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Predicting high-risk versus *higher-risk* substance use during late adolescence from early adolescent risk factors using Latent Class Analysis

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Abstract

Much of the existing risk factor literature focuses on identifying predictors of low-levels of substance use versus higher-levels of substance use. In this paper, we explore more nuanced patterns of alcohol, tobacco, and other drug (ATOD) use during late adolescence. Our aims were to: 1) identify subgroups of youth with qualitatively different patterns of ATOD use; and 2) explore whether membership among qualitatively distinct, high-risk classes could be predicted based on early adolescent risk factors. Data came from a selected subsample of the National Longitudinal Survey of Youth ($n = 1,689$). Predictors were measured when youth were about 12 years old; ATOD use was assessed when youth were aged 17 years. Results showed that adolescent ATOD use is not a homogenous behavior. Four distinct classes of adolescent ATOD users were derived. Each class had a qualitatively distinct and discriminable pattern of ATOD use. Ecological predictors were shown to differentiate between latent classes, with peer factors playing a particularly important role in differentiating between high-risk and *higher-risk* users. Implications for prevention and limitations are discussed.

Keywords

latent class analysis (LCA); adolescents; substance use; ATOD use; risk factors; youth development; peer victimization

By 12th grade, approximately 71% of high school seniors have tried alcohol, 42% have tried cigarettes, and 44% have tried marijuana at least once (Johnston, O'Malley, Bachman, & Schulenberg, 2011). Although alcohol, tobacco, and other drug use (ATOD) among adolescents is now considered a relatively 'normal' behavior (Parker, Aldridge, Measham, 1998; Measham, Newcombe, Parker, 1994; Newcombe, Measham, & Parker, 1995), use at high-levels remains a major international public health concern. Cross-culturally, high levels ATOD use have been linked to maladaptive and unhealthy behaviors during adolescence (Hawkins, Catalano, & Miller, 1992; Godfrey, Eaton, McDougall, & Culyer, 2005; Donaldson, 2008), and problems associated with use have been shown to extend into young adulthood (Duncan, Alpert, Duncan, & Hops, 1997). Risk and protective factors in all major ecological domains play a role in the onset and maintenance of adolescent ATOD over time (Scheier, 2010). Though relatively vast and comprehensive, the risk factor literature has primarily focused on factors that predict adolescent ATOD use versus abstinence (e.g. Hawkins et al., 1992; McCrystal & Percy, 2008). A considerably smaller body of research

has focused on factors that differentiate among subtypes of ATOD users. The current study furthers the field by exploring qualitatively distinct groups of adolescent ATOD users; and by testing whether known risk and protective factors for general ATOD use differentiate between more nuanced patterns of high-risk ATOD-using behavior.

Normalization of ATOD use and problem ATOD use

It is widely accepted in the ATOD literature that a distinction must be drawn between ATOD *use* and ATOD *misuse*, *problem use*, or *abuse*¹ (Newcomb & Bentler, 1989). Although the majority of youth experiment with at least one substance during adolescence (Parker, Aldridge, & Measham, 1998; Johnson et al., 2001; Measham, Newcombe, & Parker, 1994; Newcombe, Measham, & Parker, 1995), not all youth experience maladaptive consequences associated with use. There is far less research available on *problem* ATOD use than on more general or normalized ATOD-using behavior (Hawkins et al., 1992; Stice, Barrera, & Chassin, 1998). This is problematic in light of the “normalization” of relatively safe (i.e., low levels) of ATOD use that has been observed in American, European, and Australasia populations (Duff, 2005; Hunt, Moloney, Evans, 2010; Parker, Aldridge, & Measham, 1998; Parker, Williams, L., & Aldridge, 2002; Seaman & Ikegwuonu, 2010). Studies employing binary estimates of “ever use” may miss important differences in youth who use ATODs at normative, non-problematic levels and those whose ATOD use is a concern.

Data suggest that similar to the antecedents of adolescent ATOD in general, environmental factors play an important role in differentiating between problem ATOD use over normative ATOD-using behavior (Perra, Fletcher, Bonell, Higgins, & McCrystal, 2012; Baumrind, 1991; Hersh & Hussong, 2009; Scheier, Botvin, & Baker., 1997; von Sydow, Lieb, Pfister, Hofler, & Wittchen, 2002; Windle, 1996), though more in-depth work on the antecedents of problem ATOD use across all ecological domains is needed. Early work suggests that the social environment, in particular, plays an integral role. Adolescents who misuse ATODs tend to associate with a peer group that also uses ATODs, and have experienced high-levels of family risk (such as poor parental modeling or parental ATOD use) or early stressful life events (Griffin et al., 2000; Clark, Cornelius, Kirisci, & Tarter, 2005; Costa, Jessor, & Turbin, 1999; Hawkins et al., 1997; Seibenbruner et al., 2006; von Sydow et al., 2002). Similarly, a positive attachment to teachers reduces the likelihood of regular ATOD use, while school disengagement increases risk (Perra, Fletcher, Bonell, Higgins, & McCrystal, 2012). Problematic ATOD use may reflect a coping strategy for youth experiencing high-levels of environmental risk. Early externalizing behaviors also increase the risk of later problem use (Baumrind, 1991; Cornelius, Clark, Reynolds, Kirishci, & Tarter, 2007; Siebenbruner et al., 2006; Stice et al., 1998; Windle, 1996). Of particular relevance, early initiation of ATOD use, including cigarette use, is a highly cited predictor of ATOD misuse (Clark et al., 2005; Griffin et al., 2000; Hawkins et al., 1997; Kaplan et al., 1986; Tyas & Pederson, 1998; von Sydow et al., 2002; Windle, 1996). The notion that early initiation of one substance significantly increases the risk of problematic use of another substance undermines the need to examine ATOD use broadly, rather than focusing on any one particular substance alone.

From an intervention standpoint, understanding the factors that predict problem use (versus normative ATOD use) is important for early identification of youth at the *highest* risk for long-term consequences. Identifying youth at the most risk may help inform cost-effective intervention programming by allotting resources more appropriately, and by focusing

¹The terms *misuse*, *abuse*, and, *problem use* are not differentiated in this paper

program content on harm reduction, rather than complete abstinence (Bonell & Fletcher, 2008).

Distinguishing “problem” use

While many researchers seem to agree that experimental or occasional use of alcohol or marijuana by older adolescents is not abuse (Measham, Newcombe, & Parker, 1994; Newcomb & Bentler, 1989; Shedler & Block, 1990; von Sydow et al., 2002), operationalizations of abuse, problem use, or misuse vary from study to study. For instance, Baumrind (1991) classified nonusers, recreational alcohol users, experimental marijuana users, heavy alcohol and/or drug users, and dependent alcohol and/or drug users; Stice et al. (1998) looked at use versus problem use; while von Sydow et al. (2002) used DSM-IV diagnostic criteria of use, abuse, and dependence to classify ATOD use typologies; and Perra and colleagues (2012) defined six typologies of use based on frequency (ever use versus more regular use) of three substances. Variations in operationalization of misuse make it challenging to obtain a clear and meaningful understanding of the true qualitative nature of high-risk ATOD use.

Differences are partly due to the fact that the majority of previous work used *a priori* researcher-defined criteria to determine whether an adolescent's ATOD use should be considered normative or high-risk (Baumrind, 1991; Griffin, Botvin, Epstein, Doyle & Diaz, 2000; Hawkins et al., 1997; Scheier et al., 1997; Siebenbruner et al., 2006; Stice et al., 1998). These definitions are typically based on formal diagnostic criteria for substance-related disorders or the quantity and/or frequency of ATOD use, and often focus on a single substance, such as alcohol abuse. Since use of one substance is highly related to use of other substances (Bobo & Husten, 2000), the examination of any one substance in isolation may misconstrue actual typologies of use. It is possible that an adolescent who misuses one substance may completely abstain from all other substances; alternatively, an adolescent may use ATODs infrequently, but may engage in high-risk behaviors when used. Depending on the operationalization of a particular study, these behaviors may or may not be classified as ATOD misuse.

Few studies, if any, have examined patterns of use in the data to obtain empirically-derived (and theoretically-guided) subgroups of adolescent users. Consequentially, it is unclear whether *a priori* definitions of misuse and abuse best capture distinct groups of ATOD users as they occur in the general population. While certain facets of ATOD use may be well-captured, the extent which these researcher-defined classifications reflect actual typologies of use remain unknown. There is a need to better understand and operationalize qualitatively distinct patterns of ATOD use as they naturally occur.

The Current Study

Evidence suggests that ecological factors differentially predict use versus problem use; however, the vast majority of previous studies implemented regression- or ANOVA-based methods, with *a priori* classifications of users (exceptions include Hawkins et al., 1997 and Stice et al., 1998, who used structural equation modeling, and Clark et al., 2005, who used cluster analysis). The extent to which these *a priori* definitions fully capture ATOD use as it naturally occurs in the general population remains unknown. It is likely that there are subgroups of ATOD users in the population whose use is qualitatively distinct *and discriminable* from other ATOD subgroups. These ATOD-using subgroups may or may not emerge from a uni-dimensional, *a priori* definition of ATOD misuse.

The purpose of the current study is to identify distinct subpopulations of ATOD users in a normative sample of older adolescents. In the current study, we do not define classes *a*

priori. We use a novel statistical approach – i.e., latent class analysis – to empirically-derive qualitatively distinct patterns of ATOD use among a general population of adolescent users. Our approach allows for the simultaneous estimation of multiple substances and risk behaviors. This is advantageous because youth with elevated use on one drug (e.g., marijuana) may not be the same youth who misuse another drug (e.g., alcohol). We expected that *at least* three groups would emerge with, at minimum, one group showing distinctly more problematic substance using behavior than the rest, and another group showing more normative ATOD use, relative to a minimal- or no-use group. This expectation was based on previous empirical support of different types of ATOD-users through *a priori* classifications (e.g., Baumrind, 1991; von Sydow et al., 2002; Windle, 1996).

Second, given multiple risk groups, we examined whether early adolescent risk factors can be used to differentially predict between high risk ATOD use and even *higher* risk ATOD use. We aimed to identify early-adolescence factors that differentiate between high-levels of subsequent use and even higher-levels of risky use, in contrast to the more traditional approach of examining use versus non-use. We anticipated that salient, ecological risk factors for ATOD use in general, particularly those in family and peer domains, would also be predictive of different subtypes of high-risk ATOD use, with exposure to higher levels of risk predicting more risky subtypes of ATOD use.

Methods

Data for this study were drawn from the National Longitudinal Survey of Youth 1997 (NLSY97), which is part of the National Longitudinal Surveys (NLS) program released annually by the United States Bureau of Labor Statistics. The NLSY97 was designed to document the transition of youth into adulthood by, addressing factors in a range of core developmental domains, such as employment, schooling, vocational training, income and assets, family formation, family background, future expectations, attitudes, behaviors, and time use, health, political participation, and environmental characteristics. All youth aged 12 to 16 years old as of December 31, 1996 were eligible to participate in the annual survey. Two samples were selected – a cross-sectional, representative sample of US adolescents born between 1980 and 1984, and an oversample of Black and Hispanic youth. The complete NLSY97 sample consisted of 8,984 youth. At the time of writing, data up to Round 14 are available for use, with approximately 84% of round 1 participants re-interviewed in round 11. A particular strength of this data is among the only prospective longitudinal studies using a national sample of youth. Despite an approximate 10 year time lapse since outcome measurement, the prospective nature of the design is a tremendous strength, and therefore worth the costs of using an older dataset. For more information about the NLSY97 and the multistage area probability research design, please refer to <http://www.bls.gov/nls/nlsy97.htm>.

Sample

The NLSY97 includes data from 8,984 respondents who were 12 to 16 years old as of 12/31/1996. The current study utilizes the subsample of the NLSY97 youth born in 1984 (such that they were 12 years old at 12/31/1996) who had not turned 18 years old by their Round 5 interview. Youth aged 18 years or older at follow-up were excluded to capture underage ATOD use. This particular subsample was selected to obtain contemporaneous reports of age 12 predictors and to maximize the number of years lapsed between baseline and follow-up interviews. We opted not to use additional birth cohorts because predictors would be measured after ATOD initiation for a considerable proportion of older youth. Data from both the representative sample and over-sampling of minority youth were used.

Our final sample consisted of 1,689 youth; $n=139$ of these youth were deleted due to missing values on all outcome variables (see below), resulting in a final sample of 1,550 youth. Demographic of the overall sample appear in Table 1.

Procedure

All early adolescent predictor variables and covariates were measured at Round 1, when youth were roughly 12 or 13 years of age. Round 1 data were obtained through home interviews with the youth participants and their primary caregiver. All outcome measures were assessed at five year follow-up during youth interviews. NLSY97 utilized an audio and computer-assisted self-interview on sensitive items. Official school reports were used to assess academic achievement.

Measures

Predictors were derived from known ecological risk and protective factors for ATOD use (versus abstinence) during adolescence.

Demographic variables—Sex, ethnicity, and family SES were included in analyses as predictors of ATOD use.

Religion—Youth reported the number of days their family typically does something religious in an average week. Responses were truncated, such that the last coded value reflected the “four or more days”, due to low prevalence of response at the extreme values.

Parenting—Two dimensions of parenting were assessed: monitoring and warmth. To assess monitoring, students indicated on a five-point scale how much their parents knew about their friends, friends' parents, social environment outside of the home, teachers, and school. If youth provided a response for more than parent (potentially including a non-residential parent), the average rating across parents was used in the analyses. Coefficient alpha for these scales ranged from .71 (residential mother) to .85 (non-residential father). Youth also rated the degree to which they felt that their parent(s) were supportive, on a three-point scale with higher scores indicating more support.

Teen parenthood—A dichotomous variable was included that indicated whether the youth's mother was a teenager at the time of the respondent's birth.

Home environment—An index of the degree of environmental enrichment offered by the youth's home setting was included. Indicators included whether the youth reported having a home computer and/or dictionary in the past month and whether the youth reported taking extracurricular classes during a typical week. Each item was dichotomous and summed to form a composite. Higher scores reflected a more enriching environment.

Antisocial peers—To assess association with an antisocial peer group, youth rated the proportion of their peers who: smoke cigarettes, drink alcohol at least once per month, belong to a gang, cut class, and use illegal drugs on a five-point scale ranging from “Almost none” to “Almost all”. Scores were summed to create a composite variable with higher scores indicative of more involvement with antisocial peers. Coefficient alpha for the composite score in this sample was .84.

Victim of peer bullying—Previous victimization by peers was assessed by asking students to indicate whether they were the victim of peer bullying in their community during childhood (less than 12 years old).

Community gun violence—Exposure to community gun violence during childhood (less than 12 years old) was assessed by asking youth report the number of times per week the youth hears regular gunshots in his/her community. Responses were dichotomized because the minimum positive value was indicative of exposure to recurrent community violence. A positive response indicated that youth reported hearing *at least one gunshot per week* at home.

Urban—A dichotomous variable indicating whether the youth resided in an urban or rural setting was included in analyses.

School risk—Four dimensions of school risk were used. First, perceptions of school climate were assessed by asking youth to report the degree to which they agreed or disagreed with seven statements regarding teacher quality, discipline, safety, and academics. Responses were summed to create a composite index score. Next, youth reported the number of times they were threatened at school, got into a physical fight at school, and had something of value stolen from them at school. Responses were truncated (i.e., highest value reflects “six times or more”) and summed to form an index of school safety. Academic achievement was assessed via results of the PIAT standardized test using updated norms. Last, a dummy variable that indicated whether the youth was retained a grade level prior to age 12 year was included.

Outcome: Substance use—Outcome indicators used in this study were selected to capture the quantity of use of multiple substances, and engagement in risky behaviors associated with use. The first set of indicators were self-reported frequency variables for past month tobacco, alcohol (i.e., at least one drink), and marijuana use. Responses for these indicators were coded into five ordered groups for each substance (0 days, 1 day, 2-29 days, 30 days). Categorization of all ATOD use variables was used because raw data for ATOD indicators did not follow a known distribution and distribution-free techniques such as the bootstrap were not feasible for our statistical approach (i.e., mixture model; described below). The distributions for reported days of use for each substance were multimodal with a preponderance of zeros, and not subject to either standard assumptions for distributions of residuals or any normalizing transformation. We made the *a priori* decision that “no use”, “experimentation”, “more frequent use”, and “daily use” were of substantive value. We posited an important distinction between youth who use a particular substance *daily* versus those who report using substances regularly, (but not daily); and differences between youth who abstain from all use and those who experimented with substances once. Distinctions between youth who used substances two or three times were more challenging (i.e., whether it is better described as experimentation or frequent use); we ultimately decided to categorize these youth as frequent users because of the repeated use of the substance within a single month. Further, except for alcohol, the “more frequent use” (2-29 days) category is not especially large, and did not justify a need for an additional cut-point. Raw frequencies for the full range of values appear in Table 2.

Next, self-reported risky use was assessed by asking youth whether they had used alcohol or marijuana before work and/or school within the past month, whether they engaged in heavy episodic drinking (defined as more than 5 drinks on a drinking occasion) in the past month, and whether they used any other illicit drugs (e.g. cocaine, hallucinogens) in the past year. The first set of risky use indicators (alcohol use during school hours; marijuana use during school hours) were designed to capture functional impairment associated with substance use, which is typically required for diagnostic categorization of substance-related disorders. Due to low prevalences, responses for all risky use indicators were dichotomized. The proportion

of missing data on outcome indicators was modest, ranging from 8% to 9% across all indicators.

Data Analysis

Missing data

Multiple imputation is the method of choice for data assumed missing at random (MAR) in a measurement context such as the middle years of a large survey, as the standard alternative, full information maximum likelihood estimation from raw data (FIML), requires listwise deletion for missing exogenous variables. However, multiple imputation with non-deterministic analytic methods, such as LCA, is problematic (Enders & Gottschall, 2011). We used a mixed strategy with the goals of retaining the largest possible sample size while minimizing bias in the parameter estimates, with reducing bias in standard errors as the third priority. First, values for missing data in the predictor variables were imputed using the WLSMV estimator with multiple imputation facilities of *Mplus* software, version 6.1 (Muthén & Muthén, 1998-2010). All predictor and outcome variables from the analytic model were included in the imputation model, along with some additional variables that correlate with ATOD use to improve imputation quality. Values for missing data in the exogenous variables were averaged across ten imputations. Second, missingness on the outcome variables was handled via FIML estimation, also available in *Mplus*, as part of the main analyses. Finally, 139 youth did not provide data for any of the outcome indicators and were not included in the main analyses, resulting in a final sample size of 1,550.

Analysis model

Latent class analysis (LCA), a latent variable approach that empirically defines qualitatively distinct subgroups or classes from multivariate data, was used in the current study. As a latent variable model, the variable of interest in an LCA is not directly observed; but, rather, derived from common variance associated with imperfectly measured (observed) indicators. The resultant latent variable is considered to be free of measurement error. Unlike traditional factor-based latent variable models, which assume that the underlying distribution of the latent is normal, continuous, latent class analysis assumes that the latent variable is nominal (or categorical ordered) and each level represents a qualitatively distinct class of individuals within the population. The LCA model, as applied, assumes conditional independence (i.e., that the relations among observed indicators are fully captured by the latent variable) among the observed indicators. Latent classes were defined by observed ATOD variables described above. Best practice dictates that a series of models with progressively greater complexity (i.e., more latent classes) be tested to determine optimal model fit (Collins & Lanza, 2010). Model fitting was terminated at the six class solution due to low class proportions in additional classes and non-preferred fit statistics. Per convention, equality constraints were placed on class-specific variances to aid in model estimation with a modest sample size. Final model selection was based on information criteria (AIC, BIC, adj. BIC), the deviance statistic, class proportions, and substantive theory. The bootstrapped likelihood ratio test (bLRT; Nylund, Asparouhov, & Muthén, 2007) was also used to guide final model selection. Multinomial logistic regression with a latent outcome was used to test for effects of early adolescent predictors. All predictors were grand-mean-centered and the MLR estimator was used for all analyses to take non-normality of observed indicators into account. All analyses were conducted in *Mplus* software, version 6.1 (Muthén & Muthén, 2010).

In the second stage of analysis, we aimed to predict membership across the ATOD-using latent classes derived in the first step. Multiple risk factors representing each ecological domain were selected to represent various facets of risk. Inclusion of multiple risks per

domain yielded problems of multicollinearity within ecological domains; thus special considerations were made in the analytic strategy. Multicollinearity was handled by using a multiple step procedure to testing. First, risk factors were grouped into six distinct clusters, each representing a separate ecological domain (with two clusters reflecting individual-level risk): demographic factors (ethnicity, sex, SES), early ATOD use (use of alcohol, cigarettes, or marijuana before age 12), family factors (parental support, parental monitoring), peer factors (bullied as a child, association with antisocial peers), school factors (perceptions of safety at school, academic achievement, school climate, grade retention), and community factors (enriching environment, exposure to community violence, urban environment). Omnibus tests for an overall effect of any risk cluster (controlling for the effects of all other risk clusters) were performed with the polyuse class as the reference group (rendering all estimates comparisons to the highest-risk group). If the omnibus test was significant, pairwise post hoc comparisons within each risk cluster were conducted (a total of six per cluster). Each pairwise post hoc model controlled for the effects of all other ecological predictors. Family-wise, alpha inflation was controlled using the Holm-Bonferroni (stepwise Bonferroni) procedure (Holm, 1979) for the omnibus tests and all post hoc comparisons.

Results

Univariate class proportions for all observed indicators of the outcome, across latent class, appear in Table 3.

Model selection

The first step of our analysis involved testing a series of models with a progressively larger number of latent classes to determine the number of classes that provided optimal fit to the data. Results of model fitting are reported in Table 4. Approximate fit statistics favored the three-, four-, or five-class solution. The five-class solution was deemed to be unstable because the best loglikelihood value was not replicated over 1000 starts and was therefore removed from further model testing. The four-class solution was selected over the three-class solution because the bLRT indicated that the removal of the fourth latent class would significantly hurt model fit (Deviance=250.583, $df=35$, $p<0.05$). The inclusion of the fourth class (but not fifth class) was deemed to add unique substantive information to the model.

Item response probabilities for each observed outcome indicator across latent class appear in Figures 1a-1d.

The four classes were qualitatively distinct in terms of quantity of use of each substance and high-risk behaviors associated with use. The first class (herein referred to as the “majority class”) captured the behavior of approximately 56% of adolescents (implied $n=867$), and reflected minimum or experimental use only. These youth had a low probability of using marijuana, alcohol, or cigarettes, and were unlikely to have engaged in any high-risk behaviors associated with use. The second latent class (comprised of approximately 23% of youth; implied $n=356$) were likely to use alcohol and cigarettes, but were unlikely to report using other substances. Use of these substances was risky, with a high probability of engaging in high episodic drinking or drinking before or during school hours. Youth in the third latent class (approximately 10.5% of youth; implied $n=163$) – herein referred to as “smoking class” – had a high probability of smoking cigarettes and marijuana, and were unlikely to drink alcohol. Youth in this class displayed risky use through their relatively high probability of illicit substance use (in addition to marijuana) and smoking marijuana before or during school hours. The fourth latent class – herein referred to “polyuse” class – comprised approximately 10.5% of all youth (implied $n=163$) and can be described as the highest risk ATOD users. These youth had a high probability of regular use of all substances, and were the most likely to engage in all associated risk behaviors.

Put together, results indicated four latent classes: (1) reflecting minimal ATOD use or experimentation; and three risky “types” of ATOD users: (2) those who engage in risky (albeit the more commonly used substances of alcohol and cigarettes) use characterized by a high probability of drinking, including heavy episodic drinking and drinking that would interfere with academic performance; (3) those who engage in health-compromising cigarette and marijuana smoking, including use that may interfere with academic functioning; and (4) youth who engaged in regular use of all ATOD use and associated risk behaviors. Although the behavior of all three classes could be described as high-risk, the behavior of the polyuse class was deemed to be *riskier* than the behavior of the alcohol and cigarette, or smoking latent classes.

Early adolescent predictors of class membership

In the second stage of analysis, we aimed to predict membership across the four latent classes. In particular, we aimed to distinguish between the high-risk classes (i.e., smoking and alcohol and cigarette classes) and the higher-risk polyuse class based on early adolescent factors. An omnibus Wald test to test for differential prediction of each predictor set on class membership in the full model was conducted. Each risk cluster was tested in the model including all other risk clusters, rendering the omnibus test a test of the partial effects of each risk cluster (hold all other risk clusters constant). Results of the omnibus test for differences across latent classes on each predictor cluster are shown in Table 5.

Demographic factors, early ATOD use, family factors, and peer factors were shown to significantly differentiate between classes. To better understand the nature of this prediction, pairwise post hoc comparisons for each logistic regression in the model were run. Results for all pairwise contrasts (with adjusted p-values for multiple comparisons) are reported in Table 6. Differences in demographic variables (ethnicity, sex, and SES) were found between the majority class and the alcohol and cigarette class ($p < .008$) and the high-risk class ($p < .010$). Early substance use was predictive of membership in any of the ATOD use classes (polyuse, $p < .008$; smoking, $p < .010$; alcohol and cigarette, $p < .013$), but we did not find evidence for differential prediction across the high-risk versus *higher-risk* latent classes. Peer factors differentiated between the polyuse class and the majority class ($p < .010$) and the smoking class ($p < .008$). Specifically, association with an antisocial peer group increased the likelihood of being in the polyuse class over the majority use class ($OR = 1.11$; .95 $CI = 1.04-1.19$), while being bullied as a child increased the likelihood of being in the smoking group over the majority group. Of particular interest, youth who were repeatedly bullied as children were 54% more likely to be in the smoking class than the polyuse class ($OR = 1.54$, .95 $CI = 1.24-1.85$).

Discussion

The purposes of the current study were to 1) identify qualitatively distinct subpopulations of ATOD users in a normative sample of older adolescents; and 2) examine ecological risk factors that discriminate between levels of high-risk ATOD use. Latent class analyses indicated that ATOD use is not a homogenous behavior. Four distinct and discriminable patterns of ATOD use were uncovered: a “majority” class comprised of about 56% of youth whose ATOD use was minimal; an “alcohol and tobacco” class who engaged in risky alcohol and cigarette use but abstained from marijuana use; a “smoking” class who engaged in risky cigarette and marijuana use but abstained from alcohol use; and a “polyuse” class characterized by regular use of all substances and a relatively high probability of engaging in associated risk behaviors. The likelihood of membership in each latent class was shown to be based on exposure to ecological risk factor during childhood and early adolescence. In particular, maladaptive peer experiences during childhood and early adolescence was shown to differentiate between ATOD use classes. Youth who associated with an antisocial peer

group early in life were at increased risk of being polyusers later in life. Conversely, youth who were bullied as children were more likely to be smokers than the higher-risk polyusers or the lower risk majority users. Early use of ATODs placed youth at risk for any of the ATOD use classes over the majority class, and differences in the demographic profiles between the majority group and risk groups emerged.

The salience of peer factors in shaping ATOD use behaviors during adolescence has received substantial attention in the empirical literature, and our findings are consistent with the existing literature base (Dodge et al., 2009). Youth who associated with an antisocial peer group were more likely to engage in much higher-risk ATOD use than the majority of youth, pointing to socialization processes associated with high-risk behaviors (Andrews, Hops, & Scheier, 2010). Interestingly, our findings also pointed to a relationship between being bullied as a child and later smoking behavior. These findings were somewhat consistent with other research teams who report greater odds of smoking among bullied youth (Vieno, Gini & Santello, 2011; Radliff, Wheaton, Robinson & Morris, 2012; Weiss, Mouttapa, Cen, Johnson, & Unger, 2011); however, our findings further this literature in two important ways. First, we illustrate that the increased risk of smoking is not limited to cigarette use, but rather reflects an increased risk of both cigarette and marijuana smoking, as well as a relatively heightened risk for other illicit drug use and use of ATODs in ways that would cause functional impairment (e.g. use during school hours). Second, our findings suggest that although early peer victimization predicted membership in the high-risk, smoking class over the minimal risk, majority class, the risk of being in the *higher*-risk polyuse class was lesser (as compared to being in the smoking class) among youth who were bullied. This is somewhat contrary to the expectation that peer victimization is a universal risk factor for high-risk behavior, and data showing that school safety is linked to high-levels of drug use (Perra, et al., 2012). One hypothesized mechanism behind this relationship is that youth who were bullied may use smoking substances for self-medication and to cope with psychosocial stress associated with victimization. Smoking may be a way to reduce anxiety, frustration, and hostility associated with recurrent social stress (Hampson, Andrews, & Barckley, 2007; Delfino, Jamner, & Whalen, 2001). However, since victimized youth tend to be socially isolated (Georgiou & Stavrinides, 2008; Spriggs, Iannotti, Nansel, & Haynie, 2007), they may be protected from maladaptive socialization processes associated with membership in the polyuse class. Future work is needed to better explain these complex relations between peer interactions and qualitatively distinct ATOD use patterns.

A somewhat surprising outcome of this study was the limited number of significant predictors of highest risk use. There may be one or more reasons for these null effects. First, it is possible that, given use beyond minimal levels, early adolescent risks may simply not strongly predict between qualitative typologies of high risk ATOD use. If so, this may have strong implications for the identification of the highest-risk youth during adolescents, suggesting that the degree of risk behavior later in life may be poorly defined by earlier levels of risk. This may suggest that identifying youth at highest-risk may not be a feasible approach to intervention due to challenges in actually targeting youth, and other population-based or harm-reduction models may be more effective (Bonell & Fletcher, 2008). Alternatively, null findings may simply be an artifact of measurement. This study examined the effects of an observed, exogenous variable on membership into a latent class. Power to detect this type of prediction remains unknown in the methodological literature. Null effects may be related to low power for small effect sizes and should be investigated more thoroughly in a larger sample. Related, this study often measured predictors using single item indicators, many of which contained a binary response set (e.g., “urban versus rural” as an indicator of neighborhood type). Dichotomization of predictors may have limited our ability to uncover significant results. Additional work using multi-methods of assessment (including items with more variable response sets) is recommended to better delineate

whether null findings reported in this study reflect a true null relation in the population or are simply the byproduct of measurement selection in this paper.

The sophisticated statistical approach we used to estimate subgroups of adolescents allowed us to simultaneously estimate patterns of use of multiple substances without necessitating an a priori operationalization of what constitutes problematic behavior. This allowed us to accurately capture ATOD use as it exists in a normative population, thereby providing a more ecologically valid assessment of ATOD use in a generally adolescent population. It is common practice to pre-define ATOD abuse or problem ATOD use based on quantity of use (Baumrind, 1991; Kaplan et al., 1986; Scheier et al., 1997; Siebenbruner et al., 2006; Stice et al., 1998; Windle, 1996). The results presented here suggest that this practice may not accurately reflect the qualitative distinctness of latent subgroups. Differences were not solely just a matter of degree of use or diagnostic criteria. The “alcohol and cigarette”, “smoking” and “polyuse” class all used substances on a regular basis and often engaged in behaviors that would cause functional impairment. The distinctiveness of ATOD use classes was related to the *types* of substances used and level of engagement in associated risk behavior. Although both groups used ATODs regularly, groups were characterized by important qualitative differences, such as the pattern and frequency of use of each substance and probability of engaging in risk behaviors. *A priori* definitions that focused on only one or substances may miss important information and incorrectly label youth as user or misuser.

An additional strength of our model pertains to the estimation of the beta parameters (i.e., slope and intercept) in the logistic regression of early risk factors on latent class membership. In our approach, youth were not formally assigned to one latent class or another, as is typically done in traditional data-analytic approaches. Rather, the *probability* of membership in each class was estimated based on an individual's item responses. This procedure reduced error associated with misclassification of latent class.

This study has certain limitations that are worth particular note. First, the sample, though substantial in size, was normative and therefore did not include a large proportion of high-risk youth. Inclusion of a high-risk sample may have yielded greater power to distinguish finer nuanced response patterns. Similarly, observations in this study focused on the most commonly used drugs by adolescents in the US – i.e., cigarettes, alcohol, and marijuana – with a single item for all other illicit substances. Inclusion of more specific drugs or higher-risk populations may have resulted in additional latent classes (e.g. “prescription drug users”; “steroid users”; “IV drug users”). Future work may wish to examine latent classes of high-risk ATOD use across diverse populations and substances. Second, to obtain final parameter estimates and standard errors, we averaged across ten imputations. In full multiple imputation, the analyst is generally able to account for between imputation variability in the imputed responses by following the rules presented by Rubin (1987). Because our parameters linked to non-imputed data, we used the simple average across imputations. While this procedure produced the best estimate of the regression parameters, the standard errors were somewhat underestimated. Our analysis is thus likely to be overpowered to an unknown degree. The proportion of missing data on outcome indicators was modest, ranging from 8% to 9%, which likely mitigated this concern. Last, the outcome data used in this study was collected in 2001 (Round 5 of the NLSY97). Although we recognize limitations associated with using data with approximately 10 years lapsed since the data being used for follow-up, the NLSY97, with its prospectively assess, large, nationally representative sample brings tremendous and arguably unique strengths among US datasets.

The findings presented in the current study lay the foundation for a rich area of future inquiry for prevention scientists. Future research should examine the longitudinal transitions

of these latent classes and how membership in a particular class relates to more distal outcomes (e.g. young adult employment, college attendance, adult ATOD use) can be informative in clinical applications. Understanding the factors that predict high-risk versus *higher-risk* drug use may inform harm reduction-based programs. Programs that focus on decreasing risk (rather than supporting complete ATOD abstinence) may show increased effectiveness in treating ATOD behavior. The identification and prediction, as well as *sequelae*, of qualitatively distinct adolescent substance use patterns are thus subjects for further research.

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References

- Andrews, JA.; Hops, H.; Scheier, PL. The influence of peers on substance use. In: Scheier, LM., editor. *Handbook of drug use etiology: Theory, methods, and empirical findings*. Washington, DC US: American Psychological Association; 2010. p. 403-420.
- Baumrind D. The influence of parenting style on adolescent competence and substance use. *The Journal of Early Adolescence*. 1991; 11(1):56-95.
- Bobo JK, Husten C. Sociocultural influences on smoking and drinking. *Alcohol Research & Health*. 2000; 24(4):225-232. [PubMed: 15986717]
- Bonell CC, Fletcher AA. Addressing the wider determinants of problematic drug use: Advantages of whole-population over targeted interventions. *International Journal Of Drug Policy*. 2008; 19(4): 267-269.10.1016/j.drugpo.2007.09.005 [PubMed: 18032013]
- Clark DB, Cornelius JR, Kirisci L, Tarter RE. Childhood risk categories for adolescent substance involvement: A general liability typology. *Drug and Alcohol Dependence*. 2005; 77(1):13-21. [PubMed: 15607837]
- Collins, LM.; Lanza, ST. *Latent class and latent transition analysis with applications in the social, behavioral, and health sciences*. Hoboken, New Jersey: John Wiley and Sons, Inc; 2010.
- Cornelius JR, Clark DB, Reynolds M, Kirisci L, Tarter R. Early age of first sexual intercourse and affiliation with deviant peers predict development of SUD: A prospective longitudinal study. *Addictive Behaviors*. 2007; 32(4):850-854. [PubMed: 16839696]
- Costa FM, Jessor R, Turbin MS. Transition into adolescent problem drinking: The role of psychosocial risk and protective factors. *Journal of Studies on Alcohol*. 1999; 60:480-490. [PubMed: 10463804]
- Delfino RJ, Jamner LD, Whalen CK. Temporal analysis of the relationship of smoking behavior and urges to mood states in men versus women. *Nicotine & Tobacco Research*. 2001; 3(3):235-248.10.1080/14622200110050466 [PubMed: 11506767]
- Dodge KA, Malone PS, Lansford JE, Miller S, Pettit GS, Bates JE. A dynamic cascade model of the development of substance-use onset: IX Adolescent peer context factors. *Monographs of the Society for Research in Child Development*. 2009; 74(3):75-78.
- Donaldson, L. *Tackling the health of the teenage nation: Chief medical officer's annual report 2007*. London: Department of Health, England; 2008.
- Duff C. Party drugs and party people: Examining the 'normalization' of recreational drug use in Melbourne, Australia. *International Journal Of Drug Policy*. 2005; 16(3):161-170.10.1016/j.drugpo.2005.02.001
- Duncan SC, Alpert A, Duncan TE, Hops H. Adolescent alcohol use development and young adult outcomes. *Drug and Alcohol Dependence*. 1997; 49(1):39-48. [PubMed: 9476698]
- Enders CK, Gottschall AC. Multiple imputation strategies for multiple group structural equation models. *Structural Equation Modeling: A Multidisciplinary Journal*. 2011; 18(1):35-54.
- Georgiou SN, Stavriniades P. Bullies, victims and bully-victims: Psychosocial profiles and attribution styles. *School Psychology International*. 2008; 29(5):574-589.10.1177/0143034308099202

- Godfrey, C.; Eaton, G.; McDougall, C.; Culyer, A. The economic and social costs of drug use in England and Wales in 2000 Home office research study. London: Home Office; 2005.
- Griffin KW, Botvin GJ, Epstein JA, Doyle MM, Diaz T. Psychosocial and behavioral factors in early adolescence as predictors of heavy drinking among high school seniors. *Journal of Studies on Alcohol*. 2000; 61(4):603–606. [PubMed: 10928731]
- Hampson SE, Andrews JA, Barckley M. Predictors of the development of elementary-school children's intentions to smoke cigarettes: Hostility, prototypes, and subjective norms. *Nicotine & Tobacco Research*. 2007; 9(7):751–760.10.1080/14622200701397908 [PubMed: 17577804]
- Hawkins JD, Catalano RF, Miller JY. Risk and protective factors for alcohol and other drug problems in adolescence and early adulthood: Implications for substance abuse prevention. *Psychological Bulletin*. 1992; 112(1):64–105. [PubMed: 1529040]
- Hawkins JD, Graham JW, Maguin E, Abbot R, Hill KG, Catalano RF. Exploring the effects of age of alcohol use initiation and psychosocial risk factors on subsequent alcohol misuse. *Journal of Studies on Alcohol*. 1997; 58(3):280–290. [PubMed: 9130220]
- Hersh MA, Hussong AM. The association between observed parental emotion socialization and adolescent self-medication. *Journal of Abnormal Child Psychology*. 2009; 37:493–506. [PubMed: 19137423]
- Holm S. A simple sequentially rejective multiple test procedure. *Scandinavian Journal of Statistics*. 1979; 6(2):65–70.
- Hunt, G.; Moloney, M.; Evans, K. Youth, drugs and nightlife. New York: Routledge; 2010.
- Johnston, LD.; O'Malley, PM.; Bachman, JG.; Schulenberg, JE. Monitoring the Future national results on adolescent drug use: Overview of key findings, 2010. Ann Arbor: Institute for Social Research, The University of Michigan; 2011.
- Kaplan HB, Martin SS, Johnson RJ, Robbins CA. Escalation of marijuana use: Application of a general theory of deviant behavior. *Journal of Health and Social Behavior*. 1986; 27(1):44–61. [PubMed: 3486897]
- McCrystal P, Percy A. A profile of adolescent cocaine use in Northern Ireland. *International Journal of Drug Policy*. 2009; 20(4):357–364.10.1016/j.drugpo.2008.09.005 [PubMed: 19010657]
- Measham F, Newcombe R, Parker H. The normalization of recreational drug use amongst young people in North-West England. *British Journal Of Sociology*. 1994; 45(2):287–312.10.2307/591497 [PubMed: 8055218]
- Muthén, LK.; Muthén, BO. Mplus User's Guide. Sixth. Los Angeles, CA: Muthén & Muthén; 1998-2010.
- Newcomb MD, Bentler PM. Substance use and abuse among children and teenagers. *The American Psychologist*. 1989; 44(2):242–248. [PubMed: 2653136]
- Newcomb MD, Maddahian E, Bentler PM. Risk factors for drug use among adolescents: Concurrent and longitudinal analyses. *American Journal of Public Health*. 1986; 76(5):525–531. [PubMed: 3485928]
- Newcombe R, Measham F, Parker H. A survey of drinking and deviant behaviour among 14/15 year olds in north west England. *Addiction Research*. 1995; 2(4):319–341.10.3109/16066359509005552
- Nylund KL, Asparouhov T, Muthén BO. Deciding on the number of classes in latent class analysis and growth mixture modeling: A Monte Carlo simulation study. *Structural Equation Modeling*. 2007; 14(4):535–569.
- Osgood D, Wilson JK, O'Malley PM, Bachman JG. Routine activities and individual deviant behavior. *American Sociological Review*. 1996; 61(4):635–655.10.2307/2096397
- Parker, H.; Aldridge, J.; Measham, F. *Illegal leisure: The normalisation of adolescent recreational drug use*. London: Routledge; 1998.
- Parker H, Williams L, Aldridge J. The normalization of 'sensible' recreational drug use: further evidence from the North West England longitudinal study. *Sociology*. 2002; 86:941–960.
- Perra O, Fletcher A, Bonell C, Higgins K, McCrystal P. School-related predictors of smoking, drinking and drug use: Evidence from the Belfast Youth Development Study. *Journal Of Adolescence*. 2012; 35(2):315–324.10.1016/j.adolescence.2011.08.009 [PubMed: 21907402]

- Radliff KM, Wheaton JE, Robinson K, Morris J. Illuminating the relationship between bullying and substance use among middle and high school youth. *Addictive Behaviors*. 2012; 37(4):569–572.10.1016/j.addbeh.2012.01.001 [PubMed: 22277772]
- Rubin, DB. Multiple imputation for nonresponse in surveys. New York: J. Wiley & Sons; 1987.
- Rutter, M. Protective factors in children's responses to stress and disadvantage. In: Albee, GW.; Joffe, JM.; Kent, MW.; Rolf, JE., editors. *Primary prevention of psychopathology: Vol 3: Social competence in children*. Hanover, NH: University Press of New England; 1979. p. 44-79.
- Scheier, L. *Handbook of drug use etiology: Theory, methods, and empirical findings*. Washington, DC US: American Psychological Association; 2010.
- Scheier LM, Botvin GJ, Baker E. Risk and protective factors as predictors of adolescent alcohol involvement and transitions in alcohol use: A prospective analysis. *Journal of Studies on Alcohol*. 1997; 58(6):652–667. [PubMed: 9391926]
- Seaman, P.; Ikegwuonu, T. *Young people and alcohol: Influences on how they drink*. York: Joseph Rowntree Foundation; 2010.
- Shedler J, Block J. Adolescent drug use and psychological health. A longitudinal inquiry. *The American Psychologist*. 1990; 45(5):612–30. [PubMed: 2350080]
- Siebenbruner J, Englund MM, Egeland B, Hudson K. Developmental antecedents of late adolescence substance use patterns. *Development and Psychopathology*. 2006; 18(2):551–71. [PubMed: 16600067]
- Spriggs AL, Iannotti RJ, Nansel TR, Haynie DL. Adolescent bullying involvement and perceived family, peer and school relations: Commonalities and differences across race/ethnicity. *Journal of Adolescent Health*. 2007; 41(3):283–293.10.1016/j.jadohealth.2007.04.009 [PubMed: 17707299]
- Stice E, Barrera M, Chassin L. Prospective differential prediction of adolescent alcohol use and problem use: Examining the mechanisms of effect. *Journal of Abnormal Psychology*. 1998; 107(4):616–628. [PubMed: 9830249]
- Tyas SL, Pederson LL. Psychosocial factors related to adolescent smoking: A critical review of the literature. *Tobacco Control*. 1998; 7(4):409–420. [PubMed: 10093176]
- Vieno A, Gini G, Santinello M. Different Forms of Bullying and Their Association to Smoking and Drinking Behavior in Italian Adolescents. *Journal of School Health*. 2011; 81(7):393–399. [PubMed: 21668879]
- von Sydow K, Lieb R, Pfister H, Höfler M, Wittchen HU. What predicts incident use of cannabis and progression to abuse and dependence?: A 4-year prospective examination of risk factors in a community sample of adolescents and young adults. *Drug and Alcohol Dependence*. 2002; 68(1): 49–64. [PubMed: 12167552]
- Weiss JW, Mouttapa M, Cen S, Johnson C, Unger J. Longitudinal Effects of Hostility, Depression, and Bullying on Adolescent Smoking Initiation. *Journal of Adolescent Health*. 2011; 48(6):591–596.10.1016/j.jadohealth.2010.09.012 [PubMed: 21575819]
- Windle M. An alcohol involvement typology for adolescents: Convergent validity and longitudinal stability. *Journal of Studies on Alcohol*. 1996; 57:627–637. [PubMed: 8913994]

Figure 1.

- Item response probabilities for each latent class (binary indicators).
- Item response probability for marijuana frequency across latent classes.
- Item response probabilities for alcohol frequency across latent class.
- Item response probabilities for cigarette smoking across latent classes.

Table 1

Demographic characteristics of sample

	Full sample (n=1,550)	ATOD-use class			
		Majority (56%; n ^a =867)	Alc/Cig (23%; n ^a =356)	Smoking (10.5%; n ^a =163)	Polyuse (10.5%; n ^a =163)
Sex					
Male	.517	.233	.227	.283	.257
Female	.483	.267	.273	.220	.241
Ethnicity					
Black	.246	.386	.224	.228	.163
White	.527	.209	.314	.183	.294
Hispanic	.216	.265	.372	.152	.212
Mixed Race	.012	.141	.090	.437	.331

n^a=implied n

Table 2**Raw frequencies for the full range of values of ATOD use variables**

		Number of days used(raw frequencies)																														
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Alcohol	926	175	128	70	49	82	12	14	9	7	32	2	8	0	2	14	1	0	1	0	10	1	0	0	1	1	0	0	0	0	0	3
	1110	51	36	16	16	28	2	0	4	4	14	1	4	0	1	18	0	0	1	0	15	0	2	3	2	9	3	2	7	8	191	
Marijuana	1266	50	43	25	13	17	7	2	3	3	17	1	1	0	0	15	0	1	1	1	15	0	1	0	0	12	1	5	4	1	42	

Table 3

Univariate proportions of observed indicators.

Indicator	N	Proportion
Used illicit drugs	115	.07
Marijuana school	105	.07
Alcohol school	117	.08
Heavy Episodic Drinking	314	.20
Marijuana Frequency		
0 days	1266	.818
1 day	50	.032
2-29 days	189	.122
30 days	42	.027
Alcohol Frequency		
0 days	926	.598
1 day	175	.113
2-29 days	444	.287
30 days	3	.002
Cigarette Frequency		
0 days	110	.717
1 day	51	.033
2-29 days	196	.127
30 days	191	.123

Table 4

Fit Criteria for Different Model Specifications (averaged across imputations).

Model	Number of Classes					
	1-class	2-class	3-class	4-class	5-class ^a	6-class
Deviance	11482.248	9509.322	9090.286	8901.876	8794.758	8700.844
AIC	11508.248	9605.322	9256.285	9137.875	9100.757	9076.844
BIC	11577.746	9861.931	9700.004	9768.704	9918.697	10081.894
adjBIC	11536.448	9709.446	9436.333	9393.846	9432.652	9484.662
df	13	48	83	118	153	188
<i>Estimated latent class proportions(implied n)</i>						
Class 1	1.00 (1,550)	.305 (473)	.130 (201)	.560 (867)	.530 (822)	.109 (170)
Class 2	-	.695 (1077)	.216 (335)	.230 (356)	.232 (359)	.093 (144)
Class 3	-	-	.654 (1014)	.105 (163)	.094 (145)	.177 (275)
Class 4	-	-	-	.105 (163)	.029 (45)	.063 (98)
Class 5	-	-	-	-	.115 (178)	.100 (155)
						.457 (708)

^a Best loglikelihood value was not replicated with 1000 starts.

Table 5

Omnibus test (Wald) of predictors of latent class

Predictor	Wald	df	p-value	alpha (adjusted) ^a	sign
Demographics	45.914	15	.0001	.01	*
Early ATOD use	57.809	9	.0000	.008	*
Family factors	24.946	12	.0151	.017	*
Peer factors	19.486	6	.0034	.0125	*
School factors	20.127	12	.0647	.025	
Community factors	5.351	9	.8027	.05	

^aCorrections for alpha inflation were made using the Holm (stepwise)-Bonferroni method

Table 6

Pairwise contrasts (Wald) of predictors of latent class

Predictor/contrast	Wald	df	p-value	alpha(adjusted) ^a	sign
Demographics					
Polyuse vs Majority	16.285	5	.0061	.010	*
Polyuse vs Alc/Cig	4.409	5	.4922	.025	
Polyuse vs Smoking	3.385	5	.6409	.050	
Alc/Cig vs Smoking	14.206	5	.0144	.013	
Alc/Cig vs. Majority	26.802	5	.0001	.008	*
Smoking vs. Majority	6.075	5	.2990	.017	
Early ATOD use					
Polyuse vs Majority	40.972	3	.0000	.008	*
Polyuse vs Alc/Cig	5.973	3	.1129	.025	
Polyuse vs Smoking	1.680	3	.6414	.050	
Alc/Cig vs Smoking	9.420	3	.0242	.017	
Alc/Cig vs. Majority	23.812	3	.0000	.013	*
Smoking vs. Majority	34.881	3	.0000	.010	*
Family factors					
Polyuse vs Majority	6.473	4	.1665	.025	
Polyuse vs Alc/Cig	3.460	4	.4840	.050	
Polyuse vs Smoking	9.095	4	.0588	.010	
Alc/Cig vs Smoking	8.092	4	.0882	.013	
Alc/Cig vs. Majority	9.688	4	.0460	.008	
Smoking vs. Majority	6.544	4	.1620	.017	
Peer factors					
Polyuse vs Majority	9.844	2	.0073	.010	*
Polyuse vs Alc/Cig	4.532	2	.1037	.025	
Polyuse vs Smoking	11.133	2	.0038	.008	*
Alc/Cig vs Smoking	4.547	2	.1029	.017	
Alc/Cig vs. Majority	3.372	2	.1853	.050	
Smoking vs. Majority	8.240	2	.0162	.013	

^aCorrections for alpha inflation were made using the Holm (stepwise)-Bonferroni method