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Proximal and Distal Effects of Sensation Seeking and Parenting Environments on Alcohol Use Trajectories from Early Adolescence to Early Adulthood

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Abstract

Adolescent alcohol use is related to disinhibition traits and family environments. However, research is scarce on whether these factors predict alcohol use trajectories distally, from early adolescence into early adulthood. We examined whether sensation seeking and parenting environments in early adolescence predicted adolescents' alcohol use trajectories proximally (middle-adolescence) and distally (early adulthood). Using four waves of data from 345 adolescents (51.3% female; 80% white) and their primary caregivers, we estimated adolescents' alcohol use trajectories and examined variability in these by sensation seeking and parental control. The findings revealed distal, positive associations between sensation seeking and alcohol use; and negative, proximal associations between parental control and alcohol use. Also proximally, there was a significant interaction between sensation seeking and parental control. We discuss implications for theory and practice.

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Data Sharing and Declaration This manuscript's data will not be deposited.

Compliance with ethical standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures involving human participants were performed in accordance with the ethical standards of the institution and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent All adolescents in the study assented to participation; consent was obtained from each participants' primary caregiver.

Keywords

Alcohol use; Sensation seeking; Parenting; Early adolescence; Developmental Trajectories

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Introduction

Alcohol use is prevalent among adolescents, with over 75% of youth reporting having consumed alcohol by the age of 18 (Swendsen et al. 2012). The increasing prevalence of alcohol use across adolescence means that adolescence is a key developmental period for the emergence of alcohol related behaviors (Chen and Jacobson 2012). Although alcohol use in adolescence may be innocuous when not abused (e.g., heavy episodic drinking, drunkenness), adolescent consumption of alcohol has legal implications and it may still portend health risks later in life. For example, adolescents who consume alcohol, especially by age 15, are more at risk for alcohol related dependences in adulthood (Marshall 2014; McCambridge et al. 2011). Accordingly, researchers and interventionists seek a more complete understanding of the etiology of alcohol use trajectories during adolescence. Developmental perspectives are particularly helpful in this regard. According to bioecological theory (Bronfenbrenner and Morris 2006), development is driven by an individual's characteristics, his/her most salient and proximal social contexts, and the interactions among them. Applied to adolescents' alcohol use, specific child traits and family environments can make alcohol consumption more likely (Schulenberg and Maggs 2008; Cicchetti and Rogosch 2002). Importantly, developmental theory also suggests that these associations are not only likely to bear out proximally, but may also manifest distally. This happens as early-life experiences initiate far-reaching sequelae that influence behavioral trajectories across adolescence and into adulthood (Masten and Cicchetti 2010).

In this study, we examined whether the *proximal* and *distal* development of alcohol use across adolescence and into early adulthood varies meaningfully by adolescents' disinhibition traits and parenting environments, two well-established antecedents of adolescents' drinking. Specifically, we used multilevel growth models to examine whether sensation seeking and parental control, when experienced in early adolescence (ages 11–14), predicted alcohol use trajectories (initial levels, rates of increase across time) in two models: one centered at age 16 (evidence of proximal effects) and another centered at age 20 (evidence of distal effects). Because alcohol use becomes less risky and increasingly conventional as adolescents approach early adulthood, it is unclear whether disinhibition traits and parenting environments will continue to explain individual differences in alcohol use all the way into early adulthood. By estimating both proximal and distal effects, our study sheds light on how these factors (e.g., parenting environments, disinhibition traits) may influence the development of a behavior that is problematic in adolescence, but decreasingly so throughout the transition to adulthood. Within these analyses, we examined both the additive and multiplicative effects of these factors on trajectories of alcohol use.

Sensation Seeking as a Developmental Precursor of Alcohol Use

Sensation seeking, or the pursuit of intense, novel, and varied experiences (Zuckerman 1994), is elevated during early adolescence (Shulman et al. 2015). Although multiple forms

of behavioral disinhibition (e.g., impulsivity, externalizing problems) portend adolescent alcohol use, sensation seeking represents a unique pathway to drinking: because alcohol stimulates positive arousal, adolescents high in sensation seeking might consume alcohol as a means of affective enhancement (Magid et al. 2007). Sensation seeking is linked with adolescent drinking concurrently and prospectively (Stautz and Cooper 2013). Further, it reliably predicts within- and between-person variability in alcohol use trajectories from early to middle adolescence. Crawford and colleagues (2003) reported higher levels of sensation seeking in early adolescence predicted initial levels (intercepts) of alcohol use by high school. MacPherson and colleagues (2010) reported changes in sensation seeking from early to middle adolescence predicted changes in alcohol use during this same time.

Whether sensation seeking in early adolescence predicts farther-reaching trajectories into adulthood, however, is unknown. Other disinhibition traits early in life, including externalizing problems and impulsivity, predict alcohol consumption as far out as early- and middle-adulthood (Chassin et al. 2002; Englund et al. 2008). These disinhibition traits do not represent the same arousal-seeking pathways to alcohol use as sensation seeking, but given their correlation, associations between sensation seeking and distal alcohol use trajectories seem reasonable. We examined whether sensation seeking in early adolescence predicted alcohol use trajectories across middle adolescence and into early adulthood.

Parental Control as a Developmental Precursor of Alcohol Use

Adolescents' family environments play an important role in predicting adolescents' *proximal* alcohol use. In particular, family environments characterized by high levels of behavioral control, such as monitoring, consistent discipline and rule enforcement, and knowledge of the adolescent's activities and friends, predict a lower likelihood that adolescents will consume and/or abuse alcohol and other substances (Dishion and McMahon 1998; Barnes et al. 2000). However, the question remains as to whether such family environments, when experienced during early adolescence, can predict individual differences in drinking trajectories (initial levels and rates of change) into early adulthood. As individuals transition from adolescence into adulthood, they experience greater individuation from parents and spend more time in peer activities without the presence of adult supervision (Keijsers and Poulin 2013). However, theory and research are presently unclear as to whether the effects of parental control on alcohol use during early-adolescence persist across middle adolescence and into early adulthood.

Some evidence suggests this might be the case, linking parenting in early adolescence to trajectories of alcohol *abuse*. In one of the first investigations of this kind, Barnes and colleagues (2000) reported that greater monitoring predicted lower initial levels of alcohol misuse and lower rates of increase in heavy drinking into early adulthood. More recently, Abar and colleagues (2014) showed that the parallel trajectories of parental knowledge and adolescents' heavy episodic drinking were negatively associated from early to mid/late adolescence. Initial levels of parental knowledge were negatively related to initial levels of heavy episodic drinking, and higher rates of increase in parental knowledge were associated with a slower rate of increase in heavy episodic drinking.

Although informative, these findings speak specifically to alcohol *abusing* behaviors (e.g., heavy episodic drinking), and not to more general alcohol use. Heavy drinking remains an extreme and risky behavior for individuals at all ages. However, general alcohol use becomes more normative and socially acceptable as adolescents transition out of adolescence, although it remains illegal in the United States until the age of 21. Within such a context, parents' influences on their children's alcohol consumption becomes less clear. It seems that as the perceived risk and non-normativity of alcohol use diminishes over time, and as parental control diminishes, parents' influence in this domain is likely to attenuate over time and explain less meaningful variability in alcohol use. We examined whether parents' behavioral control in early adolescence would predict alcohol use trajectories proximally (at age 16) and distally (at age 20).

Parents' Problematic Substance Use

The family can also heighten opportunities for alcohol use during adolescence; substance use often aggregates within families and drinking patterns tend to transmit inter-generationally (Kerr et al. 2012). One salient factor that makes adolescents' alcohol consumption more likely is their parents' own problematic alcohol and drug use. Parents with alcohol or drug use disorders have children who consume alcohol more frequently (e.g., Chassin et al. 1999) and who are more likely to develop alcohol disorders themselves. This is attributable to a combination of environmental factors (such as greater accessibility of alcohol, modeling of drinking behavior, or compromised parenting environments) and inherited genetic predispositions for alcohol use (Cotton 1979). These factors manifest as early as late childhood (Chassin et al. 1996) and span into adulthood (Chassin et al. 1999). Because parents' problematic substance use can compromise parenting environments and may promote children's behavioral disinhibition, our two primary constructs, we accounted for its presence in adolescents' family environments, indexed as residing with a parent with a lifetime substance use disorder (SUD) diagnosis.

Person-Context Interactions in Alcohol Use

Bioecological theory posits that higher-order interactions between individual characteristics and ecological contexts are critical drivers of individual development (Bronfenbrenner and Morris 2006). Thus the multiplicative effects of sensation seeking and parenting environments are also relevant factors in the proximal and distal development of alcohol use trajectories. Such processes can provide a more complete and nuanced picture of how these salient characteristics and/or contexts might work together to diminish and/or amplify adolescents' alcohol use frequency.

Some studies report such interactive processes in the prediction of a number of deviant or risk behaviors. For example, structured and high-quality family environments are shown to buffer against risk vulnerabilities, including the influence of deviant peers (e.g., Marshal and Chassin 2000). Furthermore, when risk factors co-occur, they may be particularly deleterious. For example, and particularly relevant to the current study, when adolescents' disinhibition traits interact with low-structured parenting environments, their risk for deviant peer interaction and delinquent behavior is amplified (Mann et al. 2015). Therefore, in the

current study, a similar interaction between sensation seeking and parental control seems likely in predicting of alcohol use trajectories.

Somewhat less clear are interactions with parents' alcohol or drug use disorders. Consistent with a deviance proneness framework (Sher 1991), studies find that parents' problematic alcohol use is linked to adolescents' drinking in a mediated path through lower quality parenting (King and Chassin 2004) and children's elevated disinhibition (Ohannessian and Hesselbrock 2008). That is, when parents are heavy drinkers, family environments are more chaotic and children display less behavioral control, either as a function of these environments, shared genetic predispositions, or both. However, few studies examine whether these family-based risks *interact* with parenting practices or adolescents' disinhibition traits. For example, does parents' problematic alcohol use *amplify* the effects of children's sensation seeking? Similarly, although parental control predicts diminished alcohol use, does this remain true for adolescents who live with a parent with substance use problem? Relevant research is scarce; we examined how living with a parent with an substance use disorder (SUD) may qualify proximal and distal associations between sensation seeking, parenting environments, and adolescent alcohol use, and to see if these interactions persisted both proximally (middle-adolescence) and distally (early adulthood).

Present Study

This study had two overarching goals. The first was to examine how sensation seeking and parental control, when experienced during early adolescence, predicted characteristics of adolescents' alcohol use trajectories (intercepts, rates of change) spanning adolescence into early adulthood. We used multilevel growth models centered at age 16 and again at age 20 to examine these influences both proximally and distally, respectively. Based on theory and prior research, we predicted that sensation seeking in early adolescence would predict higher initial levels (intercept) of alcohol use at age 16 and at age 20. We also predicted that sensation seeking would predict higher rates of change (slope) over time in alcohol use frequency. We then predicted that parental control during early adolescence would predict lower levels of alcohol use at age 16 (intercept). Importantly, we expected to observe these associations above and beyond residence with a parent with a substance use disorder (SUD). However, due to diminishing parental control and an increasing social normativity of alcohol use as adolescents transition to early adulthood, we expected the magnitude of this parenting effect to attenuate by age 20.

The second goal of the study was to examine multiplicative effects of these factors and how they might interact to amplify and/or buffer one another in adolescents' alcohol use trajectories, both proximally (age 16) and distally (age 20). Based on literature indicating that risk vulnerabilities for deviant behavior can be buffered or enhanced by family environments (e.g., Mann et al., 2015; Marshal and Chassin 2000), we predicted that the sensation seeking pathway to alcohol use would be conditional upon the quality of adolescents' parenting environments. We also examined how a parents' SUD might qualify the effects of sensation seeking and parental control; predictions here were exploratory.

In all of our analyses, we accounted for adolescents' socio-cultural contexts, particularly in regards to sex, race, and social class. The antecedents and patterns of alcohol use in adolescence can be shaped by gendered and sociocultural norms (e.g., Schulte et al. 2009), as well as families' access to resources (Melotti et al. 2011). These factors may create individual differences in alcohol use trajectories by sex, ethnicity, and social class (e.g., Chen and Jacobson 2012), and therefore must be accounted for in the present study.

Central to addressing these questions was the use of a multilevel growth model with a logit link function. Our questions of how sensation seeking and parental control predict alcohol use trajectories were, at their core, developmental questions. Multilevel models adapt elegantly to nested observations and are able to produce *within-person* estimates of social processes. Further, one can estimate alcohol use frequency (i.e., the intercept) at multiple points of theoretical interest by re-centering predictors at chosen points in time (e.g., middle adolescence and early adulthood), reflecting precise estimates of individual differences in adolescents' alcohol use frequency at these chosen cross-sections (e.g., proximally and distally; King et al., 2017). This technique, therefore, is a particularly powerful analytic tool for our current questions. In the current study, models were examined with intercepts being centered at age 16 (middle adolescence) and age 20 (early adulthood).

Finally, the use of a logit link function circumvents traditional problems in modeling alcohol use data. First, alcohol use data tend to be highly skewed. Conventional approaches to normalizing these data rely on monotonic data transformations (e.g., logarithmic transformations) that retain between-person rank order. However, these transformations can bias *within-person* change processes and so they are inappropriate for modeling within-person growth patterns (Grimm et al. 2017). Second, substance use data are typically reported on ordinal scales. Treating these data as continuous is problematic because one cannot assume that the intervals between the response categories are equal. Indeed, progressing between low-ranking categories (e.g., "1–2 drinks per year" to "3–5 drinks per year") is likely much easier than progressing between higher-ranking categories (e.g., "1–2 drinks per week" to "3–5 drinks per week"). Logit link functions avoid both of these problems while they estimate parameters of growth and change (details are further described in the analytic strategy).

Method

Participants and Procedure

Data were drawn from the Adolescent/Adult Family Development Project (AFDP, Chassin et al. 1992), a multigenerational, longitudinal study on the intergenerational transmission of alcohol use. Initiated in 1988, the AFDP follows a community sample of 454 families, including parents (referred to as G1s for "generation 1"; 246 alcoholic, 208 non-alcoholic) and their children (referred to as G2s) (for recruitment procedures, see Chassin et al. 1992). These families were interviewed annually for three years (waves 1–3), and then at 5-year intervals for waves 4–6.

At wave 5 (in 2000), third generation members of these families (referred to as G3s) were enlisted in the study ($M_{\text{age}} = 7.40$), and G2s and G3s became the foci of the study for waves

5 and 6. The present study involved G3s who, at wave 6 (in 2005), were early adolescents (defined as 11–14 years of age) and their parents. The G3 adolescents were then followed up three times at an average of 18-months, 4 years, and 8 years after the wave 6 collection. Presently, 418 (81%) of the G3s have participated in the most recent data collection (8 year-follow up), and of these, 345 were early adolescents (ages 11–14) at Wave 6 (189 [54.8%] were 11 years old, 50 [14.5%] were 12 years old, 64 [18.6%] were 13 years old, and 42 [12.1%] were 14 years old). These 345 adolescents comprised the analytic sample. These adolescents were predominantly non-Hispanic Caucasian (79.6%), and Mexican-American participants (14%). A slight majority were female (53.2%). Ages at wave 6 (the first assessment for the present study) ranged from 11 to 14, with an average age of 12.23 ($SD = 1.25$). These G3 adolescents represented 243 unique nuclear families; 158 of these families had only one child participating (no other siblings), 71 families had 2 siblings, 12 families had 3 siblings, 1 family had 4 siblings, and 1 family had 5 siblings.

At wave 6, families were visited in their homes and they participated in an interview asking about their family relationships and their substance use patterns. The 18-month follow up involved telephone surveys; the last two followups were administered online. Collectively, all assessments represented ages 11–24, a cohort sequential design that allowed us to map developmental trajectories of alcohol use frequency throughout adolescence and into early adulthood.

Measures

Sensation seeking—At wave 6, parents rated their adolescents' sensation seeking using six items taken from Zuckerman's (1994) sensation seeking scale (SSS). The variable was a mean score of these six items, reported on a 5-point likert scale ($1 = Agree Strongly$, $5 = Disagree Strongly$): "My child would do almost anything on a dare," "My child does things on the spur of the moment," "My child likes being where there is something going on all the time," "My child likes to have new and exciting experiences," "My child likes to have new and exciting experiences, even if they are a little unconventional," and "My child likes wild parties." Responses were reverse coded so that high scores represented high levels of sensation seeking. Cronbach's alpha for this scale was $\alpha = .77$. Because there were many families in which parents were separated, reports were taken from parents identified as primary caregivers, defined as mothers ($n = 324$) unless children were living primarily with the fathers ($n = 21$). There were no significant differences in sensation seeking as reported by mothers versus fathers, $t(344) = -1.19$, $p = .24$.

Parental control—To assess a construct of parental control, we aggregated child reports on two scales: parental monitoring and parental consistency of discipline, which were measured at wave 6. To measure *parental monitoring*, we used 5 items adapted from a scale developed by Lamborn and colleagues (1991). The stem "Within the past three months, how much did your mother/father know..." was followed by: "who your friends were?", "where you were at night", "how you spent your money", "what you did with your free time", and "where you were most afternoons after school." Responses ranged from $1 = didn't know at all$ to $5 = knew all the time$. Cronbach's alpha for this scale was $\alpha = .83$.

Parental consistency of discipline was assessed using 10 items from the “Lax Discipline” subscale of the Children’s Report of Parental Behavior Inventory (CRPBI; Schaefer 1965). The stem “Within the past three months, my mother/father...” was followed by ten items, such as “soon forgot the rules s/he had made”, “punished me for doing something one day but ignored it the next”, and “changed his/her mind to make things easier for him/her.” Adolescents responded to these items about their primary caregiver, which was scaled on a five-point likert scale (1 = strongly disagree, 5 = strongly agree). Items were reverse scored so that higher scores indicated greater levels of parental consistency of discipline. Cronbach’s alpha was $\alpha = .74$.

Adolescents’ responses on the monitoring and consistency of discipline scales were highly correlated ($r = .63$) and so were averaged for an overall parental control score with higher values representing greater levels of parents’ behavioral control.

Residence with a biological parent with a substance use disorder—At wave 6, biological parents reported their drug or alcohol abuse and/or dependence according to DSM-IV criteria via the Computerized Diagnostic Interview Schedule (Robins et al. 2000). Adolescents reported on their living situation (e.g., live with both biological parents). We created a variable to reflect the number of biological parents with any substance use disorder (SUD) who lived with the adolescent. This variable (residence with a parent with a SUD) served to measure the risky family environment, with 10 (3%) adolescents living with 2 biological parent with a lifetime SUD, 86 adolescents (25%) living with one parent with a SUD, and 246 (72%) living with 0 biological parents with SUD. Because so few adolescents were living with 2 parents with a SUD, this variable was coded dichotomously for analyses (0 = not residing with a biological parent with a SUD; 1 = residing with one or two biological parents with a SUD).

Alcohol use frequency (past year)—Adolescents’ alcohol use frequency was assessed at each wave with a single item from the Alcohol, Health and Behavior study, “In the past year, how often did you drink alcohol?” (Sher 1993). Responses were rated on an 8-point likert scale. Response categories ranged from *Never*, *1–2 times*, *3–5 times*, *5 or more times but less than once per month*, *1–2 times per month*, *1–2 times per week*, *3–5 times per week*, and *almost every day*.

Age—At each wave, adolescents’ birth date (day, month, and year) was subtracted from the date of the interview/survey (day, month, and year) to derive their age.

Demographic controls—Information was collected on adolescents’ sex (1 = *male*, 2 = *female*), ethnicity (*Native American*, *Asian*, *Pacific Islander*, *African-American*, *Hispanic/Latina/o*, *White*, or *other*), and parent education (a proxy for socioeconomic status; 1 = *8th grade or less*, 2 = *some high school*, 3 = *high school graduate*, 4 = *GED*, 5 = *some vocational/technical school*, 6 = *completed vocational/technical school*, 7 = *some college*, 8 = *AA degree*, 9 = *BA or BS*, 10 = *some graduate/professional school*, 11 = *completed graduate/professional school*). Ethnicity was dummy coded for analyses, representing minority status (0 = *non-white minority*; 1 = *Non-Hispanic Caucasian*).

Analytic Strategy

Data screening and descriptive statistics—First, continuous predictors were screened for univariate outliers beyond ± 3.29 standard deviations from the mean. Then, patterns of missing data were examined and dummy codes for missingness were created for each of the key variables and used in logistic regressions as dependent variables to examine if there were variables within the data set that might predict missingness. Then, means, standard deviations, and correlations among the key variables were computed to identify preliminary patterns in the data.

Developmental trends in adolescents' alcohol use—A multilevel modeling framework was used to estimate developmental trends in alcohol use, with time indicated by adolescents' age. The multilevel framework allowed for the estimation of individual differences in intra-individual change patterns while appropriately accounting for the nested nature of the data (repeated observations within individuals). This also accounted for the nested nature of siblings within families. As such, between-family and between-person traits and characteristics were controlled.

Because the outcome variable, alcohol use frequency, was measured on an ordinal scale and was not normally distributed, all models were estimated with a logit link function (see Grimm et al. 2017). Rather than estimating an actual predicted value for alcohol use, this function transforms the prediction curve (not the data itself) to estimate the logarithmic odds of being in a particular response category. The parameter estimates using the logit link function are expressed in terms of the latent trait “ability”. For example, the intercept represents the average trait alcohol use “ability” across the sample at the centered age. Typically, the intercept is set at zero to identify the model, given that the latent variable has no inherent scale. The slope represents the average rate of change in trait alcohol use “ability” across time. Finally, threshold parameters, ω_c , are estimated which indicate the value of trait alcohol use for which the probability of scoring in or above a particular response category, c , is 0.50. As the outcome variable for this study, alcohol use, had eight response categories, the model estimated the seven thresholds that separate those response categories. For simplicity of expression, this latent trait “ability” is referred to herein as simply alcohol use frequency.

A model building approach was used to arrive at the best-fitting growth trajectories, beginning with a no-growth (i.e., intercept-only) model in which the effect of age (i.e., the slope) was constrained at zero, followed by a linear growth model that estimated age as a predictor of alcohol use (see Appendix for equations). The linear model was retained if it displayed better fit to the data than the previous, more parsimonious no-growth model. Fit was assessed using the Akaike Information Criterion (AIC; Akaike 1973) and the Bayesian Information Criterion (BIC; Akaike 1981). Lower values represent better fit to the data. Because these are comparative fit indices with no inherent scaling, they are only meaningful for purposes of model comparison.

Observations across all four assessments represented a wide age range (11–24). However, the observations after age 22 became particularly sparse (i.e., fewer than 20 observations at each age after 22), raising concerns about the robustness of the model at these later ages.

Therefore, we trimmed all observations after age 22, effectively narrowing our model to represent ages 11–22. To better understand the developmental processes at play, we estimated two sets of models, one in which the intercept was centered at age 16, and another model where the intercept is centered at age 20 where drinking behavior is considered increasingly normative, though still not legal in the United States. All available data until age 22 were used for these models ($n = 4$ waves, 1353 data points) and covariates were included for adolescents' sex, minority status, and parent education (see Appendix for equations).

Individual differences in proximal and distal alcohol use trajectories—Once a best-fitting growth model was obtained to describe developmental trends in alcohol use across adolescence, we then examined adolescents' sensation-seeking and parental control measured in early adolescence as predictors of individual differences in both the slope and intercept. We estimated two models, one in which the intercept was centered at age 16 and another model in which the intercept was centered at age 20. Because the time polynomial is a linear slope, the average overall slope, as well as the effects of the predictors on the slope, are unaffected by the re-centering of the variables; however, any differences in the effects of sensation seeking or parental control on the intercept from middle adolescence to early adulthood can be estimated. Controls were included for residence with a parent who has a substance use disorder (SUD), adolescent sex, minority status, and parent education.

Moderation by parent substance use disorder—The analyses culminated in models (again centered at age 16 and 20) testing for the effect of two-way interactions on the intercepts and slopes. Of primary interest were interactions between the main predictor variables (e.g., *parental control* $\times$ *sensation seeking*; *sensation seeking* $\times$ *parent SUD*; and *parental control* $\times$ *parent SUD*). Continuous predictors were grand-mean centered for these interactions and were all estimated in the same model. Models were estimated in *Mplus* 7.0 (Muthén and Muthén 1998–2013) using a full information maximum likelihood estimator (FIML), ensuring the inclusion of cases with missing data (Enders 2010).

Results

Data Screening

There were no outliers beyond ± 3.29 standard deviations on sensation seeking, although there were two outlying cases beyond -3.29 standard deviations on parental control; these cases were retained for analyses. Then, missing data patterns were analyzed on key study variables, revealing that data were missing for 5% of the cases on alcohol use. Little's MCAR test (Little 1988) was not significant, $X^2(9) = 16.48$, $p = .06$. However, because it approached significance and to be conservative, we rejected the null hypothesis that the missing values were missing completely at random (MCAR). To identify variables within the data set that might predict missingness, codes for missingness were created for each variable (0 = *non-missing*, 1 = *missing*) and logistic regressions were used to predict missingness from sex, minority status, and parent education. Logistic regressions with dummy codes for missingness revealed that missingness was more common among those

whose parents reported lower levels of formal education. As such, we included parent education as a covariate in the analyses.

Descriptive Statistics

At wave 6, adolescents reported high levels of parental control ($M = 4.29$; $SD = 0.52$, scale range 1–5) and parents reported moderate levels of their adolescents' sensation seeking ($M = 2.99$, $SD = 0.71$, scale range 1–5). Alcohol use frequency at wave 6 was correlated positively with age and sensation seeking, and negatively with parental control (see Table 1). At wave 6, about 28% of the adolescents were living with at least one biological parent with a substance use disorder. Age-related patterns of past year alcohol use frequency are presented by age in Table 2. Alcohol use was skewed at zero during early and middle adolescence, but gradually became more frequent and more variable by early adulthood.

Growth Models

First, a no-growth model was estimated in which an intercept, but no slope, was specified (i.e., slope was constrained at zero). Then, a linear slope was introduced and this model was compared to the previous model on the basis of model fit. The addition of the linear slope improved the model's fit over the no-growth model. As such, the linear model was retained. Table 3 displays comparative fit indices for these models, as well as the parameter estimates for the intercept and slope. These results indicated low initial levels of alcohol use at age 16, which increased in a steady, linear pattern into early adulthood. There was significant between-person variability in the age 16 and 20 intercepts and slopes.

Predictors of Growth Trajectories

To explain variability in the age 16 and 20 intercepts and slopes, sensation-seeking and parental control were entered as level-2 predictors of the random slopes and random intercepts, as were controls for parents' SUD, adolescents' sex, minority status, and parent education. This model was estimated with age centered at age 16 and again with age centered at age 20 (see Table 3).

Middle Adolescence—For the model centered at age 16, none of the demographic controls (parent education, sex, minority status) significantly predicted the intercept or slope. Above and beyond these, sensation seeking during early adolescence was associated with higher initial levels of alcohol use at age 16, whereas parental control predicted lower initial levels of alcohol use at this same age (see Table 3). That is, adolescents whose parents rated them higher on sensation seeking when they were early adolescents (ages 11–14) were predicted to show greater levels of alcohol use at age 16. Conversely, adolescents who perceived more parental control when they were early adolescents showed less frequent alcohol use at age 16. Parental control also predicted positive change in the slope, indicating that adolescents who perceived more parental control in early adolescence displayed more accelerated growth in alcohol use into early adulthood. Sensation seeking in early adolescence was unassociated with the alcohol use slope. Finally, parent SUD predicted greater initial levels of alcohol use at age 16, though it was not associated with rates of change. Interpreted, adolescents living with at least one parent with a substance use disorder

consumed alcohol more frequently at 16 than adolescents whose parents had no such diagnosis, but were not changing faster or slower across time.

Early Adulthood—In the model centered at age 20, the intercept was related to minority status ($\gamma = -0.69, p = .05$). Ethnic minority adolescents reported greater alcohol use frequency at age 20 than non-Hispanic Caucasian adolescents. Neither parent education nor adolescent sex predicted the alcohol use intercept or slope. Above and beyond these controls, sensation-seeking was positively associated with the intercept, but was unrelated to the slope. Parental control did not predict the age-20 intercept, but predicted a higher rate of change in alcohol use. Interpreted, the model predicted that adolescents higher on sensation seeking as early adolescents were higher in alcohol use at age 20, although their rates of change over time were no different. On the other hand, higher parental control in early adolescence no longer predicted lower alcohol use by age 20, perhaps because it had predicted a higher rate of change throughout adolescence. Parent SUD was unrelated to the age-20 slope and intercept.

Interactions among Sensation Seeking and Parenting Environments

Next, we tested two-way interactions involving the main predictors (i.e., sensation seeking-by-parental control; sensation seeking-by-parent SUD; parental control-by-parent SUD). Results of these interactions are presented in Tables 4 and 5. There were no significant two-way interactions with parent SUD in the prediction of the age 16 or age 20 intercepts or slopes. There was a significant and negative interaction between sensation-seeking and parental control in the prediction of the age 16 intercept. Interpreted, the relation between sensation seeking and alcohol use was more strongly positive for adolescents from parenting environments characterized by less control when they were early adolescents. Simple slopes for parental control, plotted at the mean and 1 *SD* above and below the mean, indicated that the effect of sensation seeking on the alcohol use intercept at age 16 was significant only at low levels of parental control (see Figure 1a in Appendix). The simple slopes for sensation seeking at mean and high levels of parental control were not significantly different from zero. More specifically, early adolescents' sensation seeking is predictive of their age 16 alcohol use, but this effect is buffered by parental control such that at moderate to high levels of parental control, sensation seeking is not predictive of alcohol use at age 16. Further illustrating this point is figure 1b (see Appendix), which displays the regions of significance and 95% confidence bands for the effect of sensation seeking on alcohol use at conditional values of parental control. A vertical line is drawn at -0.26 , which is the (centered) value at which these slopes are no longer significantly different from zero.

Discussion

Although prevalent, alcohol use during adolescence has legal implications and can pose health risks (Marshall 2014). As such, scholars and practitioners seek a more complete understanding of its etiology. Extant research identifies disinhibition traits and family environments as important antecedents of alcohol-related behavior during adolescence. Developmental theory suggests that some of these factors, when experienced early in life, might initiate far-reaching sequelae that can shape distal developmental trajectories of

alcohol use (Masten and Cicchetti 2010; Zucker 2008). However, largely due to the absence of far-reaching longitudinal designs, very few studies have examined these distal linkages. We took an initial step toward addressing this gap by examining how sensation seeking traits and parenting environments, when experienced during early adolescence, can additively and multi-plicatively predict individual differences in developmental trajectories of alcohol use frequency, proximally (middle adolescence) and distally (early adulthood). We focused on these factors as experienced in early adolescence due to the developmental sensitivities of this period (Seidman and French 2004).

Sensation Seeking and Adolescents' Alcohol Use Trajectories

Adolescents who are elevated in sensation seeking are more likely to use alcohol, perhaps in part as a means of obtaining a heightened and desired level of affective arousal (Magid et al. 2007). Studies have linked sensation seeking to alcohol use both concurrently and short-term longitudinally during adolescence (Stautz and Cooper 2013). Consistent with this literature, our findings showed that sensation seeking during early adolescence predicted past-year alcohol use frequency at age 16. Specifically, early adolescents whose parents rated them as relatively high in sensation seeking when they were early adolescents self-reported more frequent alcohol use when they were 16 years old. Extending these findings, our models also indicated that early adolescent sensation seeking uniquely predicted individual differences in alcohol use frequency at age 20. Sensation seeking did not significantly predict the rate of change in alcohol use across this period. Taken together, the model describes a pattern in which an early adolescent elevated in sensation seeking is predicted to consume alcohol more frequently than his/her peers by middle adolescence, a difference that is anticipated to persist into early adulthood, although it neither widens nor diminishes over time.

These findings extend prior literature by demonstrating the distal implications of sensation seeking traits on adolescents' alcohol using behaviors. Previous studies have identified other disinhibition traits, particularly impulsivity and externalizing behaviors, as far-reaching precursors of alcohol use and misuse (Englund et al. 2008). Sensation seeking might operate on alcohol use distally through similar mechanisms, such as deviant peer association. For example, because behaviorally uninhibited youth have more association with peers who use alcohol, they are more likely themselves to drink (Yanovitzky 2005). Sensation seeking may further operate on distal drinking outcomes through affective enhancement. Specifically, sensation seeking may influence youth to greater experimentation and use of alcohol partly as a means of obtaining a heightened level of affective arousal (Magid et al. 2007). Interestingly, there was no evidence to suggest that sensation seeking produces greater *acceleration* in alcohol use across time, a critical contextualization of these distal implications. Thus, sensation seeking establishes a typical adolescent at a higher level of alcohol use relatively early, an effect that is sustained into early adulthood. Future research is needed to identify the mechanisms of sensation seeking's pathway to *long-term* alcohol use, and whether these pathways can apply to more problematic forms of drinking, such as alcohol abuse.

Parental Control and Adolescents' Alcohol Use Trajectories

Structured and supportive parenting environments help scaffold self-regulation in adolescents and provide them with secure emotional ties, offering protection against risky behaviors and contexts (Coley et al. 2008). Parental warmth and control predict lower incidences of adolescents' alcohol use and misuse (Ryan et al. 2010). Consistent with this literature, our findings showed that adolescents' perceptions of parental control during early adolescence (i.e., monitoring of activities and consistency of discipline) predicted less frequent alcohol use at age 16. Extending this literature and strengthening our findings, this effect was unique from parents' substance use disorder (SUD) diagnosis. It was also associated with a higher rate of increase in alcohol use frequency across time (slope). In the model centered at age 20, parental control was no longer predictive of the intercept. Altogether, an adolescent who perceives high levels of parental control as an early adolescent is predicted to consume alcohol less frequently by age 16, controlling for parents' SUD status. However, this same adolescent is predicted to increase in his/her alcohol use frequency more rapidly over time, such that by age 20, s/he is consuming alcohol at an equal frequency with his/her peers (i.e., they have "caught up").

These findings indicate that the protective effects of parental control during early adolescence do not persist distally into early adulthood. This may reflect changes in parental control from adolescence to early adulthood. As adolescents approach early adulthood, they become increasingly autonomous and many leave the home (e.g., for college), leading to less frequent interactions and decreased behavioral control (Aquilino 2006; Keijsers and Poulin 2013). This effect may be further nuanced as the perceived risk and non-normativity of alcohol use lessens with age. Alcohol consumption during early and middle adolescence has risk implications, and frequently prevails within more deviant social and peer ecologies (Van Ryzin and Dishion 2014). However, by age 20, alcohol use becomes more broadly normative among peers and, although still not legal in the United States, it unlikely represents the same degree of risk. Taken together, although early, structured parenting may help establish youth on less frequent drinking trajectories *proximally* (i.e., into middle adolescence), these early effects of parenting likely will not persist uniquely into early adulthood. Of course, because parenting is likely to change over time, our findings do *not* imply that parenting loses relevance in early adulthood. High quality parenting can reduce alcohol related risks and consequences even after high school (Wood et al. 2004), and parents have been successfully engaged in interventions to reduce alcohol problems during college (e.g., LaBrie et al. 2016; Turrisi et al. 2001). Against this backdrop, our findings provide the novel insight that parental control in early adolescence itself may not reduce early adult drinking, although as parenting changes in early adulthood it may still be influential.

Interactive Effects among Key Predictors

Further nuance in these findings was evident in the presence of select interactions. We examined how sensation seeking and parenting environments might interact in the prediction of proximal and distal alcohol use trajectories. Of principal focus were two-way interactions between sensation seeking, parental control, and parent SUD (e.g., sensation-seeking x parental control; sensation seeking x parent SUD; parental control x parent SUD). There were no significant two-way interactions in the prediction of the slope at either age 16 or age

20. There was a significant interaction between sensation seeking and parental control in the prediction of the age-16 intercept. Specifically, the model indicated that at 16, the sensation-seeking pathway to alcohol use frequency was particularly pronounced for adolescents who came from less structured parenting environments. This interaction is intuitive; adolescents with dispositions for thrill- and novelty-seeking might be particularly facilitated toward alcohol use in less restrictive family contexts characterized by low control, structure, and knowledge. Indeed, research corroborates similar interactions between adolescents' disinhibition traits and family contexts as enhancing the likelihood of other deviant behaviors, such as delinquency (Mann et al. 2015).

Under this same lens, it may seem odd that residing with a parent with a SUD, another unique risk factor, did not modulate the sensation seeking or parenting pathways to alcohol use. Indeed, one may expect that, because parents' SUDs can present genetic and environmental proclivities for the use and misuse of substances, the blending of these risks with adolescents' sensation seeking traits or low-quality parenting environments might precipitate more frequent alcohol use among adolescents. The lack of such interactions found in this study, on both the slopes and intercepts at ages 16 and 20, may be because the effect of parents' SUDs on alcohol use operates through a qualitatively distinct pathway. A well-substantiated deviance proneness model suggests that parents' problematic substance use affects children's own use in a mediated pathway through child disinhibition traits and compromised parenting environments (Sher 1991), evidencing a mediated, rather than a moderated, process. Another possible reason for the lack of significance of parent SUD interactions is that our measure only tapped a *lifetime* SUD diagnosis, which means a parents' diagnosis could be current or historical. Findings may have been different had we measured exclusively current SUD diagnoses.

Limitations

The unique contributions of this study must be noted in light of its limitations. First, this study examined alcohol use frequency and not alcohol use problems or disorders. Therefore, although this study is among a minority that examines distal predictors of adolescents' alcohol use, it is unclear how well its findings generalize to more problematic forms of alcohol use, such as heavy drinking and alcohol-related disorders or dependences. Future research is needed to identify whether the early adolescent precursors herein indicated apply to more problematic alcohol-related behaviors. Second, we assessed alcohol use using a single item that inquired about alcohol consumption frequency in the past 12 months. Such measures are not uncommon in alcohol use research, but they do represent limitations, including challenges of retrospective recall. Third, although the study considered the role of parents' problematic drug and alcohol use (both as a control and interactive factor), it was indicated by parents' substance use disorder diagnosis. It should be noted that this is a lifetime diagnosis, which may represent current or historical, genetic or environmental risk. Therefore, this family-level risk factor is a broad one and the present study cannot disentangle whether these factors are historical or current, environmental or genetic. Finally, due to sparseness of observations at the older ages, we trimmed our models to represent ages 11–22. While it is notable that certain factors in adolescence, particularly sensation seeking, predicted alcohol use this far out, future studies are needed to track the course and

heterogeneity of alcohol use throughout adulthood, especially as alcohol use becomes increasingly normative and legal.

Conclusions

Most adolescents will consume alcohol by the time they reach adulthood. Although alcohol use may not always be problematic during adolescence, it can increase risk for alcohol-related problems later in life. Our study identifies specific, early-life predictors of individual differences in age-related alcohol use patterns, which emerge proximally and distally. Specifically, sensation seeking in early adolescence uniquely predicted greater alcohol use as far out as early adulthood; parental control was associated with lower alcohol use through middle adolescence, where it also modified the effects of sensation seeking. Taken together, these disinhibition traits and family characteristics can be leveraged in prevention efforts, even early in adolescence, to help steer youth toward developmentally appropriate forms of alcohol use across adolescence and into adulthood.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Correlations, means, and standard deviations among key variables at early adolescence (N = 345)

Variable	1	2	3	4	5	6
1. Sensation seeking	–					
2. Parental control	–.11 [*]	–				
3. Alcohol use frequency - past year	.17 ^{***}	–.16 ^{***}	–			
4. Parent substance use disorder	.12 [*]	–.07	.06	–		
5. Parent education	.02	.10 ⁺	.04	–.07	–	
6. Age	–.03	–.17 ^{***}	.25 ^{***}	.03	–.12 [*]	–
Mean	2.99 ^a	4.29 ^a	0.16	0.28	6.29	12.24
SD	(0.71)	(0.52)	(0.35)	(0.45)	(2.56)	(1.29)
Minority status						
Non-Hispanic caucasian	80.0%					
Non-white minority	20.0%					
Sex						
Male	48.7%					
Female	51.3%					

Note. Significant mean differences between males and females are indicated by the superscript *a*. Boys showed higher average levels of sensation seeking ($M = 3.09$, $SD = 0.75$) than girls ($M = 2.89$, $SD = 0.66$) with a small effect size, $d = .24$. Girls reported slightly higher levels of parental control ($M = 4.34$, $SD = 0.52$) than boys ($M = 4.24$, $SD = 0.52$) with a small effect size, $d = .19$. There were no significant mean differences on any of the variables according to adolescents' minority status.

⁺ $p < .10$

^{*} $p < .05$

^{**} $p < .01$,

^{***} $p < .001$

Alcohol use frequency in the past year at each age from middle adolescence to early adulthood

Table 2

Age Alcohol use frequency	11 N (%)	12 N (%)	13 N (%)	14 N (%)	15 N (%)	16 N (%)	17 N (%)	18 N (%)	19 N (%)	20 N (%)	21 N (%)	22 N (%)
Never	184 (95.5)	205 (98.5)	136 (97.2)	130 (90.3)	84 (84)	52 (76.5)	28 (75.7)	97 (52.7)	24 (37.5)	24 (40.7)	6 (15.4)	8 (17.0)
1–2 times	1 (0.5)	2 (1.0)	2 (1.4)	6 (4.2)	9 (9)	6 (8.8)	3 (8.1)	31 (16.8)	5 (7.8)	7 (11.9)	2 (5.1)	7 (14.9)
3–5 times	0 (0.0)	0 (0.0)	2 (1.4)	5 (3.5)	3 (3)	4 (5.9)	2 (5.4)	15 (8.2)	9 (14.1)	4 (6.8)	3 (7.7)	4 (8.5)
5 +, <1/month	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.7)	3 (3)	3 (4.4)	2 (5.4)	17 (9.2)	11 (17.2)	12 (20.3)	8 (20.5)	5 (10.6)
1–3/month	0 (0.0)	1 (0.5)	0 (0.0)	2 (1.4)	1 (1)	2 (2.9)	2 (5.4)	18 (9.8)	12 (18.8)	7 (11.9)	10 (25.6)	8 (17.0)
1–2/week	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.5)	0 (0.0)	4 (2.2)	3 (4.7)	3 (5.1)	8 (20.5)	9 (19.1)
3–5/week	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.5)	0 (0.0)	1 (1.7)	2 (5.1)	6 (12.8)
Every day	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
TOTAL	185	217	145	144	100	68	37	184	64	58	39	47

Table 3

Linear Growth Models predicting intercept and slope of alcohol use frequency in the past year, centered at age 16 and again at age 20

Parameters	Centered at Age 16	Centered at Age 20
Model 1: Linear Growth		
Intercept: mean	-0-	-0-
variance	2.46***	2.53**
Slope: mean	0.81***	0.81***
variance	0.06*	0.06*
Slope-intercept cov.	-0.12	0.13
Fit Indices		
AIC	1626.056	
BIC	1711.923	
SSA BIC	1657.925	
Model 2: With Predictors		
Intercept: mean	-0-	-0-
Sensation Seeking	0.64**	0.62**
Parental Control	-0.98***	-0.12
Parent SUD	0.78**	0.53 ⁺
Slope: mean	0.08	0.08
Sensation Seeking	-0.01	-0.01
Parental Control	0.21**	0.21**
Parent SUD	-0.06	-0.06
Fit Indices		
AIC	1566.589	
BIC	1682.441	
SSA BIC	1609.386	

Model 1 is the linear model without predictors; Model 2 is the linear model with sensation seeking and parental control as predictors, above and beyond parent substance use disorder and other controls (SUD). $N = 345$

Note. Analyses control for participants' sex, minority status, and parent education

⁺ $p < .10$,

* $p < .05$,

** $p < .01$

Linear growth models predicting intercept and slope for adolescents' alcohol use in the past year, centered at age 16

Table 4

Predictors	Intercept (age 16)			Linear Slope (age 16)		
	γ	SE	t-ratio	γ	SE	t-ratio
Model 3: Interactions						
Sensation seeking	0.30	0.28	1.08	0.06	0.07	0.78
Parental control	-0.62	0.33	-1.90 ⁺	0.13	0.09	1.55
Parent-SUD	0.68	0.32	2.14 [*]	-0.04	0.09	-0.49
SenSk × ParCont	-1.03	0.32	-3.23 ^{***}	0.10	0.08	0.23
SenSk × Parent SUD	0.33	0.42	0.77	-0.05	0.11	0.63
ParCont × Parent SUD	0.06	0.61	0.09	0.07	0.17	0.66

Model 3 represents two-way interactions among predictors. Presented are gamma coefficients, standard errors, and t-ratios for multilevel growth models ($N = 345$)

Note. Analyses controlled for parent education, adolescents' sex and minority status. SenSk = Sensation seeking; ParCont = Parental Control

⁺ $p < .10$;

^{*} $p < .05$;

^{***} $p < .001$

Table 5

Linear growth models predicting intercept and slope for adolescents' alcohol use in the past year, centered at age 20

Predictors	Intercept Slope (age 20)			Linear Slope (age 20)		
	γ	SE	t-ratio	γ	SE	t-ratio
Model 3: Interactions						
Sensation seeking	0.53	0.25	2.17*	0.06	0.08	0.75
Parental control	-0.09	0.31	-0.29	0.13	0.09	1.55
Parent-SUD	0.52	0.32	1.63	-0.04	0.09	-0.47
SenSk $\times$ ParCont	-0.64	0.35	-1.84 ⁺	0.10	0.08	1.20
SenSk $\times$ Parent SUD	0.12	0.40	0.30	-0.05	0.11	-0.47
ParCont $\times$ Parent SUD	0.35	0.67	0.52	0.07	0.17	0.41

Model 3 represents two-way interactions among predictors. Presented are gamma coefficients, standard errors, and t-ratios for multilevel growth models ($N = 345$).

Note. Analyses controlled for parent education, adolescents' sex and minority status. SenSk = Sensation seeking; ParCont = Parental Control

⁺ $p < .10$;

* $p < .05$