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Adolescent Transitions in Self-Management Strategies and Young Adult Alcohol Use

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Abstract

Individuals use a variety of strategies to manage their thoughts, emotions, and behaviors across the lifespan. In this study, we used latent class analysis to derive distinct subtypes of self-management skills in early adolescence and latent transition analysis to examine whether movement between different classes was associated with later young adult alcohol use. Assessments of behavioral self-control, affective self-regulation, and cognitive self-reinforcement were obtained in the seventh and 10th grades from students participating in two independent drug prevention trials (control group participants only, N = 3,939). Assessment of alcohol use was obtained when participants were young adults (23–26). A model distinguishing four subtypes of self-management skills fit best for both the seventh and 10th grades. While findings indicated modest stability in class structure over time, maintaining class membership characterized by high cognitive self-reinforcement and high affective self-regulation was consistently protective in terms of young adult alcohol use relative to movement from this to other classes. Transitions in class membership involving an expansion of self-management strategies were protective and associated with lower levels of young adult alcohol use and transitions involving a contraction of self-management strategies associated with higher young adult alcohol use. This study illustrates the important use of person-centered techniques to exemplify how typologies of self-management during adolescence can play a protective role in young adult alcohol use.

Keywords

adolescent development, alcohol use, behavioral control, latent class analysis, latent transition analysis, multinomial logistic regression, positive self-reinforcement, self-management skills

Introduction

Self-control, self-regulation, and other constructs related to managing the self, have been studied extensively in developmental, social, clinical, health, and other subfields of psychology, mostly in children. Behavioral self-control during infancy and childhood is a foundational concept in developmental psychology and is often operationalized as the ability to voluntarily delay immediate reward or gratification in order to obtain some future greater reward, goal, or ambition. Studies have shown that children who possess adequate behavioral self-control are more successful in numerous contexts. Classic studies have demonstrated that children capable of delaying gratification (e.g., not eating the marshmallow placed in front of them in order to receive a more enticing reward later) are competent in many key areas of functioning such as social relationships (Eisenberg et al., 2014), stress and coping (Mischel, 2014; Mischel et al., 1988; Moore et al., 1976), as well as academic achievement and school performance (Duckworth & Carson, 2013; Normandeau & Guay, 1998), with effects potentially lasting until later childhood and adolescence. Similar studies with older youth have examined behavioral self-control and the ability to delay gratification in the context of monetary rewards or various laboratory experimental paradigms (e.g., Iowa Gambling Task or Go/No Go Task; see for example, Upton et al., 2011 ; Ursache & Raver, 2015), with similar positive associations with other areas of functioning. Indeed, behavioral self-control is related to success in numerous contexts across the lifespan, including weight loss (Crescioni et al. 2011), improved health status (Mann et al., 2013; Miller et al., 2011), future success (Moffitt et al., 2011), and better psychosocial adjustment overall (Tangney et al., 2004). It is also well established that deficits in self-control play a central role in numerous clinically diagnosable psychological

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disorders throughout the lifespan (Nigg, 2017; Strayhorn, 2002).

Behavioral self-control is part of but not identical to self-regulation (Fujita, 2011). Self-regulation is conceptualized as involving a broader and more diverse set of metacognitive, behavioral, motivational, and attentional skills that are applied to the intentional control of thoughts, emotions, and behavior (Carver & Scheier, 1998; Duckworth et al., 2014). In this view, self-regulation differs from self-control because it not only encompasses inhibitory control of impulses, but also involves effortful and goal-directed processes used to regulate the self (e.g., Nigg, 2017; Zimmerman, 2008). Whereas behavioral self-control is studied mostly in children, self-regulation is studied extensively in adolescents as well as children. Indeed, achieving effective self-regulation has been described as a key developmental task of adolescence because it involves developing the resourcefulness and competencies needed for the successful transition to adulthood (Getsdottir & Lerner, 2008; Zimmerman, 2002). In a social cognitive formulation, self-regulation serves as forethought (consideration of future events) and contributes to action along with other motivational constructs like self-efficacy (Bandura, 1991). A person who does not feel efficacious will not begin to regulate their emotions using strategies if they don't believe implementation of certain skills will be successful. In this manner, self-regulation functions as a form of self-incentive or adaptive control to obtain desired outcomes. When faced with a stressful situation, an individual will evaluate their preparedness to invoke strategies that offset or ameliorate stress and mobilize self-reflection (i.e., evaluation of performance goals and self-incentive) that takes place in an anticipatory fashion to regulate outcomes. Self-regulation during adolescence can play a central role guiding achievements in academics, sports, music, and other lifestyle pursuits, and can contribute to effective planning and goal-setting for one's future.

Self-Control, Self-Regulation, and Substance Use

Both self-control when construed as inhibitory tendencies, and self-regulation depicted as goal planning, have been the focus of studies emphasizing alcohol and drug etiology. A considerable portion of these studies emphasize delay of gratification and impulsivity as one of several facets of self-control that may be linked with the early stages of alcohol and drug use (for a review, see Gullo & Dawe, 2008). The notion behind these studies is that impulsive youth who lack internal controls are vulnerable to drug or alcohol offers because they are focused more on the present and seek immediate gratification (e.g., drinking alcohol with my friends makes me feel good) rather than focusing on long-term consequences of substance use on health and well-being. Wills and colleagues have compiled evidence showing that behavioral undercontrol and poor self-control are predictive of alcohol and drug use during adolescence (Wills & Stoolmiller, 2002; Wills et al., 2006). Importantly, these studies extend the focus of self-control beyond impulsivity to include behavioral (i.e., sitting still) and social (i.e., bothering people) aspects of control. All told, self-control is either directly or indirectly related to alcohol and drug use in both middle and high school students (Wills et al., 1995). Wills et al. (2006) also showed that measures of good self-control (planfulness or effortful control) and poor self-control (e.g., impulsiveness or disinhibition) uniquely contributed to alcohol and drug use.

In our previous work, we have used latent variable and latent growth frameworks to examine the role of self-management skills in adolescent alcohol and drug use. Griffin et al. (2006) found that self-management skills (modeled as a latent factor with indicators of decision-making, affective self-regulation, and cognitive self-reinforcement) protected youth from early-stage substance use between the seventh and ninth grades across racial/ethnic groups, albeit the protective effect was slightly more advantageous for white youth. Using a curve-of-factor growth model, Griffin et al. (2009) found that developmental change in self-management skills (modeled as a latent factor with indicators of decision-making, problem-solving, behavioral self-control, and cognitive self-reinforcement) was protective in terms of growth in substance use (alcohol, cigarettes, and marijuana) between the seventh through 10th grades, controlling for gender, grades, and early levels of substance use and self-management. Lowe et al. (2013) explored changes in self-management skills and substance use from seventh to 11th grade in a study of predominantly minority adolescents and found that participants who reported higher self-management skills (modeled as a latent factor with indicators of decision-making, behavior self-control, and cognitive self-reinforcement) in the seventh grade had smaller increases in substance use, while those experiencing larger decreases in self-management skills tended to have greater increases in substance use. Griffin et al. (2015) examined the relationship between trajectories of affective self-regulation skills during secondary school and young adult substance use in a large multiethnic, urban sample, finding that lower seventh grade levels and less steep increases in affective self-regulation were predictive of higher young adult substance use. Taken together, these studies demonstrate that a broad set of self-management and self-regulation skills play a protective role in adolescent substance use with findings extending to racially and demographically heterogeneous samples.

Present Study

As part of this special issue on the use of LTA methods in health and evaluation studies, the present study focuses on three important issues in studies of drug etiology. First, we examine the etiological role of three broad categories of self-management skills in young adult alcohol use. The skills include behavioral self-control, involving behavioral engagement, distractibility, and task persistence; affective self-regulation, involving the use of cognitive strategies to manage affect, anxiety, or distress; and cognitive self-reinforcement, involving the use of cognitive self-talk and reinforcement skills

to maintain one's resolve. All three skills are instrumental to successful adult role socialization and disruption in their development can have untoward negative effects. Second, in contrast to previous research, we use a person-centered analytic approach to examine typologies of self-management strategies during adolescence. The search for typologies differs from traditional variable-centered approaches that rely on regression, factor analysis or other correlational techniques. With variable-centered techniques the emphasis is on finding a single parameter that can account for individual differences that exist in the population as a whole. In other words, whatever skills-to-behavior relations are observed, they hold for everyone. Any deviations are considered extraneous and treated as error. Person-centered strategies (Bergman & Magnusson, 1997; B. O. Muthén & Muthén, 2000), on the other hand, emphasize subgroup heterogeneity that capture subgroups or "mixtures" of individuals who are qualitatively different in the way they utilize self-management skills. As we demonstrate in this paper using latent class analysis (LCA), these subgroup differences produce mutually exclusive classes characterized by unique configurations of skills. It is the emphasis on the patterns of individual characteristics known as "typologies" that differentiates person-centered approaches from the more traditional variable-centered approaches.

Following application of LCA to derive classes, we then use latent transition analysis (LTA) to examine class structure over time estimating status membership in the seventh and 10th grades. The shift to LTA means the classes are now "statuses" given they represent developmental flux or how individuals change over time. This age period was attractive to examine transitions in skills for several reasons. First, it is a critical age period in development marked by manifest physiological changes driven by puberty, cognitive change in memory and executive functioning, and expansion of the peer group (Steinberg & Morris, 2001). Structural changes consistent with entering middle school can also influence adolescents, causing undue stress (Barber & Olsen, 2004). The period between seventh and 10th grades is also an age where many young people initiate alcohol and drug use (Kandel, 2002; Kosterman et al., 2000). By the time they reach the 10th grade self-management skills become more developmentally elaborated and used to guide goal setting and decision-making moving forward into young adulthood. The LTA model provides a means to examine patterns of change in status membership between the seventh and 10th grade. Once transition probabilities are obtained, we use multinomial logistic regression to estimate whether status membership from the seventh to 10th grade is related to alcohol use in young adulthood ($\sim$age 23–26). This model adjusted for demographic measures, early levels of drug use behavior, and personality factors that are potential confounds of the outcome or may influence status membership.

Based on the various perspectives outlined above, we proposed several integrated hypotheses. First, we hypothesized there would be multiple classes that correspond to the unique patterns of self-management skills in both the seventh and 10th grades. We also hypothesized there would be a modicum of stability in status membership over time, however, we expected there would be movement between statuses with some youth likely to endorse a more expanded set of self-management skills over time, while other youth would endorse fewer skills. We also expected that, regardless of the pattern or combination of skills, an expansion in self-management skills over time would be associated with less alcohol use in young adulthood, and conversely a contraction in self-management skills over time would be associated with more alcohol use in young adulthood. Taken as a whole, the study provides a sound illustration of the LTA methodology used to map discrete dynamic change in a diverse set of self-management strategies and determine whether these skills have prognostic value for later health-compromising behaviors.

Method

Participants

Data for this study came from two independent prospective school-based drug prevention trials with the analysis samples restricted to untreated control students only. The intervention period for Trial 1 took place from 1985 to 1988, corresponding to the seventh to ninth grades, and additional surveys follow-ups were conducted in the 10th (1988–1989) and 12th grades (1990–1991) and a young adult follow-up (ages 23–26) conducted in 1998 using a mail survey. The intervention period for Trial 2 took place from 1995 to 1998, corresponding to the sixth to eighth grades. Additional annual follow-ups were conducted in the ninth to 12th grades with a follow-up in young adulthood (ages 23–25) conducted in 2008–2011. Trial 2 follow-up involved a phone interview using timeline follow-back procedures emphasizing drug use and related high-risk behaviors. The current study uses longitudinal panel data from students in both trials who completed surveys in the seventh grade, 10th grade, and the young adult follow-up. The study designs and data collection protocols for both trials were highly similar, and we combined data from the two control group cohorts to increase the sample size and statistical power. These factors are critical for the proper estimation of model parameters using a large multiway contingency table, and help to avoid convergence problems and improper solutions (L. K. Muthén & Muthén, 2002).

Procedures

During the school portion of each respective trial, data were collected in classrooms using paper-and-pencil litho-coded questionnaires containing unique ID codes to link students' responses over time and ensure the confidentiality of their responses. Research staff collected the data using a standardized protocol, and teachers were not present during data collection. The research staff read from a script to provide instructions to students on how to complete the survey. Consent procedures emphasizing the confidential nature of the surveys

were approved by the University IRB. Parents were sent a letter in advance of the survey, which described the purpose of the study and the nature of the survey questions. Any parent not wishing their child to participate could have them excluded from the study by returning the consent form and declining to give consent. Students were provided an assent form at the time of survey administration and any student refusing to participate could be excused from the class.

Trial 1 used a three-form planned missing design with color-coded forms. This multiple form design increases the number of risk and protective factors assessed at each wave while limiting burden to the students (e.g., Graham et al., 1996). The design includes a common core set of items assessing demographics and behaviors, with 1/3 novel items assigned to the different forms. Trial 2 used a two-form design with assessments conducted over a two-day period. For both trials, schools were the focus of recruitment efforts, and all students in recruited schools and classrooms were eligible to participate. Exclusion criteria included significant cognitive impairment or severe learning disabilities, as designated by school personnel. For students who were absent on the day surveys were administered, trained data collectors returned to the schools up to three additional times for follow-up data collection. Additional information regarding the experimental designs, recruitment and retention strategies, data collection protocols, and theoretical focus are available for Trial 1 (Botvin et al., 1995) and Trial 2 (Botvin et al., 2006).

Measures

Latent transition indicators. Fifteen items used in both trials to assess various facets of self-management skills were specified as indicators of latent class membership. Five items assessed behavioral self-control (Self-Control Rating Scale; Kendall & Wilcox, 1979) including personal characteristics related to behavioral self-control ("I have to be reminded several times to do something") and task persistence (e.g., "I am easily distracted from my work"). Five items assessed affective self-regulation (Self-Control Schedule; Rosenbaum, 1980) including the use of cognitive strategies to manage affect, anxiety, and distress (e.g., "If an unpleasant thought is bothering me, I try to think about something pleasant"). Five items assessed cognitive self-reinforcement (Frequency of Self-Reinforcement Attitudes Scale; Heiby, 1983) including the use of strategies to reward oneself (e.g., "I silently praise myself for even small achievements") and maintain resolve (e.g., "I get myself through difficult tasks by planning to enjoy myself afterward"). Scale reliabilities were computed using McDonald's (1999) Omega and were relatively high, seventh grade: Behavioral Self-Control $\omega = .85$, Cognitive Self-Reinforcement $\omega = .87$, and Affective Self-Regulation $\omega = .90$ and 10th grade: Behavioral Self-Control $\omega = .88$, Cognitive Self-Reinforcement $\omega = .88$, and Affective Self-Regulation $\omega = .90$. Moreover, these scales have been studied extensively in both prevention and etiology studies to establish their factorial, construct, and predictive validity with measures of social competence and drug use (e.g., Scheier & Botvin, 1995, 1996, 1998).

Across all of the items, the original 5-point response formats ranged from "*strongly disagree*" (1) to "*strongly agree*" (5), however, these were recoded as >=3 = "1" and all others "0." The dichotomization scheme was structured to create indicators that lent themselves to be interpreted as "yes, I use this skill versus" "no, I don't use this skill." Numerous authors have suggested that dichotomization biases parameter estimates and reduces power (Cohen, 1983; DeCoster et al., 2009; MacCallum et al., 2002). This mainly arises because truncating distributions curtails variability and downwardly biases correlations. Indeed, variable-centered approaches utilize dispersion as one of several distributional properties in determining individual differences. However, in the current study, the analytic goal does not revolve around identifying "individual" differences, but rather it is to identify theoretically meaningful and consistent response "patterns," which are then used to characterize mutually exclusive subgroups (e.g., Meehl, 1992, 1995). When variables are categorical by nature (as in the use of categorical-ordinal measures using Likert-type response scales), it is acceptable to further dichotomize the underlying distribution, given this has little if any effect on the statistical conclusions (MacCallum et al., 2002).[1]

Covariates and Control Measures

Adolescent and young adult alcohol use. One item was used to assess alcohol use frequency during adolescence ("How often [if ever] do you drink alcoholic beverages?"), with response categories ranging from (1) "*never tried them*" through (9) "*more than once a day."* The young adult assessment was based on a composite of frequency along with two additional items including intensity (quantity) ("How much (if at all) do you usually drink each time you drink?") with response categories ranging from (1) "*I don't drink*" through (6) "*more than 6 drinks*" (6) and drunkenness ("How often (if ever) do you get drunk?") with response categories ranging from (1) "*I don't drink*" through (9) "*more than once a day.*"

As baseline control measures in the LTA, we included a measure of cigarette smoking (frequency) assessed with a single item ("How much do you currently smoke") with responses ranging from (1) "*I have never smoked*" to (10) "*a pack or more each day.*" A single item assessed frequency of marijuana use ("How often [if ever] do you usually smoke marijuana?") with responses ranging from (1) "*never tried it*" to (9) "*more than once a day*." In some cases, the response formats for substance use items were not entirely identical between the two datasets requiring that we smooth distributions by recoding answers. This usually entailed truncating (recoding) responses on the infrequent end of the scale (i.e., "more than one time/day") and Winzoring by making a 9 or 10-point scale into a 7-point scale.

Psychosocial risk. Five items were used to assess risk-taking (Eysenck & Eysenck, 1975: e.g., "I get bored more easily than most people") and five positive self-esteem items were taken

from the Rosenberg (1965) scale (e.g., "I feel that I have a number of good qualities"). Response scales for both sets of items ranged from (1) "*strongly disagree*" to (5) "*strongly agree*." MacDonald's Omega estimate of internal consistency was high for both scales based on the full baseline sample ($\omega = .79$ and .86, for risk-taking and self-esteem, respectively), and the panel sample ($\omega = .76$ and .78, respectively). Additional control measures included gender (male = 1, female = 0), grades [recoded to 1 = high grades (Mostly A's and A's and B's) and 0 = low grades], race (white = 1, other = 0), and family structure (nuclear = 0, other = 1).

Analysis strategy. All of the LCA and LTA models were tested on the longitudinal panel sample (results of separate LCA models using the independent baseline and 10th grade samples are available upon request). The LCA model produces two parameter estimates of interest; item response probabilities indicating the likelihood an individual endorsed an item conditioned on class membership in a particular latent class, and latent class prevalences indicating the probability of membership in each class based on estimated posterior probabilities (McCutcheon, 1987). Each individual can have fractional membership in each of the mixtures (which adds up to 1), which reflects measurement error (indicators are not perfect measures) and uncertainty in the class assignment process. The LTA adds to this by estimating transition probabilities, which indicate the likelihood of class membership in the 10th grade conditioned on prior class membership in the seventh grade. The LTA model requires that we impose measurement invariance (constraining the conditional response probabilities to equivalence across time) to ensure the latent class structure will have the same meaning across the two time points. Imposing this constraint helps stabilize estimation with a large multiway contingency table and increases the degrees of freedom (and decreases the number of parameter estimates). In our case, the multiway contingency table increases exponentially from 2^{14} in the LCA to 2^{28} in the LTA potentially creating sparse cells. Collins and Lanza (2010) suggest that in addition to examining the nested comparison of the restricted versus the freely estimated model based on the likelihood-ratio test difference statistic (L^2), that shrinkage in the AIC and BIC should also be examined as markers of model fit.

We then covariate-adjusted class membership in the seventh grade and also the transition probabilities.[2] Covariates were examined one at a time to avoiding masking suppression and then entered as a single block (only significant covariates were retained in the final analysis). This analysis used multinomial logistic regression (MLR), a technique appropriate for a polytomous outcome. We then modeled alcohol use as a single composite assessing "general alcohol involvement" and contrasted mean levels of drinking in the different transition subgroups. We used the Mplus statistical program to test the LCA and LTA (including the MLR) models (Muthén & Muthén, 1998-2017). We imposed the condition of local independence (Lazarsfeld & Henry, 1968), positing that the observed variables (indicators) are independent of each other and conditional only on the categorical latent variable. Model selection of whether a k class model improves on a k-1 class model is based on several statistical criteria. These include shrinkage in the Akaike (1981) and Bayesian (Schwarz, 1978) Information Criterion, both of which penalize models for overparameterization (Nylund et al, 2007), overall decrement in the Lo-Mendell-Rubin likelihood-ratio test (LRT: Lo et al., 2001) obtained by contrasting neighboring models (a model with k classes compared to k-1), and entropy (ranging from 0 to 1 where higher numbers indicate better classification accuracy (Celeux & Soromenho, 1996). In all cases, we made sure the log-likelihood function, a measure of model goodness-of-fit, was replicated and that the solution obtained in the models did not represent a local minimum.

In addition to the abovementioned statistical guides for class enumeration, a key factor in choosing one model over another is that the resulting class structure is substantively meaningful, makes logical sense, and comports with real-world behaviors. This involves examining latent class separation (analogous to simple structure in factor analysis) and homogeneity. Both require carefully inspecting the patterns of item response probabilities to determine whether they clearly distinguish uniquely identifiable and qualitatively discrete classes (i.e., the item response probabilities are either close to 0 or 1 and there is clear differentiation among the classes; Collins & Lanza, 2010). Parsimony, or the complexity of a model (number of parameters being equivalent to the number of latent class prevalences and item response probabilities estimated), is also used to gauge model fit with simpler models preferred over more complex ones enumerating more classes. To avoid sparse cells and convergence problems that can arise from weak identifiability, we did not consider classes with $<3\%$ of the sample (Garrett & Zeger, 2000). We also used 100 random starts to avoid obtaining a local solution for the log-likelihood statistic. Other articles in this special issue explain in greater detail the assumptions of LCA and its application including how the measurement model (estimating the item response probabilities that define class structure) can be structurally linked with outcomes using traditional variable-centered analyses.

Attrition. Aggressive tracking and location procedures were implemented to minimize subject loss for both trials. This included scheduling make-up dates for absentee students and the use of tracking cards with updated address information provided by the school district. A total of 3,939 students were available in the seventh grade (1,828 and 2,111 for Trial 1 and Trial 2, respectively). From the seventh to 10th grades there was a loss of 34.8% of the students (70.5% students retained in Trial 1 and 60.7% retained in Trial 2). From baseline to the young adult follow-up there was 41% retention (1,606 out of 3,939: 33.6% for Trial 1 and 47% for Trial 2, respectively) and from 10th grade to the young adult follow-up there was 48% retention (39.4% in Trial 1 and 56.9% in Trial 2, respectively).

Attrition analyses (χ^2 and t-tests) indicated that dropouts were more likely to report using alcohol in the seventh grade, $\chi^2(1) = 12.16$, $p \leq .001$ (41.5% vs. 35.8% for dropout versus

panel students, respectively) and consume more drinks per occasion, $\chi^2(1) = 7.05$, $p \leq .01$ (26.9% vs. 23.1% for dropout versus panel students, respectively). Dropouts were more likely to smoke cigarettes in the seventh grade, $\chi^2(1) = 5.07$, $p \leq .05$ (7.2% vs. 5.3%, for dropout vs. panel students) and more likely to have tried marijuana, $\chi^2(1) = 11.16$, $p \leq .001$ (6.9% vs. 4.3%, for dropout vs. panel students). Panel students were more likely to report getting mostly A's and B's for grades, $\chi^2(1) = 40.140$ $p \leq .001$ (72.9% vs. 63.0%, for panel vs. dropout students). With regard to demographic differences, females were more likely to remain in the study, $\chi^2(1) = 37.69$, $p \leq .001$ (56.3% vs. 43.7% for female and male panel students, respectively), as were non-white students, $\chi^2(1) = 40.70$, $p \leq .001$ (61.0 vs. 39.0%, for non-white vs. white students, respectively). Students living in nuclear households were more likely to remain in the study, $\chi^2(1) = 15.86$, $p \leq .001$ (61.4% vs. 38.6% nuclear and non-nuclear living situation).

Mean comparisons showed that dropouts reported lower self-esteem scores, $t(2843) = -4.054$, $p \leq .001$ (Panel $\overline{X} = 3.96$ vs. Dropout $\overline{X} = 3.83$), lower self-reinforcement, $t(3064) = -3.54$, $p \leq .001$ (Panel $\overline{X} = 18.15$ vs. Dropout $\overline{X} = 17.59$), and lower self-regulation, $t(3064) = -3.54$, $p \leq .001$ (Panel $\overline{X} = 18.07$ vs. Dropout $\overline{X} = 17.47$). A logistic regression model predicting retention status from all of the demographic measures, alcohol and drug consumption, and composite measures of the self-management skills (LCA indicators) indicated that panel students were more likely to be female ($\beta = -.386$, $p \leq .001$, OR = .680, 95% CIs: .556–.831), living in a nuclear family ($\beta = -.436$, $p \leq .001$, OR = .647, 95% CIs: .530–.789), report higher grades, ($\beta = .326$, $p \leq .01$, OR = 1.39, 95% CIs: 1.117–1.718), and report higher self-reinforcement ($\beta = .028$, $p \leq .05$, OR = 1.028, 95% CIs: 1.001–1.056). The model accounted for 5.1% of the variance in retention status.

Missing Data

There was a modicum of missing data for the LCA indicators (31%), and for the psychosocial measures (25.5%), which is expected given the planned missingness design (roughly one-third of the sample should be missing certain items). The average level of missing data for the demographic and consumption measures was considerably lower (5.5%) as these items are part of a core section and are present on every form of the survey. We used Full Information Maximum Likelihood (FIML) to handle missing data, which is an appropriate strategy with a planned missingness design (Graham et al., 1996). It is a model-based missing data treatment that produces unbiased and accurate parameter estimates when the missing data mechanism is ignorable (Little & Rubin, 2002) and is widely considered superior to case-deletion and mean substitution approaches (e.g., Baraldi & Enders, 2010). FIML leverages all of the available data, both complete and incomplete, and identifies parameters that have the greatest likelihood of producing the sample data. In addition, FIML qualifies under Rubin's assumptions (Rubin, 1987) when data are missing completely at random (where the observed data is considered a random sample of all available cases and missing data is unrelated to the study variables [independent of both observed and unobserved data]: see for example, Lang & Little, 2018). As the MLR is a complete-case analysis, we imputed for the covariates using predictive mean matching with the R-package Multiple Imputation by Chained Equations (MICE) procedure (van Buuren & Groothuis-Oudshoorn, 2011). Predictive mean matching is a model-based imputation method, does not require an explicit specification of missing values distribution (Little & Rubin, 2002), and is fairly robust to distributional properties of a target variable (van Buuren, 2018). As a form of missing data estimation, predictive mean matching produces imputations within the observed data range, thus eliminating the problem of meaningless imputations (e.g., negative values for behavior). Simulation studies (Kleinke, 2017; Marshall et al., 2010) have demonstrated that predictive mean matching is a suitable imputation method for a wide range of distributional qualities and sample sizes.

Results

Sample Description

The panel sample was 56.4% female (51.5% for Trial 1 and 59.3% for Trial 2, $\chi^2[1] = 9.12$, $p \leq .01$) and 39% white, $\chi^2(1) = 1164.04$, $p \leq .001$ (the Trial 1 sample was 92% white and the Trial 2 sample was 93.5% non-white). The disproportionate racial representation was intended by design as Trial 2 replicated the Trial 1 study with a non-white sample). Students in the Trial 2 were less likely to reside in a nuclear family situation, $\chi^2(1) = 132.17$, $p \leq .001$ (49.7% vs. 79.1% for Trial 1 vs. Trial 2, respectively). Students in Trial 1 were more likely to report getting mostly A's and B's as grades, $\chi^2(1) = 14.51$, $p \leq .001$ (78.2% vs. 69.4% for Trial 1 vs. Trial 2, respectively). A greater percent of students in Trial 1 reported drinking more drinks per occasion, $\chi^2(1) = 17.54$, $p \leq .001$ (28.6% vs. 19.4% for Trial 1 vs. Trial 2, respectively), albeit there were no significant study differences in consumption of cigarettes or marijuana.

Prevalence Rates and Psychosocial Functioning

At the seventh grade assessment, 35.8% of the students reported lifetime alcohol use. Intense and more problematic drinking, defined as at least three or more drinks per occasion was reported by 2.3% of the sample. Reported level of drunkenness (at least 2-3 times per month or more often) was reported by <1% of the sample. When asked about their general patterns of cigarette use, 3.9% said one cigarette/week, while <1% each smoked anywhere from a pack a week to a pack/day. When asked about their current smoking patterns, 8.5% said they had not smoked in the past 12 months, 4% said a few times in the past 12 months, and less than 1% each engaged in any heavier use ranging from a few times each month to ½ pack a day. A very small percentage of the seventh

graders used marijuana (2%). Males were more likely to drink, $\chi^2(1) = 7.02$, $p \leq .01$ (39.4% vs. 32.9% for males and females, respectively).

Psychosocial measures. There were some differences in psychosocial functioning in the seventh grade, both by gender and race. Females reported less risk-taking $t(1036) = -3.99$, $p \leq .001$ (females $\overline{X} = 2.73$ vs. males $\overline{X} = 2.98$), higher self-reinforcement, $t(1088) = 2.10$, $p \leq .05$ (females $\overline{X} = 18.38$ vs. males $\overline{X} = 17.87$), higher-self-control, $t(1089) = 2.39$, $p \leq .05$ (females $\overline{X} = 12.10$ vs. males $= = 11.55$), and higher self-regulation, $t(1044) = 2.34$, $p \leq .05$ (females $\overline{X} = 18.35$ vs. males $\overline{X} = 17.72$). Non-whites reported higher self-esteem, $t(884) = 10.66$, $p \leq .001$ (NW $\overline{X} = 4.12$ vs. White $\overline{X} = 3.63$), higher self-reinforcement, $t(1038) = 5.54$, $p \leq .001$ (NW $\overline{X} = 18.57$ vs. White $\overline{X} = 17.30$), and higher self-control, $t(922) = 6.65$, $p \leq .001$ (NW $\overline{X} = 12.34$ vs. White $\overline{X} = 10.85$).

Young adult follow-up. Young adult levels of alcohol and drug use were in line with national prevalence estimates for comparable demographic groups (e.g., Schulenberg et al., 2019). Use of alcohol was reported by 87.6% of participants and 63.4% reported having been drunk in the past month. A little less than one-third (29.1%) of the sample reported currently smoking cigarettes and a little more than half of the sample (56.5%) reported having used marijuana. There was some shifting in consumption patterns at the young adult follow-up. Males were more likely to smoke cigarettes, $\chi^2(1) = 10.67$, $p \leq .001$ (44.6% vs. 34.7% for males vs. females), and marijuana, $\chi^2(1) = 10.72$, $p \leq .001$ (61.1% vs. 52.9% for males vs. females) but there were no significant differences in alcohol consumption patterns.[3] Drug prevalence differed by race, with white students less likely to abstain from alcohol, $\chi^2(1) = 8.12$, $p \leq .01$ (2.3% vs. 5.1% for whites vs. non-whites), more likely to smoke cigarettes, $\chi^2(1) = 110.53$, $p \leq .001$ (60.4% vs. 27.5% for whites vs. non-whites), and more likely to use marijuana, $\chi^2(1) = 39.59$, $p \leq .001$ (66.5% vs. 50.5% for whites and non-whites).

Scale Homogeneity

Prior to conducting the LCA, we tested the dimensional structure of each item set (for each of the respective scales assessing behavioral self-control, cognitive self-reinforcement, and affective self-regulation) using Mokken's coefficient of scalability (monotone homogeneity [MH]) scale for ordinal measures (Mokken, 1971; Sijtsma & Verweij, 1992)). The benchmark MH-value of .4 indicated a single dimension was satisfactory for the cognitive self-reinforcement scale ($MH_{avg.} = .45$ for the seventh grade and $MH_{avg.} = .49$ in the 10th grade, respectively), for the affective self-regulation scale ($MH_{avg.} = .44$ and $MH_{avg.} = .48$ for each grade), and for the behavioral self-control scale ($MH_{avg.} = .46$ and $MH_{avg.} = .48$). A single self-control item (i.e., "I stick to what I'm doing until I am finished with it") had a very low MH scale value (.026 in the seventh grade). To further examine the ability of items to assess the underlying "trait," we also tested a 2-PL IRT model, conducting these models separately for each five-item scale. Items with either extreme difficulty (−3 to 3 is the usual acceptable range) or discrimination parameters (.5 is a benchmark and 2.0 is an upper limit) could be eliminated producing a more parsimonious set of items without loss in their ability to assess the scale content. The difficulty parameter for the behavioral self-control item in question was −9.676 and the discrimination parameter was .057, reinforcing that this item should be eliminated (the remaining four items uniformly assess task persistence). The decision to eliminate this item was further supported by a relatively flat (rather than S-shaped) item characteristic curve.

LCA Model Results

The top portion of Table 1 shows the results of the seventh grade LCA model. Careful inspection of the model fit indices shows that a four-class model fit best, with optimal shrinkage of the AIC and BIC as well as stabilization of entropy and the L^2 likelihood statistic. The five-class model shows some additional shrinkage in the Information Criterion, however, there was a decrement in entropy (.713 to .707). What emerged in the five-class compared to the four-class model was an additional class that exhibited very little latent class separation with most of the differences in the endorsement probabilities involving one or two items, not clearly demarcating a distinct typology. In addition, the resulting fifth class was more sparsely populated. On this basis, we chose the four-class model as the most parsimonious and most illustrative of unique configuration of self-management skills. The very same class structure repeated for the 10th grade, with the same relative finding that the four-class model was superior to the five-class model not just by fit alone, but also by the clear latent class separation and homogeneity providing evidence of distinct response profiles and clearly distinguished classes.

Table 2 shows the item response probabilities for the seventh and 10th grade models. Item response probabilities were constrained across the two age groups, therefore only 10th grade is shown. The likelihood-ratio difference test testing the equivalence of a constrained versus unconstrained model was significant, $\Delta LR(56) = -178.014$, $p < .001$ (distributed as χ^2 with model *df* equivalent to the number of free parameters estimated in each respective model). At face value the significant p-value suggests the hypothesis of equal item response probabilities should be rejected. However, among the penalized fit statistics, which are better indicators of fit in models with large degrees of freedom, shows that the BIC was more favorable to the constrained model. In the long run, however, we do not have conclusive statistical evidence the constraints provide a superior fit (i.e., some of the item response probabilities varied across age groups, however the overall pattern of endorsement was quite similar).

Findings indicated clear response patterns that distinguish class membership. Members of the first class endorsed all the

Table 1. Model Fit Statistics for Latent Class and Latent Transition Analyses.

Analysis	Classes	LL	npar	AIC	BIC	Entropy	L^2	A-LRT (Sign.)
LCA 7 grade	1	−11,330.7	14	22,689.4	22,763.5	1.000	4,494.2	—[a]
	2	−10,96.3	29	20,450.6	20,604.2	0.780	3,541.6	2248.25 (.001)
	3	−9,944.5	44	19,976.9	20,210.0	0.759	3,278.4	499.10 (.04)
	4	**−9,736.7**	**59**	**19,591.5**	**19,904.0**	**0.713**	**3,224.1**	**411.68 (.002)**
	5	−9,572.7	74	19,293.3	19,685.3	0.707	2,931.3	325.19 (.001)
	6	−9,492.4	89	19,162.8	19,634.3	0.692	2,829.1	159.04 (.038)
	7	−9,442.3	104	19,092.7	19,643.7	0.675	2,709.7	99.20 (.373)
	8	−9,405.8	119	19,049.6	19,680.0	0.693	2,605.2	72.45 (.593)
LCA 10 grade	1	−8,861.4	14	17,750.7	17,821.4	1.000	4,507.3	—[a]
	2	−8,042.0	29	16,141.9	16,288.4	0.775	3,181.5	1,623.43 (.000)
	3	−7,858.5	44	15,805.0	16,027.2	0.745	2,842.3	363.45 (.003)
	4	**−7,699.4**	**59**	**15,516.7**	**15,814.7**	**0.729**	**2,756.4**	**315.31 (.035)**
	5	−7,585.9	74	15,319.8	15,693.5	0.713	2,571.8	224.77 (.044)
	6	−7,494.1	89	15,166.1	15,615.5	0.709	2,379.4	181.98 (.012)
	7	−7,435.0	104	15,078.1	15,603.2	0.705	2,285.0	116.95 (.128)
	8	−7,389.5	119	15,017.0	15,617.9	0.716	2,212.3	90.216 (.650)
LTA	2	−18,237.7	31	36,537.5	36,704.3	0.660	—[b]	
	3	−17,798.1	50	35,696.1	35,965.2	0.647		
	4	**−17,430.7**	**71**	**35,003.5**	**35,385.5**	**0.614**		
	5	−17,165.9	94	34,519.8	35,025.7	0.605		
	6	−16,915.8	203	34,237.6	35,330.0	0.626		

Note. [a]Test not available with one class. [b]L^2 not calculated in LTA because the model df are extremely high. Labels: LL = Log Likelihood, npar = Number of Parameters, AIC = Akaike's Information Criterion, BIC = Bayesian Information Criterion, L^2 = Likelihood Ratio Chi-Square, A-LRT = Lo-Mendell-Rubin Adjusted Likelihood Ratio Test. Numbers in bold show selected models.

cognitive self-reinforcement items ($\rho_{avg} = .964$) and all affective self-regulation items ($\rho_{avg} = .972$) but had much lower probabilities for the behavioral self-control items ($< .5$). Given the dominance of the self-reinforcement and self-regulation items, we labeled this class "*High Cognitive Self-Reinforcers/ Affective Self-Regulators*" (*High CSR/ASR*). Only one of the behavioral self-control items was endorsed over the .50 threshold suggesting random or irregular use of these skills. Latent class prevalences indicating the probability of membership in this class was 24.4% and 20.5% for the seventh and 10th grades, respectively (individuals are probabilistically assigned to their classes using the most likely classification scheme). Members of the second class endorsed all the behavioral self-control items ($\rho_{avg} = .875$), and they endorsed the affective self-regulation items ($\rho_{avg} = .704$), but had much lower probabilities for the cognitive self-reinforcement items ($\rho_{avg} = .576$). We labeled this class "*High Behavioral Self-Control+*" (*High BSC+*), with the plus (+) sign indicating the endorsement of selected self-management items that characterized the other classes. Latent class prevalences showed that the probability of membership in this class was 31.7% and 32.0% for the seventh and 10th grades, respectively. The third class endorsed three cognitive self-reinforcement items $> .5$ ($\rho_{avg} = .556$), one behavioral self-control item $> .5$ ("something difficult get frustrated and quit") ($\rho_{avg} = .312$), and one of the affective self-regulation skill items $>.5$ ("doing something that makes me nervous, think about how to feel less nervous") ($\rho_{avg} = .484$). We labeled this class "*Moderate Cognitive Self-Reinforcers*" (*Moderate CSR*). The probability of membership in this class was 23.8% and 25.8%, for the seventh and 10th grades, respectively. The fourth (reference) class consistently endorsed all four behavioral self-control items ($\rho_{avg} = .810$) but had very low probabilities of endorsing cognitive self-reinforcement items ($\rho_{avg} = .288$) and affective self-regulation items ($\rho_{avg} = .122$). We labeled this class "*Moderate Behavioral Self-Controllers*" (*Moderate BSC*). The probability of membership in this class was 20.1% and 21.7%, for the seventh and 10th grades, respectively.

LTA Model Results

We next estimated the LTA model by simultaneously estimating class structures at the two time points and further estimating the incidence of transitions across time (i.e., the probability of maintaining one's status as opposed to transitioning between status groups over time). The bottom portion of Table 2 contains the transition probabilities showing the change in latent status membership at Time 2 conditioned on the prior latent status membership at Time 1.[4] The numbers on the diagonal, representing the probability of remaining in the same status at the two time points, revealed there was a modicum of stability in status membership. The off-diagonal elements indicate the probability of changing status membership in the 10th grade conditioned on prior class membership in the seventh grade. The most stable status was the *Moderate CSR* (.54) followed by the *Moderate BSC* status (.52). Several of the off-diagonal numbers indicate that there was considerable movement between the seventh and 10th grades underscoring shifts in the composition of skills used by students between these two age periods. For instance, while the transition probability for

Table 2. Item Response Probabilities and LTA Results for Four-Class Model.

	Latent Status			
	1	2	3	4
Latent status prevalences				
Time 1–7 grade	24.4%	31.7%	23.8%	20.1%
Time 2–10 grade	20.5%	32.0%	25.8%	21.7%
Item response probabilities of positive response (% endorsing "1" in seventh/10th grade)				
REINF1 (0.77/0.78)	**1.00**	**0.81**	**0.83**	0.38
REINF2 (0.65/0.66)	**0.95**	**0.66**	**0.61**	0.31
REINF3 (0.53/0.48)	**0.96**	0.46	0.41	0.15
REINF4 (0.56/0.56)	**0.94**	**0.52**	**0.57**	0.14
REINF5 (0.50/0.46)	**0.97**	0.43	0.36	0.11
CNTRL2 (0.43/0.42)	0.46	**0.86**	0.20	**0.75**
CNTRL3 (0.45/0.45)	0.39	**0.83**	0.17	**0.79**
CNTRL4 (0.27/0.19)	**0.68**	**0.94**	**0.54**	**0.88**
CNTRL5 (0.38/0.35)	0.48	**0.87**	0.34	**0.81**
REG1 (0.62/0.67)	**0.98**	**0.73**	**0.55**	0.18
REG2 (0.57/0.57)	**0.95**	**0.61**	0.45	0.19
REG3 (0.60/0.55)	**0.95**	**0.70**	0.45	0.05
REG4 (0.60/0.60)	**0.99**	**0.70**	0.48	0.11
REG5 (0.64/0.60)	**0.99**	**0.78**	0.49	0.08
Probability of transitioning to . . . conditional on seven grade latent status	. . . 10th grade latent status			
1	**0.44**	0.29	0.24	0.03
2	0.14	**0.49**	0.12	0.25
3	0.18	0.18	**0.54**	0.11
4	0.05	0.26	0.17	**0.52**

Note. Status 1 "High Cognitive Self-Reinforcers/Affective Self-Regulators," Status 2 "High Behavioral Self-Control+," Status 3 "Moderate Cognitive Self-Reinforcers," and Status 4 "Moderate Behavioral Self-Controllers."

remaining a member of the *High CSR/ASR* status was .44, the probability of moving to the *High BSC+* status was .29, and the probability of moving to the *Moderate CSR* status was .24 (i.e., 24% of the students shifted in skills use over time).

The transition from the *Moderate BSC* to *High BSC+* status (.26) indicates an expansion of self-management skills, whereas the transition from the *High BSC+* to the *Moderate BSC* status (.25) represents a contraction of self-management skills. Equally informative to the large transition probabilities are the relatively small transition probabilities, which indicate a smaller likelihood of movement from one status to another over time. To illustrate this point, the transition probability for moving from the *High CSR/ASR* status to the *Moderate BSC* status was only .03. This indicates only a 3% likelihood of moving from a very high functioning, highly skilled status to a less skilled status exhibiting moderate behavioral self-control. This pattern was also noted for the movement from the *Moderate BSC* status to the *High CSR/ASR* status (transition probability = .05), indicating a 5% likelihood of moving from the status characterized by behavioral self-control to a status utilizing more self-management skills between the seventh and 10th grade.

Multinomial Logistic Regression

The top portion of Table 3 shows the results of the multinomial logistic regression model predicting seventh grade class membership. Initially, each covariate was entered into the model one by one and then together as a block (all covariates were standardized). This was done to gauge the relative importance of each covariate and to ensure there was no masking of effects in the case of highly colinear relations. The results show that members of the *High CSR/ASR* were 22% less likely to be risk-takers, 3 times as likely to have higher self-esteem, 29% less likely to use alcohol and 2.4 times as likely to be from the Violence study compared to the reference (*Moderate BSC*) status. Members of the *High BSC* status were less 24% likely to be from a nuclear family, 24% less likely to take risks, almost twice as likely to have higher self-esteem, and 30% less likely to smoke cigarettes than members of the reference class. Members of the *Moderate CSR* status were 27% less likely to be male and 32% more likely to have higher self-esteem compared to the reference class.

The middle portion of Table 3 presents the findings adjusting the transition probabilities by the covariates. In this table, the effect of a covariate on a transition probability is equivalent to stating there is an interaction between the covariate and the categorical latent variable at Time 1 as it influences status at Time 2 (B. Muthén & Asparouhov, 2011). In effect, this is a form of moderation in which the covariate influences the slope of Time 2 status regressed on Time 1 status. In other words, this is the same as stating that a covariate that captures a particular characteristic of the sample (i.e., being male or risk-taking) influences movement between statuses over time (or stability) when contrasted with individuals that lack that specific quality (i.e., being female or a non-risk-taker). This produces one set of transition probabilities that adequately characterize individuals who possess the characteristic and another set of transition probability parameters that characterize individuals lacking the particular quality (i.e. males making the transition between statuses versus females not making the same transition).

Because we use Odds Ratios (OR) to capture the likelihood of transitioning between statuses, it is interpreted as a change in the odds of transitioning in relation to the reference latent status, conditional on the Time 1 (seventh grade) latent status. Using the first column as an example, an OR of .31 for the covariate capturing race can be interpreted as white individuals who were members of the *High CSR/ASR* status were 31% less likely to stay in the High CSR/ASR status compared to nonwhites. Males who were members of the *High BSC+* status in the seventh grade were 48% less likely to stay in the High BSC+ status compared to females who become members of the *Moderate BSC status*. Notably, for members of the *Moderate CSR* status in the seventh grade race was significantly related to both staying and moving from this class (compared to the reference class). For example, whites in the *Moderate CSR* status were much more likely to move to the *Moderate BSC* status (ORs = .05, .25, and .11) compared to nonwhites who were more likely to stay in the *Moderate CSR* status than

Table 3. Results of the Multinomial Logistic Regression Testing Covariate Influence and Class Membership Effects on Distal Measure of Alcohol Use.

	Latent Status			
	High CSR/ASR	High BSC+	Moderate CSR	Moderate BSC
Seventh grade membership				
Male	0.85	0.88	**0.73**	ref
White	1.11	0.88	0.88	ref
Grades (Better = 1)	1.04	1.17	0.93	ref
Nuclear family (=0)	0.94	**0.76**	0.83	ref
Risk taking	**0.78**	**0.76**	1.14	ref
Self-esteem	**3.31**	**1.85**	**1.32**	ref
Current smoking	1.04	**0.70**	1.12	ref
Alcohol frequency	**0.71**	0.92	0.93	ref
Study	**2.37**	0.71	1.40	ref
Odds Ratios corresponding to covariate influence on transition from 1st class in seventh grade to . . .	High CSR/ASR	High BSC+	Moderate CSR	Moderate BSC
Male	1.23	1.94	1.61	ref
White	**0.31**	0.39	0.53	ref
Grades	1.57	1.53	1.10	ref
Self-esteem	1.41	1.60	1.04	ref
Study	0.56	0.63	N/E	ref
from second class in seventh grade				
Male	0.83	**0.48**	0.60	ref
White	1.21	0.62	1.10	ref
Grades	0.94	1.06	N/E	ref
Self esteem	0.87	0.83	1.26	ref
Study	3.58	2.24	0.97	ref
from third class in seventh grade				
Male	1.26	4.08	1.03	ref
White	**0.05**	**0.25**	**0.11**	ref
Grades	0.75	0.76	0.82	ref
Self-esteem	1.83	2.98	1.71	ref
Study	0.25	0.76	**0.18**	ref
from fourth class in seventh grade[a]				
Self-esteem	15.10	0.89	0.79	ref
Study	N/E	1.62	1.94	ref
Distal outcome (Alcohol use) mean estimates (SE)				
Status 1	9.13 (0.38)	10.04 (0.77)	11.29 (0.82)	9.76 (1.59)
Status 2	11.57 (0.66)	9.48 (0.34)	12.97 (1.43)	12.09 (0.59)
Status 3	9.18 (1.50)	11.97 (4.39)	10.38 (1.13)	11.12 (1.49)
Status 4	8.17 (0.81)	10.12 (0.94)	11.49 (1.76)	10.55 (0.55)

[a] Sparse cells in this very low functioning class led to convergence problems with unsatisfactory solutions. Therefore, only predictors significant in unadjusted model carried forward to full adjusted model. Labels: Study = Violence (1). N/E = Not Estimated.

move to the *Moderate BSC* (as well as the more functional statuses). Also, students who were part of Trial 2 (Violence, predominantly non-white) were more likely to stay in the *Moderate CSR* status compared to students from the NHLBI study (predominantly white).

Comparison of Drinking Levels

The bottom portion of Table 3 shows the mean drinking levels for all four statuses as they transitioned over time. The best way to interpret the information contained in this table is to consider that the left-hand side of the table denotes status membership in the seventh grade while reading across rows represents movement to a different status in the 10th grade. For instance, participants who were members of the *High CSR/ASR* status in the seventh grade and who remained in this status in the 10th grade, representing the maintenance of strong self-management skills over time, reported mean drinking levels of 9.13 as young adults, notably among the lowest drinking levels. If the same youth transitioned to the *Moderate CSR* status in the 10th

Table 4. Results of Pairwise Comparisons for Latent Status Transitions Predicting Young Adult Alcohol Use.

Initial Status	Comparison Status	t-value	Difference	SE	Mean Comparison
C7#1.C10#1	C7#1.C10#3	−2.35*	−2.16	.92	$\overline{X} = 9.13$ vs. $\overline{X} = 11.29$
C7#1.C10#1	C7#2.C10#1	−3.07**	−2.44	.79	$\overline{X} = 9.13$ vs. $\overline{X} = 11.57$
C7#1.C10#1	C7#2.C10#3	−2.55*	−3.84	1.50	$\overline{X} = 9.13$ vs. $\overline{X} = 12.97$
C7#1.C10#1	C7#2.C10#4	−4.23***	−2.96	.70	$\overline{X} = 9.13$ vs. $\overline{X} = 12.09$
C7#1.C10#1	C7#4.C10#4	−2.15*	−1.42	.66	$\overline{X} = 9.13$ vs. $\overline{X} = 10.55$
C7#1.C10#2	C7#2.C10#4	−2.18*	−2.06	.94	$\overline{X} = 10.04$ vs. $\overline{X} = 12.09$
C7#1.C10#3	C7#4.C10#1	2.62**	3.12	1.19	$\overline{X} = 11.29$ vs. $\overline{X} = 8.17$
C7#2.C10#1	C7#2.C10#2	2.48*	2.09	.84	$\overline{X} = 11.57$ vs. $\overline{X} = 9.48$
C7#2.C10#1	C7#4.C10#1	3.01**	3.39	1.13	$\overline{X} = 11.57$ vs. $\overline{X} = 8.17$
C7#2.C10#2	C7#2.C10#3	−2.28*	−3.49	1.53	$\overline{X} = 9.48$ vs. $\overline{X} = 12.97$
C7#2.C10#2	C7#2.C10#4	−3.93***	−2.61	.66	$\overline{X} = 9.48$ vs. $\overline{X} = 12.09$
C7#2.C10#3	C7#4.C10#1	2.84**	4.80	1.69	$\overline{X} = 12.97$ vs. $\overline{X} = 8.17$
C7#2.C10#4	C7#4.C10#1	3.94***	3.92	.99	$\overline{X} = 12.09$ vs. $\overline{X} = 8.17$
C7#4.C10#1	C7#4.C10#4	−2.58*	−2.38	.92	$\overline{X} = 8.17$ vs. $\overline{X} = 10.55$

Note. * $p < .05$, ** $p < .01$, *** $p < .001$. Labels: C7#1 = seventh grade High CSR/ASR; C7#2 = High BSC+; C7#3 = Moderate CSR; C7#4 = Moderate BSC; C10#1 = 10th grade High CSR/ASR; C10#2 = High BSC+; C10#3 = Moderate CSR; C10#4 = Moderate BSC.

grade, which would represent a significant contraction of self-management skills, their mean drinking level was among the highest levels (11.29) as young adults (first row third column).

A quick glance at the table shows that relatively low levels of drinking were reported by individuals who started out as *Moderate CSR* but transitioned to *High CSR/ASR* ($\overline{X} = 9.18$), and also individuals who started out as *Moderate BSC* but ended up as *High CSR/ASR* ($\overline{X} = 8.17$), both transitions representing a gain in cognitive and affective self-management skills between the seventh and 10th grades. Also, youth who remained as *High BSC+* over time had relatively low levels of drinking ($\overline{X} = 9.48$) and somewhat surprisingly students who started as *High CSR/ASR* and ended up as *Moderate BSC* had relatively low levels of drinking ($\overline{X} = 9.76$).

Table 4 shows the results of the pairwise comparisons for different transition statuses predicting young adult alcohol use. Fourteen of the pairwise comparisons contrasting across-time transitions were statistically significant. Negative difference scores indicate the first transition status had a lower level of drinking compared to the second transition status, whereas a positive difference score indicates the first transition status had a higher level of drinking compared to the second transition status. All told, five of the pairwise comparisons involved youth who were members of the most highly skilled status (*High CSR/ASR*) and remained in this status over time and four of the comparisons involved youth who were members of *High BSC+* status and remained in this status over time or improved their skills by becoming *High CSR/ASR*. To illustrate, the Mplus syntax shorthand shows a combination (C7#1.C10#1) designating status membership in the seventh grade (*High CSR/ASR*) and remaining in this status in the 10th grade. This status transition (i.e., stability) is then contrasted to a different transition status pattern (C7#1.C10#3) indicating *High CSR/ASR* who transitioned to *Moderate CSR*. For the first row of the Table, the pairwise comparison shows that members of the *High CSR/ASR* status who remained in this status drank significantly less as young adults ($\overline{X} = 9.13$) than members who initially began as *High CSR/ASR* who then transitioned into the *Moderate CSR* status ($\overline{X} = 11.29$). The remaining five significant pairwise comparisons involved different combinations of youths moving from one status to another. The last entry in the table shows the most extreme comparison, with youth starting off in the seventh grade as *Moderate BSC* and becoming *High CSR/ASR* contrasted with youth who were *Moderate BSC* at both time points ($\overline{X} = 8.17$ vs. $\overline{X} = 10.55$). In all of the comparisons a consistent finding was that moving from a lesser skilled status to a more highly skilled status or remaining as a member of a highly skilled status compared to youth making transitions that devolved their skill set was protective and associated with lower levels of alcohol consumption as a young adult. As one final point regarding modeling covariates, we cannot contrast the model with and without covariates using the usual L^2 measure given that the models are parameterized differently and are not nested (i.e., one model with and one without restrictions). However, as an alternative means of gauging model improvement, the AIC and BIC both shrunk with the addition of covariates (AIC = 43,810.7, BIC = 44,365.0 for LTA predicting alcohol use as a distal outcome without covariates, and AIC = 43,223.5, BIC = 44,159.9 for the final model with covariates and a distal outcome).

Discussion

Although self-management skills represent a formidable focus for both studies of drug etiology and prevention, very few studies have investigated subgroup heterogeneity in skills development with a longitudinal component. Even more scant have been studies that have identified typologies of self-management skills and then examined the implications of these typologies for future alcohol use. In this study we examined typologies of self-management skills both in the seventh and

10th grades. Then, using the longitudinal component of the data, we examined whether there were changes in status membership over time using LTA methods. Once we derived the transitional probabilities, we then examined whether the different statuses predicted alcohol use in young adulthood. We discuss the findings in this order, turning first to the derivation of typologies (LCA), then the longitudinal component (LTA), and then the prediction of a distal outcome involving alcohol use.

The LCA pointed to four unique typologies that represented distinct configurations of skills. Latent class prevalences indicated there was considerable balance in the numbers of youth within each of the four classes suggesting that no one subgroup with its unique composition of skills was more prevalent. Tests of measurement invariance indicated the plausibility of the same measurement model in the 10th grade, with roughly the same latent class prevalences. A noticeable feature of the four-class model was both ideal homogeneity and very clear latent class separation. In the case of the *High CSR/ASR* status, the magnitude of item response probabilities was very large ($>.94$) consistently for indicators of cognitive self-reinforcement and affective self-regulation. At the same time, members of this status did not endorse the behavioral self-control items with the exception of one item ("find something is difficult get frustrated and quit," reverse scored). Members of the *High BSC+* status endorsed many of the same indicators as the *High CSR/ASR* status, however, there were subtle differences in the pattern of item endorsement and likewise the magnitude of the item response probabilities. Individuals who readily used self-control and self-regulation skills were less inclined to reward themselves for small achievements using self-talk and praise. Their ability to control impulses and stay focused on tasks with little distraction was paralleled by an ability to control internal events like pain, sadness, negative thoughts or anxiety. In comparison, members of the *High CSR/ASR* status used self-talk and praised themselves for small accomplishments in addition to regulating their emotions, finding ways to calm themselves when upset and reducing their anxiety.

Members of the *Moderate CSR* status inconsistently endorsed the indicators for self-reinforcement (only two items $>.6$) and had probabilities close to .5 (chance) for one behavioral self-control and one affective self-regulation item. In essence, this is a low functioning group that shows very little reliance on these skills. Members of the *Moderate BSC* status distinguished themselves from any other class by consistently endorsing skills reflecting behavioral inhibition involving task persistence and attentional focus (i.e., concentration) with very low endorsement of the remaining cognitive or affective self-management skills.

We then examined the different typologies as "discrete dynamic processes" using the longitudinal component of the data. Movement between statuses could reflect acquisition of skills (i.e., moving from *Moderate BSC* to *High CSR/ASR*) or conversely a contraction of skills (moving from *High CSR/ASR* to *Moderate BSC*). This type of focus emphasizes the developmental implications of self-management skills and whether there is developmental flux in skill acquisition during this age period. Skills that are effective and yield favorable outcomes should become an indelible part of the behavioral repertoire of youth. On the other hand, ineffective skills that do not produce desired results can be discarded or refined over time. The LTA showed there was some evidence of stability in class membership across time, however, there was also evidence suggesting that many youths shifted and either acquired new skills or contracted their use over time. The largest of these transitions indicated that members of the *High CSR/ASR* status, who routinely utilized self-reinforcement and self-regulation skills early in adolescence, shifted their membership to become *High BSC+*. It is not entirely unexpected that there was an increased reliance on behavioral self-control skills as this is consistent with the developmental literature showing an increased reliance on self-control spanning most of adolescence (Monahan et al., 2009). There was also evidence that some youth were able to gain new skills over time, shifting from primarily exercising behavioral self-control skills in the seventh grade to employing self-regulation skills in the 10th grade. Self-regulation skills enable youth to manage their emotions, be less worried, and learn to stay calm, and also restructure their thinking to be less negative. These skills are critical to avoid depression and anxiety, two highly prevalent psychological conditions that affect not only youth, but young adults and adults as well (Ialongo et al., 2004; Mojtabai et al., 2016).

As part of the LTA modeling, we also introduced covariates to determine whether specific characteristics of the individual differentially influenced their transition probabilities. We chose to adjust the seventh grade class membership models for covariate influences because they reflect early socialization experiences, possible temperamental differences, and early adolescent substance use behavior that may put young people at risk for poor skill development early in life and remaining an indelible feature of their skills development over time. These influences should then carry forward to the latent statuses in the 10th grade. Taken as a whole, gender and nuclear living situation, risk-taking and self-esteem, and frequency of smoking and alcohol use actively discriminated seventh grade class membership. These same variables had much less influence when predicting the transitional probabilities, perhaps suggesting that their influence placed youth at risk initially but this influence waned when youth moved (or stayed) in their various statuses over time.

Perhaps the most consistently performing covariate in discerning seventh grade class membership was self-esteem, which was three times as likely to influence membership in the *High CSR/ASR* class compared to the reference class of *Moderate BSC*. This is not surprising given the important role played by self-esteem in skills acquisition. Bandura (1986), for example, was careful to point out there is a close alliance between routinized use of skills, self-efficacy, and self-esteem. However, he also clearly articulated that self-efficacy is not the same thing as self-esteem. The former entails judgment of capability ("can I do this"), whereas the latter reflects judgment of self-worth ("liking oneself"). The downstream

effect of youth who evaluate their performance and determine they can competently engage and successfully execute a task is to boost their self-esteem. That is, continued reward for their investment in using high-end "executive" cognitive strategies will reinforce sustained effort. Seeing that they benefit from applying these skills will auger well for youth to continue applying the same strategies in other situations, ultimately building a positive self-evaluation that is protective.

The third research question was concerned with whether movement between statuses from the seventh to 10th grade was associated differentially with young adult alcohol consumption. The results suggest that variation in drinking levels in young adulthood could be explained to some degree by movement between statuses from the seventh to the 10th grades. In five out of 14 significant pairwise comparisons, members of the *High CSR/ASR* status who remained steadfast in the use of these skills drank less alcohol than youth who transitioned to any other status. This protective effect was particularly notable for youth who were initially reliant on cognitive self-reinforcement and affective self-regulation skills but then either abandoned one or another set of skills and became *Moderate CSRs* or favored behavioral self-control skills (*High BSC+*). Indeed, all of the other skills combinations that did not involve self-reinforcement (including both behavioral self-control in combination with affective self-regulation or just behavioral self-control) drank alcohol more frequently, in heavier quantities and reported being drunk more often as young adults.

Implications for Prevention

The findings from the current study have important implications for how drug and alcohol prevention and treatment services are provided. By identifying self-management typologies and their stability over time, we can gain an understanding of how youth typically combine skills in unique ways and how combinations of skill strengths and deficits may work together to increase risk behavior. Findings indicate that naturally occurring skill sets cluster within individuals and have an impact on development and risk-taking including alcohol use. In particular, we found that an expansion of cognitive and affective self-management skills over the course of adolescence is a protective factor for young adult alcohol use. Whereas many drug prevention programs assume that effective prevention programs have a ubiquitous effect; it may be that programs work synergistically with a priori skill sets among youth. Young people with limited self-management skills in middle school may benefit most from broad-based skills building programs that are supplemented with tailored individual or group workshops, behavioral homework assignments, or adjunctive interventions that emphasize inhibitory control, attention regulation, goal setting, and related skills. These findings may also have implications for treatment approaches. Studies have found that coping skills and self-regulation flexibility are positively associated with adaptive psychological functioning among alcohol dependent persons (Borzyszkowska & Basińska, 2018). Further, individuals with a broad repertoire of coping skills have better alcohol treatment outcomes (Roos & Witkiewitz, 2016), and coping skills training can improve alcohol use treatment outcomes when delivered as part of a comprehensive treatment program (Longabaugh & Moregenstern, 1999). Future research should examine other typologies of self-management skills, including poor emotional regulation or poor social competency, both of which are critical to development in the early years. Clustering of such competencies may be predictive of different substance use and risk behavior outcomes as adolescents make the transition to emerging adulthood. Such findings have the potential to modify both our preventive and treatment intervention approaches and our theoretical models by placing greater emphasis on individual differences and unique combinations of skills that operate as integrated systems within the individual.

The results of this study go one step further by reinforcing the utility of a skills-based competence-enhancement prevention approaches that focuses on teaching self-management skills and other generic "life skills" (Botvin & Griffin, 2004). A competence-enhancement prevention approach teaches youth skills to make better decisions, be more planful, use strategies to solve problems including internal self-talk to maintain high levels of motivation in the face of challenging tasks (e.g., Botvin et al., 1995, 2006). It also teaches youth skills to remain calm in the face of adversity, avoid negative or unpleasant thinking when stressed, and maintain attentional focus to improve frustration tolerance. For instance, teaching skills for coping with anxiety and cognitive strategies that promote positive thinking can promote better decision making under conditions that are perceived as stressful (Botvin & Griffin, 2015).Youth who acquire these skills are less likely to be succumb to alcohol and drug offers, and less susceptible to negative peer pressure and other social influences to drink or use drugs.

Limitations

There are a number of limitations associated with this study. First, there was considerable subject loss between the baseline and follow-up years. In an effort to minimize any systematic bias that resulted from attrition, we controlled for demographic and personality measures, all of which were related to panel loss. We also examined the LCA model separately using the full baseline sample and found the class structure replicated across samples, suggesting there is minimal bias with the panel sample. Notwithstanding adjustments for attrition, the fact that students lost to follow-up were more likely to smoke cigarettes, drink alcohol and use marijuana, be risk-takers and have lower self-esteem indicates loss of relevant variability in the final sample and limits the ability to generalize findings to higher risk youth.

Certain technical features of testing LTA may have hindered our interpretation of the results. For one thing, we did not obtain statistical evidence supporting cross-grade invariance in the item response probabilities. This suggests there were

some qualitative differences in the meaning of the different statuses between the seventh and 10th grades that may affect interpretation of what each class represents. Upon careful inspection, grade differences in the item response probabilities were trivially small and any significant findings were perhaps an artifact of sample size and the large number of parameters being estimated. It is essential to constrain item response probabilities to equivalence in order to ensure the statuses retain the same meaning. We also did not test for invariance by gender or race/ethnicity, two factors that may influence both the measurement model and, based on the covariate-adjusted analyses, also influence the transition probabilities. Future studies may warrant more extensive examination of these issues and with larger samples address their relative influence on class composition and stability.

We also don't know what prompted the acquisition or loss of certain skills, why some youth shifted their reliance from one cognitive strategy to another. Controlling for covariates is one means of introducing factors that may accelerate or retard development of these skills.[5] Other factors that should be considered include neurobiological causes of executive cognitive functioning that could contribute to deficits in the strategies we assessed (e.g., Hare & Casey, 2005). There was also a sizable gap in the time between 10th grade and the young adult follow-up. As quickly as youth transition from one class to another between the seventh and 10th grades, they can also change their configuration of skills and shift again between the 10th grade and later follow-up. From the point of view of cognitive development, theories of cognitive development suggest that during the transitional period from the seventh to 10th grade youth begin to apply formal operational thinking and also crystallize their identity through academic pursuits. Also, the type of cognitive skills emphasized in the LTA model may undergo further refinement in the ensuing years, however, there is less chance youth would dramatically alter their thinking styles as they mature through the end of high school and beyond. Furthermore, the reliance on self-report may bias the findings to those voluntary thought processes that youth recall, but still not be representative of their actual decision processes.

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Notes

1. The strategy of dichotomizing indicators also makes the data analysis more manageable given the size of the multiway contingency table had we left the 5-point response formats intact. The modal values for the seventh grade cognitive self-reinforcement items were 4, the same modal values were 3 for the behavioral self-control items, and 4 for the affective self-regulation items. This pattern repeated itself in the 10th grade with the exception of one behavioral self-control item, which a modal value of 2 (i.e., "If I find that something is really difficult, I get frustrated and quit"). In sum, there is very little loss of information truncating scales into binary format using the >=3 inflection point.
2. The decision of precisely how to model covariates depends on the research questions being addressed. In our case, we controlled for the influence of covariates from the class membership structure in seventh grade and controlled for their effects on the transition probabilities.
3. The were notable study differences in consumption patterns both in the seventh grade and at the young adult follow-up. Whereas seventh grade females in Trial 2 had the highest prevalence for cigarette use (7% and 3.8% vs. 4.2% and 5.2% for Trial 2 females and males versus the same for Trial 1) these numbers shifted dramatically by the young adult follow-up where females and males in Trial 1 had the highest smoking prevalence (62% vs. 60.8% for Trial 1 females and males vs. 23.1% and 32.8% for Trial 2 females and males, respectively). A different picture emerged for drinking prevalence because seventh grade female and male students in Trial 1 had higher prevalence than the Trial 2 students (63.2% and 47.1% for male and female vs. 21.1% and 25.1% Trial 2 males and females, respectively). However, there was relatively no differences in the young adult follow-up sample where almost every individual reported having tried alcohol (96.9 and 98.7% vs. 94. 7% and 95.0% for the same male female by study comparisons). Prevalence for marijuana use also underscore the dramatic change between gender by study between the seventh grade (5.2% and 1. 9% vs. 5.4% and 4.5% for Trial 1 males and females vs. Trial 2 males and females, respectively) and the young adult follow-up (68.7% and 63.4% Trial 1 males and females vs. 59.3% and 45. 1% for Trial 2 males and females).
4. We tested a model positing that latent status membership at Time 2 was equivalent to Time 1 constraining the diagonal of the transition probability matrix to 1's (the remaining elements of the transition probability matrix are constrained to 0). The nested comparison to a model that freely estimates the transition probabilities, was significant, $\chi^2(12) = 1197.3$, $p < .001$, allowing us to reject the null that latent status membership is identical at the two time points (indicating that students shifted in their latent statuses over time).
5. One assumption of the LTA model, a type of first-order Markov model, is that all of the information to establish the class structure at Time 2 is available at Time 1. This means the transition probabilities at Time 2 can be conditioned on Time 1 only. Notwithstanding this assumption, there are many factors that fuel development of self-management skills and we have only scratched the surface of these contributing factors with the full set of indicators at Time 1 and the covariates that were modeled.

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