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Longitudinal Relationships Between Self-Management Skills and Substance Use in an Urban Sample of Predominantly Minority Adolescents

Sarah R. Lowe¹, Bianca P. Acevedo², Kenneth W. Griffin², and Gilbert J. Botvin²

¹University of Massachusetts Boston, Boston, MA, USA

²Weill Cornell Medical College, New York, NY, USA

Abstract

We explored changes in self-management skills and substance use from 7th to 11th grade in a multiwave study of predominantly minority adolescents ($N = 1,756$). Using latent growth curve analysis, we found that substance use significantly increased, whereas self-management skills significantly decreased. In a parallel process model, we found that participants who reported higher self-management skills in the 7th grade had smaller increases in substance use. Participants who had larger decreases in self-management skills tended to have greater increases in substance use. We also explored the influence of grades and gender and found that (a) participants with higher grades at baseline had lower initial substance use, higher initial self-management skills, and smaller increases in substance use, and (b) male participants had greater increases in substance use. These results suggest that the provision of self-management skills may be an effective strategy for preventing substance-use initiation and escalation during adolescence.

Keywords

adolescence; substance use; self-management skills; latent growth curve modeling

Adolescent substance use is highly prevalent in the United States and has major consequences for developmental outcomes. A national survey of studies found that approximately 19.5 million Americans age 12 and older reported using an illicit drug in the past month (Substance Abuse and Mental Health Services Administration [SAMHSA], 2003). In addition, data from the centers for disease control and prevention (CDC) and Youth Risk Behavior Surveillance suggest that by 12th grade, roughly 40% of high-school students smoke regularly, more than 50% drink alcohol regularly, and more than 20% use marijuana regularly (Bauman & Phongsavan, 1999). Moreover, numerous studies suggest that substance use tends to escalate substantially over the course of adolescence (e.g., Bauman & Phongsavan, 1999; Zapert, Snow, & Tebes, 2002). Substance use and abuse are associated with impaired judgment and compromised decision-making skills, which may result in a host of risk behaviors, including drunk driving, criminal behavior, risky sex, decreased condom use, unintended pregnancy, and decreases in academic achievement (e.g., D'Amico & Cardaci, 2003; Lynne-Landsman, Bradshaw, & Ialongo, 2010; Mason, 2010).

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Corresponding Author: Kenneth W. Griffin, Department of Public Health, Weill Cornell Medical College, 402 East 67th Street, New York, NY 10065 USA kgriffin@med.cornell.edu.

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Thus, it is important to understand factors that might prevent initiation of substance use and its escalation.

In recent years, researchers have increasingly focused on a range of *core competencies* as factors at the individual level that protect against adolescent substance use (Haegerich & Tolan, 2008). Among these competencies are a range of *self-management skills* that adolescents utilize to be active agents in their own development, including self-control, decision making, and self-reinforcement. Neurobiological research has found that the brain areas associated with self-management skills do not mature until late adolescence or early adulthood, whereas those associated with the processing of social and emotional stimuli undergo rapid development in early adolescence (Steinberg, 2012). Furthermore, as adolescents mature, there is increased connectivity between areas of the brain that process emotional stimuli and those implicated in self-control, such that young adults are more able to draw on both cognitive and emotional information in making decisions (Steinberg, 2012). Early and middle adolescents are therefore less able to modulate their emotional responses with self-management skills than older adolescents and young adults, making them more susceptible to risk-taking behaviors, including substance use. Adolescents' reward-related brain area activity, sensitivity to the value of more immediate (vs. longer term) rewards, and subsequent risk-taking behaviors are heightened in the presence of peers, suggesting that peer influence further undermines adolescents' decision making regarding risk (Chein, Albert, O'Brien, Uckert, & Steinberg, 2011; O'Brien, Albert, Chein, & Steinberg, 2011).

It is important to note, however, that adolescents vary in their levels of self-management skills, which could account for differential rates of substance use. Cross-sectional research has consistently demonstrated significant negative associations between self-management skills and substance use. A study by Wills, Walker, Mendoza, and Ainette (2006), for example, found that adolescents with high levels of self-management skills—specifically, planfulness, problem solving, cognitive effort, and self-reinforcement—were less likely to use substances. Fishbein and colleagues (2006) similarly found that adolescents with low abilities to control their emotions reported greater alcohol and marijuana use. The protective effects of a variety of self-management skills have been replicated in several other studies (e.g., Brody & Ge, 2001; Vaughn, Beaver, DeLisi, Perron, & Schelbe, 2009; Wills, Ainette, Stoolmiller, Gibbons, & Shinar 2008). Given these consistent associations, it is perhaps not surprising that interventions that foster self-management skills have been found to be significantly more effective in decreasing adolescent substance than didactic programs that focus solely on the negative effects of substance use (e.g., Griffin & Botvin, 2010; Tobler et al., 2000).

The impact of interventions that enhance self-management skills suggests that these capacities evolve over time and are shaped by contextual factors. Furthermore, the rate of development of self-management skills is not constant and seems to stall during adolescence. A study by Raffaelli, Crockett, and Shen (2005), for example, found that self-regulation significantly increased from early to middle childhood, but this increase did not continue from middle childhood to early adolescence. Similarly, King, Fleming, Monahan, and Catalano (2011) found that self-control problems did not significantly change among adolescents assessed annually from 6th to 11th grade. Growth in self-control problems varied, however, with some youth experiencing increases and others decreases (King et al., 2011).

The differential rates of growth in self-management skills have implications for adolescent substance-use trajectories. For example, King and colleagues (2011) found that youth with more deficits in self-management (operationalized as self-control and attention) at 6th grade, and whose deficits had greater increases over time, had significantly greater substance use at

11th grade. Other studies have used Latent Growth Curve Modeling (LGCM) to assess relationship between self-management skill and substance-use trajectories. A study by Wills and Stoolmacher (2002) found that adolescents who experienced greater increases on an index of poor self-control experienced steeper increases in substance use. Similarly, Chassin and colleagues (2010) found that adolescents with steeper increases in marijuana use had smaller increases in what the authors labeled *psychological maturity*, defined by responsibility, ability to control impulses, and perspective taking, capacities that overlap with self-management skills.

In a study of predominantly White suburban adolescents, Griffin, Scheier, and Botvin (2009) investigated trajectories of self-management skills and substance use, and found significant relationships between initial levels and changes in each construct. Higher initial levels of self-management skills were associated with less steep increases in substance use, whereas higher initial substance use was associated with greater declines in self-management. In addition, greater increases in substance use were associated with greater decreases in self-management skills.

In the current study, we replicated Griffin and colleagues' (2009) study and extended it by testing whether there is a protective effect of self-management skills in a different demographic group of adolescents, in this case, an urban, predominantly ethnic minority sample. We also included controls for demographic variables that previous research indicates as significant predictors of self-management skills and substance use. First, we controlled for gender, since adolescent females have been found to have higher self-management skills and lower substance abuse than adolescent males, as well as less steep decreases in self-management skills and less steep increases in substance use over the course of adolescence (Griffin et al., 2009; Raffaelli et al., 2005; White, Labouvie, & Papadaratsakis, 2005). Second, we included a control for baseline academic achievement due to previous findings, indicating that lower achievement is associated with higher substance use and lower self-management skills, and greater increases in substance use and steeper decreases in self-management skills (e.g., Bryant, Schulenberg, O'Malley, Bachman, & Johnston, 2003; Griffin et al., 2009).

Current Study

Previous research and theory suggest that self-management skills (including decision making, self-control, and self-reinforcement) are associated with lower rates of substance use (alcohol, cigarette, and marijuana) during adolescence. Although a small number of studies have examined the relationship between self-control and substance use over time, no study has focused analyses on a predominantly ethnic minority sample of urban youth. In the present study, we investigated changes in self-management skills and substance use from 7th to 11th grade among a sample of predominantly Black and Hispanic adolescents from economically disadvantaged communities in New York City over a 4-year multiwave study ($N = 1,756$). We expected to replicate findings from previous research showing that management skills would be significantly associated with lower initial levels of and smaller increases in substance use over time. We also expanded on previous research by examining the association of self-control and substance use with gender and academic performance.

Method

Procedures

Participants in the present study were members of the control group from a large, school-based drug abuse and violence prevention trial conducted with a sample of predominantly minority middle-school youth. From the 7th to 11th grades, students completed a survey as

part of the larger study that included demographic information, self-reported academic performance, a measure of self-management skills, and items assessing frequency of alcohol, cigarette, and marijuana use. Questionnaires were administered in regular classroom periods by teams of three to five study personnel, and students were informed that their responses would not be made available to school personnel, teachers, or parents. Because participants were of various racial/ethnic backgrounds, efforts were made to recruit a racially and ethnically diverse data collection staff.

Various tracking procedures, including a comprehensive database that documented the progress of tracking and data collection, and annual updates on changes in participants' contact information from the New York City Board of Education, were used to increase study retention. All study procedures were approved by the Institutional Review Board at Weill Cornell Medical College. Because the current study sought to investigate trajectories of substance use and self-management skills independent of the intervention, only control participants were included in the analysis.

Participants

We included participants who completed at least one assessment in middle school (i.e., 7th or 8th grade) and one assessment in high school (i.e., 9th through 11th grade). Under this inclusion criterion, 1,177 (40.0%) participants were dropped from the analysis. In addition, participants who omitted at least half of the substance-use items on any wave were excluded ($n = 6$). The final sample consisted of 1,756 participants. Bonferroni-corrected independent-samples t tests (for continuous variables) and Cramer's V tests (for categorical variables) detected three significant differences between participants who were retained and those who were dropped due to missing data. Dropped participants were more likely to be male, had lower grades at baseline, and had higher levels of 8th grade marijuana use (all $p < .05$). Demographics for the final sample of 1,756 participants were as follows. More than half (53.0%) were female, slightly less than half identified as Black (49.0%) and 27.7% as Latino or Hispanic; about half (50.5%) received free lunch, and 55.5% lived in a two-parent household at baseline.

Measures

Demographic variables—Because males and those with low grades in school are at higher risk for substance use (e.g., Bryant, et al., 2003; Griffin et al., 2009), gender and grades at baseline were included as exogenous control variables. Gender was included as a dummy-coded variable (0 = *female*, 1 = *male*). At baseline, participants were asked to indicate what grade they generally received, with response options ranging from 1 = “Ds or lower” to 5 = “mostly As.”

Substance use—Three forms of substance use were assessed at each wave of the study: alcohol, cigarette, and marijuana use. The average of three items was used as an indicator of *alcohol use*. Participants indicated the frequency of (a) drinking alcohol (beer, wine, or hard liquor) and (b) drinking “until you get drunk,” both with response options ranging from 1 = “never” to 9 = “more than once a day.” Participants also indicated how many drinks they consume when they drink, ranging from 1 = “I don't drink” to 6 = “more than 6 drinks.”

The average of two items was used as an indicator of *cigarette use*. First, participants reported on how often they smoke, with response options ranging from 1 = “never” to 9 = “more than once a day.” Second, participants who reported smoking indicated how much they smoke, from 1 = “none at all” to 8 = “more than two packs a day.”

Last, the average of two items was used as an indicator of *marijuana use*. Participants reported on their frequency of (a) marijuana use and (b) marijuana use “until you get high or stoned,” from 1 = “never” to 9 = “more than once a day.”

Self-management skills—Three multi-item indicators were used to assess a latent construct of self-management skills, including scales that measured decision making, self-reinforcement skills, and self-regulation skills. Decision making was measured using five 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 1 = “never” through 5 = “always.” Internal consistency of this scale for the current study (measured with Cronbach’s α) ranged from .89 to .94.

Self-reinforcement was measured using five 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 1 = “strongly disagree” through 5 = “strongly agree.” Internal consistency for this scale based on the present sample ranged from $\alpha = .84$ to .88.

Five items from the Kendall and Wilcox (1979) Self-Control Rating Scale were used to measure self-control skills. The scale assesses cognitive-behavioral elements of self-control, including the ability to manage impulsive, distracting, or disruptive behavior, particularly those occurring in school settings. Sample items include, “I stick to what I am doing until I’m finished with it,” “I have to be reminded several times to do something,” and “I am easily distracted from my work.” Response categories ranged from 1 = *strongly disagree* to 5 = *strongly agree* ($\alpha = .63$ -.75).

Data Analysis

LGCM was used to model developmental trajectories of substance use and self-management skills over time. LGCM is a statistical method used for repeated measures of the same observed variable over time (Duncan, Duncan, Stryker, Li, & Alpert, 1999). Latent factors representing the initial starting point (i.e., the intercept) and rate of change (i.e., the slope) are estimated for the full sample. Variance terms for the intercept and slope, accounting for individual differences in participants’ starting points and rates of change, were also included and can be predicted by other variables in the model. Figure 1 illustrates the LGC models for substance use and self-management skills. The identical loadings for the intercept term (1, 1, 1, and 1) indicate that the intercept term was set at the first time point (seventh grade). The loadings for the slope (0, 1, 2, and 3) specify linear growth, with a constant rate of change over the course of the study.

The models in Figure 1 also specify a covariance between intercept and slope terms. The association reflects whether there is a relationship between initial starting points and change over the course of the study. A positive association would indicate that participants who started with higher initial values tended to have larger increases (or smaller decreases) on the repeated measure compared with those starting with lower initial values. In contrast, a negative association would indicate the participants who started with higher initial values

tended to have smaller increases (or larger decreases) on the repeated measure compared with those who started with lower initial values.

A final note about Figure 1 is that multiple indicators of substance use (alcohol, cigarette, and marijuana) and self-management skills (decision making, self-control, and self-reinforcement) were used at each time point. This approach, termed curve-of-factors or higher-order factor model (COF; McArdle, 1986), estimates growth based on variability and change in the mean structure for a common, latent factor, which is hypothesized to capture the associations between each indicator. Conceptually, the models are thought to capture growth in underlying constructs that account for all of the observed indicators of substance use and self-management skills. Before intercept and slope terms were added to the models, measurement invariance was established through the following steps: (a) test of equal factor loadings at each time point (i.e., weak measurement invariance) and (b) test of equal intercepts at each time point (i.e., strong measurement invariance). This procedure involved testing a series of nested models with a less restricted model compared with a more restricted model (i.e., more degrees of freedom). To assess the significance of each comparison, we evaluated whether the change in comparative fit index (CFI) was .01 (Cheung & Rensvold, 2002). A value beyond these specifications suggests that the imposed restrictions are not supported.

After trajectories of substance use and self-management skills were modeled separately, a parallel process model was computed (Figure 2; for simplicity, measurement models are not depicted). Parallel process modeling allows for the investigation of bidirectional influences of intercept and growth parameters from the two different domains. Cross-domain paths from intercept terms to slope terms test whether participants' starting point in one domain influences rate of change in the other domain. In this case, we hypothesized that participants with higher substance use at baseline would have smaller increases (or larger decreases) in self-management skills. Similarly, we hypothesized that participants with higher self-management skills at baseline would have smaller increases (or larger decreases) in substance use.

An additional feature of the parallel process model is that it permits the examination of the relationship between how two domains change over time (i.e., the covariance between the two slope terms). Based on previous research, we hypothesized a negative covariance between substance use and self-control, meaning that participants who experienced increases in substance use would tend to have decreases in self-management skills, and vice versa.

After a parallel process model was established, we examined the influence of gender and grades at baseline in explaining significant variance in intercept and slope terms. Based on prior research, we hypothesized that males and participants with lower grades at baseline would start with higher initial substance use and experience greater increases (or lower decreases) in substance use over time. In contrast, we expected that females and participants with higher grades at baseline would start with higher self-management skills and experience greater increases (or lower decreases) over time. Paths from demographic variables to slope and intercept terms were added to the cross-domain model, and nonsignificant paths were trimmed.

All LGC models were conducted in Mplus statistical software (Muthén & Muthén, 1998-2010). Full-information maximum likelihood (FIML) was used to handle missing data. Goodness of fit was assessed using three criteria: chi-square (χ^2), root mean square error of approximation (RMSEA), and CFI. Following the recommendations of Hu and Bentler (1998), we set the cutoff for acceptable model fit at RMSEA < .08 and CFI > .90, and superior fit at RMSEA < .05 and CFI > .95. Standardized values for regression paths and

covariances are presented in the results. Nostandardized results are presented for variance and residual variance terms, since standardized variances in Mplus are set at 1.00.

Results

Descriptive Analysis

Means and standard deviation for substance-use indicators and self-management scales at each wave of the study are listed in Table 1.

Substance Use

The first LGC model estimated linear growth in substance use, using the repeated measures indicators of alcohol, cigarettes, and marijuana use (Figure 1). In the initial model, seventh-grade substance use had a negative residual variance. Inspection of the data suggested this to be due to low rates of substance use. Consequently, the residual variance of seventh-grade substance use was set at zero. Weak measurement invariance was established for substance use, whereas strong invariance was not. Factor loadings for each indicator were as follows: alcohol $\lambda = 1.00$, cigarettes $\lambda = 0.98$, and marijuana $\lambda = 1.43$. The LGC model had acceptable fit with the data, $\chi^2(77) = 506.15$, $p < .001$, RMSEA = .06 (90% confidence interval [CI] = [.05, .06]), CFI = .94. The mean estimate for the slope was statistically significant ($\mu S = .59$, $p < .001$), indicating that substance use significantly increased over time. There was significant variance in both the intercept and slope terms ($\psi I = .10$, $p < .001$, and $\psi S = .05$, $p < .001$), indicating significant variability in participants' initial substance use, as well as in the rate at which substance use changed over time. The covariance between the intercept terms was statistically significant ($r = -.24$, $p < .001$), indicating that participants who started with higher substance use tended to have less steep (i.e., smaller) increases in substance use over time.

Self-Management Skills

The second LGC model estimated linear growth in self-management skills, with repeated measures indicators of decision making, self-control, and self-reinforcement (Figure 1). Again, weak measurement invariance was established, whereas strong invariance was not. Loadings for the self-management indicators were as follows: decision making $\lambda = 1.00$, self-control $\lambda = 0.27$, and self-reinforcement $\lambda = 0.59$. The LCG model had acceptable fit with the data, $\chi^2(76) = 410.82$, $p < .001$, RMSEA = .05 (90% CI = [.05, .06]), CFI = .92. The mean slope term was statistically significant ($\mu S = -.19$, $p < .01$), indicating that self-management skills decreased over the course of the study. There was significant variance in the intercept and slope terms ($\psi I = .39$, $p < .001$, and $\psi S = .02$, $p < .01$), meaning that there was significant variability in participants' initial levels of self-management skills, as well as in the rate at which their skills changed over time. The covariance between the intercept and slope terms was statistically significant ($r = -.53$, $p < .001$). Participants who started with higher self-management skills tended to have steeper decreases (i.e., more negative slopes) in skills over time.

Parallel Process Model

Next, a parallel process model, including both substance use and self-management skills, was tested. The model had acceptable fit to the data, $\chi^2(374) = 1,232.41$, $p < .001$, RMSEA = .04 (90% CI = [.03, .04]), CFI = .93. Slope terms remained significant for both substance use ($\mu S = .59$, $p < .001$) and self-management skills ($\mu S = -.20$, $p < .01$), and there remained significant variance around both terms (substance use $\psi S = .05$, $p < .001$, and self-management skills $\psi S = .01$, $p < .01$). In addition, there remained significant variance around both intercept terms (substance use $\psi I = .11$, $p < .001$, and self-management skills

$\psi I = .39, p < .001$). The covariances between intercept and slope terms also remained statistically significant for substance use ($r = -.28, p < .001$) and self-management skills ($r = -.48, p < .001$).

There was a significant association between initial substance use and self-management skills ($r = -.25, p < .001$), indicating that participants who started with higher substance use had significantly lower initial self-management skills. The path from initial substance use to changes in self-management skills was significant ($B = .28, p < .001$); participants with higher initial substance use tended to have less steep decreases in self-management over time. The path from initial self-management skills to changes in substance use was also statistically significant ($B = -.15, p < .01$); participants who started higher in self-management skills tended to have smaller increases in substance use over time. Last, the covariance between the substance use and self-management skills slope terms was statistically significant ($r = -.26, p < .001$), indicating that participants with greater increases in substance use tended to have greater decreases in self-management skills.

Exogenous Influences

Gender and grades were entered as exogenous influences affecting the intercept and slope terms of both substance abuse and self-management skills. The resulting model had adequate fit to the data, $\chi^2(426) = 1,384.48, p < .001$, RMSEA = .04 (90% CI = [.03, .04]), CFI = .92. The following four nonsignificant paths were then trimmed from the model: (a) gender to the substance-use intercept term, (b) gender to the self-management skills intercept term, (c) gender to the self-management skills slope term, and (d) grades to the self-management skills slope term. Without these paths, the model fit was still adequate, $\chi^2(430) = 1,389.55, p < .001$, RMSEA = .04 (90% CI = [.03, .04]), CFI = .92. Although a chi-square difference test detected no significant difference in model fit between the full and trimmed models, $\chi^2\Delta(4) = 5.07, p > .05$, the trimmed model was retained because it was more parsimonious (Figure 2).

In the final model, the paths from baseline grades to initial substance use and initial self-management skills were statistically significant ($B = -.07, p < .05$, and $B = .06, p < .05$, respectively), indicating that participants with higher grades at baseline had lower initial substance use and higher self-management skills. The paths from grades at baseline and gender to changes in substance use were also statistically significant ($B = -.09, p < .01$, and $B = .07, p < .05$, respectively); participants with lower baseline grades and males had significantly greater increases in substance use than their counterparts.

The final means and residual variances for slope and intercept terms, as well as regression paths and covariances between them, are shown in Figure 2. Inclusion of exogenous variables had little change on these values. The one notable change was that, controlling for baseline grades and gender, the slope of substance use decreased from $\mu S = .59$ to $\mu S = .30$ (both $p < .001$).

Discussion

The purpose of this study was to explore trajectories of substance abuse and self-management skills between 7th and 11th grade among a sample of predominantly minority adolescents, as well as how trajectories of these constructs relate to each other over time. Consistent with national epidemiological studies (e.g., Monitoring the Future National Survey Results on Drug Use, Johnston et al., 2007), we found that adolescent substance use, including cigarette, alcohol, and marijuana use, increased over time. It is worth noting that early initiators of substance use might not be at an especially high risk of escalation over the course of adolescence. Specifically, we found that 7th graders who began the study with

higher levels of substance use experienced less steep increases in substance use over the course of the study. One possible explanation is that there may have been ceiling effects, such that early initiators reached their peak levels of use earlier than participants who began using substances later on. Nonetheless, this finding suggests that interventions should not be solely targeted toward early initiators, but rather youth at risk of beginning substance use at any point during adolescence.

Next, we found that self-management skills, including decision making, self-control, and self-reinforcement, decreased over the course of adolescence. Research has also shown that other capacities, overlapping with the self-management skills assessed in the study, continue to develop into early adulthood. For example, between the ages of 18 and 30, youth experience increases metacognition (Vukman, 2005), attentional control (Plude, Enns, & Brodeur, 1994), emotion regulation (John & Gross, 2004), and perspective taking (Eisenberg, Cumberland, & Guthrie, 2005). Studies investigating neurodevelopment over the transition to adulthood have also shown that brain areas associated with behavioral and emotional regulation do not fully develop until as late as the mid-20s (e.g., Bartzokis et al., 2001; Gogtay et al., 2004; Shaw et al., 2008). It is therefore possible that adolescents have the cognitive capacities to analyze their emotional and behavioral responses, but not to regulate them when faced with challenges, and this discrepancy could lead them to perceive their self-management skills as declining. We also found that adolescents who began the study with high self-management skills tended to have steeper decreases in skills over time. It could be that early adolescents who perceive themselves as competent in self-management are especially attuned to declines in these skills. Alternatively, their steeper declines could represent regression to the mean.

It is possible that the decline in reports of self-management skills observed in the study could reflect youth's perceptions, rather than their actual skill level. It is also important to note that, although the slope of self-management skills was significantly negative, the mean values of each construct were fairly stable over time. Again, this suggests that youth were not necessarily experiencing a decline in skills, but perhaps a stalling of skill development. This would be consistent with prior findings indicating no significant growth in self-management capacities over adolescence (e.g., King et al., 2011; Raffaelli et al., 2005). Further research is needed to clarify whether self-regulation declines or stalls during adolescence, and what factors predict variation in developmental trajectories. Alternative means of accessing self-management skills, such as behavioral tasks that rely on self-regulatory capacities, would provide greater insight into how skills develop over time, independent of youth's perceptions.

After establishing growth models for substance use and self-management skills, we computed a parallel process model that investigated relationships between the two constructs. Consistent with our expectations, we found that participants who had initially higher substance use also had initially lower self-management skills, and that participants who had steeper increases in substance use had steeper decreases in self-management skills over the course of the study. These findings provide additional support for the relationship between these two constructs in adolescence, and suggest the potential benefits of fostering self-management skills in reducing substance-use initiation and escalation.

In the parallel process model, we also found that adolescents who began with higher substance use had less steep decreases in self-management skills, and those who began with higher self-management skills had less steep increases in substance use. Although the former finding is somewhat counterintuitive, it could be due to the significant association between initial levels of each construct. For example, because participants who had lower initial self-management skills had higher initial substance use, they had less potential growth in

substance use before reaching maximum levels than those who began with higher self-management skills and lower substance use. The result might therefore represent a ceiling effect for participants who began with low self-management skills and high substance use.

Last, we explored the influence of gender and grades at baseline in shaping trajectories of substance use and self-management skills. We found that participants with lower baseline grades had higher initial substance use, lower initial self-management skills, and steeper increases in substance use. These findings, consistent with prior research (e.g., Bryant et al., 2003), indicate the vulnerability of low-achieving adolescents to early and escalating substance use, and suggest a lack of self-management skills as underlying this vulnerability. We also found that male participants had steeper increases in substance use over the course of the study, again replicating the results of previous studies (e.g., White et al., 2005).

Implications

The results of the study have implications for research, policy, and practice. First, future studies could explore the potential mechanisms underlying changes in both substance use and self-management skills over adolescence. Longitudinal studies of neurodevelopment as it relates to self-reported self-management skills and substance use would further our understanding of how skill development attenuates risk. For example, a study could follow adolescents enrolled in a randomized controlled study of a self-management skill intervention to assess whether training had meaningful effects on neurodevelopment.

Researchers could also explore contextual effects on development, independent of interventions. A study by Bennett and Baird (2006) found that freshman college students assessed in the beginning and end of their first semester experienced growth in brain areas associated with emotion and behavioral regulation in their first semester of college, compared with freshman assessed in back-to-back sessions and community-dwelling young adults. This finding suggests the potentially important role of time spent in higher educational settings in shaping self-management skills and could account for lower rates of substance use among college graduates compared with young adults who did not attend college (White, et al., 2005). It could also be that early substance use compromises the development of relevant brain areas, decreasing self-management skills and increasing risk of substance use and other impulsive behaviors (e.g., Changeux & Lou, 2011; Percy, 2008), and in turn decreasing educational attainment (e.g., King, Meehan, Trim, & Chassin, 2006). Cross-lagged longitudinal models of self-management and substance would allow for a deeper understanding of the direction of the relationships between the two constructs.

Future researchers could also explore the relationships between self-management skills and substance use into young adulthood. The aforementioned delayed development of capacities related to self-management skills corresponds to the declining rates of substance use that have been observed in early adulthood (Bachman et al., 2002). An extension of the current study into early adulthood could explore nonlinear trends in both constructs and whether they relate to each other over time. Such research would have important implications for understanding what distinguishes adolescents that do and do not go on to have long-term substance abuse. Similarly, research on demographic variables that moderate trajectories and relationships between them would help interventions target youth most at risk for substance use and for whom self-management skills are especially protective.

Although future research is needed, the results of the current study suggest the importance of intervention programs that enhance self-management skills. Moreover, programs that target substance use and other risk behaviors might be even more beneficial if they include skills-building activities. This is consistent with previous findings that school-based interventions that aim to increase self-management skills are effective in reducing substance use and other

risk behaviors (e.g., Piquero, Jennings, & Farrington, 2010). Given that adolescents' susceptibility to substance use is heightened under peer influence (e.g., Chein et al., 2011), interventions that foster peer refusal skills alongside self-management skill could further reduce risk (e.g., Wynn, Schulenberg, Maggs, & Zucker, 2000). Interventions could be integrated into school settings, as well as other environments in which youth spend time, such as community centers, summer camps, athletic programs, and churches. To this end, it would be important to instruct program personnel on how to build skills in the youth that they serve, as well as how to identify youth lacking self-management. Formal mentoring programs that connect adults with youth might be an especially useful context to build self-management skills. Mentors have been described as building emotion regulation, coping, and relationship skills among youth that they serve (Rhodes, 2002). The extent to which they have the training and ongoing support to do so, the greater their impact could be on youth outcomes (Rhodes & Lowe, 2009).

Limitations

Limitations to the study are worth noting. First, a sizable percentage of participants were excluded due to attrition, which limits the extent to which the findings of the study generalize to the larger population. This is a particular concern given that we found systematic differences between completers and noncompleters, with the latter being more likely to be male, and having lower grades at baseline and higher seventh-grade marijuana use.

Second, the measures included in the study were brief. Although the advantage of this was a reduction in the burden on participants, perhaps increasing the retention rate, a potential drawback was that the constructs were not thoroughly or reliably assessed. In addition, data were all self-report, and future research, including data from parents, teachers, and peers, could shed additional light on how self-management skills and substance use develop over adolescence. Although participants were informed that their responses would not be shared with school personnel and parents, it is also possible that participants' reports of substance use were unreliable due to concerns of confidentiality. Given that the survey included demographic information alongside substance-use items, students could have speculated that their responses could be identified.

Last, the participants were from the same urban area, and the majority were from ethnic minority groups. Although the relatively homogeneous nature of the sample allowed for exploration of self-management and substance-use trajectories among youth particularly vulnerable to adverse outcomes, it does limit the generalizability of the study. Therefore, the results should be interpreted with caution and replicated with other samples.

Conclusion

Despite these limitations, this study represents a step toward a deeper understanding of how self-management skills and substance use develop and relate to each other over the course of adolescence. The results suggest that the extent to which interventions can build self-management skills, and identify youth who lack them early on, the more they can prevent substance-use initiation and escalation.

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Biography

Sarah R. Lowe, PhD, is a postdoctoral fellow in the Psychiatric Epidemiology Training (PET) program at Mailman School of Public Health, Columbia University. She completed her doctoral degree in clinical psychology at the University of Massachusetts Boston, and her predoctoral internship at Weill Cornell Medical Center/New York Presbyterian Hospital. Her research interests include positive adaptation over the transition to adulthood and resilience after traumatic events.

Bianca P. Acevedo, PhD, is a postdoctoral associate in the Division of Prevention and Health Behavior, Department of Public Health, Weill Cornell Medical College. Her research interests include the neural circuits underlying human pair-bonding, prevention program implementation fidelity, and factors associated with risky behaviors, with a focus on relationships.

Kenneth W. Griffin, PhD, MPH, is a professor in the Division of Prevention and Health Behavior, Department of Public Health, Weill Cornell Medical College. He has published extensively on the etiology and prevention of risk behaviors including alcohol, tobacco, and other drug use among children, adolescents, and young adults.

Gilbert J. Botvin, PhD, is a professor of psychology in public health and chief of the Division of Prevention and Health Behavior at Weill Cornell Medical College. He is nationally and internationally recognized for his work on drug abuse prevention and has published more than 200 scientific papers.

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Figure 1.

Measurement model of substance use and self-management skills from 7th to 11th grades.

Note. Indicators for substance use are alcohol (Alc), cigarettes (Cig), and marijuana (Mar); Indicators for self-management skills are decision making (DM), self-control (SC), and self-reinforcement (SR).

Figure 2.

Parallel process model of substance use and self-management skills, with gender and grades as covariates.

Note. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table 1

Means and Standard Deviation for Substance-Use and Self-Management Indicators

	7th grade	8th grade	9th grade	10th grade	11th grade
Self-management skills					
Decision making	3.91 (1.06)	3.85 (1.06)	3.82 (0.90)	3.82 (0.84)	3.98 (0.81)
Self-control	3.33 (0.56)	3.35 (0.55)	3.14 (0.78)	3.18 (0.78)	3.11 (0.73)
Self-reinforcement	3.73 (0.92)	3.67 (0.90)	3.60 (0.84)	3.65 (0.80)	3.72 (0.82)
Substance abuse					
Alcohol use	1.29 (0.66)	1.44 (0.94)	1.53 (0.90)	1.77 (1.07)	1.90 (1.15)
Cigarette use	1.18 (0.63)	1.28 (0.92)	1.29 (0.90)	1.39 (1.05)	1.38 (1.13)
Marijuana use	1.10 (0.58)	1.24 (1.07)	1.35 (1.16)	1.59 (1.56)	1.51 (1.44)

Note. $N = 1,756$. Standard deviations are listed in parentheses.