTORIES OF SELF-MANAGEMENT SKILLS AND ADOLESCENT SUBSTANCE USE

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ABSTRACT

This study examined whether transitions in self-management skills were associated with change in gateway substance use (alcohol, cigarettes, and marijuana) from early to mid-adolescence, using a latent growth framework for data analysis. The sample consisted of predominantly white, suburban, and middle-class students (N=2,277) attending 22 middle schools who were followed-up annually from the 7th through 10th grades. Findings indicated that substance use increased in a steady fashion, whereas change in self-management skills (represented by a latent construct with indicators of decision-making, problem solving, self-reinforcement, and self control skills) was relatively flat with a gradual decline over time. A conditioned growth model indicated that early levels of substance use increased the decline in self-management skills over time. Early self-management skills, on the other hand, were protective and slowed growth in substance use. Relations between the two slope growth factors indicated that increases in substance use over time were associated with parallel decreases in self-management skills. Receiving higher grades in

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school was protective and downwardly influenced growth in substance use, whereas being male was associated with a greater decline in self-management skills. These findings support the utility of prevention programs emphasizing self-management skills training as an effective deterrent to early-stage substance use.

Key words: self-management skills, substance use, developmental trajectories, growth modeling.

Substance abuse is an important global public health problem that can have pervasive negative effects on physical, psychological, social, and occupational functioning (Newcomb & Locke, 2005). Longitudinal cohort studies show that the earlier that young people begin to use substances, the greater the risk for heavy substance use and related problems later in life (Griffin, Bang, & Botvin, 2009). Efforts to prevent or delay the onset and escalation of substance use during adolescence are critical to reducing overall morbidity and mortality across the lifespan and across the globe. Reviews of the scientific literature have revealed that the most significant progress in research-based substance abuse prevention has been made in school settings (Griffin & Botvin, 2009).

The advances made in school-based substance use prevention over the past few decades have stemmed from an increase in scientific knowledge regarding the epidemiology, etiologic risk and protective factors, and psychosocial theory related to substance abuse. A contemporary research-based approach to prevention is based on the social resistance model, which assumes that young people first engage in substance use due to exposure to pro-drug social influences from peers and adults who use drugs, and advertising and media portrayals encouraging use. To address these negative influences, social influence programs teach students to recognize and resist negative social influences such as peer pressure to engage in substance use. Another contemporary prevention approach is the competence enhancement model, a general skills building approach designed to increase psychosocial resilience. This approach acknowledges that young people with poor social skills and those who lack adequate self-management skills may be more vulnerable to both the external social influences and internal psychological processes that promote substance use (Botvin, 2000). Thus, this approach aims to improve overall social skills such as communication, assertiveness, and conflict resolution skills, and as well improve self-management skills that help

youth manage cognitions, behaviors, and affect such as decision-making, problem-solving, and coping skills. Extending the focus of preventive interventions from drug refusal skills to a broader set of competence skills has been an important advance in drug abuse prevention programming. Broadly conceptualized skills building interventions can provide young people with the skills needed to confront a variety of developmental challenges as they transition from childhood to adolescence. By focusing on improving core competencies, this approach is more closely linked to the positive youth development literature (Haegerich & Tolan, 2008). Mastering competence skills that promote appropriate social interactions and good self-management may promote overall resilience and address risk and protective factors for multiple problem behavior outcomes (Masten & Obradovic, 2006).

LINKING PREVENTION AND ETIOLOGY RESEARCH

More work is needed that ties together the content of effective preventive interventions with findings and theory on substance abuse etiology. In particular, an important step in moving prevention science forward is to increase our understanding of the core components of interventions that effectively prevent or delay substance use and related risk behaviors. One way to achieve this is to examine within an etiologic framework the key skills taught in effective programs and test how they are related to substance use in the absence of intervention.

In the present study, we examine the relationships between self-management skills and substance use from early to mid-adolescence. Self-management skills refer to the type of skills taught in competence enhancement programs that help young people manage cognitions, behaviors, and affect. In the present study, we examine a latent construct of self-management which is comprised of indicator measures of decision-making, problem-solving, self-control, and self-reinforcement skills. The body of research focusing on the role of such skills in the development of behavior problems among children and adolescence has been growing in recent years. Several recent studies have examined the protective effects of conceptually related constructs such as self-control, self-regulation, and executive functioning skills in youth development and in the etiology of substance use, as described below.

Self-control has been found to be an important protective factor in adolescent substance use. Self-control has been defined as “a set of related abilities that include focusing and shifting attention, monitoring behavior, linking behaviors and consequences over time, and considering alternatives before acting” (Wills et al., 2006). Self-control has been described as having emotional and behavioral components: emotional self-control involves issues such as dealing with anxiety, depression, and anger; behavioral self-control involves the ability to inhibit inappropriate behavior and delay gratification in order to achieve better long-term outcomes (Wills et al., 2006). A recent longitudinal study of middle and high school students found that those with low behavioral control skills reported subsequently higher levels of alcohol, tobacco, and marijuana use, and this effect was mediated by deviant peer associations (Wills et al., 2006). Students with low emotional control skills also reported subsequently higher levels of substance use, and this effect was mediated by coping motives for substance use.

Self-regulation has been found to be an important etiologic component for substance use and a number of other problem behaviors among children and adolescents. Self-regulation has been defined as “the ability to control, modify, and adapt one’s emotions, impulses, or desires,” and it is often described as having emotional and cognitive subcategories (Magar et al., 2008). In a study of college undergraduates, poor emotional self-regulation was associated with greater participation in risky behaviors such as smoking, while poor cognitive self-regulation appeared to increase faulty risk assessments and led to an over-emphasis on the benefits of risky behavior (Magar et al., 2008). Other research has shown that adults with substance dependence have impaired self-regulation as assessed with neuropsychological testing, although it is unclear as to whether such deficits precede drug use or are a consequence of use (Verdejo-García et al., 2007).

Cognitive components of self-regulation or self-control have been referred to as executive functioning (EF). EF is a broad construct that refers to interrelated internal processes that are necessary for enacting purposeful, goal-directed behavior. The literature on EF has focused not only on the adolescent years but also on childhood. The need for EF skills can be seen among children as they enter kindergarten and elementary school, a transition in which they must become increasingly reliant on internal self-management processes rather than that provided by parents or other caregivers. Children must learn to adapt appropriately to the

classroom setting by following new social rules, comply with teacher requests, and interact appropriately with peers. Many of the basic tasks required of students such as sitting still, being quiet, and raising their hand to ask questions test their ability to appropriately self-regulate their thoughts, emotions, and social interactions (Riggs et al., 2006). Research has shown that children with poor EF skills are at increased risk for substance use and other problem behaviors in adolescence and young adulthood, and that the earlier that problems due to poor cognitive, behavioral, and emotional regulation appear, the greater the risk for negative outcomes in the short and long-term (Aytaclar et al., 1999; Fothergill et al., 2008; Kellam & Anthony, 1998; Siebenbruner et al., 2006; Zucker et al., 2008).

Although there is some conceptual overlap and ambiguity in terminology across studies that focus on variables related to self-management, the general construct is clearly relevant to adolescent substance use both theoretically and empirically. In the present study, we use the term self-management skills in order to be consistent with the goals and content of skills-training drug abuse prevention interventions that teach youth how to use a variety of cognitive, behavioral, and affective self-management techniques. We examine how this construct is related to adolescent alcohol, tobacco, and marijuana use from early to mid-adolescence in a latent growth framework.

METHOD

STUDY & SAMPLE CHARACTERISTICS

The sample consisted of control group students participating in a group-randomized, drug abuse prevention trial conducted in the Northeast region of the United States between 1987 and 1991. Participants were assessed beginning in the 7th grade (N=3,549) and follow-up assessments were conducted annually in the 8th grade (N=2,919), 9th grade (N=2,702) and 10th grade (N=2,520). The study received approval from the Cornell Institutional Review Board. Passive consent procedures were used and parental consent was obtained by sending a letter home to parents describing the intervention and survey assessments. The confidential nature of the survey was stressed both in writing and presented orally at the time of administration (a Certificate of Confidentiality was issued by the Department of Health and Human Services). Trained personnel

administered questionnaires during a 45-minute classroom period and coded identification numbers were used to link surveys across time. The sample was 90% White and 82% reported living in suburban areas, 7% in urban areas, and 11% in rural areas. Seventy-two percent of the students reported living with both biological parents, 26.5% reported living with one parent (mother or father) and 2% with family other than their parents.

MEASURES

Substance use. The three indicators of gateway substance use (alcohol, cigarettes, and marijuana) were modeled as a latent construct tapping general involvement in substance use. The alcohol use indicator was based on three items. One assessed frequency of alcohol use with response categories ranging from 'Never tried them' (1) through 'More than once a day' (9). A second item using the same response options assessed drunkenness frequency. A third item assessed quantity of alcohol use per drinking occasion with response categories ranging from 'I don't drink' (1) through 'More than 6 drinks' (6). The three items were averaged into a single indicator tapping extent of alcohol involvement. A second multi-item indicator assessed frequency and intensity of cigarette use. First an index of recent cigarette use was created based on responses to dichotomous items (yes/no) assessing past month, past week, and daily smoking. A second smoking index was created based on number of cigarettes smoked in the past month, past week, and past day. These two indices were cross-multiplied to create a single frequency/quantity score. The same procedure was used to construct an index of marijuana use frequency/quantity.

Self-Management Skills. Four multi-item indicators were used to assess a latent construct of Self-Management Skills. The indicators were scale scores for survey items assessing skills related to decision-making, problem-solving, self-control, and self-reinforcement. Decision-making was measured using seven items from the Response Profile of the Coping Assessment Battery (Bugen & Hawkins, 1981). These items assess the frequency of implementing decision-making skills that involve planning, evaluating, and weighing options. Students read a common stem ("When I have a problem I") and were presented with seven strategies (e.g., "Think about choices that exist before I take any action," and "Think about the possible consequences of each alternative"). Response categories ranged from 'Never' (1) through 'Almost always' (5). Internal consistency for

this scale based on the present sample was .88. Problem-solving was assessed using seven items from the 35-item Problem-Solving Inventory (PSI: Heppner & Petersen, 1982). Sample items include "Many of the problems I face are too hard to solve" and "When a problem comes up, I can usually think of many different ways of dealing with it." Response categories ranged from 'Strongly disagree' (1) through 'Strongly agree' (5). Internal consistency for this scale based on the present sample was .74. Self-control strategies were assessed using eight items from the 36-item Self Control Schedule (SCS: Rosenbaum, 1980). The SCS includes behaviorally oriented self-statements (i.e., cognitions) invoked to reduce emotional distress. Sample items include "If an unpleasant thought is bothering me, I try to think about something pleasant," and "When I am worried about something, I try to keep myself busy with things that I like." Response categories ranged from 'Never true' (1) through 'Almost always true' (5). Internal consistency for this scale based on the present sample was .75. Self-reinforcement was measured using items from the Frequency of Self-Reinforcement Attitudes Questionnaire (Heiby, 1983). According to Heiby, positive thinking reflects underlying cognitive reward mechanisms, the absence of which contributes to low self-confidence. Sample items include "When I succeed at small things, I become encouraged to go on," and "The way I achieve my goals is by rewarding myself every step along the way." Response categories ranged from 'Strongly disagree' (1) through 'Strongly agree' (5). Internal consistency for this scale based on the present sample was .79.

To account for missing data, we used the NORM statistical program to impute five datasets based on the expectation maximization (EM) algorithm estimation procedure (Schafer, 1997). Rubin (1987) shows the gain in efficiency for point estimates is nominal with more than five imputations (i.e., the improvement based on $m=10$ imputations would entail only a gain of 3% efficiency with a missing data rate hovering around 30%).

DATA ANALYSIS

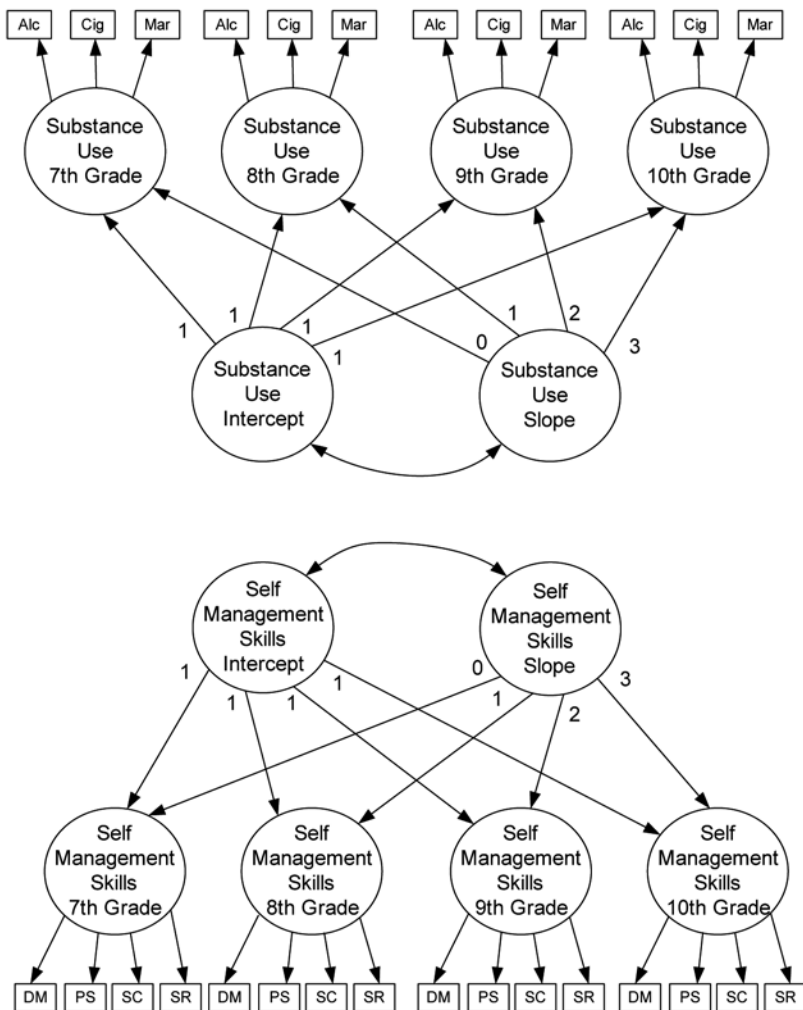
The longitudinal design of the larger prevention trial provides several unique features suitable for conducting growth curve analysis. Data were collected at one year intervals and students provided data on the same set of observed variables at each data collection, providing an opportunity to examine transitions in the mean structure of select measures over time. Latent growth models provide certain advantages over traditional fixed-effect regression approaches which treat change

between any two adjacent time points as independent of any previous or subsequent change. Instead, LGM treats developmental transitions that occur between assessments as dependent on prior change (e.g., McArdle & Epstein, 1987; Muthén, 1991). LGM imposes a structure on the vector of sample means and the covariance matrix (capturing both between-wave and within-person variation) decomposing these into distinct statistical entities (i.e., random and fixed). Figure 1 provides a template to estimate growth in substance use (top) and self-management skills (bottom) over four discrete measurement occasions. The identical basis loadings for the intercept growth factors (1, 1, 1, and 1) indicate the initial reference point for the growth curve is designated as the 7th grade. This parameter reflects the group average level of each construct prior to estimation of growth. Stated in growth terms, the mean of the intercept is the average of all of the individual levels with a metric established by the measure of 7th grade. As shown in the top of Figure 1, a variance term is required to account for individual differences in the intercept growth parameter because not every student initiates substance use at the same level (and some students may never initiate substance use). Figure 1 also shows a second set of basis loadings specifying a functional form of growth also expressed as a mean. The equidistant basis points (0, 1, 2, and 3) posit straight line growth with a constant rate of change over the different measurement occasions, and a variance term is specified to capture individual-level variation in the slope growth parameter.

The models in Figure 1 also specify an association (covariance) between the intercept and slope growth factors (denoted by the double-headed curved line). This association details whether knowledge of where the group begins their growth curve is informative with regard to the group or average rate of growth. In estimating this parameter in the top part of the diagram, for example, we are interested in determining which students grow faster in their reported levels of substance use; youth reporting little or no substance use in the 7th grade or youth with prior substance use. A positive association indicates that individuals reporting relatively high substance use at baseline grow faster than individuals with relatively lower substance use at baseline, while a negative association indicates that individuals with lower levels of substance use at baseline grow faster than individuals with higher initial values.

Curve-of-Factor Method. Figure 1 also shows one other design feature associated with the present study. Typically estimation of growth would be based on repeated measures of observed indicators of substance use

Figure 1

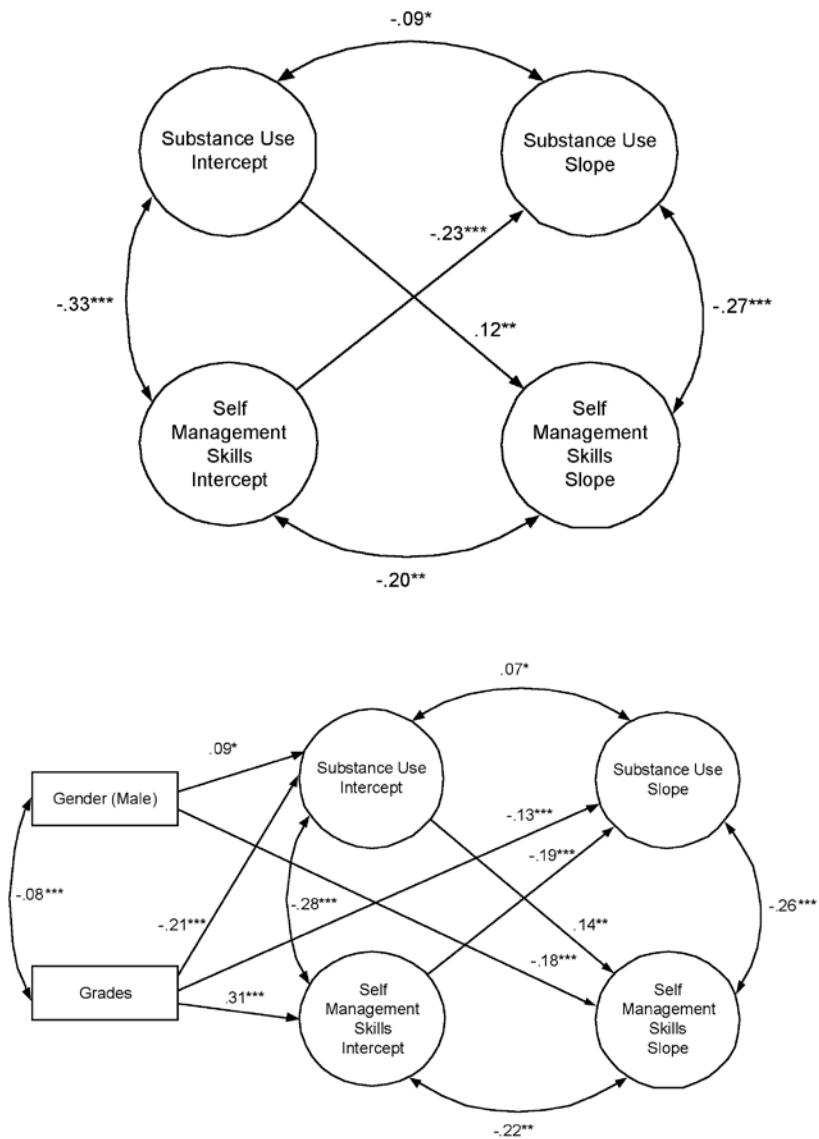


(denoted by boxes in the top of Figure 1). Each measurement occasion would entail a single observed measure, and the growth curve is based on the underlying variation in these repeated measures. In the present study, we used multiple indicators of alcohol, cigarettes, and marijuana use to reflect a latent construct of substance use at each measurement occasion. In contrast to the single indicator approach, a curve-of-factors or higher-order factor model (COF: McArdle, 1986) suggests that growth is based on variability and changes in the mean structure for a common factor, which is hypothesized to statistically cause the associations among the three measures of substance use. In this respect, the model tested in the present study combines a common factor model specifying latent factors for substance use and self-management skills with a chronometric growth model specifying change in both constructs over four years. From a classic psychometric point of view, we are interested in the 'true' score component of a person's individual growth trajectory and the production of error-free estimates of factor loading parameters using confirmatory factor analysis procedures should improve the overall reliability of the model.

There are also conceptual advantages that accompany use of multiple indicators. For example, increasing evidence suggests that most youth characteristically experiment with a wide range of substances during the early-onset years (Hansen, Graham, Wolkenstein, et al., 1987; Kandel, Yamaguchi, & Chen, 1992). This has led several investigators using structural equation methods to model multiple or polydrug use based on youths' involvement with several different types of drugs (e.g., Newcomb, & Bentler, 1988). This statistical convention is supported by over two decades of research examining the gateway hypothesis, suggesting that involvement in early substance use follows a typical sequence consisting initially of alcohol, cigarettes, and marijuana use (Kandel, 2002). Importantly, it is not essential that an individual engages in the use of all three substances simultaneously, but rather, they report some use of all three substances (Earleywine & Newcomb, 1997).

Cross-Domain Model. Figure 2 outlines our basic hypotheses regarding growth in substance use and self-management skills (for simplicity the measurement model is not depicted). In contrast to the level 1 statistical model that specifies the functional form of growth based on individual growth curves within a single domain, a second level of growth parameters considers the influence of growth in one domain on a second domain. The simultaneous or bi-directional influences of

Figure 2



the intercept and growth parameters from the two different domains comprise the level 2 statistical (population) growth model. It is worth noting that the hypothesized cross-domain linkages shown in Figure 2 reflect an important statistical component of growth curve analysis otherwise unavailable with standard regression approaches. In the present study, we hypothesize a protective effect of early competence on initial levels of substance use such that youth reporting higher initial levels of self-management skills also will report lower initial levels of substance use. Moreover, we anticipate that higher initial levels of self-management skills will slow growth in substance use over time and that higher initial levels of substance use will retard the development of self-management skills.

One other important piece of information obtained from the level 2 statistical model captures the influence of growth in substance use on growth in self-management skills (curved line with double-headed arrows on right side in Figure 2). This latter association details whether the developmental trajectory for substance use parallels changes over time in self-management skills or whether the two developmental trajectories are essentially independent. Based on the existing drug etiology literature, we expect that increasing involvement in substance use over time will parallel decreases in self-management skills. To date, most published studies have used static-effects models to account for relations between substance use and self-management skills (Scheier & Botvin, 1995). Although these studies help to elucidate the basic relations between competence and substance use they do not account for developmental fluctuations that may exist from one assessment point to another in either construct. In light of this, we hypothesize that any deleterious effects associated with early substance use on self-management skills will consolidate over time. In other words, the more an individual engages in substance use, the more likely they will lose confidence in their abilities to self-manage their thoughts and behaviors.

Modeling Exogenous Influences. After modeling cross-influence of growth trajectories, a third stage in the modeling procedure includes estimation of effects associated with exogenous predictors. It is likely that certain individual-level demographic characteristics influence the rate of growth in substance use. For example, males traditionally report higher mean levels of substance use compared to females and may accelerate their substance use faster than females. In the condi-

tioned growth model, we estimated parameters showing an influence of gender on the respective intercept and slope growth factors for both domains. A second exogenous influence includes grades, which serve as a proxy for academic achievement. One possible mechanism to account for the influence of grades on self-management suggests that grades provide a litmus test of success or failure. More specifically, repeated academic successes resulting from strong cognitive strategies should accelerate development of ability to manage one's own thoughts and actions. Although we expect some fluctuation in self-reported grades over the course of the study, they are modeled as a time-invariant influence, exerting their effect by retarding initial levels of self-management skills and thereby slowing the rate of growth in these skills over time.

RESULTS

Prevalence rates for the different substance use items indicated an increasing number of youth reported lifetime use of alcohol, cigarettes, and marijuana use. In the 7th grade, 21% indicated lifetime use of alcohol, 7.6% cigarette, and 2.4% marijuana use. By the 8th grade this had increased to 39%, 14.5%, and 7.4% for alcohol, cigarette, and marijuana, respectively. By the 9th grade rates were 52%, 20%, and 12%, respectively, and by the 10th grade rates were 64%, 22%, and 17.6%, respectively. All transitional probabilities from the 7th through 10th grades were significant ($p < .001$) by chi-square proportional test highlighting the gain in reported alcohol, cigarettes, and marijuana users from year to year.

Aggressive tracking and location procedures were implemented to minimize subject loss including at least three make-up dates for absentee students and the use of tracking cards with updated address information provided by the school district. From the 7th to 8th grade there was a loss of 17.7% of the students and an additional 7.4% and 6.7%, respectively, were lost in the two subsequent follow-up assessments (final panel sample $N=2,277$). The rate of attrition is moderate but does not exceed acceptable standards for conducting school-based drug abuse prevention studies (e.g., Hansen, Collins, Malotte, Johnson, & Fielding, 1985). Attrition analyses were conducted to determine whether any systematic bias was associated with the resultant panel sample. The loss of reported substance users (conducted independently for each drug type) was

significant for cigarette users, $\chi^2(1) = 107.6$, $p \leq .0001$ (14% vs. 4.2% for dropout vs. panel students using cigarettes, respectively), and marijuana users, $\chi^2(1) = 31.4$, $p \leq .0001$ (4% vs. 1% for dropout vs. panel students, respectively).

Male students were more likely to drop out over the course of the study, $\chi^2(1) = 8.59$, $p \leq .01$ (55.8% vs. 44.1%, for male and female students, respectively). Panel students also were more likely to live in a two-parent household, $\chi^2(1) = 77.37$, $p < .0001$ (86.5% reporting intact living situation vs. 74.7%, for panel vs. dropout students respectively). A regression model predicting retention status indicated that students retained across all four waves reported higher grades ($\beta = .20$, $p \leq .001$), less cigarette involvement ($\beta = -.10$, $p \leq .05$), and were more likely to report an intact living situation ($\beta = .12$, $p \leq .01$), controlling for risk-taking, gender, and the four indicators of self-management skills. The complete model accounted for 9.6% of the variance, $F(11,705) = 6.83$, $p \leq .0001$.

Results of the Growth Modeling Procedures

All of the growth models were estimated using the EQS statistical program with normal theory maximum likelihood estimation (Bentler, 1995). The first model specified linear growth in Substance Use using the three repeated measures indicators of alcohol, cigarettes, and marijuana. This model fit well based on several model fit criteria (Hu & Bentler, 1998), $\chi^2(38, N = 2277) = 217.34$, $p \leq .001$ ($\chi^2/df = 5.72$), Normed Fit Index (NFI: Bentler & Bonett, 1980) = .983, Comparative Fit Index (CFI: Bentler, 1990) = .986, Standardized Root Mean Square Residual (SRMSR) = .04 and Root Mean Square Error of Approximation (RMSEA: MacCallum, Browne, & Sugawara, 1996; Steiger & Lind, 1980) = .05. Although not shown in any of the figures, additional constraints in the model included equality of error variances across time (i.e., homoscedasticity for the observed measure residual terms), and measurement invariance (Pentz & Chou, 1994). Both sets of restrictions are essential to correctly fit a COF growth model. Taken together the model fit indices underscore a good fit between the hypothesized growth model and the sample covariance and mean structure.

Estimated basis loadings for the substance use growth curve indicated decreasing reliability over time ($\lambda = .850, .476, .327$, and $.248$ for 7th through 10th grades, respectively). Computation of dynamic features of the curvature using motion (R_0) and velocity (R_1) ratios (McArdle, 1986) indicates the fastest change in the curvature occurred between the 7th

and 8th grades with another less precipitous increase between the 9th and 10th grades (R_0 : 1.0, .49, .30, and .20 and R_1 : 0, 3.14, 1.22, and 0.65). Parameter estimates for the intercept, $\mu I = 1.083$ ($t=108.15$, $p \leq .001$) and slope, $\mu S = .199$ ($t=19.92$, $p \leq .001$) mean terms were both highly significant. Overall, these estimates indicate that average group growth started at about 1.1 on the substance use scale and increased at a rate of approximately 20% of the factor (scale) metric each year. Variance components were significant for the intercept, $\psi I = .075$ ($t=9.52$, $p \leq .001$) and slope factors, $\psi = .083$ ($t=15.97$, $p \leq .001$) indicating there was substantial individual differences in terms of the departure point for the growth curve as well as differences in the trajectories for the estimated individual curves. There was a positive, albeit nonsignificant association between the intercept and slope growth factors ($r = .25$, $p = \text{n.s.}$) the non-significant relation indicates little information is gained regarding how fast they acquired this behavior from knowing their initial starting point.

Next, we estimated a linear growth curve for the measures of self-management skills. The same intercept and slope growth factors were estimated using the four repeated measures of self-management skills at each measurement occasion. Model fit indices underscored a reasonable fit to the data, $\chi^2(88, N = 2277) = 949.29$, $p \leq .001$ ($\chi^2/df = 10.78$), $NFI = .928$, $CFI = .934$, $SRMSR = .04$ and $RMSEA = .07$. Among the key growth parameters, there was a significant mean for the intercept, $\mu I = 27.15$ ($t=180.24$, $p \leq .001$) and slope growth factors, $\mu S = -.56$ ($t=5.80$, $p \leq .001$). The negative mean indicates that on average the group declined over time in their self-management skills at a rate of $\frac{1}{2}$ of the designated factor metric per year. Variance components for the intercept, $\psi I = 9.95$ ($t=10.63$, $p \leq .001$) and slope factors, $\psi = 1.23$ ($t=7.24$, $p \leq .001$) indicated significant amounts of individual differences in initial level and rate of growth in self-management skills over time. The association between the intercept and slope growth factors was negative ($r = -.23$, $p \leq .05$) indicating that participants reporting initially higher levels of self-management skills declined (the mean was negative) more slowly over time than participants with initially lower levels of self-management skills. In contrast to the sudden change in substance use between two adjacent time periods, inspection of the estimated loadings for the self-management skills slope growth factor indicates a relatively flat and smooth declining curve ($\lambda = .788, .762, .710$, and $.697$ for 7th through 10th grades, respectively). A more dynamic interpretation of the curvature using motion (R_0) and velocity (R_1) ratios indicates the

fastest change occurred between the 7th and 8th grades with another rapid decline between the 9th and 10th grades (R_0 : 1.0, .85, .70, and .62 and R_1 : 0, 4.24, 2.18, and 8.24).

The next step in the modeling process involved estimating a conditioned model with growth parameters estimated for both substance use and self-management skills. This model includes bi-directional or lagged influences of each domain on growth in the other domain, respectively. Configurations for both linear growth curves from the substance use and self-management skills models were carried over to the conditioned model. Model fit indices indicated an adequate fit, $\chi^2(323, N = 2277) = 2269.78, p \leq .001$ ($\chi^2/df = 7.03$), NFI = .917, CFI = .927, SRMSR = .05 and RMSEA = .05. There was some appreciable change in the mean terms primarily for the slope growth factors with the conditioned model (Substance Use: $\mu S = .76$ [$t=8.24, p \leq .001$] and Self-Management Skills: $\mu S = -1.06$ [$t=4.46, p \leq .001$]). In terms of the association between initial levels for each domain, self-management skills were protective and deterred involvement in early-stage substance use ($r = -.33, p \leq .001$). With respect to the growth portion of the model, a significant negative effect of early self-management skills on growth in substance use ($\beta = -.23, p \leq .001$) indicated that although the entire group is accelerating in their reported levels of substance use over time, participants with initially lower levels of self-management skills accelerated at a faster rate than those with higher initial levels of self-management skills. A positive and significant effect of initial levels of substance use on growth in self-management skills ($\beta = .12, p \leq .05$), highlights that while the entire group is declining in self-management skills over time, participants reporting lower levels of substance use in the 7th grade declined more slowly in their self-management skills compared to students with initially higher levels of substance use. Growth trajectories for both domains were inversely and significantly related ($r = -.27, p \leq .001$) indicating that increased reported levels of substance use paralleled decreased reported levels of self-management skills.

Figure 3 shows the final model specifying inclusion of two exogenous predictors. Overall this model fit well, $\chi^2(374, N = 2277) = 2658.81, p \leq .001$ ($\chi^2/df = 7.11$), NFI = .905, CFI = .917, SRMSR = .05 and RMSEA = .05. Although not shown for purposes of clarity, the addition of the exogenous measures did little to change the respective means for the intercept and slope growth factors in each domain. Turning to the effects

of gender first, male students reported higher involvement in substance use ($\beta = .09$, $p \leq .001$), and female students reported less rapid declines in self-management skills compared to male students ($\beta = -.18$, $p \leq .001$). Interestingly, gender did not significantly influence initial levels of self-management skills, despite its effect on the developmental trajectory of self-management skills over time.

As expected, grades were protective and associated with lower reported initial levels of substance use ($\beta = -.21$, $p \leq .001$). Students reporting higher grades also reported higher initial levels of self-management skills ($\beta = .31$, $p \leq .001$). With respect to the growth portion of the model, grades were protective and associated with slower growth in substance use ($\beta = -.13$, $p \leq .001$). The overall effect of including the two exogenous predictors on the lagged effects was to capture a part of the overall variation in the model and lead to some diminution of the cross-domain effect sizes (although none changed appreciably in magnitude or direction).

DISCUSSION

This study examined how self-management skills (represented by a latent construct with indicators of decision-making, problem solving, self-reinforcement, and self control skills) were related to adolescent alcohol, tobacco, and marijuana use from early to mid-adolescence in a latent growth framework. We use the term self-management skills to refer to the type of skills taught in competence enhancement prevention programs that help young people manage cognitions, behaviors, and affect. Findings indicated that substance use increased in a steady fashion, whereas change in self-management skills was relatively flat with a gradual decline over time. Increases in substance use over time were associated with decreases in self-management skills. Initial levels of substance use increased the decline in self-management skills over time, while initial self-management skills were protective and slowed growth in substance use. The present study contributes to the literature by showing that the self-management skills taught in the most effective contemporary skills building preventive interventions are important protective factors for adolescent substance use.

In the present study, we found a direct effect of self-management skills on adolescent substance use. However, it is also likely that self-

management skills act indirectly to reduce substance use by protecting young people from other risk factors. Indeed, the term resilience refers to how individual differences in protective factors protect individuals from the effects of environmental risk, broadly defined. A consistent finding in the literature is that various self-management skills buffer young people from negative peer influences. A recent study found that students with low self-regulation were more vulnerable to the influence of deviant peers; while those high in self-regulation, with better volitional control of attention and behavior, were less affected by peer deviance (Gardner et al., 2008). It is also likely that the effects of poor self-management skills on problem behavior result from the fact that skill deficits may impede learning opportunities provided through early schooling (Stott, 1981), resulting in poor academic performance. School failure, combined with inefficient problem solving skills, poor self-regulation and inadequate self-monitoring skills can lead to rejection by peers (e.g., Frenzt, Gresham, & Elliott, 1991; Kupersmidt & Patterson, 1991). During early elementary school, the most impulsive students who have difficulty remaining on task or sitting still during class may have more difficulty with the skills needed to progress academically and socially, which in turn exacerbates skills deficits and increases feelings of disenfranchisement and alienation from school. Thus, it is likely that a number of developmental phenomena can explain the link between poor self-management skills and experimentation with alcohol, tobacco and other drugs in early adolescence and beyond.

The findings from the present study have important implications for prevention. These findings support the utility of prevention programs emphasizing cognitive, affective, and behavioral self-management skills training as an effective deterrent to early-stage substance use. The importance of self-management skills suggests that interventions should begin early and be maintained over time. Intervention research has shown that prevention programs for early elementary school which focus on helping students develop self-management or self-control skills can reduce early risk factors for later substance use such as attention problems, aggression, and poor academic performance (Conduct Problems Prevention Research Group, 1999; Ialongo et al., 2001). To the extent that self-management skills are malleable, promoting these skills throughout elementary and secondary school would be an important part of increasing resilience and preventing problem behaviors, particularly for those young people who lack these skills to begin with.

The constructs related to self-management (e.g., self-control, self-regulation, behavioral disinhibition, etc.) have considerable conceptual overlap as described in the literature. Greater clarity from both a theoretical and measurement standpoint would improve our ability to study the protective effects of these individual difference variables in regard to drug use and other adolescent problem behaviors. One issue is whether these related constructs represent genetic or dispositional traits, or if they can be better characterized as modifiable skills and competencies amenable to intervention on the other hand. Some researchers emphasize the notion that there is a common genetic liability to behavioral disinhibition, explained in part by neurocognitive processes in the prefrontal cortex of the brain, which underlies the co-occurrence of addictive or externalizing behaviors (Iacono, Malone, & McGue, 2008). This underlying risk is believed to be shaped by gene-environment interactions, such that exposure to adverse environments amplifies the genetic liability for behavioral disinhibition (Iacono et al., 2008). From the competence and resilience literatures comes the perspective that many protective factors and skills can indeed be the target of intervention. It has been pointed out that even subcategories of the same construct may be differentially amenable to intervention. For example, Eisenberg and colleagues differentiate between two types of self-control: reactive control, which is less voluntary and involves processes that are automatic, reflective, and unintentional, and effortful control, which refer to voluntary, goal-oriented control processes (e.g., Eisenberg et al., 2004). They propose that emotion and behavioral regulation are a result of effortful control, suggesting that they are worthwhile targets of intervention.

Strengths and Limitations of the Study

There are several strengths and limitations associated with the present study. Strengths of the study include the longitudinal panel data collected over a key transition point in early adolescence and the use of validated measures of skills that represent the domain of self-management. One limitation is that the data used for this study are based on self-reports which may introduce a certain level of uncontrolled method variance into the analyses. Another limitation is that the sample was racially homogeneous, consisting primarily of white, middle-class students. Extension of these findings to other ethnic groups is essential and will factor heavily in determining the utility of this model for primary prevention. A third limitation is that we did not conduct mediation analyses

to examine the mechanisms that potentially link poor self-management skills and substance use, nor did we examine self-management skills as a potential buffer against other risk factors. Future research should examine mediation and moderation effects in diverse samples of young people to further elucidate the nature of the protective effects of self-management skills that were observed in the present study.

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