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Diminished Alternative Reinforcement as a Mechanism Underlying Socioeconomic Disparities in Adolescent Substance Use

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Abstract

OBJECTIVE—This study examined socioeconomic disparities in adolescent substance use utilizing a behavioral economic theoretical framework. We tested the hypothesis that teens of lower (vs. higher) socioeconomic status (SES) are vulnerable to substance use because they engage in fewer pleasurable substance-free activities that provide reinforcement and may deter substance use.

METHOD—In a cross-sectional correlational design, 9th grade students (N=2,839; mean age=14.1 years) in Los Angeles, California, USA completed surveys in Fall 2013 measuring SES (i.e., parental education), alternative reinforcement (engagement in pleasurable substance-free activities, e.g., hobbies), substance use susceptibility, initiation, and frequency, and other factors.

RESULTS—For multi-substance composite outcomes, lower parental education was associated with greater likelihood of substance use initiation in the overall sample, frequency of use among lifetime substance users, and susceptibility to substance use in never users. Substance-specific analyses revealed that lower parental education was associated with higher likelihood of initiating cigarettes, alcohol, and marijuana use as well as greater susceptibility to use cigarettes in never smokers. Each inverse association between parental education and substance-related outcomes was statistically mediated by diminished alternative reinforcement; lower parental education was associated with lower engagement in alternative reinforcers, which, in turn, was associated with greater substance use susceptibility, initiation, and frequency.

CONCLUSION—These results point to a behavioral economic interpretation for socioeconomic disparities in adolescent substance use. Replication and extension of these findings would suggest

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Conflict of Interest Statement

The authors declare that there are no conflicts of interest.

that prevention programs that increase access to and engagement in healthy and fun activities may reduce youth socioeconomic health disparities related to substance use.

Keywords

Health Disparities; Socioeconomic Status; Adolescents; Substance Use; Behavioral Economics

Introduction

Socioeconomic disparities in the prevalence of substance use, abuse, and dependence across a wide range of psychoactive substances are well documented,[1–8] and may emerge as early as adolescence.[2,9–12] Markers of socioeconomic status (SES) such as level of parental education are inversely associated with substance use initiation and frequency in adolescents.[9,11,13] Given that adolescent onset of substance use is associated with more chronic and severe adult substance use with relatively poor treatment response,[14–18] it is important to identify modifiable factors that underlie the association between SES and adolescent substance use that can be targeted in prevention programs that may ultimately reduce disparities across the lifespan.

Behavioral economic theory identifies potentially-malleable determinants of substance use.[19–22] Behavioral economic theory purports that individuals allocate their behavior among available alternatives, and the choices they make among alternatives are determined by the number and attractiveness of those alternatives, as well as individual predisposing factors.[22–26] Substances represent one particularly potent alternative in that they are powerful primary reinforcers that produce pleasure and are easy to obtain in many communities with a high proportion of residents of lower SES; hence, substances may be attractive and available for teens of lower SES.[27–31] Also, teens of lower SES may have less access to substance-free alternative pleasant activities due to financial restrictions (e.g., low-SES teens may not be able to go shopping), neighborhood deprivation (e.g., low-SES teens may be surrounded by fewer recreational outlets like parks), or other constraints.[32–36] Research has documented that youths who report engaging in fewer pleasant activities that provide alternative substance-free reinforcement are at increased risk for substance use.[19,37,38] Therefore, adolescents with lower (vs. higher) SES may be more likely to choose substance use as a means of deriving pleasure because of fewer available substance-free alternative reinforcers. Yet, we are unaware of any study that has empirically tested this hypothesis.

This study examined diminished alternative reinforcement as a behavioral economic mechanism underlying socioeconomic disparities in adolescent substance use. In a cross-sectional analysis of 14-year-olds, we hypothesized that diminished alternative reinforcement would mediate the inverse relation between SES (i.e., parental education) and markers of three different points of the substance use prevention continuum: (1) susceptibility to substance use among never users; (2) substance use initiation in the entire sample; and (3) substance use frequency among those who have initiated use. We also examined substance-specific outcomes for cigarettes, alcohol, and marijuana because we were interested in the generalizability of findings across substances; these three substances

were selected because they are among the most common substances used in adolescents.[39] Given that engagement in pleasant substance-free activities is modifiable via intervention,[40–42] this work may inform prevention programming that reduces socioeconomic disparities in youth substance use.

Methods

Participants and Procedures

This article describes an analysis of a survey of 9th grade students enrolled in ten public high schools in the Los Angeles, CA, USA metropolitan area. The schools were selected based on their adequate representation of diverse demographic characteristics; the percent of students eligible for free lunch within each school (i.e., student's parental income ≤ 185% of the national poverty level) on average across the ten schools was 31.1% (*SD*=19.7, range: 8.0% – 68.2%). Students who were not enrolled in special education (e.g., severe learning disabilities) or English as a Second Language Programs (*N*=4,100) were eligible. In total, 3,874 (94.5%) of eligible students assented to participate in the study, of whom 3,383 (82.5%) provided active written parental consent and enrolled in the study.[1] Paper-and-pencil surveys were distributed in the Fall of 2013 during two separate in-class 60-minute survey administrations conducted less than two weeks apart. While all students completed the same measures, there were three versions of survey packets; each version had a different order in which the individual measures appeared within the packet. Each school that was randomized received one of the three versions. Researchers informed students that their responses would be confidential and not shared with their teachers, parents, or school staff. Each participating school was compensated $2,500 for their general activity fund; students were not individually compensated. Some students did not complete all the survey items within the time allotted or were absent on one of assessment days, and consequently, participants who did not complete measures used in this report (*n*=141) or who selected the response "Don't know" for both parents' education level (*n*=403) were not included in final sample used in analyses (*N*=2,839).[2] The study was approved by the University of Southern California Institutional Review Board.

Measures

Parental education—Highest level of parental education completed was assessed using ordinal forced choice item for each parent (1=8th grade or less, 2=some high school, 3=high school graduate, 4=some college, 5=college graduate, 6=advanced degree). As in prior work using parental education as a marker of adolescent SES,[11] the highest education level across the two parents was used in analyses; if data was available for only one parent (*n*=414), that response was used.

Susceptibility to Substance Use—As in prior work,[43,44] susceptibility to substance use was measured with three items for each of the six key substances (alcohol, cigarettes,

[1]There was no correlation between school-level participation rates and percent of students eligible for free lunch across the six schools (r = .31; p = .41).

[2]Those included (vs. excluded) in the final sample were more likely to report lifetime substance use (*OR* = 1.24, p = .001) but did not differ in substance use frequency (p = .35) or susceptibility (p = .93).

marijuana, stimulants, prescription stimulants, and prescription opioids): “Would you try [substance] if one of your best friends offered it to you?”, “Do you think you would use [substance] in the next 6 months?” (Intention), and “Have you ever been curious about using [substance]?” on 4-point scales (Definitely Not=1, Probably Not=2, Probably Yes=3, Definitely Yes=4). These six substances were selected because they had the highest prevalence of use in previous adolescent samples from the region in which we sampled for this study.[45] For each substance, the three items are summed to create a susceptibility score. We analyzed the susceptibility score for cigarettes, alcohol, and marijuana. We also created a composite sum of susceptibility scores across the six substances (possible range: 12 – 72).

Lifetime and Past 30 Day Substance Use—Substance use was assessed using standard validated items used in epidemiologic surveys of adolescents.[39,46] For lifetime use, students were asked whether they had ever used any of the substances for recreational purposes or to get “high”: cigarettes (prevalence of endorsement in overall sample, 10.4%), electronic cigarettes (18.5%), smokeless tobacco (1.4%), big cigars (1.7%), little cigars or cigarillos (3.4%), hookah water pipes (15.2%), other forms of tobacco products (2.3%), marijuana (15.1%), blunts (11.3%), one full drink of alcohol (26.5%), inhalants (6.0%), cocaine (1.0%), methamphetamines (0.7%), ecstasy (1.5%), LSD/mushrooms/psychedelics (1.7%), salvia (1.0%), heroin (0.5%), prescription pain killers (2.3%), tranquilizers or sedatives (3.3%), diet pills (1.7%), prescription stimulant pills (0.8%), and other substances (1.2%). Those who endorsed use of any substance we assessed were coded as lifetime users of any substance (40.7% of the sample); we also analyzed lifetime use of cigarettes, alcohol, and marijuana as separate outcomes. Frequency of recreational use in the past 30 days was assessed for each of the six key substances with 9 ordinal response options coded 0 to 8 (0, 1–2, 3–5, 6–9, 10–14, 15–19, 20–24, 25–29, 30 days). A composite index that summed ordinal responses across the six substances was computed. Ordinal use frequency responses for cigarettes, alcohol, and marijuana were also used analyses.

Alternative Reinforcement—We utilized a modified version of the Pleasant Events Schedule (PES)[47] for adolescents as in prior work.[48] Participants rated 42 different typically pleasant activities (e.g., going out to eat at a restaurant, playing musical instruments, visiting/hanging out with friends, participating in clubs or community organizations) for both frequency of engagement (0=Never; 1=1–6 times; 2=7 or more times) and pleasure experienced (0=not pleasurable; 1=somewhat pleasurable; 2=very pleasurable) in the past 30 days. Additionally, participants were asked to indicate (yes/no) whether they associated the pleasant activity with alcohol, smoking, or drug use.[26] The primary regressor is the sum of each item’s cross-product (engagement frequency × pleasure) for activities not associated with substance use.[3]

[3]In addition to using the PES composite score, we also examined whether empirically-distinct dimensions that could be utilized in subscale analyses could be derived by conducting a principal components analysis of individual PES items (i.e., activities). Results yielded one primary factor that accounted for 17.4% of the variance (eigenvalue = 7.65) and several secondary factors that explained the remainder of the variance (eigenvalues = 2.64, 2.21, 1.67, 1.57, 1.43, 1.28, 1.16, 1.15, 1.04, <1.0). Given the non-linearity in the scree plot distribution of eigenvalues, and apparent break in the distribution between the first factor and the others, we interpret this pattern as supportive of a single-factor solution and therefore did not attempt to create subscales.

Covariates—Age, gender, race/ethnicity (coded as nominal variable to reflect the 8 categories listed in Table 1), living situation (i.e., who do you live with most of the time?; coded as 1=Both Parents, 0=Other type of living situation [e.g., single parent household, other relative]), and family history of substance use (i.e., does anyone in your immediate family [brothers, sisters, parents, grandparents] have a history of smoking, alcohol problems, or substance problems?) were measured as covariates. These factors may be associated with substance use or SES and therefore may confound key associations.[14,49–54]

Analytical Approach

Primary analyses utilized generalized estimating equations GEEs[55] that accounted for clustering of students within schools.[56] For each substance-related outcome (i.e., susceptibility, lifetime use, past 30 day use) and each substance type (i.e., cigarettes, alcohol, marijuana, multi-substance composite), we first computed the "total effect" in separate GEEs with parental education as the predictor. For outcomes with significant total effects, mediation of the relation of parental education to each substance-related outcome through alternative reinforcement was computed via the product of coefficients from two component GEEs: (1) the relation of parental education to alternative reinforcement; and (2) the relation of alternative reinforcement to the outcome controlling for parental education. The product of the coefficients from these models indicated the strength of the indirect ("mediated") effect. Using the PRODCLIN approach, we then determined significance via asymmetric confidence intervals (*CI*s) around the mediational effect.[57] We reported the remaining direct effects of parental education controlling for the mediator and the proportion of the total effect accounted for through the mediator. All GEEs were tested both unadjusted and after adjusting for the covariates described above. Analyses were conducted in SAS with PROC GENMOD[58] using an exchangeable correlation matrix and modeling parental education as a continuous variable. In analyses predicting substance use susceptibility, the subsample of never users of that substance was utilized and a Gaussian distribution was specified. In analyses predicting lifetime substance use (yes/no), the entire sample was used and a binary outcome distribution was specified. In analyses predicting past 30-day use, the subsample who endorsed lifetime substance use for that substance type was utilized and negative binomial outcome distribution was specified to account for the skewed outcome distribution. Parental education and alternative reinforcement were reversed scored for analyses to facilitate ease of interpretation. Results are reported as parameter estimates (*B* ±95% *CI*s).

Results

Descriptive statistics for demographics and study variables as well as internal consistency estimates within lifetime substance users, never substance users, and the overall sample are depicted in Table 1. For the multi-substance composite outcomes, there were significant total effects of lower parental education on greater likelihood of substance use initiation in the overall sample, past 30 day use frequency in the sample of lifetime users, and substance use susceptibility in never users (Table 2). These relations were significantly mediated by diminished alternative reinforcement, such that lower parental education was associated with lower alternative reinforcement, which in turn was associated with higher substance use

likelihood, susceptibility, and frequency. Findings were consistent across analyses that were unadjusted and adjusted for cofactors (Table 2), with the exception that the total effect of parental education on substance use susceptibility was non-significant in adjusted models, which precluded adjusted mediational analyses for this outcome.

As indicated in Table 3, we observed total effects of lower parental education on higher likelihood of cigarette, alcohol, and marijuana use initiation in the overall sample. Similarly, we observed total effects of lower parental education on susceptibility to cigarette use in the subsample of never smokers. Each of these associations were significantly mediated by diminished alternative reinforcement and consistent across adjusted and unadjusted analyses (Table 3). We did not find total effects of parental education on marijuana and alcohol susceptibility in never marijuana and alcohol users, respectively (see Table 3), and on 30 day use frequency in the sample of lifetime users of each respective substance (*p*s > .10, data not shown), which precluded mediational analyses of these outcomes.

In each case of mediation, the remaining direct effects were significant, suggesting partial (rather than full) mediation, with proportion mediated effects being larger for frequency (33% to 38%) than initiation and susceptibility (9% to 16%) outcomes.

Discussion

The present study offers initial evidence for diminished alternative reinforcement as a mechanism underlying socioeconomic disparities in several indicators of adolescent substance use uptake. These results were consistent across each substance initiation outcome as well as susceptibility to cigarette use. Hence, adolescents of lower SES who have never used substances may perhaps be more prone to substance experimentation because they have limited alternative outlets for deriving pleasure. The inverse association between SES and past 30-day use frequency in the multi-substance composite among lifetime users suggests that diminished alternative reinforcement may be implicated in escalation after experimentation. The total effect relations of lower parental education to past 30-day use in substance-specific analyses of alcohol, marijuana, and cigarettes were non-significant. Given that these analyses were conducted in subsamples of lifetime users of each substance, which had low prevalence, we likely lacked sufficient power to detect total effects and ultimately explore mediators of these relations. Thus, it is difficult to discern on the bases of these data whether different substance types operate distinctly in this putative risk pathway to substance use escalation that involves SES and alternative reinforcement.

In the instances we found mediation, the relative proportion of relations explained by the mediational pathway involving diminished alternative reinforcement appeared larger for frequency outcomes than initiation and susceptibility outcomes. From an intervention perspective, this pattern suggests that targeting alternative reinforcement may be a more promising intervention to prevent escalation than initiation. From a theoretical perspective, one might expect less robust mediation for susceptibility/initiation outcomes than use escalation outcomes if the psychopharmacological response to substance administration plays an important role in behavioral economic mechanisms of substance use risk.

Some substances (e.g., nicotine, methamphetamine, cocaine) have reward-enhancing properties that amplify the reinforcing effects of non-substance rewards experienced concurrently during substance use.[59–61] That is, in addition to acting as a primary reward that causes direct psychoactive effects irrespective of environmental context, some substances also modulate the mood-enhancing effects of rewarding stimuli that are present in the environmental context in which substances are consumed. Likewise, alcohol has social facilitation effects that enhance pleasure and social reinforcement derived from certain experiences.[37] Hence, low-SES teens who have less opportunity to experience reward may be more motivated to continue using substances after initiation because the pharmacological activity of some substances may magnify the potency of the limited available rewards. Accordingly, substance use may be a means for enhancing the well-being one derives from their environment when altering one's environment is difficult or impossible. If adolescents are able to derive greater reinforcement from their environment when using substances, and their environment is otherwise reward deficient, the net gain in reward experience may heighten motivation to continue and escalate use following initiation. If this is the case, enhancing alternative reinforcement through non-pharmacological means may prevent escalation to addiction among teens of lower SES who have already experimented with substances.

It is also possible that these findings involving use frequency could reflect a bi-directional relationship; substance use may be a mechanism underlying socioeconomic disparities in alternative reinforcement. Substance use reduces the reward threshold for substance-free activities,[24,37,62] perhaps due to the dysregulating effects of substance use on the brain's reward system, which could reduce one's ability to derive pleasure from any type of reinforcer.[63] If this alternative pathway is operating, finding other means of reducing substance use may perhaps benefit alternative reinforcement and offset mental health problems, such as depression, that originate from lack of reinforcement.[38] Future longitudinal research is warranted to clarify the direction of the relations demonstrated herein.

In considering study limitations, the cross-sectional, correlational design precludes definitive inferences regarding directionality or causality, which should be addressed in future prospective and experimental work. Although parental education is an important SES indicator,[64] it would have been ideal to investigate multiple indicators of SES given the multidimensionality of this construct and to capture SES among teens who do not know their parents' education level.[64,65] Similarly, it would have been ideal to include biochemical indicators of substance use to validate self-report.[4] Additionally, an interesting direction for future research will be to test curvilinear relations between alternative reinforcers and substance use in the context of socioeconomic disparities, such that low levels of substance use may be positively related with alternative reinforcers, but there may be a threshold beyond which deficits are evident in adolescents of lower versus higher SES

[4]As an indicator of the response validity, the survey included items assessing lifetime use of a fictitious substance and self-reported degree of honesty in responding. Because responses of students who endorsed use of the fictitious substance or reported not being honest (n=30) might have questionable validity, we re-tested each analysis after excluding data from these participants. Results of these analyses were equivalent to primary results that did not exclude these individuals.

position. Also, participants were from a single age group (14 years old), sampled from a restricted geographic region, and data on key measures were unavailable for some students enrolled in the study and may differ from final sample included in this report on certain characteristics, which raises limitations on generalizability. The PES was not developed with the intention of capture the various types of pleasant activities in diverse youth[5] and future work should utilize measures designed to isolate empirically-distinct dimensions of activities to elucidate which specific activity types may play the strongest role in socioeconomic disparities in adolescent substance use, which would inform more precise interventions that address the most relevant reinforcer deficit areas for lower-SES adolescents. Furthermore, our primary analyses did not control for other covariates such as depression, anxiety, and other personality risk factors which may have been confounding variables that accounted for increased substance use, diminished involvement in alternative reinforcers, and SES in the present sample population. Likewise, we did not explore delay discounting in the current study, which is a key behavioral economic concept in addictions,[66,67] that may have also impacted the associations between socioeconomic status, alternative reinforcement, and substance use. Prior work has illustrated that delayed discounting impacts the type of reinforcers that adolescents choose[19] and predicts adolescent smoking uptake.[68] Thus, it will be important for future research to investigate whether lower-SES teens with limited access to non-substance alternatives in combination with the tendency discount future rewards are disproportionately more vulnerable to substance use.

Conclusion

This study highlights the utility of behavioral economic perspectives for understanding socioeconomic disparities in adolescent substance use. These findings support continued implementation of low-cost recreational programs that improve access to a variety of substance-free activities and resources in socioeconomically-deprived neighborhoods and schools, such as programs that promote park use, access to trails, playgrounds, and sports-related activities,[69,70] and after-school youth programs that provide creative outlets for self-expression, social games and activities, and field trips.[71,72] Behavioral activation interventions are also an effective means of decreasing substance use by helping youth identify and engage in more non-substance, rewarding alternative reinforcers.[28] Formative work to develop interventions that help adolescents access developmentally-appropriate, low-cost substance-free alternative activities and promote parental involvement to facilitate engagement in these activities[73] will be critical to advance such efforts. Furthermore, policies that aim to enhance the availability of recreational avenues in deprived neighborhoods could be an important strategy to promoting healthy, substance-free lifestyles in the lower SES adolescent population. Because adolescent onset substance use often leads to chronic and severe trajectories of adult addiction with harmful health consequences,[3,4,53] research like this may have broad implications for understanding and reducing substance use disparities across the lifespan.

[5]To determine whether the psychometrics differed as a function of parental education, we examined the internal consistency across subsampled stratified by level of parental education. Internal consistency estimates very similar in magnitude across stratified subsamples (Cronbach's α range .88 to .90), suggesting equivalent reliability across differing levels of parental education.

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Highlights

- Lower SES teens had higher substance use susceptibility, initiation, and frequency.
- Declining alternative reinforcers mediated relations of SES and substance outcomes.
- Findings support behavioral economic approach for SES disparities in teen drug use.

Table 1

Sample Characteristics and Internal Consistency Estimates

Variable: % or M (SD) / α	**Overall Sample (*N* = 2,839)**	**Lifetime Substance Users (*N* =1,155)**	**Never Users (*N* =1,684)**
Age	14.07 (0.41)	14.12 (0.41)	14.05 (0.41)
Gender			
Female	54.4	55.3	53.8
Male	45.6	44.7	46.2
Race/Ethnicity			
American Indian or Alaskan Native	0.88	0.88	0.72
Asian	16.2	9.4	20.7
Black or African American	5.4	5.5	5.3
Hispanic or Latino	45.3	54.4	39.1
Native Hawaiian or Pacific Islander	3.5	3.4	3.7
White	16.8	15.0	18.1
Multiracial	6.2	5.6	6.7
Other	5.8	5.8	5.8
Highest Parental Education			
8th grade or less	4.0	5.1	3.2
Some high school	9.2	11.7	7.4
High school graduate	16.8	21.5	13.5
Some college	19.6	20.2	19.2
College graduate	31.6	26.6	35.0
Advanced degree	19.0	15.0	21.7
Living Situation			
Both Parents	63.8	55.2	69.7
Other	35.1	43.3	29.5
Family History of Substance Use	71.2	80.4	64.9
Alternative Reinforcers	73.4 (27.8) / .89	70.0 (28.2) / .89	75.7 (27.2) / .89
Substance Use			
Lifetime use of any substance	40.7	100	0
Past 30 day use frequency	-	1.39 (3.38) / .67	-

Variable: % or M (SD) / α	**Overall Sample (*N* = 2,839)**	**Lifetime Substance Users (*N* =1,155)**	**Never Users (*N* =1,684)**
Susceptibility Index	-	-	20.2 (3.73) / .85
Willingness to Use			
Cigarettes	1.21 (.48)	1.40 (.64)	1.08 (.25)
Alcohol	1.77 (.80)	2.33 (.81)	1.39 (.52)
Marijuana	1.47 (.77)	1.96 (.93)	1.14 (.37)

Note. Data from 9th grade students in Los Angeles, California, USA collected in Fall 2013. α = Cronbach's α internal consistent estimate

Table 2

Association of Parental Education to Substance Use-Related Outcomes and Mediation by Alternative Reinforcement

	Total Effect	Component Paths		Mediation: SES → Alt. Reinf. → Outcome		
	SES → Outcome	**SES → Alt. Reinf.**	**Alt. Reinf. → Outcome Controlling for SES**	**Indirect effect**	**Direct effect**	**Proportion mediated by**
	B (95% CI)	***B (95% CI)***	***B (95% CI)***	***B (95% CI)***	***B (95% CI)***	***%***
Outcome: Substance Use Susceptibility (Never Users; N = 1,684)						
Unadjusted	.07 (.02, .14)*	2.4 (1.4, 3.5)†	.01 (.003, .01)†	.01 (.01, .02)†	.06 (.003, .13)*	14.3%
Adjusted[a]	.05 (−.02, .12)	2.1 (1.2, 3.1)†	.01 (.003, .01)†	-	-	-
Outcome: Lifetime Substance Use (Overall Sample; N = 2,839)						
Unadjusted	.17 (.12, .22)†	2.8 (2.2, 3.4)†	.01 (.003, .01)†	.02 (.01, .03)†	.15 (.10, .21)†	11.8%
Adjusted[a]	.11 (.06, .17)***	2.3 (1.7, 2.8)†	.01 (.002, .01)**	.01 (.004, .02)**	.10 (.04, .16)***	9.1%
Outcome: Past 30 Day Substance Use (Lifetime Substance Users; N = 1,155)						
Unadjusted	.16 (.06, .27)**	3.1 (2.2, 3.9)†	.02 (.01, .02)†	.06 (.03, .08)†	.10 (.02, .18)*	37.5%
Adjusted[a]	.09 (.04, .14)***	2.2 (1.4, 3.1)†	.02 (.01, .02)†	.03 (.02, .05)†	.06 (.02, .09)**	33.3%

Note. Data from 9th grade students in Los Angeles, California, USA collected in Fall 2013. SES = Socioeconomic status as indicated by highest parental education. *B* (95%*CI*) = Parameter estimate for predictor from Generalized Estimating Equation with 95% confidence interval.

[a]Models adjusted for age, gender, ethnicity/race, living situation, and family history of substance use.

° $p < .10$,

* $p < .05$,

** $p < .01$,

*** $p < .001$,

† $p < .0001$.

Table 3

Association of Parental Education to Substance-Related Outcomes for Cigarettes, Alcohol, and Marijuana and Mediation by Alternative Reinforcement

	Total Effect	Component Paths		Mediation: SES → Alt. Reinf. → Outcome		
	SES → Outcome	SES → Alt. Reinf.	Alt. Reinf. → Outcome Controlling for SES	Indirect effect	Direct effect	Proportion mediated by
	B (95% CI)	*B (95% CI)*	*B (95% CI)*	*B (95% CI)*	*B (95% CI)*	*%*
Outcome: Substance Use Susceptibility (Subsample of Never Users of Each Specific Substance)						
Unadjusted						
Cigarettes[b]	.02 (.01, .03)†	2.4 (1.4, 3.4)†	.001 (.001, .002)***	.002 (.001, .004)***	.02 (.01, .03)***	10.0%
Alcohol[c]	.04 (.02, .07)***	2.8 (1.9, 3.8)†	.001 (.001, .002)†	.004 (.002, .01)***	.04 (.02, .06)**	10.0%
Marijuana[d]	.03 (.01, .05)**	2.3 (1.4, 3.1)†	.002 (.001, .003)†	.004 (.002, .01)†	.03 (.003, .05)*	13.3%
Adjusted[a]						
Cigarettes[b]	.02 (.004, .03)*	1.9 (1.0, 2.8)†	.001 (.001, .002)***	.002 (.001, .004)**	.013 (.001, .03)*	10.0%
Alcohol[c]	.03 (−.004, .05)$^{\circ}$	2.5 (1.6, 3.4)†	.002 (.001, .002)†	-	-	-
Marijuana[d]	.02 (−.01, .04)	2.0 (1.2, 2.8)†	.002 (.001, .003)†	-	-	-
Outcome: Lifetime Substance Use (Overall Sample; N = 2,839)						
Unadjusted						
Cigarettes	.25 (.19, .31)†	2.8 (2.2, 3.4)†	.01 (.01, .018)†	.03 (.02, .05)†	.22 (.16, .29)†	12.0%
Alcohol	.21 (.17, .26)†	2.9 (2.3, 3.5)†	.01 (.004, .01)†	.02 (.01, .03)†	.19 (.15, .25)†	9.5%
Marijuana	.26 (.19, .33)†	2.8 (2.2, 3.4)†	.01 (.01, .02)†	.03 (.03, .05)†	.23 (.15, .31)†	11.5%
Adjusted[a]						
Cigarettes	.23 (.16, .30)†	2.3 (1.8, 2.9)†	.01 (.01, .02)†	.03 (.02, .04)†	.20 (.13, .27)†	13.0%
Alcohol	.16 (.10, .22)†	2.4 (1.8, 3.0)†	.01 (.003, .01)†	.02 (.01, .02)†	.14 (.09, .20)†	12.5%
Marijuana	.19 (.09, .28)***	2.3 (1.8, 2.9)†	.01 (.01, .02)†	.03 (.02, .04)†	.16 (.06, .27)**	15.8%

Note. Data from 9th grade students in Los Angeles, California, USA collected in Fall 2013. SES = Socioeconomic status as indicated by highest parental education. *B* (95%*CI*) = Parameter estimate for predictor from Generalized Estimating Equation with 95% confidence interval.

[a] Models adjusted for age, gender, ethnicity/race, living situation, and family history of substance use.

[b] *N*=2,537.

[c] *N*=2,066.

[d] N=2,395.

° $p < .10$,

* $p < .05$,

** $p < .01$,

*** $p < .001$,

† $p < .0001$.

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