Self-Regulation, Alcohol Consumption, and Consequences in College Student Heavy Drinkers: A Simultaneous Latent Growth Analysis*

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ABSTRACT. Objective: Lower levels of self-regulation have been associated with higher rates of alcohol-related consequences. Self-regulation refers to the effortful ability to plan and achieve delayed adaptive outcomes through goal-directed behavior, and this skill may play a role in adaptive behavioral change. The purpose of this prospective, longitudinal study was to test predictions from self-regulation theory about the relationship among self-regulation and weekly alcohol consumption and alcohol-related consequences over 12 months. **Method:** Participants were 170 heavy drinking college students who provided data on alcohol use and consequences at baseline and at 1-, 6-, and 12-month assessments.

Results: Using a simultaneous latent growth model, self-regulation ability predicted the amount of initial alcohol-related consequences, the rate of change for alcohol-related consequences, and the rate of change for drinks per week. In contrast, self-regulation was not related to the initial level of alcohol use. **Conclusions:** Collectively, these results suggest that lower self-regulation ability functions as a risk factor for experiencing alcohol-related consequences and attenuates naturally occurring reductions in alcohol use and consequences over time for heavier drinking college students. (*J. Stud. Alcohol Drugs* 70: 373-382, 2009)

COLLEGE STUDENT DRINKING is frequently characterized by heavy episodic consumption, often defined as the consumption of five drinks for male (four drinks for female) students at one sitting (Wechsler et al., 1995). Traditionally college students consume more alcohol per drinking occasion than their non-college-attending peers (Slutske, 2005), and recent national surveys estimate that approximately 40% of all students engage in heavy episodic drinking during any given 2-week period (O'Malley and Johnston, 2002). This style of drinking leads to negative consequences across academic, interpersonal, health, and legal domains (Presley et al., 1994). Because of their high level of risky alcohol use, college students have been defined as a high-risk population deserving of attention (National Center on Addiction and Substance Abuse at Columbia University, 2007; Task Force of the National Advisory Council on Alcohol Abuse and Alcoholism, 2002).

Considerable heterogeneity exists in alcohol-use trajectories for individuals transitioning from adolescence into adulthood (Bartholow et al., 2003; Schulenberg et al., 1996;

Tucker et al., 2003). Identification of risk factors for higher risk alcohol-use trajectories may help with the development and implementation of appropriate and efficacious treatment. Although little empirical evidence exists concerning statistical predictors of naturally occurring adaptive behavioral change regarding heavy episodic drinking (Tucker et al., 2003), theory suggests that self-regulation (SR) is a critical component for the initiation of behavioral change (Kanfer, 1986; Miller and Brown, 1991).

Self-regulation

SR refers to the effortful ability to plan and achieve adaptive outcomes through goal-directed behavior, often by delaying gratification (Carver and Scheier, 1982). Kanfer (1970a,b, 1971) provided the first comprehensive psychological theoretical explanation concerning SR, which involved three stages, consisting of self-monitoring, self-evaluation, and self-reinforcement. The process of SR involves monitoring information about one's current state and comparing it with the desired goal. Miller and Brown (1991) expanded the framework of SR and theorized that SR contains seven dimensions: (1) informational input, (2) self-monitoring current progress toward a personal goal, (3) motivation for change, (4) commitment to reach the change goal, (5) development of a plan to reach the personal goal, (6) work according to the plan, and (7) re-evaluation of the plan. The primary adjustment to SR theory made by Miller

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and Brown involves articulating individual-difference factors (i.e., motivation and commitment) to reach the desired behavioral change or goal. In addition, Miller and Brown suggested that self-regulatory impairment can occur at each of the seven dimensions, and psychological interventions can be tailored to assist with the difficulties that can occur at any particular dimension that prevent efficient behavioral SR.

In summary, SR theory holds that individuals with low generalized self-regulatory capacity will be less capable of developing adaptive goals and monitoring their current status toward those goals than individuals with higher self-regulatory capacities. Furthermore, individuals with lower self-regulatory capacities will prefer activities that provide immediate gratification. Thus, SR theory applied to alcohol use suggests that individuals with lower self-regulatory capacities would be more likely to initiate alcohol consumption and be less likely to maintain moderate use and avoid negative consequences. In other words, SR theory suggests that individuals with lower self-regulatory capacities will be more likely to become heavier drinkers who frequently disregard their previous alcohol consequences as “warning signs” and fail to adjust their drinking patterns to avoid them in the future.

Research on self-regulation and alcohol use

Previous research has explored SR as a correlate of alcohol consumption and alcohol-related consequences at both the aggregate and event levels. For example, SR was significantly and negatively related to aggregate alcohol consequences ($r = -.25$) but not to alcohol consumption in a cross-sectional study of 391 college students (Carey et al., 2004). Congruent with SR theory, lower SR scores on a self-report inventory were associated with increased levels of reported alcohol consequences even after controlling for alcohol consumption and social desirability. This finding suggests that individuals with lower SR ability behave in a manner leading to increased levels of negative consequences, independent of how much alcohol they have consumed. Notably, these results were replicated using an independent sample (Neal and Carey, 2005).

Event-level analyses have highlighted the unique contribution of self-report measures of SR over self-report measures of impulsivity for predicting alcohol-related consequences. Specifically, Neal and Carey (2007) evaluated SR and impulsivity as moderating variables of the relationship between alcohol use and alcohol-related consequences that occurred on a specific drinking event in a sample of undergraduate students ($N = 206$) who completed daily drinking diaries for 4 weeks. Separately, both SR and impulsivity moderated the relationship between alcohol consumption and alcohol-related consequences, suggesting that participants with higher levels of SR and lower levels of impulsivity were less likely to experience alcohol-related consequences as intoxication

increased during a specific drinking event than individuals with lower levels of SR and higher levels of impulsivity. However, impulsivity failed to moderate the relationship when controlling for SR, suggesting that impulsivity is a component of the self-regulatory system. The possibility that impulsivity may be a component of the self-regulatory system parallels neuropsychological research suggesting that SR is a higher order construct often referred to as executive functioning. According to Giancola (2004), executive functioning can be thought of as a single-factor solution comprised of self-monitoring, abstract reasoning, problem solving, planning, cognitive flexibility, impulse control, and the ability to systematize relevant material.

To date, the relationship between generalized SR and alcohol-use variables (i.e., consumption and consequences) in young adults has not been evaluated longitudinally. However, developmental research using a large sample of adolescents in the sixth grade ($N = 1,526$) indicates that lower levels of SR are related to increased substance use over three annual assessments (Wills and Stoolmiller, 2002). Using latent growth curve (LGC) modeling, these investigators used a measure of poor SR (a composite of impatience, distractibility, angerability) and good SR (a composite of dependability, planning, and problem solving) as predictors of the initial level and the rate of change of substance-use involvement. Good SR was related to lower initial levels of substance use, and poor SR was related to higher initial levels of substance use. Only poor SR predicted the rate of change in substance use. This longitudinal study suggests that poor SR functions as a risk factor for increased substance use and consequences in young adolescents. However, the nature and correlates of substance-use involvement differ across developmental periods of early adolescence to young adulthood (Johnson et al., 2003a,b). Thus, research extending these observations in a young adult sample is needed to determine if findings from the adolescent literature apply to users of alcohol emerging into adulthood (cf. Arnett, 2000). Developmentally, the college years afford considerable personal freedom and environmental facilitation of drinking. It is likely that individual differences such as SR may play an important role in determining outcomes as young adults manage their drinking opportunities.

The present study investigated the longitudinal relationships among SR and alcohol consumption and consequences in college student drinkers. Specifically, this study evaluated four hypotheses derived from SR theory and previous research using the control group data from a previous intervention study with heavier drinking college students (Carey et al., 2006). First, we hypothesized that SR would be negatively related to the initial level of alcohol consequences. Specifically, we predicted that lower levels of SR would be related to higher levels of initial reported alcohol-related consequences, replicating previous results (Hypothesis 1; Carey et al., 2004; Neal and Carey, 2005). Second, we hy-

TABLE 1. Descriptive raw data of the sample, by gender

Variable	Female (<i>n</i> = 114)		Male (<i>n</i> = 56)		Overall (<i>n</i> = 170)	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Class standing ^a						
Freshman	68	60	24	43	92	54
Sophomore	35	31	24	43	59	35
Junior	9	8	5	9	14	8
Senior	1	1	2	4	3	2
Ethnicity ^b						
White	96	87	46	84	142	86
Black	3	3	3	5	6	4
Asian	3	3	3	5	6	4
Latino/Latina	2	2	0	0	2	1
Other	6	5	3	4	9	5
	Mean (SD)		Mean (SD)		Mean (SD)	
Age	19.1 (0.67)		19.5 (0.92)		19.2 (0.78)	
Typical drinks per week						
Baseline	16.40 (8.32)		23.30 (11.69)		18.68 (10.06)	
1 month	14.20 (8.12)		19.99 (13.74)		16.51 (10.68)	
6 month	14.69 (8.76)		20.22 (12.66)		16.61 (10.58)	
12 month	13.51 (9.45)		19.66 (12.77)		15.67 (11.08)	
Alcohol-related consequences						
Baseline	7.91 (5.98)		8.20 (5.58)		8.01 (5.84)	
1 month	8.06 (6.23)		7.63 (6.23)		7.92 (6.17)	
6 month	8.23 (7.30)		6.64 (5.79)		7.67 (6.83)	
12 month	7.00 (7.05)		5.33 (5.30)		6.42 (6.52)	
Self-regulation scores						
Baseline	112.2 (13.0)		113.5 (14.4)		112.7 (13.5)	

^aTwo participants (one male and one female) did not report their year in school; ^bfive participants (1 male and 4 females) did not report their ethnic background.

pothesized that individual differences in SR would account for differences (i.e., increases and decreases) in the rate of change for alcohol-related consequences, consistent with hypothesized deficits in self-monitoring and self-evaluation (Hypothesis 2). Third, SR should not be related to the initial level (i.e., the intercept) of typical alcohol use, given that previous studies have not observed this relationship (Hypothesis 3; Carey et al., 2004; Neal and Carey, 2005). Fourth, SR will predict the rate of change in alcohol consumption (i.e., the slope) over time because of the theoretical association between lower SR and the focus on immediate versus delayed rewards (Hypothesis 4).

Method

Design and participants

The present study consists of a secondary analysis of data from a longitudinal study investigating the effects of a brief motivational interview on college student alcohol use (Carey et al., 2006). In the original study, participants ($N = 1,407$) were recruited from an Introduction to Psychology subject pool at a private university in New York, and they earned course credit for their participation. Of the 623 eligible students who indicated interest in participating in future studies, met eligibility criteria (one or more heavy episodic drinking

events per average week or four or more heavy drinking episodes in the month before the baseline appointment), and were successfully contacted, 509 (82%) were randomly assigned to one of the six conditions (i.e., assessment only, assessment only and a Timeline Followback [TLFB] interview [Sobell et al., 1996], a brief motivational interview [BMI], BMI and a TLFB, enhanced BMI, and enhanced BMI with TLFB).

The present analyses focus on the behavior of the participants ($n = 170$) in the assessment-only control group who did not complete the TLFB. Participants completed a baseline assessment and follow-up assessments at 1, 6, and 12 months after baseline. The sample was 67% female, 86% white, and 54% freshmen. Participants in this study were no different than participants in the other experimental conditions on demographic and alcohol-use variables (Carey et al., 2006). Sample descriptive data can be found in Table 1.

Procedure

Study procedures involved baseline assessment and screening, recruitment of heavier drinkers, and repeated follow-up assessments over 12 months. Information concerning demographics, alcohol use, alcohol consequences, and level of SR were collected at a baseline/screening assessment. The baseline appointment took less than 1 hour. Follow-up

appointments took place 1, 6, and 12 months after the baseline assessment. Research staff made reminder calls to participants before each scheduled assessment, and participants earned course credit for the 1-month follow-up, and \$20 and \$25 for the 6- and 12-month follow-ups, respectively.

Measures

Participants completed parallel forms of self-report questionnaires throughout the course of the study. Listed below are the measures that provided data for the present study.

Demographics. Demographic items relevant to this study consisted of age, gender, ethnicity, and year in college. Gender was incorporated into the primary analysis to control for gender differences in alcohol consumption, alcohol-related consequences, and SR previously reported in the literature (Brown et al., 1999). The remaining demographic items were used for descriptive purposes.

Alcohol consumption. Participants were asked to report the number of standard drinks of alcohol consumed on each day of a 7-day grid representing a typical week of alcohol consumption during the past month. Typical drinks per week was operationalized by the total number of standard drinks reported across the 7 days, consistent with previous use of these grids in studies of college student drinkers (Dimeff et al., 1999).

Alcohol consequences. Alcohol consequences occurring over the course of 1 month were measured by the Rutgers Alcohol Problem Index (RAPI), a 23-item inventory (White and Labouvie, 1989). The RAPI is internally consistent in college samples (e.g., $\alpha = .92$; Neal and Carey, 2005), uses a Likert scale for responses ranging from never (0) to more than 10 times (4), and has demonstrated strong test-retest reliability ($r = .89$) over periods of 6 months. Scores on the RAPI are positively correlated with alcohol-use disorders (Ginzler et al., 2007).

Short Self-Regulation Questionnaire (SSRQ). The SSRQ (Carey et al., 2004) is a 31-item inventory based on the 63-item SR Questionnaire (Brown et al., 1999) that is designed to quantify an individual's ability to self-regulate his/her behavior in each of the seven hypothesized factors of generalized SR (i.e., information input, self-evaluation, investigation to change, plan searching, ability to plan, plan implementing, and plan evaluation). The SSRQ uses a 5-point Likert scale (ranging from strongly disagree [1] to strongly agree [5]), has demonstrated strong internal consistency (α 's ranged from .86 to .92; Neal and Carey, 2005), and is significantly correlated ($r = .96$) with the original version of the SRQ (Carey et al., 2004).

Analysis plan

LGC modeling (Muthén and Curran, 1997) was used to test all hypotheses. LGC analysis identifies homogenous

group trajectories from repeated-measures data to model individual and group variation occurring over time (Walker et al., 1996). LGC modeling is based on structural equation modeling and is used to estimate two latent constructs for each repeated-measures "factor" representing (1) the initial value (the intercept) and (2) the degree of change (the slope). These latent variables are obtained using a process analogous to confirmatory factor analysis (Muthén and Curran, 1997).

This study investigated the process of change using a simultaneous LGC model. Specifically, repeated measurements of alcohol consequences (the first factor, measured by the RAPI) and alcohol consumption (the second factor, drinks per week) were modeled simultaneously to investigate the growth patterns of correlated factors. The model included covariates to help explain the relationship between the latent variables (i.e., the slope and intercept) for each of the two growth factors (alcohol consumption and related consequences). First, gender was included to increase the fit of the growth model by accounting for gender differences. Second, SR was used to test a priori hypotheses about its relationship to intercepts and slopes. Goodness of fit for an LGC model exists when chi-square is not statistically significant (root mean square error of approximation [RMSEA] $\leq .06$; standardized root mean square residual [SRMR] $\leq .08$; comparative fit index [CFI] $\geq .95$; Tucker-Lewis index [TLI] $\geq .95$) (Hu and Bentler, 1999). Mplus 3.12 (Muthén and Muthén, 1998), with the full information maximum likelihood missing data estimator, was used for the LGC modeling.

Results

Preliminary data analysis

The data were examined for missing values. No missing data existed for the measures used in the primary analyses that were obtained at the baseline appointment (i.e., gender, SR, drinks per week, and alcohol-related consequences). However, missing data occurred at each of the remaining assessments. Four participants at the 1-month follow-up, 35 participants at the 6-month follow-up, and 41 individuals at the 12-month follow-up did not provide data for SR scores, drinks per week, or alcohol consequences. Participants with at least one missing data point ($n = 56$, 33%) did not differ (all p 's $> .05$) from those with complete data with respect to baseline SR scores ($t = -0.08$, 168 df), gender ($\chi^2 = 0.72$, 1 df), drinks per week ($t = -0.27$, 164 df), and alcohol-related consequences ($t = -1.50$, 168 df). The distribution for alcohol use and alcohol-related consequences deviated from the normal distribution (>2 skewness and >4 kurtosis) and a square-root transformation for the RAPI scores and a natural log transformation for drinks per week were performed to help normalize the multivariate distributions (Tabachnick and Fidell, 1996).

TABLE 2. Correlation matrix for the variables included in the analyses

	1.	2.	3.	4.
1. Gender	1.00			
2. Self-regulation	-.04	1.00		
3. Typical week alcohol consumption	-.32†	-.01	1.00	
4. Alcohol-related consequences	-.05	-.23*	.25*	1.00

Notes: Variables obtained at baseline appointment. Self-regulation scores obtained by the Short Self-Regulation Questionnaire. Alcohol-related consequences obtained by the total score from the Rutgers Alcohol Problem Index. Typical week alcohol consumption variables were natural log-transformed, and alcohol-related consequences scores were obtained after being square-root transformed.

* $p < .05$; † $p < .01$.

To determine whether SR would be a time-varying or time-invariant covariate, the temporal stability of the SSRQ scores was examined. The SSRQ did not exhibit a time effect ($F = 0.89$, 2/169 df); test-retest correlations ranged from $r = .71$ to $r = .80$ for 6-month delay, and $r = .52$ for a 12-month delay, and these correlations were not statistically different (z score of Fisher r to z difference = 1.32, $p = .19$). Thus, the score from baseline was treated as a time-invariant covariate for these analyses. A correlation matrix consisting of variables collected at baseline is presented in Table 2.

Latent growth curve model building

These data were modeled using a comprehensive model-building process. The model-building process started by analyzing the best-fitting model for each repeated measures factor. Each of the unconditional models (e.g., without covariates) was built by setting the loadings of each factor to zero for the intercept latent variable and by setting the slope parameters to 0, 1, 6, and 12 according to the chronological spacing of the assessments. In addition, the latent variables representing the intercept and slope were allowed to correlate. Linear and higher order polynomial slopes along with the modification indices were investigated.

Unconditional models

Typical alcohol-use unconditional model. The linear growth model for typical alcohol use fit these data well after placing a threshold on the variance on typical alcohol use at the 1-month follow-up ($\chi^2 = 6.19$, 4 df, $p = .19$; CFI = .98; TLI = .97; SRMR = .05; RMSEA = .06). This linear model provided a better fit than a no-growth model and nonlinear models. The mean (SE) latent variable representing the intercept for typical alcohol use was 2.858 (0.037) with a variance of 0.148 (0.026), and both values were significantly different from zero ($p < .0001$). The mean latent variable representing the slope for typical alcohol use was -0.028 (0.006) with a variance of 0.005 (0.001), and both values were significantly different from zero ($p < .0001$). The cor-

relation between the intercept and slope for typical week alcohol use was not significant ($r = -.026$).

Alcohol consequences unconditional model. The initial linear model for alcohol-related consequences fit the data adequately ($\chi^2 = 5.57$, 5 df, $p = .35$; CFI = .98; TLI = 1.00; SRMR = .06; RMSEA = .03). This linear model provided a better fit than a no-growth model and higher order polynomial models. The mean latent variable representing the intercept for alcohol-related consequences was 2.623 (0.076) with a variance of 0.693 (0.112), and both values were significantly different from zero ($p < .0001$). The mean latent variable representing the slope for alcohol-related consequences was -0.044 (0.009) with a variance of 0.007 (0.002), and both values were significantly different from zero ($p < .0001$). The correlation between the intercept and slope for alcohol-related consequences use was not significant ($r = -.055$).

Combined/simultaneous unconditional growth model for alcohol use and alcohol consequences. The best-fitting unconditional linear growth model for drinks per week was combined with the best-fitting model for alcohol-related consequences to produce the simultaneous growth model. The initial simultaneous growth model did not fit the data well ($\chi^2 = 79.08$, 23 df, $p < .0001$; CFI = .88; TLI = .85; SRMR = .10; RMSEA = .12), and the modification indices were explored to increase the fit of the model. The modification indices suggested that the fit of the model would increase by correlating the error terms for alcohol use and alcohol-related consequences obtained at the 1-month and 6-month follow-up. In addition, nonsignificant relationships between the typical-alcohol-use intercept and the slope for alcohol-related consequences ($z = 0.03$), the intercept for alcohol consequences and typical-alcohol-use slope ($z = 0.88$), the typical-alcohol-use intercept and the slope for typical alcohol use ($z = -0.18$), and the intercept for alcohol consequences and the slope for alcohol consequences ($z = 0.57$) were dropped from future models (i.e., the paths were not fixed at zero). After these modifications, the unconditional simultaneous growth model fit the data well ($\chi^2 = 31.87$, 22 df, $p = .08$; CFI = 0.98; TLI = 0.97; SRMR = .06; RMSEA = .051). The mean (SE) for the intercept for typical drinks per week (2.810 [0.036]) and alcohol consequences (2.684 [0.077]) and the slope for typical drinks per week (-0.025 [0.006]) and alcohol-related consequences (-0.049 [0.009]) were all significantly different from zero ($p < .0001$).

Alcohol-use and alcohol-related consequences conditional growth model. Covariates (SR and gender) were added to the best-fitting unconditional simultaneous growth model to account for variance in the latent variables. Each of the covariates was entered one at a time in a univariate analysis for the drinks per week and alcohol consequences growth model. A main effect for SR was investigated for each of the intercepts and slopes in the simultaneous growth model. SR scores were expressed as the average score per question

FIGURE 1. The alcohol-use and alcohol-related consequences latent growth model. All values are standardized beta coefficients, except for factor loadings, and means for the latent variables. Only significant relationships are presented. Significant covariation between the error terms is not presented in this path diagram. M = mean.

* $p < .05$; $^{\dagger}p < .01$; $^{\ddagger}p < .001$.

(i.e., total score/number of questions on the questionnaire, mean [SD] = 3.63 [0.44]) to increase the interpretability of the beta coefficients. As predicted in Hypothesis 1, SR was inversely related to the intercept for alcohol-related consequences ($z = -3.68, p < .001$). Consistent with Hypothesis 2, SR was also inversely related to the slope for alcohol-related consequences ($z = -1.69, p < .05$ using a one-tailed test). Consistent with Hypothesis 3, SR was not related to the intercept for drinks per week ($z = -0.29$). Finally, consistent with Hypothesis 4, SR was a significant predictor of the slope for drinks per week ($z = -2.97, p < .01$). A main effect for gender was investigated for each of the intercepts and slopes in the simultaneous growth model. Gender had a significant main effect on the intercept for drinks per week, with male students reporting higher average alcohol consumption than female students ($z = -5.48, p < .001$); the relations between gender and the remaining latent variables were nonsignificant.

Next, the covariates found to be significant predictors of the latent variables were included in the model simultaneously to examine whether these variables accounted for independent amounts of variance in the slopes and intercepts of the latent variables. In addition, a Gender $\times$ SR interaction was added to evaluate whether gender moderated the relations between SR and the latent variables. Although this model fit the data well ($\chi^2 = 42.89, 36 \text{ df}, p = .20$; CFI = 0.99; TLI = .98; SRMR = .05; RMSEA = .03), this interaction was not significantly related to the latent variables (z 's = -0.40 - 0.31) and was removed from the model.

The final model with the covariates fit well ($\chi^2 = 38.88, 32 \text{ df}, p = .15$; CFI = 0.99; TLI = .98; SRMR = .04, RMSEA = .04). SR was added as a predictor of the intercept for alco-

hol-related consequences and the slope for both alcohol use and alcohol-related consequences, while gender was added as a predictor of the intercept of alcohol use. All covariates remained significant predictors for the specified paths in the multivariate model, and the final model is presented in Figure 1. Specifically, SR was significantly related to the intercept for alcohol-related consequences ($z = -3.68, p < .001$), the slope for alcohol consumption ($z = -2.97, p < .01$), and the slope of alcohol consequences ($z = -1.69, p < .05$). Specifically, when compared with students with higher SR (i.e., 1 SD above the mean for SR), individuals with lower SR (i.e., 1 SD below the mean for SR) were more likely to report alcohol-related consequences at baseline, and shallower reductions in their alcohol consumption and alcohol-related consequences were observed (see Figure 2). In addition, gender was related to the typical drinks per week intercept ($z = -5.48, p < .001$), indicating that male students consumed more alcohol during a typical week of drinking than female students.

To evaluate whether these results were affected by attrition, a supplemental LGC analysis was conducted without employing the missing data estimator procedure and including data from only participants with no missing data in these analyses ($n = 114$, or 67% of total sample). The results were similar to the model using the full information maximum likelihood missing data estimator. Specifically, gender predicted the intercept for typical alcohol use ($z = -5.41, p < .001$), and SR predicted the rate of change for typical alcohol use ($z = -2.51, p < .001$) as well as the intercept for alcohol-related consequences ($z = -3.99, p < .001$). However, the relationship between SR and the slope for alcohol consequences was no longer significant ($z = -0.99$).

FIGURE 2. Estimated typical drinks per week (Panel A) and alcohol consequences (Panel B) latent growth curves for individuals with self-regulation (SR) scores one standard deviation above (higher) and one standard deviation below (lower) the sample mean SR score. Ln = natural log; Sqrt = square root.

Discussion

College students find increased autonomy as they continue to develop their personal identity while transitioning into adulthood (Arnett, 2000). During their college career, students will become involved in social situations where alcohol is easily accessible, and they will make personal decisions regarding their alcohol use without frequent parental monitoring (Borsari et al., 2007). Although some decisions made while drinking are relatively innocuous, other decisions can be life altering (see Perkins, 2002, for a review). This study examined whether SR was related to the natural history of alcohol use and alcohol-related consequences in a sample of heavy drinking college students. The results indicate that SR ability is related to the initial level of alcohol-related consequences and changes in consequences and alcohol consumption over the following year. On average, college students in our sample decreased their weekly alcohol use, as well as the reported number of alcohol-related consequences over the course of the 12-month study. Although these results are consistent with previous longitudinal studies on college student drinking that observed decreased trajectories of alcohol use and associated harms over longer periods in the absence of any intervention (e.g., Jackson et al., 2000; Marlatt et al., 1998; Schulenberg et al., 2001), the current findings suggest SR protects against the development of alcohol-related consequences among young adult drinkers, as would be predicted by SR theory.

Perhaps contradicting SR theory, SR was unrelated to the amount of alcohol consumed per week. In general, college students perceive heavier alcohol use as normative and acceptable in the college setting (Perkins and Berkowitz, 1986; Perkins et al., 2005). As a result, heavier use may be determined more by social and environmental factors and less by intrapersonal factors such as SR. However, the relationship between SR and alcohol use in college students is mixed. Although some studies failed to find a relationship between SR and alcohol consumption (Carey et al., 2004; Neal and Carey, 2005), other studies have found that low SR or related constructs predicted a higher degree of alcohol involvement (Piquero et al., 2002; Werch and Gorman, 1988; Wills et al., 2002). Although undetected differences in samples may help explain these discrepant findings, it is possible that the mixed findings are related at least in part to method variance between studies; support against an SR and alcohol-use relationship employed the SSRQ to quantify generalized SR capacity, and support in favor of the relationship between SR and alcohol consumption relied on different self-report inventories.

Despite the lack of association with baseline levels of alcohol consumption, SR predicted the rate of change in drinks per week over time. This main effect for SR on change in alcohol use is consistent with previous developmental studies of adolescent substance use (Wills and Stoolmiller,

2002); our findings extend knowledge by demonstrating the relevance of SR on alcohol-use trajectories in young adult drinkers. Although several studies have identified varying trajectories of drinking over time (e.g., Bartholow et al., 2003; Casswell et al., 2002; Tucker et al., 2003), none has examined SR as a potential correlate of trajectory membership. Our findings suggest that SR is an individual difference variable that should be considered when attempting to explain a young adult's vulnerability to alcohol consequences as well as decreasing trajectories of use and consequences.

Collectively, results from the hypothesis testing derived from SR theory indicated that individuals with higher levels of SR capacity are capable of adjusting their behavior and learn from maladaptive past alcohol experiences (cf. Perkins, 2002). Relative to individuals with higher levels of SR, individuals with lower SR ability made more modest reductions (i.e., shallower slopes) in both alcohol consumption and alcohol consequences over time. In addition, SR theory helps explain the maturation effect documented in the literature, where there is a trend for college students to naturally reduce their alcohol consumption and alcohol consequences over time (Jackson et al., 2001; Marlatt et al., 1998; Schulenberg et al., 1996). Moreover, these findings highlight the increased risk for alcohol consequences for individuals with lower SR capacities.

Findings of a prospective relationship between SR and natural change suggest that SR may help to explain treatment outcome. Future research could examine whether SR ability predicts a response to risk-reduction interventions. For example, there is evidence that heavier drinking college students with higher levels of SR ability may be more likely to reduce their consumption and alcohol consequences after receiving a minimal intervention or brief feedback than individuals with lower SR ability (Carey et al., 2007). Self-management-oriented therapies (e.g., Hester, 1995) may be particularly useful for individuals with lower SR capacities by providing behavioral assistance with self-monitoring, goal setting, and self-reinforcement. Furthermore, because of the seven theorized dimensions of SR (Miller and Brown, 1991), tailored interventions can potentially assist with the difficulties that can occur at any particular dimension that prevent efficient behavioral SR.

SR refers to a global process used to achieve goals and is not unique to alcohol and consequences. Future research is needed to determine if the results from this study generalize to other areas, such as academic achievement, gambling, financial difficulties, reckless driving, and interpersonal violence. Potentially, prevention efforts for incoming college students who are low on SR ability may help alleviate problematic transitions across multiple areas as students emerge into adulthood.

In addition, future research is needed to investigate the discriminant validity between SR and other correlated constructs, such as impulsivity and behavioral undercontrol. The

findings that self-regulatory ability is negatively related to alcohol-related consequences but not to initial alcohol use is consistent with cross-sectional research on behavioral undercontrol (Capone and Wood, 2008). Because of the similarities between SR and related constructs, such as impulsivity and behavioral undercontrol, future research is needed to explore the unique contribution of SR ability on alcohol use and associated consequences, along with correlated constructs.

We recognize the limitations of this study. Results may not generalize to students with lighter drinking patterns, students attending public universities or campuses in other regions of the country, or students who do not participate in periodic assessments of their alcohol consumption. This study investigated the relationship between SR and alcohol use and alcohol-related consequences in a sample of heavier drinking college students, who as a group reported lower SR than the lighter drinking students deemed ineligible for the parent study (Carey, unpublished data). In addition, although this study explored the “natural history” of alcohol use and alcohol consequences in the absence of formal intervention, it is possible that these results may have been influenced by assessment reactivity. Specifically, participation in alcohol assessments (e.g., Baer et al., 1994) and self-monitoring of alcohol use (Garvin et al., 1990) are related to decreased alcohol use and consequences. Participants in this study may have reflected on their behavior during the assessments to a greater degree than what would normally occur for students who were not involved in a longitudinal study. An interaction between SR and the assessments is plausible considering that an initial association between SR and alcohol consumption was not observed, yet SR in the present study predicted rates of change in alcohol use. Finally, because of the use of transformations, the measurement scale for the transformed data no longer follows the measurement scale of the raw data. Although conclusions about the relationships between the variables in this study are unlikely to be affected, we are limited in characterizing the pattern of growth over time because of the use of transformed variables.

The results from this study add to the existing literature concerning the natural history of college student drinking. Using LGC modeling to simultaneously investigate alcohol use and alcohol-related consequences in young adults, we extended cross-sectional research showing correlations between use and consequences by establishing that the rate of change in alcohol use is related to the rate of change in consequences. In addition, this longitudinal study established a significant impact of generalized SR on alcohol use and alcohol-related consequences in college student drinkers. Results were consistent with a priori and theoretically based predictions, demonstrating that SR protects drinkers from experiencing alcohol-related consequences across levels of consumption. SR also promotes reductions in alcohol use over time. Our findings support the use of LGC modeling to investigate the relationships between covariates and alcohol

use and alcohol consequences, and justify further exploration of the role of SR in explaining vulnerability to the negative effects of drinking.

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