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ORIGINAL ARTICLE

Mechanisms of Influence on Youth Substance Use for a Social-Emotional and Character Development Program: A Theory-Based Approach

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ABSTRACT

Background: The Theory of Triadic Influence (TTI) provides a comprehensive framework for understanding adolescent substance use. *Objectives:* We examined mechanisms by which a TTI-guided social-emotional and character development program, *Positive Action* (*PA*), influences adolescent substance use. Study data come from the *PA*-Chicago, longitudinal matched-pairs cluster-randomized control trial. A diverse, dynamic cohort of approximately 1,200 students from 14 low-performing schools were assessed at eight points of time, between grades 3-8, across a six-year period. Students completed scales related to substance use, self-control, deviant peer affiliation, and school attachment, adapted from the Risk Behavior Survey, Social-Emotional and Character Development Scale, Conventional Friends Scale, and People in My Life Scale. After testing the overall effect of *PA* on substance use, we used latent growth modeling to assess whether effects on each outcome were mediated by longitudinal changes in three composite measures aligning with the TTIs three streams. *Results*: Students in *PA* schools reported fewer experiences with drinking, getting drunk, and overall substance use. In the multiple mediator models, significant indirect effects of *PA* on substance use via changes in self-control were evident. *Conclusions/ Importance*: Findings are consistent with theory and past research suggesting the influence of self-control on youth substance use. Future studies should include implementation in different settings and additional theory-based measures.

Early initiation of substance use is a prevalent high-risk health behavior among adolescents. According to 2020 Monitoring the Future data (National Institute on Drug Abuse [NIDA], 2020), 11.5% of surveyed eighth grade students reported ever trying a cigarette, 25.6% reported having had at least one drink of alcohol in their lifetime, and 14.8% reported using marijuana at least once in their lifetime. The prevalence of early substance use initiation among youth is problematic given its association with multiple adverse outcomes. For example, school dropout (Fernández-Suárez et al., 2016; Valkov, 2018), negative psychosocial outcomes (e.g., Poudel & Gautam, 2017), future substance use (Van Ryzin & Dishion, 2014), high-risk sexual activity (Stueve & O'Donnell, 2005), and violence (e.g., Lim & Liu, 2016) have all been associated with early onset of substance use. In addition, given its ability to exacerbate health inequities through its disproportionate impact on low-income communities (Voisin & Kim, 2018), the need exists to better understand factors and programs that influence substance use initiation and maintenance. Guided by a comprehensive health behavior theory (i.e., the Theory of Triadic Influence), we examined the mechanisms by which a social-emotional

and character development program, *Positive Action* (PA), influences adolescent substance use.

According to the Theory of Triadic Influence (TTI; Flay et al., 2009), behaviors such as substance use are understood to be multi-etiological in nature. Moreover, a combination of factors unique to the individual (i.e., the intrapersonal stream of influence), factors reflective of one's social context (i.e., the interpersonal stream of influence, which includes social learning and normative beliefs), and factors within the broader environment (i.e., the sociocultural environmental stream of influence) simultaneously influence health behavior decision making (Flay et al., 2009). According to the TTI, it is important to understand and address the multifaceted etiology of adolescent substance use by incorporating intrapersonal, interpersonal, and environmental factors in the development and evaluation of intervention programs.

Within the TTI's Intrapersonal stream of influence, self-control is a factor that merits further examination for its existing relationship with adolescent substance use. Self-control is defined as the set of skills, capacities, and behaviors that individuals need to function in a self-regulation

feedback loop (Gillebaart, 2018). Self-regulation includes the ability to formulate goals and desired end-results, as well as everything individuals do to direct their behavior toward their desired end-results (Gillebaart, 2018). According to the TTI (Flay et al., 2009), having greater self-control can lead to improvements in self-determination (e.g., to achieve goals), which can lead to improved levels of self-efficacy (e.g., such as confidence in the ability to refuse substance use offers). High levels of self-efficacy, in turn, should result in lower levels of substance use intentions and behaviors. Associations have been found between levels of self-control and adolescent engagement in substance use. In one study where 6th grade students were assessed annually until 9th grade, self-control had significant associations with both initial use and growth in substance use over time (Wills & Stoolmiller, 2002). Specifically, increases in good self-control were protective against substance use growth, whereas increases in poor self-control was associated with growth in substance use. A follow-up study also demonstrated that higher levels of good self-control is protective against substance use, even when youth experience adverse events (Wills et al., 2008). In a related study that included middle- and high-school students, youth substance use was inversely associated with good behavioral self-control and good emotional self-control, whereas the association with poor behavioral control and poor emotional control with substance use was positive (Wills et al., 2006). A cohort study including over 21,000 participants also found that greater levels of self-control in childhood were associated with a decreased likelihood of smoking in adulthood (Daly et al., 2016). Thus, interventions aiming to address adolescent substance use should aim to enhance youths' self-control, and determining whether self-control serves to mediate program effects on behavior is warranted.

The behaviors of peers, which are categorized within the TTI's Interpersonal stream of influence, can also influence early initiation of substance use among youth. Specifically, deviant peer affiliation, which measures the degree to which students associate with peers who engage in high-risk behaviors, has been shown to have an association with adolescent substance use. According to the TTI (Flay et al., 2009), greater levels of deviant peer affiliation may result in greater levels of adolescent substance use as the behaviors of peers can influence both social learning (e.g., by observing the behaviors of others and the reinforcements they receive) and normative beliefs about behaviors, which can then influence behavioral intention and initiation. For example, one study including youth in grades 6-8 found increases in marijuana use among friends was predictive of increases in individual marijuana use (Kobus & Henry, 2010). In another study including a low-income, ethnically diverse sample of fifth graders followed into adulthood, greater levels of peer substance use was associated with greater levels of alcohol, tobacco, and marijuana use in adolescence (Jones et al., 2019). Similarly, analyses of data from the Seattle Social Development Project have shown that deviant peer affiliation is associated with increased adolescent smoking and alcohol use (Cambron et al., 2018). Additionally, a longitudinal study of New Zealand youth from age 14 to age 21 found increased

alcohol, nicotine and cannabis abuse and dependence to be associated with deviant peer affiliation (Fergusson et al., 2002). In a separate study including youth ages 12-18, dyadic analyses showed the similarity in substance use behaviors between best friends, and alcohol use by the more popular friend was positively associated with increased substance use by the less popular friend in the dyad (de Water et al., 2017). Collectively, these studies illustrate how interpersonal contexts, and specifically the behaviors of peers, can impact youths' substance use initiation and maintenance. Thus, interventions aiming to address adolescent substance use should also aim to minimize deviant peer affiliation, and its role as a mediator in preventing or minimizing substance use should be examined.

The third stream of the TTI represents factors in the broader environment that can ultimately influence attitudes toward a behavior. Within the adolescent population, one important environment that influences attitudes toward substance use is that of the school (e.g., Flay et al., 2009; Link, 2008). The related concepts of school connectedness and attachment reflect feelings of belonging and pride in one's school (Chapman et al., 2013); According to the TTI (Flay et al., 2009), a more positive school environment can lead to more positive interactions within the school, which can lead to greater values being placed on behaviors that promote the school environment, and therefore more negative attitudes toward behaviors, like substance use, which can negatively affect the school environment. The negative attitude, in turn, can lead to lower intentions and lower substance use initiation. Prior research has shown that, in general, students are less likely to engage in risky behaviors, including substance use, when they feel more school attachment or connectedness (Chapman et al., 2013). For example, one study that analyzed data from the National Longitudinal Study on Adolescent Health found that greater levels of school connectedness were associated inversely with prevalence of cigarette smoking (Dornbusch et al., 2001). A separate longitudinal study that surveyed students in grade 8, grade 10, and again after one year of post-secondary school, found low levels of school connectedness in grade 8 were associated with subsequent alcohol, marijuana, and tobacco use (Bond et al., 2007). Another longitudinal study using data from the COMPASS study found that increases in school connectedness across time were associated with less frequent binge drinking, and marijuana and tobacco use (Weatherson et al., 2018). Moreover, a longitudinal study that included over 2,000 middle-school children found that the prevention of substance use initiation was associated with a positive school climate (Daily et al., 2020). Taken together, these findings suggest interventions aiming to address adolescent substance use should cultivate school attachment, and determine whether improvements in school attachment serve to mediate program effects on substance use.

Given the aforementioned literature, it is not surprising that existing programs have aimed to address substance use by addressing self-control, deviant peer affiliation, and/or school attachment. For example, adolescents who participated in the afterschool Positive Youth Development

Collaborative (PYDC) received an 18-lesson curriculum designed to promote decision-making skills and resist peer pressure, which are related to self-control and peer affiliation, respectively. A study of PYDC discovered that participants in the treatment group had a significant reduction in past-30-day use of alcohol, marijuana, and other drugs (Tebes et al., 2007). The Iowa Strengthening Families Program is another multifaceted program that also addressed prosocial behaviors and peer resistance skills (Spoth et al., 2019). Findings from a randomized controlled trial of the program revealed that students' positive relationships with parents, friends, and the school in middle school were inversely associated with both past year illicit substance use, and use of marijuana in high school (Spoth et al., 2019). In the Healthy School Ethos (HSE) intervention, the school environment is addressed not via a curriculum, but instead via an action-team used to promote social support, school engagement, and teacher- and peer-relationships. A pilot study of the HSE intervention in London found relationships between student participation and reduced substance use (Bonell et al., 2010). These studies demonstrate the impact of multifaceted programs on substance use behaviors. To date, however, all three streams of the TTI have not been used simultaneously when identifying the ways by which multifaceted programs influence substance use behavior. Doing so should better elucidate mechanisms by which programs achieve their impacts.

In light of the aforementioned research and existing gaps, the goal of the present study was to test one longitudinal, multiple-mediator, model to elucidate mechanisms of impact on adolescent substance use overall, and by each form of substance use. We used data from a school-based program (i.e., *Positive Action* [*PA*]) that was implemented among youth in low-income Chicago public schools. The *PA* program is guided by a curriculum that aligns with the three streams in the TTI. Specifically, by fostering (among other things) self-control (Intrapersonal), reducing deviant peer affiliation (Interpersonal), and promoting improvements in school attachment (Environmental), the *PA* program posits that it simultaneously promotes positive behaviors while preventing negative behaviors (Flay & Allred, 2010). Our research hypotheses were:

1. Students in schools that receive PA will engage in less substance use (overall, and by substance) at study end point in grade 8 in comparison to students in schools that served as controls; and
2. When examining mediational pathways corresponding to the three streams simultaneously (i.e., via a multiple mediator model), change in TTI constructs over time will mediate the effects of PA on substance use.

The findings that result from addressing these research hypotheses have the potential to contribute to existing literature by clarifying the mechanisms by which multifaceted programs impact adolescent substance use. As such, it is possible for findings to be used to support the prioritization of implementation efforts (e.g., ensuring barriers to implementation are addressed) for multifaceted programs during early phases of program planning.

Materials and methods

Intervention

Positive Action [*PA*], a comprehensive and universal program with curricula delivered by the trained classroom teacher, consists of age-appropriate, interactive lessons per grade. Specifically, the K-6 curriculum includes over 140, 15-minute lessons, and the curriculum for grades 7 and 8 include over 70 lessons. The six units of program curriculum align with the TTI's three streams. That is, within the curriculum, self-control, deviant peer affiliation, and school attachment are directly and indirectly targeted. Units 1 through 3 address self-discovery. Unit 2 also addresses school safety, and Unit 4 addresses positive social skills and social interactions; thus, these units should lead to decreased affiliations with deviant peers. Units 5 and 6 are designed to help students identify social and emotional strengths. As such, these units should improve self-control by explaining what it is and how it is performed. The *PA* School Climate Development Kit, which reflects schoolwide activities that are thematically aligned with the units of the curriculum, was implemented concurrently with the classroom curriculum to reinforce classroom lessons. The school climate kit was implemented only by *PA* schools, and is designed to promote a positive learning environment throughout the school (e.g., classroom, playground, etc.). Therefore, the curriculum should lead to improvements in school attachment.

Design and participants

Data for this study are from the longitudinal (i.e., approximately 6 years), Chicago randomized control trial of *PA*. Fourteen diverse, low-performing, schools located in areas of high poverty were matched into seven pairs, and schools within each pair were randomized to the treatment (receipt of *PA*) or control (business-as-usual) condition. Details about the inclusion criteria for eligible Chicago Public Schools, as well as the matching process, are published elsewhere (Lewis et al., 2017). Treatment and control schools did not differ on any matching variables at baseline or at several points throughout the study (Lewis et al., 2017). The sample included 1,170 students; demographic makeup of the students was 53% female, 48% African American, 27% Latinx/a/o, 7% White and 12% other (e.g., the percentage of students identifying as Asian, and Native American, and "Other" were each less than 3%). The dynamic cohort was followed between the Fall semester of grade 3 in 2004 and the Spring semester of grade 8 in 2010. Specifically, assessments occurred over 8 time points coinciding with the beginning of Fall semester and end of Spring semester: grade 3 (fall and spring), grade 4 (fall and spring), grade 5 (spring only), grade 7 (fall and spring), and grade 8 (spring only). We use the term "dynamic" as student mobility/attrition did occur. Namely, the population in this study was highly

mobile (i.e., transferring in and out of schools), evidenced by the 3.1 average number of waves per student. Additionally, only 21% of the initial sample of students participated in all eight waves of data collection. Similar levels of mobility and attrition have been observed in similar settings (e.g., Tobler & Komro, 2011). The place-focused intent-to-treat design allows for this kind of mobility into schools as late entrants to the trial are included in the study (Vuchinich et al., 2012).

Data collection procedures

Data collection procedures have been previously reported (Lewis et al., 2017). Briefly, recruitment occurred at the school, rather than student level. Study participation required parental consent and student assent throughout the duration of the study. Small monetary compensation was provided to parents for submitting their consent forms, as well as a pizza party for classrooms with over 90% consent form submission. Data were collected from students via questionnaires that were administered during class time by research staff. Two 45-minute sessions were used for each data collection event. During early waves (1-5), research staff read the survey instructions and items aloud to students. Debriefing was not included. For the data used in the current study, small monetary compensation was provided for students who completed surveys (e.g., $5 gift card to a local restaurant). All procedures were approved by the Institutional Review Boards of the institutions involved.

Measures

The primary independent variable for this study was condition status (*PA* or control). The outcome of interest was substance use at wave 8; the variable was analyzed as a composite, as well as by specific item (e.g., alcohol use, tobacco use, marijuana use). The three mediators were available across all eight waves of data collection. The Intrapersonal variable was self-control; the Interpersonal variable was deviant peer affiliation; and the Environmental variable was school attachment. All the measures are student self-report.

Substance use behaviors

Substance use behaviors were assessed using five items adapted from the Risk Behavior Survey (Centers for Disease Control & Prevention, 2004). These questions were not asked of students until Wave 5 (Grade 5) given their sensitive nature. Students were asked to indicate if they had ever 1) smoked a cigarette (or used some other form of tobacco), 2) used alcohol (beer, wine, or liquor), 3) gotten drunk on alcohol, 4) used marijuana, and 5) used any more serious drug. Responses to these items were 1= no; 2= yes, once; 3= yes, 2 to 5 times; and 4= yes, more than 5 times. A composite (mean) substance use score was created as an average of all five questions. We analyzed this composite as

well as the individual items at grade 8, and controlled for grade 5 substance use in additional analyses. Alpha for the composite score at grade 5 was 0.68, and for grade 8 was 0.79.

Mediators

Self-control was assessed using four items from the Social-Emotional and Character Development Scale (SECDS; Ji et al., 2013). Items were "I wait my turn in line patiently," "I keep my temper when I have an argument with other kids," "I follow the rules even when nobody is watching," and "I ignore other children when they tease me or call me a bad name." Responses to these items were on a 4-point scale that allowed students to indicate how often they performed each behavior (1= none of the time; 2 = some of the time; 3 = most of the time; and 4 = all of the time). A scale was created at each wave by taking the mean of all the items. Alphas ranged from .62 to .81 across the eight waves.

Deviant peer affiliation was assessed using four items adapted from the Conventional Friends Scale (Elliott et al., 1996). Students were asked to respond to the prompt "How many of your friends do these things?" with a 4-point scale (1= none; 2= some; 3= most; and 4= all). Rather than asking specifically about substance use, items were "Bully other kids," "Get into fights at school," "Do bad things," and "Make fun of other kids." A scale was created at each wave by taking the mean of all the items. Alphas ranged from .81 to .87 across the eight waves.

School attachment was assessed using four items. These items were adapted from the People in My Life Scale (Cook et al., 1995), and measures of relationships to school and teachers (Goodenow, 1993; Murray & Greenberg, 2000). Students were asked if they agree with a series of statements on a 4-point scale (1 = NO!, 2 = no, 3 = yes, 4 = YES!). Statements were "I feel like I belong to this school," "I care about my school," "I wish I were in a different school," (reverse coded) and "I'm proud I go to this school." A scale was created at each wave by taking the mean of all the items. Alphas ranged from .73 to .89.

Data analytic plan

Analyses were run in Mplus v8.5. For the two hypotheses, missing data were handled using full information maximum likelihood (FIML). We first tested the overall effects of condition on each substance use outcome in separate models (i.e., what is traditionally referred to as the "c" path in mediation testing). These analyses tested our first hypothesis that substance use would be lower at study end point for students in *PA* schools relative to those in control schools. We used two-tailed *p* values of .05 to assess significance.

We then estimated multiple mediator models to test our second hypothesis. Analyses tested for mediation of program effects by using a structural equation model (SEM) approach, and specifically, latent growth modeling (LGM). LGM includes an intercept that represents the students' initial

level or starting point of a measure (e.g., baseline score) and a slope that represents the students' change over time. The mediational aspect of the analyses involved testing a model that broke down effects on outcomes into direct effects of *PA* on the outcomes and indirect effects via the program's effects on growth/change over time (i.e., slope) of the mediators (MacKinnon, 2008). These models tested each mediator (i.e., change over time in self-control, deviant peer affiliation, or school attachment) including other mediators in the same model. Mediators were modeled using all eight waves of data. Time was measured as years since beginning of program implementation, which was a total of 5.58 years by the end of grade 8.

Five multiple mediator models were estimated, one per outcome (i.e., cigarettes, drinking, getting drunk, marijuana, and the substance use composite; given the very low frequency of "other drug" use, we did not conduct separate analyses for this outcome but did include it in the substance use composite). In specifying these models, we controlled for substance use at wave 5 by including paths from condition to substance use at wave 5, and wave 5 substance use to wave 8 substance use. Temporally adjacent waves of the mediators were correlated (e.g., self-control at Wave 1 with self-control at Wave 2, self-control at Wave 2 with self-control at Wave 3) as health behavior theories such as the TTI (Flay et al., 2009) posit trial behavior influences future behavior. We added several correlations that aligned with the interrelationships across streams of influence posited by the TTI (Flay et al., 2009). For example, we correlated error terms of mediator variables within each waves (e.g., self-control at Wave 1 with deviant peer affiliations at Wave 1 and school attachment at Wave 1). We also modeled the intercorrelations among the intercept and slope growth parameters of the mediators (i.e., all 3 intercepts with one another (intercept of self-control with intercepts of deviant peer affiliation and school attachment) and all 3 slopes with

each other (slope of self-control with slope of deviant peer affiliation and school attachment). These actions were both guided by theory and model fit. Mediator variables were centered to aid in interpretation of the results. As distributions of outcome variables were non-normal, we used bootstrap estimation with 1,000 random re-samples (Efron & Tibshirani, 2013). Bias-corrected bootstrapped 95% confidence intervals were used to test for indirect effects. This method has been found to provide greater power and more accurate Type I error rates than the product and other resampling methods for testing indirect effects, which appear to be more susceptible to bias stemming from skewness and non-normality in the distributions of indirect effects (MacKinnon et al., 2004). For all models, when testing the mediator to outcome path, the outcome was modeled onto the slope of the mediator. These models are shown in Figure 1. Given the low intra-class correlations (as defined by Singer & Willet, 2003) between schools for each form of substance use at wave 8 (ICC range of 0.02 for cigarettes to 0.07 for drinking), the skewed distribution of each outcome, and the small number of clusters, we did not estimate multi-level models.

Results

Substance use was reported by adolescents in both control and *PA* schools. With respect to cigarette use, the corresponding means and standard deviations for students in control versus *PA* schools at wave 8 was 1.46 (0.83) and 1.39 (0.7), respectively. With respect to drinking, the mean score for control students was 2.03 (SD = 1.11), and the mean score for getting drunk was 1.52 (SD = 0.93). For *PA* students, the corresponding mean for drinking was 1.62 (SD =0.89) and getting drunk was 1.28 (SD = 0.70). For students in control schools, the mean score on marijuana was 1.46 (SD = 0.88), whereas in *PA* schools, the mean score was
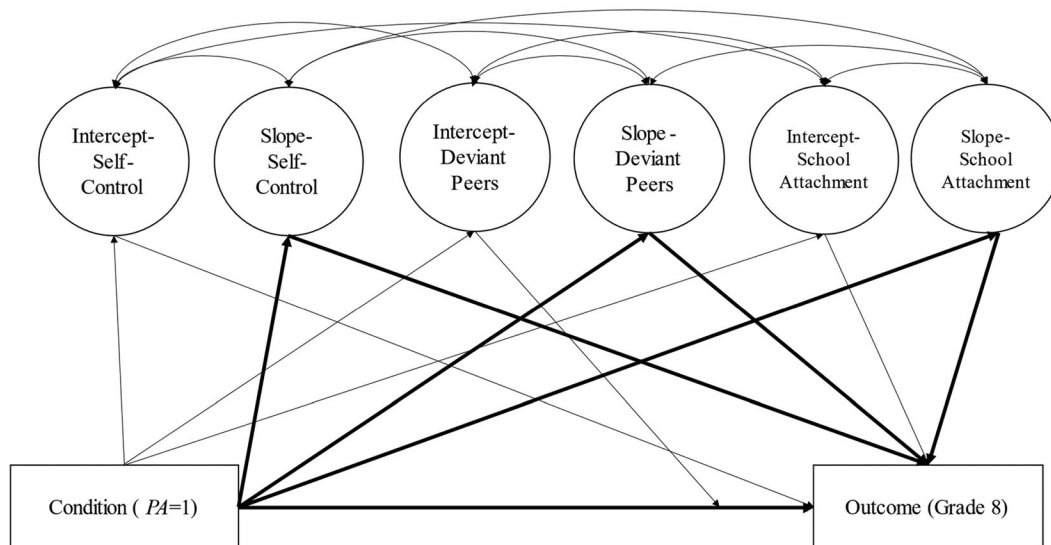

Figure 1. Multiple mediator model.*Note*: Bolded solid paths are the mediational model pathways of interest. This figure does not include the observed variables of the mediator (all 8 waves of each scale used); adjacent waves of these observed variables were correlated (e.g., Wave 1 with Wave 2, Wave 2 with Wave 3, etc.). These models also controlled for substance use at wave 5.

Table 1. Effects of condition (receipt of PA intervention) on each substance use outcome at Grade 8 ("c" pathway).

Outcome	N	Condition→Outcome (β)
Cigarettes	330	−.04, p = .47
Drinking	332	−.20, p < .001
Getting drunk	333	−.14, p < .01
Marijuana	332	−.09, p = .12
Substance use composite	333	−.14, p < .05

Note: Models are just identified and therefore model fit is not presented. The substance use composite included student responses to items assessing experiences with cigarettes, drinking, getting drunk, marijuana, and "other" drugs.
β = standardized beta.

1.31 (SD = 0.80). Supplemental descriptive statistics are provided on the team website.

For hypothesis 1, in testing the effect of condition on endpoint (i.e., wave 8) substance use ("c" path), results showed that students in *PA* schools reported fewer instances of drinking (β [standardized path coefficient] = −.20, p < .001), getting drunk (β = −.14, p<.01), and overall substance use (β = −.14, p<.05). There were no significant differences in marijuana use and cigarette use between *PA* schools and control. Therefore, our first hypothesis was partially supported. Results are in Table 1.

In the multiple mediator latent growth model testing (hypothesis #2), using the bias-corrected 95% bootstrap confidence intervals, we found significant indirect effects through self-control for the five tested substance use outcomes: cigarettes (β =-.14, CI= −.58, −.04), drinking (β = −.13, CI= −.46, −.03), getting drunk (β =-.14, CI= −.56, −.04), marijuana (β = −.29, CI= −.57, −.04), and the substance use composite (β = −.19, CI= −.62, −.06). We did not find a significant indirect effect on any outcome through deviant peer affiliation or school attachment. These models provide partial support for our hypothesis. Results are presented in Table 2.

Discussion

Substance use is a multifaceted behavior that requires a multifaceted approach to address. We aimed to evaluate the mechanisms by which one such multifaceted approach, the *PA* program, impacts adolescent substance use. This study is the first, to our knowledge, to test a TTI-based, three-mediator latent growth model to understand the mechanisms by which a program had its impact on adolescent substance use. Briefly, in the eight-wave, longitudinal, randomized control trial of *PA* in Chicago Public Schools, we found receipt of the *PA* program was inversely associated with substance use at wave 8. Our selection of mediation variables (i.e., self-control, deviant peer affiliation, and school attachment) to examine was guided by the TTI. The results revealed the mediating effect of self-control. Our findings are insightful, and should be viewed within the context of both strengths and limitations.

Our first hypothesis was based on the Theory of Triadic Influence, as the theory posits that programs that address the more underlying causes of behavior should be more successful in influencing behavior change. As previous research had shown that the *PA* program reduces substance use overall (Lewis et al., 2012), we sought to examine the differential impact on varying types of substance use. We found that the program had its greatest impact on alcohol-related behaviors (i.e., drinking and getting drunk). One possible explanation is that alcohol use was the most prevalent form of substance use among our participants. Given that alcohol is the most prevalent form of substance use by the time adolescents reach grade 12 (Johnson et al., 2014; NIDA, 2020), the impact on the alcohol use behaviors among grade 8 students in our study is noteworthy, particularly given that students in the study were in environments that increased their risk for adverse mental, emotional and behavioral health outcomes (Yoshikawa et al., 2012). Moreover, as compared to other drugs, alcohol may be more readily available, perceived to be more socially acceptable, and be performed more socially than other forms of substance use for which we did not observe an effect. As such, a follow-up qualitative study to understand why effects were strongest for alcohol use is warranted.

Our mediation analyses were based on an ecological theory, as we incorporated all three streams from the TTI in the analyses. Results are consistent with the protective effects of self-control established in prior research. In the multiple mediator models, self-control emerged as protective against substance use. This finding is understandable, given that past research has consistently found associations between self-control and the substance use behaviors of adolescents (e.g., Daly et al., 2016; Wills et al., 2008; Wills & Stoolmiller, 2002). Additionally, the *PA* curriculum's emphasis on emotion self-control and behavior self-control help to explain its greater development among students who received the intervention. Nonetheless, substance use behaviors, particularly among adolescents, can also be seen as social behaviors, occurring among friends. Thus, that deviant peer affiliation did not demonstrate significance in the multiple mediator model was unexpected, given theory and past research has shown the strong influence of peer behavior on adolescent substance use (e.g., Hussong, 2002). Although multicollinearity is a possible explanation, post-hoc analyses did not reveal particularly high correlations between the slopes of self-control and deviant peers (results available upon request). Although it is plausible that the program's impact on substance use was truly mediated solely through self-control, we believe our findings may be better explained by additional explanations. With respect to measurement limitations, the items used to measure deviant peer affiliation did not directly inquire about peer substance use (e.g., the items focus more on bullying behaviors and only one item, "Do bad things," may include substance use). Given the positive relationship between substance use behaviors of peers and youths' own substance use (e.g., Jones et al., 2019; Kobus & Henry, 2010), future studies should directly asked students about the substance using behaviors of their peers. With respect to multi-step mediation, it is possible the effect of deviant peer affiliation on substance use can be further mediated by other factors, such as perceived risk of use (e.g., Link, 2008). As such, future research can explore two-step mediation models.

Table 2. Results of multiple mediator models.

Outcome	N	Chi-Square (DF)	RMSEA	CFI	AIC	Condition→ outcome [β indirect via self-control] (CI)[a]	Condition→ Outcome [β indirect via deviant peer affiliation] (CI)[a]	Condition→ Outcome [β indirect via school attachment] (CI)[a]
Cigarettes	1118	536.36(294)	.03	.92	23790.42	**-.14 (-.58, -.04)**	.02 (-.05, .17)	-.01 (-.08, .07)
Drinking	1118	562.19(294)	.03	.91	24271.85	**-.13 (-.46, -.03)**	.00 (-.09, .11)	-.02 (-.11, .02)
Getting drunk	1118	532.62(294)	.03	.92	23554.55	**-.14 (-.56, -.04)**	.00 (-.07, .13)	-.00 (-.05, .07)
Marijuana	1118	522.48(294)	.03	.93	23354.35	**-.29 (-.57, -.04)**	-.00 (-.12, .13)	-.02 (-.09, .06)
Substance use composite	1118	578.75(294)	.03	.91	23037.56	**-.19 (-.62, -.06)**	.01 (-.06, .16)	-.01 (-.08, .05)

Outcome	Condition→ Self-control slope (β)	Condition→ Deviant peer affiliation slope (β)	Condition→ School attachment slope (β)	Self-control Slope→ outcome (β)	Deviant peer affiliation Slope→ outcome (β)	Attachment slope→ Outcome (β)	Condition→ Outcome (β direct)
Cigarettes	.33, p < .01	-.18, p < .01	.17, p < .05	-.44, p = .09	-.09, p = .77	-.03, p = .86	.06, p = .61
Drinking	.32, p < .01	-.18, p < .01	.17, p = .05	-.40, p = .08	-.00, p = .99	-.15, p = .35	-.07, p = .50
Getting drunk	.33, p < .01	-.18, p < .01	.17, p < .05	-.42, p = .09	.01, p = .98	-.01, p = .97	-.05, p = .66
Marijuana	.33, p < .01	-.19, p < .01	.17, p = .05	-.44, p = .06	-.01, p = .97	-.07, p = .70	.03, p = .78
Substance use composite	.33, p < .01	-.18, p < .01	.17, p = .05	-.54, p < .05	-.05, p = .85	-.06, p = .72	.01, p = .92

	Wave 5 on Wave 8	Condition on Wave 5
Cigarettes	-.03, p = .77	-.07, p = .13
Drink	.02, p = .82	-.08, p = .06
Drunk	-.10, p < .05	-.11, p < .05
Marijuana	.12, p = .19	.01, p = .78
Substance	-.09, p = .20	-.08, p = .05

[a]CI=Confidence Interval. These are bias-corrected 95% confidence intervals for the bootstrapped indirect effect estimates.

β = standardized beta.

With respect to social attrition as a possible explanation for the null effect, the average number of waves of participation was approximately 3 out of 8, suggesting high mobility. Past research has shown that youth who engage in deviant behaviors are more likely to associate with peers who also engage in these behaviors, particularly when they live within close proximity to each other (e.g., Dishion et al., 1995). As such, it is plausible that the mobility within our population could reduce power for detecting peer group effects, even when they are present, due to the changing compositions in peer groups over time.

The limited influence of school attachment was surprising given prior research (e.g., Henry & Slater, 2007) implicating it as a protective factor for adolescent substance use. Upon reviewing the *PA* curriculum, it is possible that the school climate development kit, which is separate from the core six-unit curriculum, was not subject to the same level of implementation and oversight. A further consideration is that some research supports the potential for contextual effects of school attachment whereby the average level of attachment among students in the school can influence risk for substance use, independent of the student's own level of attachment (Henry & Slater, 2007). Thus, future implementation efforts should seek to better engage this curriculum component, and future research should explore the potential for mediational processes at multiple levels of analysis.

The TTI posits, and prior research has shown, the importance of multiple factors in multiple streams of influence on substance use (Flay et al., 2009); yet our hypotheses were only partially supported. In aiming to understand our findings, it is notable that we did not test the whole TTI, only paths from ultimate underlying causes to the outcome. The TTI does posit distal and proximal factors influence intentions and behavior (Flay et al., 2009). Thus, it is possible that limiting our analyses to three ultimate underlying causes led to the findings we observed. As such, it is important for future research to include pathways from ultimate to distal to proximal across all three streams (e.g., deviant peer affiliation (ultimate) to peer behavior (distal) to social normative beliefs (proximal) to adolescent substance use). For example, future studies can include measures of neighborhood context, parental behaviors, perceived risk of use and indicators of mental health difficulties within the distal level, and measures of self-efficacy, normative beliefs, and attitudes toward substance use in the proximal level (e.g., Link, 2008). Examining these paths both within and across streams may better elucidate the ways by which such multifaceted programs exert their impact. Moderated mediation, which would also allow for differences by race, gender, mobility group, could also be examined in future research.

Our results should be viewed within the context of strengths and limitations. Strengths include the longitudinal nature, whereby we were able to follow a dynamic cohort of students via eight assessments across six years in time. In addition, we were able to successfully implement the study in a setting with participants that could most benefit from such an intervention, demonstrating feasibility for those seeking replication. Moreover, our analytic approach incorporated the ecological theory guiding program development. Nonetheless, our study is not without limitations. All the measures of interest were based on student self-report. As such, future research should aim for data triangulation via supplemental reports from teachers, parents, and peers. In addition, because of the multitude of survey items and the young age of our participants, the measures used in this study were limited to four items for each mediator, and five items for the outcome. Moreover, although our mediators were measured across eight points in time, our substance use outcomes were limited to measurement at one point in time (i.e., grade 8). In addition, the substance use outcomes did not account for forms of substance use that we know are currently pressing public health concerns (e.g., e-cigarette use and prescription drug misuse). Additionally, given the number of mediators and outcomes we were interested in examining, we estimated multiple models; such multiple testing could lead to inflated Type I errors. Lastly, although the setting in which our study took place was a strength, the attrition common in such settings could lead to attrition bias, and findings may not be generalizable to dissimilar settings. As such, replication across settings is essential.

To summarize, we observed that a theory-and school-based program that was not a traditional substance use prevention program had an impact primarily on adolescent alcohol use. It is possible the program achieved its impact by focusing on more ultimate causes of behavior, particularly self-control. Implications for schools aiming to implement such a program in resource-limited settings should include engaging those who deliver the curriculum (e.g., classroom instructors) to pay particular attention to lessons that address self-control. With respect to future research, exploring the impact of the program on frequency of substance use behavior is warranted, as more frequent substance use has been associated with adverse health (e.g., Gamarel et al., 2018) and educational outcomes (e.g., Thompson et al., 2019). Additionally, as this study followed students into grade 8, and these students are now young adults, a long-term follow-up study that examines the substance use (and related) trajectories would be particularly insightful.

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wish to dedicate this article to the memory of the late Dr. Brian Flay. We miss you.

References

Bond, L., Butler, H., Thomas, L., Carlin, J., Glover, S., Bowes, G., & Patton, G. (2007). Social and school connectedness in early secondary school as predictors of late teenage substance use, mental health, and academic outcomes. *Journal of Adolescent Health*, 40(4), 357. e9. https://doi.org/10.1016/j.jadohealth.2006.10.013

Bonell, C. P., Sorhaindo, A. M., Allen, E. E., Strange, V. J., Wiggins, M., Fletcher, A., Oakley, A. R. A., Bond, L. M., Flay, B. R., Patton, G. C., & Rhodes, T. (2010). Pilot multimethod trial of a school-ethos intervention to reduce substance use: Building hypotheses about upstream pathways to prevention. *Journal of Adolescent Health*, 47(6), 555–563. https://doi.org/10.1016/j.jadohealth.2010.04.011

Cambron, C., Kosterman, R., Catalano, R. F., Guttmannova, K., & Hawkins, J. D. (2018). Neighborhood, family, and peer factors associated with early adolescent smoking and alcohol use. *Journal of Youth and Adolescence*, 47(2), 369–382. https://doi.org/10.1007/s10964-017-0728-y

Chapman, R. L., Buckley, L., Sheehan, M., & Shochet, I. (2013). School-based programs for increasing connectedness and reducing risk behavior: A systematic review. *Educational Psychology Review*, 25(1), 95–114. https://doi.org/10.1007/s10648-013-9216-4

Centers for Disease Control and Prevention. (2004). *Methodology of the youth risk behavior surveillance system*. http://www.cdc.gov/HealthyYouth/yrbs/index.htm.

Cook, E. T., Greenberg, M. T., & Kusche, C. A. (1995). People In My Life: Attachment relationships in middle childhood [Paper presentation]. Society for Research in Child Development, Indianapolis.

Daly, M., Egan, M., Quigley, J., Delaney, L., & Baumeister, R. F. (2016). Childhood self-control predicts smoking throughout life: Evidence from 21,000 cohort study participants. *Health Psychology*, 35(11), 1254–1263. https://doi.org/10.1037/hea0000393

Daily, S. M., Mann, M. J., Lilly, C. L., Bias, T. K., Smith, M. L., & Kristjansson, A. L. (2020). School climate as a universal intervention to prevent substance use initiation in early adolescence: A longitudinal study. *Health Education & Behavior*, 47(3), 402–411. https://doi.org/10.1177/1090198120914250

de Water, E., Burk, W. J., Cillessen, A. H., & Scheres, A. (2017). Substance use and decision-making in adolescent best friendship dyads: The role of popularity. *Social Development*, 26(4), 860–875. https://doi.org/10.1111/sode.12227

Dishion, T. J., Andrews, D. W., & Crosby, L. (1995). Antisocial boys and their friends in early adolescence: Relationship characteristics, quality, and interactional process. *Child Development*, 66(1), 139–151. https://doi.org/10.1111/j.1467-8624.1995.tb00861.x

Dornbusch, S. M., Erickson, K. G., Laird, J., & Wong, C. A. (2001). The relation of family and school attachment to adolescent deviance in diverse groups and communities. *Journal of Adolescent Research*, 16(4), 396–422. https://doi.org/10.1177/0743558401164006

Efron, B., & Tibshirani, R. J. (2013). *An introduction to the bootstrap*. CRC Press.

Elliott, D. S., Wilson, W. J., Huizinga, D., Sampson, R. J., Elliott, A., & Rankin, B. (1996). The effects of neighborhood disadvantage on adolescent development. *Journal of Research in Crime and Delinquency*, 33(4), 389–426. https://doi.org/10.1177/0022427896033004002

Fergusson, D. M., Swain-Campbell, N. R., & Horwood, L. J. (2002). Deviant peer affiliations, crime and substance use: A fixed effects regression analysis. *Journal of Abnormal Child Psychology*, 30(4), 419–430. https://doi.org/10.1023/A:1015774125952

Fernández-Suárez, A., Herrero, J., Pérez, B., Juarros-Basterretxea, J., & Rodríguez-Díaz, F. J. (2016). Risk factors for school dropout in a sample of juvenile offenders. *Frontiers in Psychology*, 7, 1993. https://doi.org/10.3389/fpsyg.2016.01993

Flay, B. R., & Allred, C. G. (2010). The Positive Action program: Improving academics, behavior and character by teaching comprehensive skills for successful learning and living. In T. Lovat, R. Tommey, N. Clement (Eds.), *International research handbook on values education and student wellbeing* (pp. 471–501). Springer.

Flay, B. R., Snyder, F., & Petraitis, J. (2009). The theory of triadic influence. In R. J. DiClemente, M. C. Kegler, R. A. Crosby (Eds.), *Emerging theories in health promotion practice and research* (2nd ed., pp. 451–510). Wiley and Sons.

Gamarel, K. E., Nichols, S., Kahler, C. W., Westfall, A. O., Lally, M. A., & Wilson, C. M. (2018). A cross-sectional study examining associations between substance use frequency, problematic use and STIs among youth living with HIV. *Sexually Transmitted Infections*, 94(4), 304–308. https://doi.org/10.1136/sextrans-2017-053334

Gillebaart, M. (2018). The 'operational' definition of self-control. *Frontiers in Psychology*, 9, 1231. https://doi.org/10.3389/fpsyg.2018.01231

Goodenow, C. (1993). The psychological sense of school membership among adolescents: Scale development and educational correlates. *Psychology in the Schools*, 30(1), 79–90. https://doi.org/10.1002/1520-6807(199301)30:1≤79::AID-PITS2310300113≥3.0.CO;2-X

Henry, K. L., & Slater, M. D. (2007). The contextual effect of school attachment on young adolescents' alcohol use. *Journal of School Health*, 77(2), 67–74. https://doi.org/10.1111/j.1746-1561.2007.00169.x

Hussong, A. M. (2002). Differentiating peer contexts and risk for adolescent substance use. *Journal of Youth and Adolescence*, 31(3), 207–220. https://doi.org/10.1023/A:1015085203097

Ji, P., Flay, B., & DuBois, D. (2013). Social-emotional and character development scale – Development and initial validation with urban elementary school students. *Journal of Research in Character Education*, 9(2), 121–147.

Jones, T. M., Epstein, M., Hill, K. G., Bailey, J. A., & Hawkins, J. D. (2019). General and specific predictors of comorbid substance use and internalizing problems from adolescence to age 33. *Prevention Science*, 20(5), 705–714. https://doi.org/10.1007/s11121-018-0959-5

Johnson, L. D., O'Malley, P. M., Bachman, J. G., Schulenberg, J. E., & Miech, R. A. (2014) *Monitoring the future national survey results on drug use, 1975-2013:* Volume 1, Secondary school students. University of Michigan.

Kobus, K., & Henry, D. B. (2010). Interplay of network position and peer substance use in early adolescent cigarette, alcohol, and marijuana use. *Journal of Early Adolescence*, 30(2), 225–245. https://doi.org/10.1177/0272431609333300

Lewis, K. M., Bavarian, N., Snyder, F. J., Acock, A., Day, J., Dubois, D. L., Ji, P., Schure, M. B., Silverthorn, N., Vuchinich, S., & Flay,

B. R. (2012). Direct and mediated effects of a social-emotional and character development program on adolescent substance use. *The International Journal of Emotional Education*, 4(1), 56–78. https://www.um.edu.mt/library/oar//handle/123456789/6138

Lewis, K. M., DuBois, D. L., Ji, P., Day, J., Silverthorn, N., Bavarian, N., Vuchinich, S., Acock, A., Malloy, M., Schure, M., & Flay, B. R. (2017). Meeting the challenges of longitudinal cluster-based trials in schools: Lessons from the Chicago trial of Positive Action. *Evaluation & the Health Professions*, 40(4), 450–482. https://doi.org/10.1177/0163278716673688

Lim, J. Y., & Lui, C. K. (2016). Longitudinal associations between substance use and violence in adolescence through adulthood. *Journal of Social Work Practice in the Addictions*, 16(1–2), 72–92. https://doi.org/10.1080/1533256X.2016.1162166

Link, T. C. (2008). Adolescent substance use in Germany and the United States: A cross-cultural test of the applicability and generalizability of theoretical indicators. *European Journal of Criminology*, 5(4), 453–480. https://doi.org/10.1177/1477370808095126

MacKinnon, D. P., Lockwood, C. L., & Williams, J. (2004). Confidence limits for the indirect effect: Distribution of the product and resampling approaches. *Multivariate Behavioral Research*, 39(1), 99–128. https://doi.org/10.1207/s15327906mbr3901_4

MacKinnon, D. P. (2008). *Introduction to statistical mediation analysis.* Lawrence Erlbaum Associates.

Murray, C., & Greenberg, M. T. (2000). Children's relationships with teachers and bonds with school: An investigation of patterns and correlates in middle childhood. *Journal of School Psychology*, 38(5), 423–445. https://doi.org/10.1016/S0022-4405(00)00034-0

National Institute on Drug Abuse. (2020). *Monitoring the future study: Trends in prevalence of various drugs.* https://www.drugabuse.gov/drug-topics/trendsstatistics/monitoring-future/monitoring-future-study-trends-in-prevalence-various-drugs.

Poudel, A., & Gautam, S. (2017). Age of onset of substance use and psychosocial problems among individuals with substance use disorders. *BMC Psychiatry*, 17(1), 10. https://doi.org/10.1186/s12888-016-1191-0[PMC][28077106]

Singer, J. D., & Willet, J. B. (2003). *Applied longitudinal analysis: Modeling change and event occurrence.* Oxford University Press.

Spoth, R., Trudeau, L., Shin, C., Randall, G. K., & Mason, W. A. (2019). Testing a model of universal prevention effects on adolescent relationships and marijuana use as pathways to young adult outcomes. *Journal of Youth and Adolescence*, 48(3), 444–458. https://doi.org/10.1007/s10964-018-0946-y

Suh, S., Suh, J., & Houston, I. (2007). Predictors of categorical at-risk high school dropouts. *Journal of Counseling & Development*, 85(2), 196–203. https://doi.org/10.1002/j.1556-6678.2007.tb00463.x

Stueve, A., & O'Donnell, L. N. (2005). Early alcohol initiation and subsequent sexual and alcohol risk behaviors among urban youths. *American Journal of Public Health*, 95(5), 887–893. https://doi.org/10.2105/AJPH.2003.026567

Tebes, J. K., Feinn, R., Vanderploeg, J. J., Chinman, M. J., Shepard, J., Brabham, T., Genovese, M., & Connell, C. (2007). Impact of a positive youth development program in urban after-school settings on the prevention of adolescent substance use. *Journal of Adolescent Health*, 41(3), 239–247. https://doi.org/10.1016/j.jadohealth.2007.02.016

Thompson, K., Leadbeater, B., Ames, M., & Merrin, G. J. (2019). Associations between marijuana use trajectories and educational and occupational success in young adulthood. *Prevention Science*, 20(2), 257–269. https://doi.org/10.1007/s11121-018-0904-7

Tobler, A. L., & Komro, K. A. (2011). Contemporary options for longitudinal follow-up: Lessons learned from a cohort of urban adolescents. *Evaluation and Program Planning*, 34(2), 87–96. https://doi.org/10.1016/j.evalprogplan.2010.12.002

Valkov, P. (2018). School dropout and substance use: Consequence or predictor. *Trakia Journal of Science*, 16(2), 95–101. https://doi.org/10.15547/tjs.2018.02.004

Van Ryzin, M. J., & Dishion, T. J. (2014). Adolescent deviant peer clustering as an amplifying mechanism underlying the progression from early substance use to late adolescent dependence. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, 55(10), 1153–1161. https://doi.org/10.1111/jcpp.12211

Voisin, D. R., & Kim, D. H. (2018). "Broken windows": Relationship between neighborhood conditions and behavioral health among low-income African American adolescents. *Journal of Health Psychology*, 23(4), 527–537. https://doi.org/10.1177/1359105316681064

Vuchinich, S., Flay, B., Aber, L., & Bickman, L. (2012). Person mobility in the design and analysis of cluster-randomized cohort prevention trials. *Prevention Science*, 13(3), 300–313. https://doi.org/10.1007/s11121-011-0265-y

Weatherson, K. A., O'Neill, M., Lau, E. Y., Qian, W., Leatherdale, S. T., & Faulkner, G. E. (2018). The protective effects of school connectedness on substance use and physical activity. *Journal of Adolescent Health*, 63(6), 724–731. https://doi.org/10.1016/j.jadohealth.2018.07.002

Wills, T. A., & Stoolmiller, M. (2002). The role of self-control in early escalation of substance use: A time-varying analysis. *Journal of Consulting and Clinical Psychology*, 70(4), 986–997. https://doi.org/10.1037/0022-006X.70.4.986

Wills, T. A., Ainette, M. G., Stoolmiller, M., Gibbons, F. X., & Shinar, O. (2008). Good self-control as a buffering agent for adolescent substance use: An investigation in early adolescence with time-varying covariates. *Psychology of Addictive Behaviors*, 22(4), 459–471. https://doi.org/10.1037/a0012965

Wills, T. A., Walker, C., Mendoza, D., & Ainette, M. G. (2006). Behavioral and emotional self-control: Relations to substance use in samples of middle and high school students. *Psychology of Addictive Behaviors*, 20(3), 265–278. https://doi.org/10.1037/0893-164X.20.3.265

Yoshikawa, H., Aber, J. L., & Beardslee, W. R. (2012). The effects of poverty on the mental, emotional, and behavioral health of children and youth: Implications for prevention. *American Psychologist*, 67(4), 272–284. https://doi.org/10.1037/a0028015