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Substance Use Progression from Adolescence to Early Adulthood: Effortful Control in the Context of Friendship Influence and Early-Onset Use

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Abstract

In a sample of 998 ethnically diverse adolescents, a multiagent, multimethod approach to the measurement of adolescent effortful control, adolescent substance use, and friendship influence was used to predict escalations to early-adult tobacco, alcohol, and marijuana use by ages 22–23. Structural equation modeling revealed that adolescent substance use and friends' substance use tended to be highly correlated and together were robust predictors of a problematic pattern of usage for all substances in early adulthood. In addition, the adolescent effortful control construct directly predicted progressions to problematic use of tobacco and marijuana, but not for alcohol. In the alcohol model, effortful control interacted with the construct of substance use lifestyle (based on adolescent alcohol use and friends' substance use) when predicting problematic alcohol use in early adulthood. Results held when comparing across genders and across ethnic groups. These findings emphasize the importance of addressing adolescent self-regulation in interventions designed to treat and prevent early-adult substance abuse.

Keywords

Adolescence; Early adulthood; Substance use; Effortful control; Peer influence

Substance use in adolescence and early adulthood is a correlate of several health-related concerns, including future substance abuse disorders in adulthood (D'Amico et al. 2005; Wills et al. 2005); risky sexual behaviors, including STI and HIV transmission (Howard and Wang 2004); and adolescent suicide (Rowan 2001). Furthermore, adolescent substance use is associated with delinquency, teenage pregnancy, school misbehavior, and school dropout (Elliott et al. 1989; Jessor and Jessor 1977; Zabin et al. 1986). On a societal level, the consequences of adolescent and early adult substance abuse represent significant costs in health care, mental health services, drug and alcohol treatment, and juvenile justice (Hawkins et al. 1992).

Given these implications, a considerable amount of research has been devoted to understanding individual and contextual factors for the development of adolescent substance use, and more important, escalations to adult substance abuse and dependence. Adult substance use and abuse peaks in early adulthood (Anthony 1991; Kandel et al. 1986) and is associated with a compromised ability to develop mature adult occupational roles and

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interpersonal relationships that are sustainable (Chassin et al. 1999; Newcomb and Bentler 1988a, b; Yamaguchi and Kandel 1985). Not surprisingly, use of substances in adolescence is one of the most powerful predictors of early-adulthood substance abuse and dependence (Robins and Przybeck 1985).

The goals of this study are to examine the unique role of individual differences in effortful control, an aspect of self-regulation, in the progression from adolescent use to problematic substance use in early adulthood, in the context of friendship influence. Longitudinal models that link substance use over adolescence to problematic use of substances in early adults (ages 22–23, two yearly assessments) are tested in the context of friendship influence, which was assessed within a multimethod and multiagent framework that incorporated direct observations of “drug talk”.

Peer Influence on Substance Use

Having friends who use drugs and support drug use in relationships is the most robust predictor of substance use during adolescence (e.g., Dishion and Owen 2002; Elliott et al. 1985; Hawkins et al. 1992). This strong association likely relies on several mechanisms, including influence and selection effects (e.g., Dishion and Owen 2002; Kandel 1978; Steglich et al. 2010). Adolescents who associate with substance-using peers are exposed to substance use and have increased opportunities for use. Furthermore, peer groups are likely to shape adolescents’ attitudes about substance use, and those youth who associate with substance-using peers demonstrate more favorable attitudes about use (Hawkins et al. 1992).

Studies of early-adolescent drug use have revealed that friendship cliques that included drug-using peers resulted in either increased substance use within the clique over the course of a year, or breaking up of the clique (Kandel 1986). Observational studies of friendships revealed that a process of friendship support for drug use can be easily measured from videotaped friendship interactions and captured as a process of “deviancy training” (Dishion et al. 1995). Friends’ positive responses to drug use talk have been associated with increases in substance use in the next two years and when followed longitudinally into early adulthood (Dishion and Owen 2002).

Self-Regulation and Effortful Control

Self-regulation is an individual difference characteristic of adolescents that includes goal setting, planning, and task persistence, as well as the more immediate ability to manage emotions and attention in such a way as to promote longer term outcomes such as health, relationship satisfaction, and goal attainment (Schmeichel and Baumeister 2004). This core temperamental individual difference factor clearly covaries with child and adolescent problem behavior such as hyperactivity, antisocial behavior and early substance use (Beauchaine and Neuhaus 2008), as well as young adult substance use (Cadoret 1992; Whiteside and Lynam 2001). It is hypothesized that by adolescence, individual differences are partially attributable to temperament (see Rothbart 2011; Wills and Dishion 2004) but also to a set of skills learned in the context of family and school environments (Dishion and Patterson 2006), which are reinforced in friendships (Tipsord and Dishion in prep) and, later on, in successful intimate relationships (Gottman and Levenson 1984).

Various indices of self-regulation have been consistently negatively associated with substance use (Caspi et al. 1996; Chassin et al. 2003; Hawkins et al. 1992; Wills and Dishion 2004). In particular, the construct known as *effortful control*, which lies at the core of self-regulation, has received considerable empirical interest (Rothbart et al. 1995; Rothbart 2011). Effortful control is considered central to the regulation of emotion and behavior (Eisenberg et al. 2000). It involves the conscious, voluntary regulation of

attentional processes, goal-directed attentional persistence, and inhibitory control (Rothbart and Bates 1998). More generally, effortful control is determined by the ability to suppress prepotent responses in favor of behavior that may have long-term value to the individual (Rothbart et al. 1995). It has been well documented that related poorly developed self-regulatory abilities, such as self-control, impulsivity, behavioral reactivity, and attention control, are strongly associated with substance use in adolescence (Chassin et al. 2003; Hawkins et al. 1992; Wills et al. 2005). One limitation observed in the vast majority of studies negatively linking self-regulation and related constructs such as effortful control to adolescent problem behavior is that they relied exclusively on self-report. An aim of our study was to effectively utilize a latent effortful control construct using both youth and parent report, as well as teacher-reported items relevant to adolescents' effortful control.

Moderation Effects

Studying the role of effortful control in the progression from adolescent substance use to early-adult problematic substance use requires taking into account other contextual factors that are also associated with this progression. Research has begun to elucidate the combined role of adolescent self-regulation and these contextual risk factors in predicting adolescent substance use (Dishion and Patterson 2006; Stice and Gonzales 1998; Wills et al. 2001a, b; Wills and Dishion 2004). These researchers argue that self-regulation may serve to moderate contextual risk and thus act as a protective factor. The purpose of our study was to examine the unique and interactive roles of effortful control in the progression from adolescent substance use to abuse and dependence by early adulthood, while taking into account the critical risk factor of friends' support for drug use in adolescence.

The precise relationship between self-regulatory abilities and substance use has not been fully elucidated. Several researchers have investigated the role that self-regulatory temperament (e.g., relatively stable individual differences in self-regulatory ability) may play in promoting vulnerability to or resilience relevant to other contextual risk factors for substance use (Stice and Gonzales 1998; Wills et al. 2001a, b; Wills and Dishion 2004). Wills and colleagues proposed using epigenetic theory to explain this interaction between temperament and contextual factors (Wills et al. 2001a, b), purporting that temperament organizes behavioral patterns that grow more complex during the development of increasingly sophisticated cognitive, emotional, and behavioral regulation skills. With regard to substance use, Wills proposed that temperament variables will not have a direct relationship to growth in substance use over time, but they will affect the extent to which one is influenced by family and peer environments, which in turn affects risk for substance use (Wills and Dishion 2004).

The hypothesis that traits associated with effortful control can moderate other risk factors has gained empirical support. Wills et al. (2001b) investigated a temperament construct related to effortful control, known as *task attentional orientation*, and found that together with higher levels of positive emotionality, youth higher in this protective temperament trait demonstrated a weaker association between the risk factors of peer and parental substance use and the adolescents' own substance use. No direct effect between protective temperament dimensions and substance use was reported in their model. Looking at antisocial behavior, Gardner et al. (2008) examined a multi-reporter construct of effortful control for adolescents and found both direct negative effects on growth in antisocial behavior and a moderation of the impact of association with deviant peers. This finding replicated similar findings linking poor self-regulation to the development of antisocial behavior in adolescence (Goodnight et al. 2007). Dishion and Connell (2007) promoted the conceptualization that adolescent self-regulation functions as a resilience factor in

adolescent development. That is, adolescents with greater levels of self-regulation are better able to resist joining in their peers' problem behavior.

The present study sought to predict early-adulthood substance abuse and dependence (tobacco, alcohol, and marijuana) from adolescent substance use, friends' support for use, the direct and interaction effects of the construct of effortful control. The major hypotheses of our study were that (a) high levels of adolescent effortful control will predict reduced problematic substance use in early adulthood, (b) adolescent friends' support of substance use will predict growth in problematic substance in early adulthood, and (c) high levels of adolescent effortful control will play a moderator role by promoting resiliency to the risk factors of a history of adolescent substance use and friends' support of substance use.

Method

Participants

The data presented in this article are from Project Alliance, an ongoing longitudinal study in a large city in the Pacific Northwest. The sample and methodology have been described in detail in other publications (Dishion and Kavanagh 2003; Dishion et al. 2002, 2003). In brief, participants were recruited from the entire population of 6th grade students in three public middle schools in an ethnically diverse metropolitan community. A total of 998 children and their families completed the initial assessment in the 6th grade (that is, 90% of the targeted population). Of those, 997 provided data at least once over the next 3 years (7th, 8th, and 9th grades); 803 provided data in the 11th grade; and 880 provided data at least once over the two assessments that took place in early adulthood (the first one was completed at an average age of 22 years and 3 months, $SD = 7.5$ months, and the second at age 23 years and 4 months, $SD = 7.8$ months). In Grade 11, 72.2% of participants brought a friend in our laboratory to participate in an interaction task, and on that occasion, we were able gather friends' report on their own substance use for 64.0% of participants. Also in Grade 11, the rate of completion of an effortful control measure by parents was at 68.5%, and it was at 66.7% for the teacher report. Overall in Grade 11, 49% of the sample (489 participants) had complete data on all measures at that assessment point.

Our study sample consisted of 42.8% European American adolescents, 29.8% African American adolescents, 6.0% Latino adolescents, 5.1% Asian American adolescents, 2.0% American Indian adolescents, 0.8% Pacific Islander adolescents, and 13.4% adolescents with multiple ethnic or racial backgrounds. Forty-nine percent of the adolescents were female and 34.7% were from single-parent families. Gross annual household income measured in middle adolescence ranged from \$4,999 or less to \$90,000 or more, with a median value of \$30,000–\$39,999. Primary caregivers' education ranged from "no formal schooling" to "graduate degree," with a median value corresponding to "partial college." Although some participants were lost to attrition by the last wave of data collection, the demographic composition of the sample remained essentially the same. By age 23, a majority of the young adults from this community-based sample reported having used tobacco, alcohol, and marijuana at least once.

Procedure

From 6th grade through 9th grade, self-report and teacher surveys were conducted primarily in the school context. If participants moved out of their original schools, they were followed to their new location. In the 11th grade, participants, their teachers, and their parents were assessed through the mail and through the school system. Participants were asked to bring a friend who would participate in a videotaped interaction task in the laboratory. The friend also completed a few questionnaires at the time of the interaction task. At the two early-

adulthood assessment points, participants were assessed through the mail. All respondents were assured of the confidentiality of their responses. Participants, parents, teachers, and friends were compensated for their participation.

Intervention Protocol

In the 6th grade, approximately half of the group ($n = 500$) were randomly assigned to a family-centered intervention and were offered participation in the Ecological Approach to Family Intervention and Treatment (EcoFIT). Although potential intervention effects were not a focus of this study, we tested for differences in the results across the intervention and control group, so a brief description of this program is in order. The intervention, described in greater detail elsewhere (Connell et al. 2007; Dishion and Kavanagh 2003; Dishion and Stormshak 2007), is a multilevel (universal, selected, indicated), ecological approach to family engagement and intervention implemented in the public school environment.

Measures

Tables 1, 2 and 3 presents the mean and standard deviation for each measure, prior to any transformation. Substance use data were subsequently log transformed for SEM analyses.

Adolescent Substance Use—Participants completed surveys in the 6th, 7th, 8th, 9th, and 11th grades so the extent of their substance use could be assessed throughout an extended developmental period. Separate use scores were created at each assessment point for each substance class evaluated, including tobacco, alcohol, and marijuana. At Grades 6 through 9, participants were asked to report how many cigarettes they had smoked in the past month by using a scale ranging from 0 (*0 cigarettes*) to 23 (*31 or more packs*). During these same assessment points, participants were asked to indicate how many drinks of alcohol they had consumed and how many times they had smoked marijuana during the past month by using a scale ranging from 0 (*0*) to 14 (*41 or more*). In Grade 11, participants indicated their level of use of tobacco, alcohol, and marijuana by using a scale ranging from 0 (*never*) to 7 (*2–3 times a day [or more]*).

Early-Adulthood Problematic Substance Use—Substance use in early adulthood was assessed at two time points, ages 22 and 23 (on average). At each assessment point, two primary scores were created in evaluating early-adulthood problematic substance use, including measures of both frequency of use and symptoms of abuse/dependence for each substance evaluated. At the two assessment points, participants indicated the frequency of their use of cigarettes, alcohol, and marijuana on 8-point scales ranging from *never* to *2–3 times a day or more* for each substance.

Participants were also asked questions about behaviors that could reflect either substance dependence or substance abuse for each substance. The items were modeled after items in the Composite International Diagnostic Interview (CIDI) version 2.1 (Robins et al. 1989) and included “Have you tried to stop using [a substance] and found you could not?” (used for all substances), “When you used [this substance], did you get high?” and “Have you found that you can’t get as high on [this substance] as you used to?” (used for alcohol and marijuana), “Have you ever gone to school or work when you were high on [this substance]?” and “Have you ever had any problems related to school or work, such as not doing assignments or forgetting things because of [this substance]?” (used for marijuana). All those questions were answered by *yes* or *no*. For the “... did you get high?” item, an additional question followed for those who responded in the affirmative, asking “How high did you get?” Participants responded on a 3-point scale, indicating if they got “a little,” “quite a bit,” or “very much” high. In scoring this item, participants’ responses were combined with the previous item and placed on a scale between 0 and 1, such that possible

scores included 0 (*did not get high*), 0.33 (*a little high*), 0.66 (*quite a bit high*), and 1 (*very much high*). Each item was summed such that total scores on the early-adulthood problematic substance use scale varied from 0 to 5, depending on the substance.

Adolescent Effortful Control—All measures of effortful control were administered in Grade 11. For parent and child report, the Effortful Control scale from the short form of the Early Adolescent Temperament Questionnaire–Revised (EATQ-R; Ellis and Rothbart 2005) was utilized. The EATQ-R was initially validated in a sample of youth ranging in age from 10 to 16 (Ellis and Rothbart 2001). Thus, the age of the current sample (16–17) at the assessment point represents a minor extension of the age range for which the measure was previously validated. The full EATQ-R consists of 12 subscales and has demonstrated adequate internal consistency and moderate convergence between adolescent and parent reports on each scale (Ellis 2002). For these analyses, adolescent and parent reports on the three subscales that constitute the Effortful Control scale were used.

The three EATQ-R subscales comprising the Effortful Control scale were Activation Control, Attention, and Inhibitory Control. The adolescent report and the parent report used essentially the same items with the pronouns changed appropriately. Activation Control was measured using 5 items and refers to “the capacity to perform an action when there is a strong tendency to avoid it” (e.g., “She/he has a hard time finishing things on time”); Attention was measured using 6 items and refers to “the capacity to focus attention as well as shift attention when desired” (e.g., “It is easy for me to concentrate on homework problems”); and Inhibitory Control was measured using 6 items and refers to “the capacity to plan and to suppress inappropriate responses” (e.g., “It’s hard for me not to open presents before I’m supposed to”) (Ellis 2002). Adolescents and their parents responded to each item by using a 5-point scale to rate how true each statement was for the adolescent. For the teacher-reported effortful control scale, teachers responded to five items related to effortful control by rating the frequency of each participant’s behaviors on a 5-point scale (e.g., “thinks ahead of time about the consequences of actions;” “pays attention to what he or she is doing,”). The adolescent-report scale had inter-subscale correlations ranging from 0.22 to 0.45, a mean inter-item correlation of 0.14, and a standardized item alpha of 0.63. When multiple parent respondents were available, those responses were averaged into one parent-reported scale. The parent-report scale had inter-subscale correlations from 0.39 to 0.66, a mean inter-item correlation of 0.22, and a standardized item alpha of 0.79. The teacher-report scale had a mean inter-item correlation of 0.76 and a standardized item alpha of 0.94.

Friends’ Support for Substance Use—Three measures of friends’ support for substance use were utilized to assess perceptions of substance use across participants’ peer groups as well as the substance use and support of specific close friends. The measures included a self-report of friends’ substance use broadly, a friend report of substance use, and an observed friend drug talk measure. Friends’ support for substance use was measured using questionnaire data collected from participants and from a same-sex, self-nominated friend, and data from the coding of the videotaped Peer Interaction Task (Dishion et al. 1995; Piehler and Dishion 2007) involving the youth and this friend. All data were collected in Grade 11. Participants completed surveys to assess the substance use of their group of friends by using a scale to rate how frequently during the past 3 months their friends used tobacco, drank alcohol, smoked marijuana, or used other hard drugs, with ratings ranging from 1 (*never*) to 8 (*2–3 times a day or more*) ($\alpha = 0.64$, mean inter-item correlation = 0.37). The friend who participated in the videotaped Peer Interaction Task also filled out the Problem Inventory (Oregon Social Learning Center 1990) by using *yes* or *no* responses to identify potential areas of concern that had been an issue (i.e., problematic) for him or her in the past 4 weeks. Answers regarding three topics—use of drugs, consumption of beer or other liquor, and use of tobacco—were summed to yield a score ranging from 0 to 3.

All participants were invited to participate in the Peer Interaction Task. Each was instructed to bring a same-sex friend to the research office who was between 14 and 21 years old and had no familial relationship to the participant. The participant and the friend each provided informed consent; if the friend was younger than 18, his or her parents were asked to provide informed consent. A 45-minute, videotaped discussion between the friends ensued that covered a wide range of topics. The Peer Interaction Task was designed to elicit a wide range of interactive behaviors within the dyad; similar procedures had been used in previous research by Dishion and colleagues (Dishion et al. 1995, 1996, 1997). Eight different topics were discussed for 5 minutes each, and the measure of the friend's drug use was based on two of these discussions: "drug and alcohol use" and "planning a party." An interviewer entered the room to end each topic of discussion and to provide the next topic. Both the participant and the friend were compensated for completing the task.

The videotapes were coded by undergraduate trained research assistants who were blind to information about the participant groupings and experiment hypotheses. Coders completed macroratings of peer interaction dynamics following each observation task on the basis of their general impression of the interaction. Fifteen percent of the data were randomly sampled and coded by two coders for all codes to assess reliability and ensure that it remained at least at $\kappa = 0.70$, with an interrater agreement at 85% or more for macroratings.

The observed friend drug talk scale was based on coders' macroratings of the Peer Interaction Task. It was averaged from eight macroratings that reflected observations of the friend (a) making favorable or specific references to alcohol, tobacco, marijuana, cocaine, hallucinogens, speed or meth; (b) appearing to be favorable toward alcohol or drug use at a party; and (c) boasting about alcohol or drug use at a party. Each macrorating was scored on a scale ranging from 1 (*not at all*) to 9 (*very much*). Internal consistency for this scale was adequate ($\alpha = 0.77$, mean inter-item correlation = 0.29).

Analytic Strategy

Multiagent structural equation models were estimated using the SEM program Mplus version 6. Three separate main effect models were run for tobacco use, alcohol use, and marijuana use, respectively. Interaction effects were added into each model as a subsequent step.

Missing values were present in the dataset because of the longitudinal nature of the research design, but adequate covariance coverage was present (ranging from 0.59 to 0.88). Missing data in all models were managed with the full information maximum likelihood (FIML) procedure used by Mplus version 6. This method has been shown to be very efficient when analyzing data from samples with moderate levels of missing values, and it is adequate even when data are not missing completely at random, as long as the predictors of missingness are included in the model (Widaman 2006). When using FIML, the estimation of each parameter is made on the basis of all available information from each participant. Consequently, we can retain in the analysis participants with missing data so they contribute to model estimation.

The general framework of the structural equation model that was first used to assess main effects is exemplified in Fig. 1. Each model included substance use (specifically tobacco use in Fig. 1), friends' support of substance use, and effortful control as three latent factors hypothesized to have main effects on problematic substance use in early adulthood. However, for alcohol and marijuana, multicollinearity issues emerged because substance use in adolescence was correlated with friends' substance use at $r = 0.84$ or greater. The very large amount of shared variance between these two latent constructs did not allow us to make reliable predictions about the relative contribution of each factor to problematic

substance use in early adulthood. A reduced model was thus developed in which a single “substance use lifestyle” factor was formed from the eight items previously used for participants’ substance use and friends’ substance use. Within these alternative models, residual errors between adjacent substance use assessment points were allowed to covary in order to improve model fit. This alternative model approach was used for the alcohol and marijuana models (see Figs. 2 and 3).

After testing the model fit for each substance on the overall sample, we examined the covariance equivalence of the model across genders, across ethnic groups, and across the treatment and control group by using multiple group analyses. Because of the large sample size, the change in comparative fit index (Δ CFI) was used to assess the significance of the difference between the multiple group “constrained” models, in which correlations and regression paths were assumed to be equivalent in the two groups, and the multiple group “unconstrained” models, in which correlations and regression paths were not assumed to be identical in the two groups. According to Cheung and Rensvold (2002), Δ CFI of 0.01 or greater indicates a significant difference between the two models.

Following each main effect model, interaction models were estimated for each substance. For the alcohol use and marijuana use models, interaction models were computed by the addition of an interaction term between the latent variables of effortful control and substance use lifestyle. Because the tobacco model retained separate factors for friends’ support of substance use and adolescent tobacco use, two interaction terms were included in the model: Effortful Control \times Friends’ Substance Use Support, along with Effortful Control \times Adolescent Tobacco Use.

All models were tested using SEM. According to Kline (2005), a good model fit should yield a nonsignificant χ^2 value, but this test tends to be too conservative with larger sample sizes. In that case, other fit indices are usually preferred to assess model fit. CFI values at 0.90 or more, root mean square error of approximation (RMSEA) values at 0.10 or less, and standardized root mean square residual (SRMR) values lower than 0.10 indicate adequate model fit. Because of positively skewed distributions, all continuous substance use data were log transformed when they were used in the SEM analyses. The transformation generally improved skewness issues for all substance use variables and kurtosis issues for most variables (see Tables 1, 2 and 3).

Results

Preliminary Analyses

Tables 1, 2 and 3 present correlations among all the measures (indicators) used in this model. A missing value analysis was conducted using the PASW (SPSS) software version 18.0.2. The Little’s MCAR test conducted on all measures (excluding categorical variables, i.e., gender, ethnicity, and treatment group) revealed that the pattern of missing values was not completely random, $\chi^2(577) = 756.91, p < 0.001$. We thus conducted further analyses to understand the missing data patterns by creating a measure of missing data representing the number of indicators used in the model for which we had no valid data (an occasional failure from any informant to answer one question within a scale was not counted as missing data, because average scale scores were computed). A lower score on all three effortful control measures (self, parent, and teacher reports) predicted a higher number of missing values, which is not surprising because a certain level of effortful control is necessary for students to be able to persevere through the task of completing all measures, year after year. Also, a higher number of missing values was related to higher levels of tobacco use in Grade 11. Last, boys had significantly more missing data than girls did. All the significant correlations

between the number of missing values and the previously mentioned variables were in the small range, that is, $r = 0.15$.

Because one aim of the study was to examine a multi-report construct of effortful control, a confirmatory factor analysis (CFA) was run in order to examine the fit of this construct for the data. A single latent effortful control construct was estimated using effortful control scores from each reporter (including parent-, child-, and teacher-report) as indicators. All participants with effortful control scores from any reporter were included in the model ($n = 798$). Except for a significant χ^2 value, all fit indices were reflective of acceptable fit for the data: $\chi^2(8) = 59.05$, $p < 0.001$, CFI = 0.96, RMSEA = 0.09, SRMR = 0.04. It should be noted that the latent effortful control construct explained less variance in the youth and teacher-reported effortful control scores than the parent-reported scores, indicating that the latent construct may be most reflective of parental report.

Primary Analyses

Tobacco—Figure 1 shows the results of the main effect model used to test for the contribution of effortful control to the progression from tobacco use in adolescence to problematic tobacco use in early adulthood, controlling for exposure to substance-using friends. Except for a significant χ^2 value, fit indices for this model were adequate: $\chi^2(84) = 310.50$, $p < 0.001$, CFI = 0.93, RMSEA = 0.05 (90% C.I. = 0.05 to 0.06), SRMR = 0.05.

All indicators were significantly related to the latent variable to which they were assigned at $p < 0.001$. All three predictors (tobacco use, friends' support of substance use, and effortful control in adolescence) had significant main effects ($p < 0.001$) on problematic tobacco use in early adulthood, and all the regression paths were in the expected direction, with both friends' support of substance use and effortful control accounting for variation in early-adult tobacco use and dependence in early adulthood, controlling for the level of tobacco use in adolescence. The tobacco interaction model was estimated by adding two interaction terms: Effortful Control \times Friends' Support of Substance Use and Effortful Control \times Tobacco Use. The model revealed that neither interaction term contributed significantly to the model.

Alcohol—As described above, a supraordinate substance use lifestyle factor, built from the eight indicators representing adolescent alcohol use and friends' support of substance use, was used due to high level of multicollinearity between adolescent alcohol use and friends' support of substance use ($r = 0.89$). This alternative model (Fig. 2) had better (i.e., lower) Bayesian (BIC) information criteria (BIC = 18159.05) than did the first model (BIC = 18160.28). Except for a significant χ^2 value, fit indices for the alternative model were adequate: $\chi^2(81) = 308.01$, $p < 0.001$, CFI = 0.91, RMSEA = 0.05 (90% CI = 0.05 to 0.06), SRMR = 0.05. In this model, all indicators were significantly related to the latent variable to which they were assigned at $p < 0.001$. Substance use lifestyle in adolescence was a strong, significant predictor of problematic alcohol use in early adulthood ($p < 0.001$), but effortful control was not a significant predictor.

An alcohol interaction model was computed by adding an interaction term involving Substance Use Lifestyle \times Effortful Control to the single-factor main effects model described previously. The interaction term between effortful control and the substance use lifestyle factor contributed significantly to predicting early-adulthood problematic alcohol use (unstandardized estimate = 0.90, $SE = 0.44$, $p < 0.05$). Figure 2 also reveals the interaction between adolescent substance use lifestyle and effortful control, demonstrating that for those youth with low levels of exposure to an alcohol-use lifestyle, poor effortful control appears to more strongly predict future problematic alcohol use. For youth with higher levels of exposure to alcohol during adolescence, levels of effortful control did not appear to protect against problematic alcohol use in early adulthood. In fact, at very high

levels of exposure to an alcohol-use lifestyle, higher levels of effortful control might even contribute to experiencing more problems with alcohol by early adulthood.

Marijuana—As described above, a supraordinate substance use lifestyle factor, built from the eight indicators representing adolescent marijuana use and friends' support of substance use, was used due to high level of multicollinearity between adolescent marijuana use and friends' support of substance use ($r = 0.84$). This alternative model (Fig. 3) had better BIC (17221.81) than did the first model (BIC = 17225.23). Except for a significant χ^2 value, fit indices for this alternative model were adequate: $\chi^2(81) = 316.38$, $p < 0.001$, CFI = 0.93, RMSEA = 0.05 (90% C.I. = 0.05 to 0.06), SRMR = 0.05. In this alternative model, all indicators were significantly related to the latent variable to which they were assigned at $p < 0.001$. Substance use lifestyle in adolescence was a strong, significant predictor of problematic marijuana use in early adulthood ($p < 0.001$), and effortful control was a significant, negative predictor ($p < 0.01$), although its effect size was in the small range (Cohen 1988). An interaction model for marijuana use was estimated by adding an interaction term between effortful control and the substance use lifestyle factor. The interaction term was not a significant predictor of early adulthood problematic marijuana use.

Multiple Group Analyses—Multiple group analyses revealed no significant differences across genders, ethnic groups, or treatment groups across all main effects for all substances.

Discussion

The goal of this study was to verify if effortful control contributed to the progression from substance use in adolescence to problematic substance use in early adulthood, above and beyond the contribution of early-onset substance use and peer support for substance use. As expected, we found that in general, higher levels of effortful control in adolescence were related to lower levels of problematic substance use in early adulthood. This relationship held for tobacco and marijuana use. These findings are generally consistent with the hypothesis that a low level of effortful control and associated self-regulation is associated with development of addictive behavior (Miller and Brown 1991).

Although a direct association between effortful control and problematic alcohol use did not emerge, an interaction was present between effortful control and exposure to an "substance use lifestyle." Poor self-regulatory skills of individuals with low to moderate exposure to and experience with alcohol use during adolescence placed them most at risk for escalations in alcohol use by early adulthood, when increased autonomy and freedom heighten risk. In these youth, effortful control may allow them to resist the influence of peers towards maladaptive alcohol use or avoid situations in which such negative influence may occur. In contrast, for youth who were already demonstrating high levels of alcohol use during adolescence and were deeply enmeshed in a culture of alcohol use, individual differences in effortful control had a limited protective effect on future problematic alcohol use. In fact, effortful control might even precipitate problematic alcohol use in adulthood. Although seemingly counterintuitive, these results are consistent with previous findings about the development of antisocial behavior in adolescence. In fact, past research (Piehler and Dishion 2007) showed that dyads of friends who were talking about deviant topics and who were highly mutual in their interactions (i.e., responsive, understanding of each other, reciprocal, cooperative) were more antisocial than dyads who did not show as much mutuality during their conversation about deviant topics. In other words, having good intrapersonal (e.g., effortful control) and interpersonal (e.g., mutuality) skills may not always be sufficient to keep high risk adolescents out of trouble, because these skills may drive youth to be more compliant to deviant norms in terms of alcohol use.

This study represented several improvements over past work. It used a multiagent and multimethod assessment of adolescent friends' support of substance use and of adolescent effortful control to examine the direct and interaction effects of the construct of effortful control. First, by analyzing adolescent tobacco, alcohol, and marijuana use separately, potentially unique effects for each of these substances could be investigated. Second, our study controlled for past substance use earlier in adolescence and for peer support for substance use to more directly examine the role of effortful control in promoting growth in substance use into early adulthood. Finally, the use of structural equation modeling (SEM) techniques facilitated better control of measurement error and took into account information from multiple reporters for key constructs, including effortful control.

In the longitudinal models predicting alcohol and marijuana use, the constructs of early-onset substance use and friends' support of substance use were so highly intercorrelated that multicollinearity disrupted the potential for testing the model. Creating a supraordinate construct of substance use lifestyle that was indicated by the two constructs resolved the statistical problem. The solution, however, is more than statistical; it is also substantive. It appears that in general, early- to middle-adolescent substance use is indeed a lifestyle process that is highly linked to the peer network and activities that support and promote adolescent substance use. If this social and developmental process is firmly in place by age 16–17, there is a strong likelihood of at least maintenance of substance use, if not escalation to dependence and abuse.

This study's limitations would be useful to consider in future work. First, our study did not consider comorbid conduct problems. It is possible that a shared association with other problem behaviors (e.g., a tendency for rule violation) inflated the association between effortful control and substance use. Second, it would be useful to consider the role of parenting practices, such as monitoring and limit setting, as moderators of exposure to substance use by peers and for their potential relationship to effortful control. Finally, limitations in our data did not allow us to investigate any potential transactional effects between effortful control and other key constructs. Better understanding the reciprocal relationship between the development of self-regulatory processes and environmental risk factors may represent an important direction of future work in this area.

The current findings align with empirically supported prevention protocols, such as life skills training (Botvin et al. 1990), and with comprehensive treatment protocols for adolescents using alcohol and marijuana (Dennis et al. 2004; Waldron and Brody 2010). Furthermore, fostering effortful control in early adolescence may enhance the effects of other prevention programs, including those that teach refusal skills (see review by Lemstra et al. 2010). Given how central self-regulation is to several forms of psychopathology and problem behavior (Lengua 2002), the need is clear for future translational research to design and examine interventions that address attention processes as delineated in the effortful control construct (Dishion et al. 2012). Mindfulness-based interventions that are currently being developed and tested on adults could also be used with adolescents, especially when intervening before exposure to substances, with the hope of preventing multiple forms of psychopathology and escalation of problem behaviors that undermine adult development.

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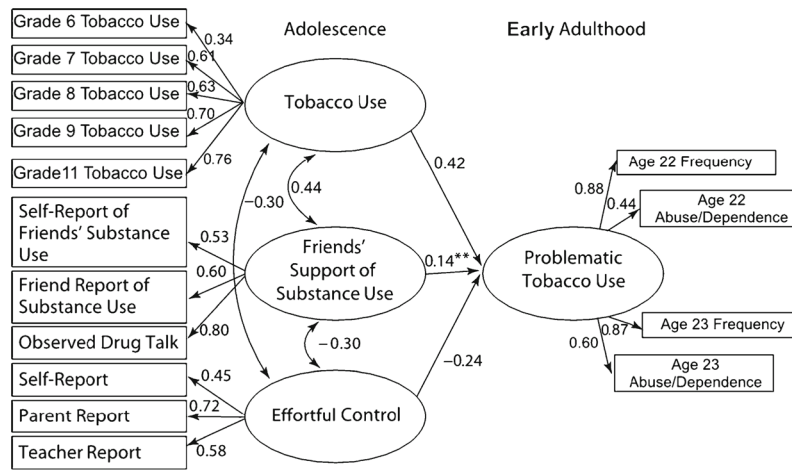


Fig. 1. Prediction of problematic tobacco use by early adulthood. Standardized values are reported. All parameters are significant at $p < 0.001$ except when otherwise specified. ** $p < 0.01$

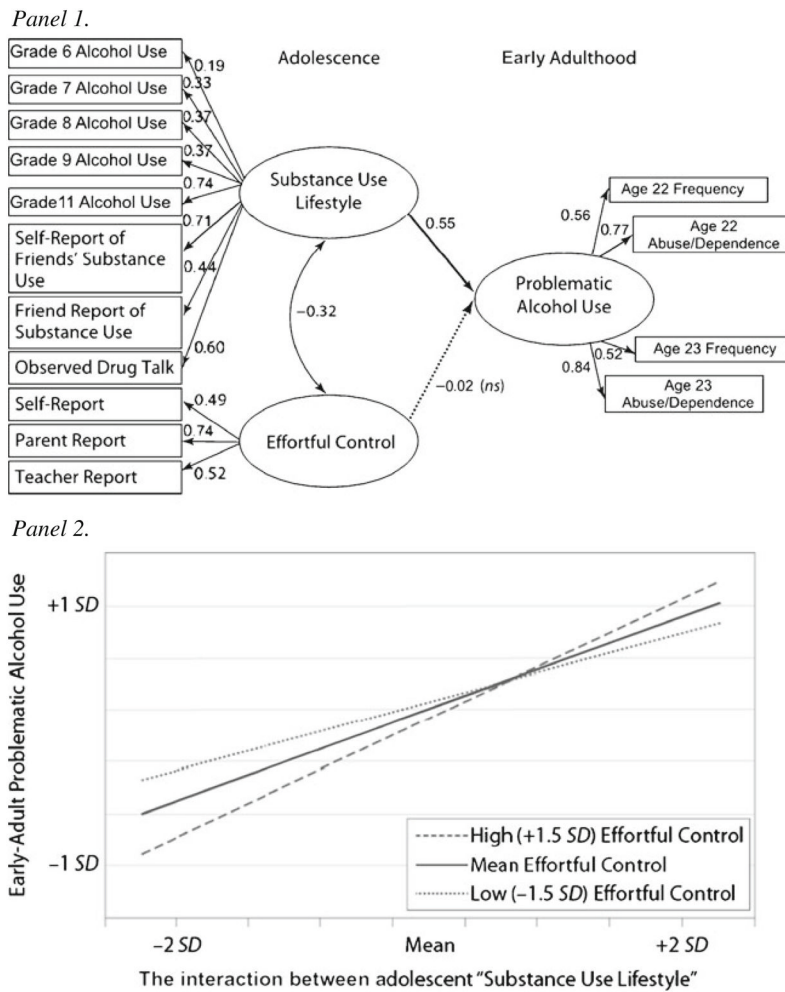


Fig. 2. *Panel 1* Prediction of problematic alcohol use by early adulthood. Standardized values are reported. All parameters are significant at $p < 0.001$ except when otherwise specified. *ns* = nonsignificant. *Panel 2.* The interaction between adolescent substance use lifestyle (including past use and peer exposure) and effortful control in predicting problematic alcohol use in early adulthood

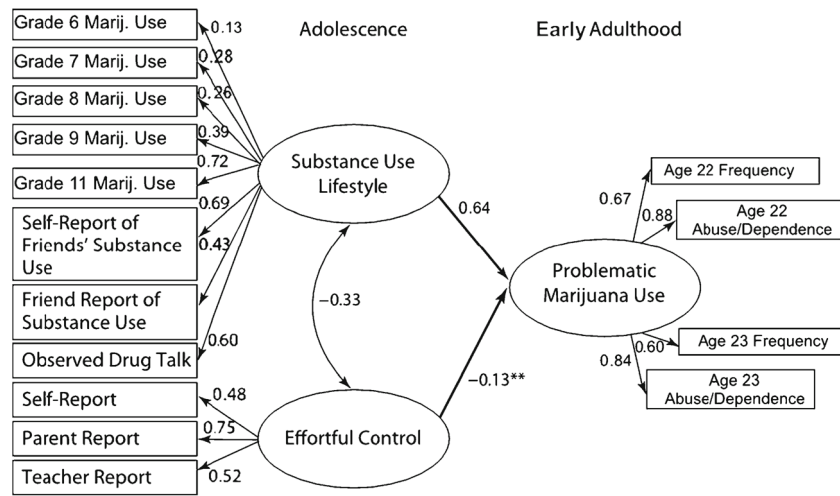


Fig. 3. Prediction of problematic marijuana use by early adulthood. Note: Standardized values are reported. All parameters are significant at $p < 0.001$ except when otherwise specified. ** $p < 0.01$

Table 1

Descriptive statistics and correlations among measures for tobacco model

	Adolescence															
	Participant substance use (adolescence)							Participant effortful control				Friends' support for substance use			Early adulthood	
	Grade 6-Tob	Grade 7-Tob	Grade 8-Tob	Grade 9-Tob	Grade 11-Tob	Partic.-EFC	Parent-EFC	Teach.-EFC	Partic.-FSU	Friend-FSU	Drug Talk	Age 22-Tob Freq.	Age 23-Tob Freq.	Sx	Age 22-Tob Sx	Age 23-Tob Sx
Grade 6-Tob	–															
Grade 7-Tob	0.23	–														
Grade 8-Tob	0.20	0.44	–													
Grade 9-Tob	0.12**	0.35	0.52	–												
Grade 11-Tob	0.14	0.36	0.40	0.56	–											
Partic.-EFC	-0.05 ^{ns}	-0.03 ^{ns}	-0.07 ^{ns}	-0.09*	-0.08*	–										
Parent-EFC	-0.09**	-0.06 ^{ns}	-0.07 ^{ns}	-0.08*	-0.18	0.34	–									
Teach.-EFC	-0.07 ^{ns}	-0.06 ^{ns}	-0.05 ^{ns}	-0.08*	-0.19	0.20	0.41	–								
Partic.-FSU	0.11**	0.17	0.15	0.19	0.33	-0.20	-0.13**	-0.08	–							
Friend-FSU	0.00 ^{ns}	0.05 ^{ns}	0.07 ^{ns}	0.07 ^{ns}	0.17	-0.07 ^{ns}	-0.12**	-0.04 ^{ns}	0.26	–						
Drug Talk	0.04 ^{ns}	0.14	0.13**	0.18	0.29	-0.12**	-0.17	-0.14	0.37	0.52	–					
Age 22-Tob Freq.	0.12	0.25	0.27	0.33	0.45	-0.18	-0.22	-0.26	0.26	0.11**	0.25	–				
Age 23-Tob Freq.	0.11**	0.21	0.23	0.30	0.45	-0.11**	-0.24	-0.27	0.26	0.11**	0.26	0.81	–			
Age 22-Tob Sx	0.00 ^{ns}	0.14	0.10**	0.14	0.24	-0.03 ^{ns}	-0.08*	-0.13**	0.25	0.06 ^{ns}	0.13**	0.40	0.36	–		
Age 23-Tob Sx	0.14	0.21	0.24	0.25	0.36	-0.12**	-0.22	-0.26	0.27	0.13	0.22	0.52	0.55	0.37	–	
MEAN	0.50	0.70	0.60	1.13	1.11	3.35	3.30	3.72	1.28	0.74	2.40	2.36	2.35	0.25	0.20	
SD	2.20	2.59	2.44	3.75	2.35	0.48	0.54	0.79	1.43	1.06	1.32	3.02	3.04	0.43	0.40	
Skew/Kurtosis	6.29/45.86	4.59/22.93	5.11/28.18	3.70/13.43	1.89/1.84	0.26/0.34	-0.20/-0.03	-0.18/-0.56	0.99/0.15	1.01/-0.26	0.93/0.06	0.68/-1.37	0.69/-1.38	1.16/-0.66	1.52/0.31	
Post-Log Trans. Skew/Kurtosis	3.72/14.17	3.15/9.11	3.52/11.87	2.80/6.52	1.62/0.86	n/a	n/a	n/a	0.34/-1.32	n/a	0.40/-0.98	0.49/-1.63	0.50/-1.62	1.16/-0.66	1.52/0.31	

Tob = Tobacco; Partic. = Participant report; Parent = Parent report; Teach. = Teacher report; EFC = Effortful Control; Friend = Friend report; FSU = Friend Substance Use; Freq. = Frequency; Sx = Symptoms of abuse/dependence

All correlations are significant at $p < 0.001$ except when otherwise specified.** $p < 0.01$,* $p < 0.05$,

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Table 2

Descriptive statistics and correlations among measures for alcohol model

	Adolescence											Early adulthood							
	Participant substance use (adolescence)											Friends' support for substance use				Frequency of use			
	Grade 6-Alc	Grade 7-Alc	Grade 8-Alc	Grade 9-Alc	Grade 11-Alc	Partic.-EFC	Parent-EFC	Teach.-EFC	Partic.-FSU	Friend-FSU	Drug Talk	Age 22-Alc Freq.	Age 23-Alc Freq.	Age 22-Alc Sx	Age 23-Alc Sx				
Grade 6-Alc	-																		
Grade 7-Alc	0.24	-																	
Grade 8-Alc	0.26	0.43	-																
Grade 9-Alc	0.03 ^{ns}	0.18	0.30	-															
Grade 11-Alc	0.08 [*]	0.21	0.23	0.30	-														
Partic.-EFC	-0.09 [*]	-0.11 [*]	-0.13	-0.10 ^{**}	-0.18	-													
Parent-EFC	-0.05 ^{ns}	-0.11 [*]	-0.11 ^{**}	-0.08 [*]	-0.13	0.34	-												
Teach.-EFC	-0.03 ^{ns}	-0.04 ^{ns}	-0.03 ^{ns}	-0.08 [*]	-0.07 ^{ns}	0.20	0.41	-											
Partic.-FSU	0.09 [*]	0.14	0.16	0.23	0.52	-0.20	-0.13 ^{**}	-0.08 [*]	-										
Friend-FSU	0.06 ^{ns}	0.05 ^{ns}	0.07 ^{ns}	0.06 ^{ns}	0.25	-0.07 ^{ns}	-0.12 ^{**}	-0.04 ^{ns}	0.26	-									
Drug Talk	0.07 ^{ns}	0.10 ^{**}	0.18	0.15	0.39	-0.12 ^{**}	-0.17	-0.14	0.37	0.52	-								
Age 22-Alc Freq.	0.03 ^{ns}	0.08 [*]	0.05 ^{ns}	0.07 ^{ns}	0.27	-0.08 [*]	-0.05 ^{ns}	0.06 ^{ns}	0.25	0.14	0.17	-							
Age 23-Alc Freq.	0.02 ^{ns}	0.05 ^{ns}	0.09 [*]	0.05 ^{ns}	0.25	-0.03 ^{ns}	-0.05 ^{ns}	0.05 ^{ns}	0.17	0.16	0.15	0.61	-						
Age 22-Alc Sx	0.08 [*]	0.10 ^{**}	0.17	0.13	0.32	-0.21	-0.13 ^{**}	-0.03 ^{ns}	0.32	0.22	0.22	0.42	0.35	-					
Age 23-Alc Sx	0.08 [*]	0.14	0.12 ^{**}	0.13	0.31	-0.17	-0.12 ^{**}	-0.03 ^{ns}	0.30	0.23	0.23	0.45	0.43	0.60	-				
MEAN	0.55	0.61	0.65	0.69	0.93	3.35	3.30	3.72	1.28	0.74	2.40	3.16	3.21	1.34	1.42				
SD	1.76	1.69	1.82	1.99	1.46	0.48	0.54	0.79	1.43	1.06	1.32	2.13	2.18	1.09	1.07				
Skew/Kurtosis	4.83/25.92	3.90/16.98	4.04/18.09	3.94/17.12	1.60/1.56	0.26/0.34	-0.20/-0.03	-0.18/-0.56	0.99/0.15	1.01/-0.26	0.93/0.06	-0.01/-0.97	-0.02/-0.98	0.81/0.26	0.68/0.11				
Post-Log Trans. Skew/Kurtosis	2.68/7.10	2.28/4.56	2.26/4.45	2.31/4.48	0.97/-0.49	n/a	n/a	n/a	0.34/-1.32	n/a	0.40/-0.98	-0.78/-0.71	-0.78/-0.74	-0.06/-0.91	-0.20/-0.82				

Alc = Alcohol; Partic. = Participant report; Parent = Parent report; Teach. = Teacher report; EFC = Effortful Control; Friend = Friend report; FSU = Friend Substance Use; Freq. = Frequency; Sx = Symptoms of abuse/dependence

All correlations are significant at $p < 0.001$ except when otherwise specified.

** $p < 0.01$,

* $p < 0.05$,

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Table 3

Descriptive statistics and correlations among measures for marijuana model

	Adolescence											Early adulthood							
	Participant substance use (adolescence)											Friends' support for substance use				Frequency of use		Symptoms of abuse/dependence	
	Grade 6-Mar	Grade 7-Mar	Grade 8-Mar	Grade 9-Mar	Grade 11-Mar	Partic.-EFC	Parent-EFC	Teach.-EFC	Partic.-FSU	Friend-FSU	Drug Talk	Age 22-Mar Freq.	Age 23-Mar Freq.	Age 22-Mar Sx	Age 23-Mar Sx				
Grade 6-Mar	-																		
Grade 7-Mar	0.28	-																	
Grade 8-Mar	0.14	0.32	-																
Grade 9-Mar	0.14	0.23	0.36	-															
Grade 11-Mar	0.10**	0.17	0.09*	0.38	-														
Partic.-EFC	0.01 ^{ns}	-0.09*	-0.10**	-0.08*	-0.13	-													
Parent-EFC	-0.03 ^{ns}	-0.08 ^{ns}	-0.11*	-0.09*	-0.16	0.34	-												
Teach.-EFC	-0.08 ^{ns}	-0.06 ^{ns}	-0.04 ^{ns}	-0.08*	-0.13**	0.20	0.41	-											
Partic.-FSU	0.10**	0.15	0.16	0.26	0.53	-0.20	-0.13**	-0.08*	-										
Friend-FSU	0.04 ^{ns}	0.06 ^{ns}	0.05 ^{ns}	0.06 ^{ns}	0.21	-0.07 ^{ns}	-0.12**	-0.04 ^{ns}	0.26	-									
Drug Talk	0.03 ^{ns}	0.10**	0.18	0.21	0.37	-0.12**	-0.17	-0.14	0.37	0.52	-								
Age 22-Mar Freq.	0.03 ^{ns}	-0.01 ^{ns}	0.04 ^{ns}	0.15	0.44	-0.15	-0.14	-0.07 ^{ns}	0.32	0.16	0.26	-							
Age 23-Mar Freq.	0.01 ^{ns}	0.02 ^{ns}	0.06 ^{ns}	0.11**	0.37	-0.15	-0.13	-0.07 ^{ns}	0.29	0.18	0.24	0.75	-						
Age 22-Mar Sx	0.05 ^{ns}	0.05 ^{ns}	0.09*	0.19	0.45	-0.19	-0.21	-0.12**	0.42	0.26	0.32	0.59	0.50	-					
Age 23-Mar Sx.	0.06 ^{ns}	0.10**	0.09	0.17	0.41	-0.22	-0.23	-0.13**	0.37	0.23	0.37	0.56	0.52	0.75	-				
MEAN	0.22	0.34	0.46	0.69	0.83	3.35	3.30	3.72	1.28	0.74	2.40	1.57	1.43	1.19	1.18				
SD	1.26	1.50	1.77	2.30	1.79	0.48	0.54	0.79	1.43	1.06	1.32	2.50	2.43	1.33	1.29				
Skew/Kurtosis	7.21/55.47	5.89/38.16	4.90/25.76	3.95/15.23	2.21/3.66	0.26/0.34	-0.20/-0.03	-0.18/-0.56	0.99/0.15	1.01/-0.26	0.93/0.06	1.26/-0.09	1.40/0.28	1.05/0.09	1.05/0.18				
Post-Log Trans. Skew/Kurtosis	5.21/28.38	3.94/15.62	3.35/10.72	2.88/7.33	1.68/1.31	n/a	n/a	n/a	0.34/-1.32	n/a	0.40/-0.98	0.94/-0.87	1.09/-0.58	0.41/-1.17	0.38/-1.16				

Mar = Marijuana; Partic. = Participant report; Parent = Parent report; Teach. = Teacher report; EFC = Effortful Control; Friend = Friend report; FSU = Friend Substance Use; Freq. = Frequency; Sx = Symptoms of abuse/dependence

All correlations are significant at $p < 0.001$ except when otherwise specified.

** $p < 0.01$,

* $p < 0.05$,

500d
su

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