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Growth Curve Analysis of the Situational Temptations Scale in a College Sample

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GROWTH CURVE ANALYSIS OF THE SITUATIONAL TEMPTATIONS SCALE IN A COLLEGE SAMPLE

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ABSTRACT

The temptation to engage in risky drinking is culturally embedded in the social life of young adults and college students. Studies have shown that more than 2 out of 3 students report drinking in the past month (Johnston, O'Malley, & Bachman, 2003) and over 80% will drink on at least one occasion during the school year (Del Boca et al, 2004). Heavy alcohol use and frequent binge drinking by college students has received much attention over the years because many drinkers engage in risky patterns of alcohol consumption, which is at the crux of a wide range of negative college alcohol-related consequences (Curry, Southwick, & Steele, 1987; Talbott et al., 2008; Wechsler et al., 2000). The present study reports the results of a secondary data analysis that used growth curve modeling (GCM) to examine growth trajectories of situational temptations over a two year period with data from a large sample (N=1067) of college student participants in a randomized trial of the efficacy of a brief intervention for alcohol harm reduction. A mixed effects piecewise model that estimated separate linear growth effects for the treatment and post-treatment phases of the study was found to fit the data best. At baseline, male students and those with higher rates of self-reported college alcohol-related problems had significantly higher temptations scores. Growth model results showed that self-reported temptations increased rapidly over the first 6 months during the treatment phase, then gradually decreased. No differences between the treatment and control groups in growth of temptations was observed during the treatment phase (0 to 6 months), however a small significant treatment effect was found over the post-treatment phase of the study (6 to 24 months). Temptations scores were reduced over time for students who had

moderate or high levels of alcohol-related problems at baseline. After adjusting for treatment and alcohol problems, gender was not related to situational temptations.

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Finally, I would like to leave the remaining space in memory of Dr. Mark Wood (1960-2015), a brilliant scholar who will be deeply missed.

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CHAPTER 1
Introduction

Alcohol use is culturally embedded in the social lives of many underage youth, especially those attending college. Monitoring the Future (2013), a national study that monitor trends in drug use and alcohol consumption, found approximately 1 in 5 students reported binge drinking (consuming five or more drinks in a row within the past two weeks) by senior year of high school. The research data shows the proclivity of risky drinking begins in high school and increases over the first few years of college. Studies have shown that more than 2 out of 3 college students reported drinking alcohol in the past 30 days (Johnston, O'Malley, & Bachman, 2003) and over 80% consumed alcohol at least once during the school year (Del Boca et al, 2004). Risky drinking has received much attention over the years because it is associated with a wide array of social, emotional, behavioral and health problems (Curry, Southwick, & Steele, 1987; Hingson, Zha, & Weitzman, 2009; Talbott et al., 2008; Wechsler et al., 2002). Heavy drinkers (1 drink per day for women, 1-2 drinks per day for men) and binge drinkers are at greater risk of experiencing a variety of problems compared to their nondrinking peers (Ham & Hope, 2003; Hatzenbuehler, Corbin, & Fromme, 2011; Hingson, Heeren, Zakocs, Kopstein, & Wechsler, 2002; Murphy, Hoyme, Colby, & Borsari, 2006; Nelson, Xuan, Lee, Weitzman, & Wechsler, 2009). Of note, 1st year students, particularly men affiliated with Greek organizations are very high risk for alcohol-related impairment that led to behaviors that they later regretted (Borsari, Murphy & Barnett, 2007; Capone, et al., 2007; Sher & Rutledge, 2007). For example, alcohol impairment was associated with over 1,825 deaths, 599,000 injuries, 646,000 assaults, and 97,000 sexual assaults each year from 1998-2005 (Hingson, Zha, & Weitzman, 2009). The proclivity of underage drinking and prevalence of alcohol-impaired motor vehicle accidents (Hingson et al., 2009) have spawned the recognition that risky drinking is the most important health hazard facing college students (U.S. Department of Health and Human Services, 2010). Accordingly, many college administrations have responded by giving high risk students brief motivational interventions to mitigate the influence of factors related to alcohol misuse and problems (Borsari & Mastroleo, 2013; Larimer & Cronce, 2007; Larimer et al., 2007; Saunders, Kypri, Walters, Laforge, & Larimer, 2004; Wechsler, Lee, Nelson, & Kuo, 2002; Wechsler & Nelson, 2008)Walters & Neighbors, 2001; 2005).

Based on the extant literature, some of the strongest predictors of alcohol misuse include having a history of alcohol-related problems (Zakletskaia, Mundt, & Fleming, 2009), male gender (Wechsler et al., 2002), involvement in collegiate sports, race and ethnicity (Zapolski et al., 2014). One important mediator of risky drinking and alcohol-related problems—what the present paper will discuss—is situational temptations (Maddock, LaForge, & Rossi, 2000; Migneault, 1995; Prochaska & DiClemente, 1982).

Situational temptations for heavy drinking is an important mediator of alcohol-related problems in the Transtheoretical model (TTM)—the TTM consists of stages of change, self-efficacy, and other variables that describe cognitive and behavioral processes of change—and situational temptations is a latent variable comprised of four primary psychosocial variables including peer pressure, social anxiety, negative affect and positive/social situations (Migneault, 1995). Other Situational temptations scales have demonstrated reliability and consistency across a wide range of health behaviors, including smoking (DiClemente et al., 1985; Velicer et al., 1990), drinking (Migneault 1995; Maddock et al., 2000), dieting and exercise (Rossi, et al., 2001). Herein, situational temptations will be simply stated as *temptations*.

As previously mentioned, underage alcohol use is deeply rooted in American culture. Hence, most youth are tempted to try alcohol before they enroll into college (Sillice et al., 2014). Although varying degrees of temptations may or may not lead to risky drinking in college, very strong temptations or urges to engage in heavy drinking can be problematic for some students who are inexperienced and/or emotionally ill-equipped to control his/her drinking insofar that they may experience negative consequences because of drinking. To date, there has been little research that has examined the development of temptations to drink in early college, which is why several pivotal research questions about temptations remain, such as what is the average amount of temptations students have to drink when they enroll into college, does this change over time and what are the risk factors that influences the growth of temptations? Thus, the purpose of this thesis was to fill these gaps in the literature by examining the growth trajectories of temptations in a longitudinal sample of first and second year college students. A growth curve analysis would be conducted using Mplus 7 structural equation modeling (SEM) software to build growth curve models (GCM). The dependent variable in this study is situational temptations. The primary aim of this study was to find the optimal functional form of time using repeated measures of students' total scores on the Situational Temptations scale obtained from the College based alcohol risk reduction (CBARR) study (Laforge, 2000). The secondary aims were to examine the main effects of treatment on the growth of temptations and observe the changes in the growth trajectories due to gender and different levels of college alcohol-related problems.

Theoretical Framework

The theoretical framework for the current study was the Transtheoretical Model (TTM). The TTM is a model of behavior change that has integrated many key constructs from the biopsychosocial model and other psychological theories into a comprehensive theory of change that can be applied to a variety of behaviors, populations, and settings (Prochaska & DiClemente, 1982; Prochaska, DiClemente, & Norcross, 1997). The TTM conceptualizes temptations as an important latent variable and risk factor of heavy drinking and alcohol-related problems (Maddock et al., 2000; Migneault, 1995; Prochaska & DiClemente, 1982). Alternative-forms of the scale have been used to assess temptations across various maladaptive behaviors such as, diet & exercise (Rossi, et al., 2001), immoderate-heavy drinking (Maddock et al., 2000) and smoking (Velicer et al., 1990).

Situational Temptations Scale

The present study used the 8-item Situational Temptations Scale (see Appendix A) at each time point to measure the total strength of temptations to drink in different situations. The temptations scale was adapted by Maddock, Laforge, & Rossi (2000) from the original 21-item Situational Temptations Scale (Migneault, 1995). The scale is comprised of four primary factors (Peer Pressure, Social Anxiety, Negative Affect, and Positive/Social) and the second-order factor, Situational Temptations (Maddock et al., 2000; Migneault, 1995). The subscales are used to guide individualized treatment interventions in the specific areas where the individual feels most compelled to drink (Prochaska & DiClemente, 1982). The total temptation scores was the primary outcome measure of the present study.

Drinking Restraint and Orthogonal Temptations Factors

Ruderman & McKirnan (1984) developed the Restrained Drinking Scale (RDS) to quantify college students' self-reports of their maladaptive thoughts about heavy drinking. The RDS was adapted from measures of abstemious dieting to be the first inventory of drinking restraint (Herman & Polivy, 1980; Polivy & Herman, 1985). Ruderman and McKirnan did not continue their line of research but Collins and colleagues (1989; 1992) continued to refine the scale and identified other endogenous constructs captured by the original RDS. Collins, George, and Lapp (1989) conducted a confirmatory factor analysis on the RDS and expanded drinking restraint from the single-factor structure into an multidimensional factor structure. The Temptation and Restraint Inventory (TRI; Collins et al., 1989) has three primary orthogonal factors: Govern (difficulty controlling alcohol intake), Restrict (attempts to limit drinking), and Emotion (negative affect as a reason for drinking). Collins and Lapp (1992) expanded the factor structure with two higher-order factors labeled: Concern about drinking (plans to reduce drinking/worry about controlling drinking) and Cognitive Preoccupation (thoughts about drinking). The TRI has been shown to be a robust measure of one's preoccupation to control their alcohol intake and a strong predictor of excessive drinking and negative alcohol consequences in college students (Collins & Lapp, 1992; Collins et al., 2002).

The RDS, TRI and Situational Temptations scales are reliable measures of college students' cognitions about restricting alcohol intake. However, there has been a long-standing debate over conceptual definitions and temptations scales (Collins & Lapp, 1992; Drummond et al., 2000; DiClemente, Prochaska & Gibertini, 1985; Marlatt & Gordon, 1985; Ruderman & McKirnan, 1984; Kavanagh et al., 2009; Schmidt et al., 2011; Sinha et al., 2011; Skinner & Aubin, 2010; Witkiewitz, 2013). For example, a complication of temptations research is that some researchers resort to using single-item indicators of alcohol "cravings" to gauge the strength of temptations in their models (e.g. Schmitt et al., 2011; Witkiewitz, 2013). The study by Witkiewitz (2013) used a single item measure of how tempted to drink people were during the past week. The single-item measure of temptation to drink was a reasonable predictor of short- and long-term drinking outcomes following treatment and results were comparable to commonly used measures of drinking outcomes for alcohol clinical trials. While the predictive validity of single-item measures are supported in the literature (Desalvo et al., 2006; Gardner, Cummings, Dunham & Pierce, 1998) temptations has largely been defined as a multidimensional construct (Collins & Lapp, 1992; Drummond et al., 2000; DiClemente, Prochaska & Gibertini, 1985; Marlatt & Gordon, 1985), hence multi-item s scales capture importance features of temptations.

Potential Moderators of Situational Temptations

Numerous studies have shown extreme variability in drinking patterns by the time students actually reach college (Baer, 2002; Del Boca et al., 2004; Talbott et al., 2008; Wechsler & Nelson, 2008), students will increase their overall alcohol consumption within the first few weeks (Capone, et al., 2007; Del Boca, Darkes, Greenbum, & Goldman, 2004; Sher & Rutledge, 2007; Wechsler et al., 2000) and that weekly drinking changed considerably as a function of academic requirements and holidays (Del Boca et al., 2004). Del Boca and colleagues (2004) looked at drinking over the entire first year of college and found large individual variation in drinking rates each week. The findings from this study found alcohol consumption was consistently different for three parts of the week (i.e., lowest on Sunday–Wednesday, elevated on Thursday, highest on Friday–Saturday). Other studies have gender differences in drinking over time (Borsari & Carey, 2006; Greenbaum et al., 2005; Wechsler et al., 2002). Research suggests that gender and a history of alcohol abuse are some of the strongest predictors of alcohol misuse in the first year of college (Agostinelli, Brown, & Miller, 1995; Baer, 2002; Borsari, Murphy, & Barnett, 2007; Capone, Wood, Borsari, & Laird, 2007; Carey, Scott-Sheldon, Carey, & DeMartini, 2007; Chiauzzi, Dasmahapatra, & Black, 2013; Hingson et al., 2002; Talbott et al., 2008; Wechsler et al., 2002; Wood, Sher, & Rutledge, 2007). Moreover, it appears that men in early college with a history of alcohol-related problems may benefit from motivational interventions. To that end, the next section will focus on brief motivational interventions that have been used to lower rates of alcohol misuse and alcohol-related problems in college students.

Alcohol Interventions

Brief motivational interventions are used to mitigate the increase in alcohol misuse and alcohol-related problems for first year students (Chiauzzi et al., 2013; Hustad & Borsari, 2010; Lojewski, Rotunda, & Arruda, 2010; Saunders et al., 2004; Wechsler & Nelson, 2008; Zakletskaia, Mundt, Balousek, Wilson, & Fleming, 2009). A number of recent research trials have demonstrated lower rates of alcohol misuse and alcohol-related problems in heavy drinking college students who were given at least one brief intervention (Borsari & Mastroleo, 2013; Larimer & Cronce, 2007; Larimer et al., 2007; Saunders et al., 2004; Wechsler et al., 2002; Wechsler & Nelson, 2008).

Motivational interviewing is one type of intervention that has garnered support in the literature with college students. As with TTM interventions, motivational interviews provide personalized feedback messages that are based on the student's self-reported drinking behaviors. The feedback reports usually consist of alcohol misuse information including a discussion about potential risk factors associated with alcohol dependence. Licensed professionals usually deliver the feedback in a very brief one-to-one session (e.g. 5-10 minutes), or in groups. The sessions are tailored to the needs of the clients who are interested in making changes to their drinking (Jouriles et al., 2010; Lojewski et al., 2010; Mastroleo, Oakley, Eaton, & Borsari, 2014).

Providing feedback in the mail is an alternative, cost effective way of introducing interventions to high-risk students. Several studies have found mailed feedback lead to significant reductions in alcohol use by heavy drinkers (Agostinelli et al., 1995; Saunders et al., 2004). For example, Agostinelli and colleagues (1995) identified 24 heavy drinkers and randomly assigned subjects to either receive feedback in the mail or to a control condition. The study found the average number of drinks consumed per week was lower in the feedback group relative to the control group after just six weeks. Similarly, Collins, Carey, and Sliwinski (2002) found participants who got his/her feedback in the mail reported consuming significantly fewer drinks per week and drank less than the control group, but the between-group differences were no longer significant after 6 months. These studies provided evidence that mailed feedback can have short term effectiveness for very heavy drinkers. However, each of these studies were limited by the relatively short-term follow-up period and small samples.

Based on previous research it is apparent that mailed feedback is effective but little research has been done to determine whether treatment outcomes may be differentiated by gender. Other research has investigated whether gender-based feedback may be as or more effective than gender-neutral treatment messages (Bishof et al., 2005; Lojewski et al., 2010). The aforementioned studies, however, did not have a mailed feedback component that delivered treatment messages differentiated by gender. Despite these shortcomings, the efficacy of direct-mail feedback warrants larger scale studies with bigger sample sizes (Larimer & Cronce, 2007) and an ample number of repeated measures and longer-term follow-ups (Cole & Maxwell, 2003; Jouriles et al., 2010; Walters and Neighbors, 2005). The present study will observe treatment interactions and gender over time.

Examining Intervention Effects Over Time

Cross-sectional research is the most common approach used to examine proximal variables of interest and identify average developmental trends based on the results of an intervention. Cross-sectional research, however, provides limited information about the dynamic changes in alcohol use. It is likely that drinking will vary over the first few years of college, hence longitudinal data are collected over important developmental periods and these research designs are well equipped to evaluate causal relationships (Cole & Maxwell., 2003; Duncan et al., 2006; Hox &

Stroel, 2005; Singer & Willet, 2003). Longitudinal randomized control trial (RCT) studies are considered the gold standard for research (Larimer & Cronce, 2007). RCTs reduce bias by assigning subjects to one of the different treatments under study. The secondary data for this study comes from a longitudinal RCT.

The Current Study

To date, little scientific research has been conducted to assess the growth trajectories of situational temptations to drink in college. Moreover, no studies have observed factors that can potentially moderate the growth of temptations in a sample of underage heavy drinkers. This study will fill the current gap in research by utilizing GCM to model the growth of temptations in a large sample of college students.

The present study utilized a longitudinal dataset that contains a large sample of college students (N=1067) that were followed for over two years of early college. The secondary data comes from a proactive study on college student drinking. The college based alcohol risk reduction (CBARR) collected data from freshmen and sophomore drinkers matriculating in the fall of 2001 (Laforge, 2000). The CBARR's randomized control trial (RCT) design provided an excellent opportunity to observe behavior change for up to two years of early college and equally important, the interventions' influence on risky drinking. RCT studies are superior to cross-sectional studies insofar that repeated measures on several key variables in large clusters of students can be analyzed with sophisticated longitudinal models. Participants were randomized into treatment or control conditions based on his/her gender and readiness to change heavy drinking at baseline, which were two prognostic factors that were related to the primary outcome measures of the CBARR trial. The eligibility criteria to participate in the CBARR included having consumed at least one drink in the previous year, no prior history of treatment for substance abuse, and a score below16 on the AUDIT-alcohol use dependence identification test (Babor & Higgins, 2001). All of the survey data was collected by a telephone research center (Laforge, 2000).

Many of the participants were assessed up to six times over 24 months. Three brief individually tailored computer generated feedback reports were mailed to participants in the treatment group (N=534), after the baseline, 3 and 6 month telephone survey assessments. The individualized feedback reports were based on the students' responses to the survey assessments on up to 17 different constructs, including situational temptations, decisional balance, stage of change for heavy episodic ("binge") drinking, measures of alcohol use, blood alcohol content during heavy drinking episodes, normative feedback of peer drinking and beliefs.

Research Methods

Growth curve analysis can analyze repeated measurements to obtain a growth curve that represents the dynamic rate of change in human behavior across time. Growth curve modeling (GCM) is widely used in the social sciences to estimate the growth of factors over a period of time (Bullock, Harlow, & Mulaik, 1994; Cole & Maxwell, 2003; Del Boca et al., 2004; Heck & Thomas, 2015; Little, 2013; van Geert, et al., 2012). Two common analytic methods used to construct GCMs are structural equation models (SEM) and multi-level models (MLM). The SEM approach combines the best features of path analysis, regression and factor analysis to model within-person and between-person change over time or situations (Hox & Storl, 2005; Kline, 2006; Preacher et al., 2008). In contrast, the MLM (also called hierarchical linear models) model for change, includes a hierarchy of nested effects in the model to disentangle the influences of within-person and between-person change simultaneously (Singer & Willet, 2003). Both statistical models provide equivalent mathematical results. Additionally, GCM is more flexible than traditional ad hoc categorization procedures like ANOVA and MANOVA because ANOVA and MANOVA can only include complete case data and these antiquated methods are ill equipped to handle unequally spaced time points (Bryk & Raudenbush, 1992; Duncan, Duncan & Stryker, 2006). Furthermore, GCMs can also include time-varying variables to study different phenomena that affect the individual growth trajectories in the model (Duncan, Duncan & Stryker, 2006). Hence, GCM was the optimal statistical method for the specific research aims of this study, which will be discussed next.

Research Aims

The primary aim of this study sought out to evaluate the functional form of time to bridge the current gap in the literature. The best unconditional GCM would provide robust estimates of the inter-individual variability in the sample and estimate the systematic changes in temptations over time via the slope. Given the centrality of the growth processes and SEM approach, the statistical models were expressed using parameters that represented specific quantities and subgroups of interest (e.g. intercepts, slopes, variances, covariates, etc.). The present study will increase our understanding of the temporal development of temptations to drink and will add to the current literature on alcohol interventions for college students.

Hypotheses

Consistent with the literature, it was hypothesized that treatment would reduce the average rate of growth in temptations over time (DiClemente et al., 1985; Witkiewitz, 2013). The study by DiClemente and colleagues (1985) observed situational temptations in former smokers for four years and found high temptations scores took upwards of six months to reduce to moderate levels after receiving TTM interventions (DiClemente et al., 1986; Velicer et al., 1990). More recently, the study by Witkiewitz (2013) looked at the change in temptations and drinking outcomes in a national sample of alcoholics in outpatient treatment and found cravings to drink decreased over 3 years. It is important to note that a major limitation of that study was the single-item cravings measure was defined as temptations to drink—that measure was also used to construct the GCM. The current study, observed the influence of TTM treatment interventions on the average rate of growth in temptations to drink for two years.

It was hypothesized that high levels of college alcohol-related problems would be significantly associated with higher situational temptations at baseline and over time. Finally, consistent with a large body of literature, it was hypothesized that gender differences would be found at baseline and in the growth of situational temptations over time (Bishof et al., 2005; Lojewski et al., 2010).

In summary, the growth of temptations to drink will be evaluated with GCM, which will provide some additional insight into the changes in temptations as a function of time.

CHAPTER 2

Methods

Participants

The sample (*N*=1067) ranged from 17 to 44 years old (*M*=18.82, *SD*=1.81) and 88% of the sample was white (*n*=939) and 56% were female (*n*=596). Participants were randomly assigned by stage of change and gender to one of two experimental group conditions: (1) treatment (*n*= 534) and (2) assessment-matched control (*n*=533). The experimental groups were found to be comparable at baseline on gender and all measures of alcohol use and alcohol-related problems (Laforge, et al., 2001). All of the participants were given identical assessments at baseline and were scheduled for post-baseline assessments at 3, 6, 12, 18 and 24 months.

Measures

Situational Temptations Scale. The eight-item Situational Temptations scale (Maddock et al., 2000) is the primary outcome measure. The 8-item scale was adapted by Maddock, Laforge & Rossi (2000) from the 21-item scale (Migneault, 1995). Respondents were asked to rate "how tempted you are to drink a lot" (e.g. "When I am offered a drink") with a reduced scale that consists of eight items that were judged on 5-point Likert scales (1=*Not at all tempted* and 5= *Extremely tempted*). The total score is the summed from each subscale. Total scores may range from 8 to 40, with higher scores representing stronger temptations to drink. The Cronbach's alpha-coefficient (α) reliability estimate was .89 for the total sample.

College Alcohol Problems Scale (CAPS). The CAPS is an eight-item instrument that measures self-reported frequencies of personal and social problems commonly associated with college student alcohol use. Study participants were asked questions such as, "as a result of drinking, how often have you felt sad, blue or depressed" and students rated how often they experienced problems as a result of drinking alcoholic beverages within the past six months on a five-point Likert scale (1= *Never/Almost never* and 5= *Very often*). The CAPS score at baseline was used and coefficient alpha was .83 in the sample.

Categorical College Alcohol Problems Scale (CCAPS). The CAPS variable was dummy-coded and total problem scores were reclassified as CCAPS to aid the descriptive comparisons of alcohol-related problems. The distribution of the sum scores for CAPS was non-normal and zero-inflated at baseline. The scores ranged from 0 to 21 (M=3.9, SD=3.7). CCAPS is a categorical variable with four mutually exclusive and all inclusive levels created from the CAPS score. These categories represent approximate quartiles of the sample distribution of the CAPS variable Students with a CAPS score of 0 reported "*no alcohol problems*" in the previous three months, and are used as the reference group for CCAPS in the regression models. Students who reported any alcohol related problems were compared to the reference group (1= *Low* [1< 3], 2= *Medium* [3<6], and 3= *High* [>6]). It is important to note that dichotomizing the CAPS scores was considered for this analysis (i.e. 0= *No problems* and 1=*One or more problems*), however, as Garson (2012) points out, transforming continuous variables into binary indicators would have only expurgated the variance, which would lead to greater attenuation of the coefficients in the correlation matrix in Mplus (Garson, 2012). For that reason, CCAPS was categorized to optimize the variance in the models as well aid in the descriptive comparisons of college problems in the GCM analyses. The CCAPS variable was entered into the statistical models with three indicator or dummy variables (coded 0 or 1) for the "*Low"*, "*Medium,"* and "*High"* categories. Therefore, the model estimates shown in the statistical model in Tables 4 and 6 represent differences in situational temptations for each level of CCAPS compared to the reference level; "*None.*"

Treat. Feedback reports were four to nine pages long and offered either primary or secondary prevention messages, depending on the individual's alcohol risk status. The intervention group received three feedback reports in the mail starting after the first assessment at baseline. Feedback reports were generated based on students' responses on 17 different constructs, such as frequency of high-risk alcohol use; motivational readiness; decisional balance measures of alcohol expectancies; situational temptations; cognitive barriers to change; and behavioral, experiential, and cognitive processes that have been found to be related to behavioral change (Saunders et al., 2004). The control group did not receive any feedback. *Treat* was dummy coded (0=Control and 1=Treatment) and is the moderator that represents the main effect of treatment in the conditional GCM analyses.

Female. Gender were dummy coded (0=Male and 1=Female). *Female* is the moderator that represents the main effect for gender in the conditional GCM analyses.

Analytic Plan

The ensuing models would be developed in two steps: The first step is a factor analysis that maps the temptations repeated measures variables onto the latent variables (i.e. intercepts, slopes). This step involved comparing a series of increasingly complex “unconditional” GCM models to identify the best fitting functional form of change in situational temptations. This procedure compared models with various polynomial functions in seriatim, starting from the fixed intercept only linear regression model (i.e. baseline model), to several increasingly complex mixed-models with higher-order polynomial functions commonly used in to express time (e.g. quadratic, piecewise.) The second step involved conducting hypothesis tests on the causal and correlational links between the variables in the structural part of the model (e.g. covariates, covariances, etc.) in a series of increasingly complex “conditional” models to evaluate the potential independent effects of the three hypothesized moderators of situational temptations; Treat, Gender and CCAPS. The final conditional model presents the results of only the significant predictors or moderators of growth in situational temptations.

Statistical Approach

The models were constructed using Mplus 7.11 latent variable software. Six non-equidistant time points were modeled in Mplus. Time was incorporated into GCM by setting the factor loadings to the six scaled time values. Among the benefits of fitting growth curves with SEM is the ability to test and evaluate a variety of different residual structures (e.g. Autoregressive, Compound Symmetry, Toeplitz, or Unstructured). The choice of an unstructured residual matrix was made a priori; the unstructured matrix is the most flexible structure for exploring nonlinear change patterns (Duncan, Duncan & Stryker, 2006). All of the GCMs were estimated with full information maximum likelihood estimation and the unstructured (default) covariance-variance matrix. There were 33 response-patterns where missingness in the data occurred and 33% attrition rate at the final wave of data collection. Therefore, missing data was handled using full information maximum likelihood (FIML) and the standard errors for the parameter estimates were computed using the observed information matrix (Kenward & Molenberghs, 1998). Any observations with missing data on the covariates were deleted from the model.

Modeling Time

To estimate the initial status and slope growth factors in MPLUS, time was represented by fixed time scores entered directly into the model software. Time since baseline at each survey assessment (0, 3, 6, 12, 18 and 24 months post-baseline) was rescaled to represent time since baseline in years (0, .25, .5, 1, 1.5, and 2.0) to facilitate the convergence of the polynomial growth curve models. Thus, the fixed time score for the baseline assessment was entered as 0, at 3 month assessment the fixed time score was 0.25, at 6 months as 0.5 and so forth.

Models containing statistical Interactions.

Inclusion of variables in the statistical models compared in this study followed the hierarchy principal for modeling statistical interaction (Cox and Donnelly, 2011). The hierarchy principle of interaction modeling requires that a statistical model with one or more statistically significant interactions terms must also contain of the all lower order terms and main effects for each of the variables involved in the higher order interaction, regardless of whether the lower order terms are statistically significant. For example, a model with a statistically significant term representing the cubic polynomial function of time, also includes terms for the quadratic and linear functions of time, even if the lower order terms do not appear to be statistically significant. This principal is needed in most instances for valid interpretation of the interaction effects.

Mixed-Models

The fixed components (aka. fixed effects) of a mixed-model (β_0, β_1, β_2 ….β_n) accounts for the deviation from the mean of the sample distribution of scores (i.e. inter-individual variability). The random components (random effects) of the mixed model (b_{0i}, b_{1i}, b_{2i}) accounts for the deviations or dispersion of an individual's scores (i.e. intra-individual variability) over time (Duncan et al., 2006; Little, 2013). The fixed effect estimate for the intercept (β_0) parameter is the grand mean for the sample at baseline. The mean change over time is the fixed slope (β_1, β_2 ….β_n). The random effect estimates the variation due to individual differences surrounding the fixed effects (i.e. "residual variances and covariances" in GCM output in MPLUS) and are represented in the mixed model by b_{0i}, b_{1i}. Finally, the unexplained variation or error term ($e_{ij,}$) in the mixed model represents the residual error that was left over *after* all of the variation due to the fixed and random effects have been accounted for.

No Change Model

The null model estimated the intercept without including the random effect in the model. The next model included the random effect term to account for individual differences around the intercept. The random intercept model is expressed with the following function:

$$Y_{ij} = (\beta_0 + b_{0i}) + \varepsilon_{ij} \tag{1}$$

The function, Y_{ij}= represents temptations scores at for individual *i at observation time j,* β_0 is the intercept, b_{0i} is the random effect for the intercept for individual *i* and ε_{ij} is the unexplained residual error at time *j*. This model assumes no change over time, hence the intercept only model is sometimes referred to as the "no change model."

Growth curve Models

Next, the first-order polynomial was added to the no change model to construct the linear curve model. Starting from the intercept, the linear slope was used to express the fixed rate of positive or negative change over time. A restricted linear change model included only the fixed effect for the intercept and the fixed linear slope to model the initial status and average rate of change over time, respectively. The random linear slope mixed model included the following fixed and random effects:

$$Y_{ij} = (\beta_0 + b_{0\iota}) + (\beta_1 + b_{1\iota})\, t_i + \varepsilon_{ij} \tag{2}$$

The dependent variable, Y_{ij}, represents temptations score for individual *i* at time *j*, β_0 is the fixed effect of the intercept; β_1 is the fixed estimate for the slope ; $b_{0\iota}$ is the random effect of the intercept for individual *i*, $b_{1\iota}$ is the random effect of the slope for individual *i*, t_i is fixed effect or value of time at time *j*, and ε_{ij} is the measurement error term. The residual errors ε_{ij} are assumed be from an independent, normally distributed random variable with a mean of 0 and an a known variance, $\varepsilon_{ij} \sim N(0, \sigma_l^2)$, *iid.* Similar assumptions are made for the random effects, b_{0i}, $b_{1i\ldots}$ $b_{ni} \sim N(0, \sigma_u^2)$, *iid.*

The higher-order polynomials were evaluated in seriatim, with each new model adding new growth parameters and/or constraints on the growth parameters (e.g. slope and/or random effects) to evaluate the best functional form of time. The second-order polynomial expressed curvilinear change via a quadratic slope. The quadratic slope evaluated the average acceleration or deceleration of the growth across time. In addition, a piecewise polynomial was used to represent the different phases of the study in the model. The piecewise models estimated two linear slope functions of time (defining two line segments) connected via a spline knot at 6 months to represent the end of the treatment phase, after which it was assumed the rate of change might differ for the treatment group compared to controls due to the possible influence of a delayed or an attenuated intervention effect. The first line segment was coupled with the second, to model the biphasic rate of change during the treatment phase (baseline to 6 months) and the average change that occurred immediately following the treatment phase (6 months to 24 months), respectively. Finally, constructing these different models in seriatim concomitantly tested the hypothesis that the average growth trajectory of temptations was nonlinear over the length of the study.

Model Selection

Model fit refers to the ability of that particular model to reproduce the data (i.e., the variance-covariance matrix). Constructing the unconditional GCM with the best functional form of time was an iterative procedure, in which theory led to a model and a number of goodness of fit statistics could be used to evaluate the fit of the models (Bentler, 1990; Cheung & Rensvold, 2002; Kline, 2006; Preacher, Wichman, MacCallum & Briggs, 2008). If the statistical fit of a model, compared to the null or a smaller model was better, then the larger model was selected as a reasonable (perhaps better) representation of temptations. Two or more alternative models (including the null) were compared in terms of model fit. The selection of the final model was aided by several model fit statistics (Hox and Stoel, 2005) and the chi-square difference test. The Comparative Fit Index (CFI) is a statistic used to indicate the relative improvement in the fit of the measurement model compared to a statistical baseline model. A value of .90 indicates good fit and estimates ≥.95 indicates excellent fit (Bentler, 1990; Kline, 2006). The root mean square error of approximation (RMSEA) is a parsimony-adjusted, absolute model fit index that accounts for the degrees of freedom in the model and sample size. Estimates below .10 indicated acceptable fit, <.05 was good fit and a value of zero indicated the best fit (Kline, 2006). The standard root mean squared residual (SRMR) is an estimate of the standardized differences between the observed and the predicted covariances. SRMR residuals should be close to zero for a very close fit, but estimates below .08 indicate acceptable model fit (Kline, 2006). These statistics (e.g. CFI, RMSEA, and SRMR) are used to assess the extent to which the covariances predicted by the model correspond to the observed covariances in the data. Models that met the minimum acceptable model fit using the criteria mentioned previously, were required before the structural parameters (i.e. causal paths) of the models were interpreted.

In addition, information-based indices such as Akaike's information criterion (AIC) and Bayes information criterion (BIC) were used in conjunction with the other statistical fit tests to compare the fit between two or more nested and non-nested models. A nested model is a subset of a more complicated model. A model may be nested within another if the addition or subtraction of paths in the model is the only contradistinction between the two models. Both the AIC and BIC assessed the goodness-of-fit of the top comparison models, in which lower estimates indicated an improvement in model fit.

Finally, the statistical significance of adding parameters to the model was evaluated with the chi-square difference test. The log-likelihood ratio test (LLRT) is the chi-square difference test used to evaluate the statistical significance between nested models. If the p value for the LLRT was less than .05 then the smaller model was rejected in favor of the larger one.

$$E(Y_{ij}) = (\beta_0 + b_{0i}) + (\beta_1 + b_{nj})(t_n) + \beta_2(Treat_i) + \beta_3(Female_i) + \beta_4(CCAPS_i) + \beta_5(t_n * Treat_i) + \beta_6(t_n * Female_i) + \beta_7(t_n * CCAPS_i) + \beta_8(Female_i * Treat_i) + \beta_9(Female_i * CCAPS_i) + \beta_{10}(CCAPS_i * Treat_i) + \beta_{11}(t_n * female_i * CCAPS_i) + \beta_{12}(t_n * female_i * Treat_i) + \beta_{13}(t_n * CCAPS_i * Treat_i) + \varepsilon_{ij} \quad (3)$$

The final conditional model shown in Table 6 in the next chapter contains only statistically significant model terms. It is the best fitting model resulting from the comparison of fit statistics for the conditional models first examined, and then examined in the full multivariable model. The full multivariable model piecewise linear mixed GCM described in equation (3) is an example of the full hierarchical interaction model that was to be evaluated to identify the best fitting final model of the growth in situational temptations. The values of the fixed independent variables (Treat, Female and CCAPS level) were determined at baseline and therefore do not vary over time. Fixed effect terms were included to test hypotheses concerning potential main and moderation effects of each of the independent variables; treat (β_3), female (β_4) and baseline alcohol problems, CCAPS (β_5). Specifically, the multivariable piecewise model included terms for the fixed and random intercept, β_0, and b_{0i}, respectively. Time (t_n) is represented in the piecewise multivariable model by fixed and random effect terms for each of the two linear time segments, $\beta_1(t_{1,}\ b_{1i})$ covering the intervention period from baseline to 6 months, and $\beta_1(t_{2,}\ b_{2i})$ covering the post-intervention period from 6 months to 24 months post-baseline. Following the hierarchy principal of interaction modeling, the initial multivariable model includes all of the fixed and random effects terms for time as well model terms for all three way higher-order interactions and subordinate lower order interactions and main effect terms for all three hypothesized independent variables. Tests of whether situational temptation growth was moderated over time in the piecewise model therefore requires two interaction terms for each potential moderator (moderator* t_1) and (moderator* t_2), corresponding to the test of whether growth was moderated during the either intervention phase (0 to 6 months), or during the post intervention phase (6 months to 18 months), respectively. Two-way interaction terms of interest related to the study examine hypotheses concerning whether growth in situational temptations differed over time conditional on the value of each of the potential moderators ($b_{5,}$ b_6 and b_7).

Hypothesis Testing

The conditional GCMs evaluated the effects of the main effects and moderators of the growth in situational temptations over the two year period. It was hypothesized that the growth of temptations will be significantly lower in the treatment group. Additionally, gender and college alcohol-related problems would moderate the growth parameters. The hypothesis testing whether baseline situational temptations differed by treatment group (Treat) was evaluated by the p-value associated with t-test or Wald χ^2-*test* of the slope of fixed effect term, β_2. The hypothesis testing whether the growth curve of situational temptations during the intervention period was moderated by treatment was tested by evaluating the statistical significance of the slope of the fixed effect term, $\beta_5(t_1*Treat)$. Similarly, the test of whether the growth in temptations for the treatment group differed significantly from the control group was evaluated with the fixed effect term $\beta_5(t_2*Treat)$. The hypothesis testing whether baseline situational temptations differed by gender (Female) or levels of college alcohol-related problems (CCAPS) was evaluated by the *p*-value associated with fixed effect terms, β_3 and β_4, respectively. The hypothesis testing whether the slope of the temptations differed by experimental group (Treatment vs Control) during the intervention phase was tested by the slope of the fixed effect interaction term, $\beta_6(t_1*Treat)$, and during the post intervention period by the test of the statistical significance of the $\beta_6(t_1*Treat)$ interaction term. Similarly, the hypothesis testing whether the slope of the temptations differed by gender over time was tested by the slope of the fixed effect term, $\beta_6(t_n*Female)$. Finally, the test of whether the growth in temptations differed by alcohol problems over time was tested by the slope of the fixed effect term, $\beta_7(t_n*CCAPS)$.

Although, in this study no specific hypotheses were proposed concerning the potential for the moderation of the treatment effect by either gender or level of baseline alcohol problems, the approach to modeling used in this study can provide answers to these potentially important questions. Since, all three-way interactions were evaluated the model can provide new insight into whether effect of treatment on situational temptations differed by gender (b_{12}), or by the level of alcohol problems reported during the three months prior to baseline (b_{13}). Specifically whether significant gender moderation in the treatment effect was observed during the intervention phase (0 to 6 months.) is addressed by the test of the term $\beta_{12}(t_1 * female * treat)$. Whether there is evidence for gender moderation of the treatment effect during the post-intervention phase (6 to 24 months) of the study can be determined by the test of the $\beta_{12}(t_1 * female_i * treat_i)$ model term. Similarly, research questions concerning moderation of the treatment effect by the levels of baseline alcohol problems can be tested with the $\beta_{13}(t_1 * ccaps * treat)$ interaction term.

CHAPTER 3

Results

Descriptives

The summary statistics for the primary dependent variable at baseline, situational temptations, revealed that the variable was normally distributed (*M*= 18.4, *SD*= 5.6, Median= 19, Mode= 20, Skewness= 0.11, Kurtosis= -0.47). The correlation matrix of temptations scores over time is presented in Table 1. It shows that there was substantial dependency among the repeated observations, which was addressed in the longitudinal analyses. Figure 1 displayed the boxplots over time. These findings suggest that the analysis of situational temptations data over time can be performed employing statistical methods for normally distributed outcome data.

Sample Characteristics

Table 2 presents the means, SDs, and sample size for the repeated measures of situational temptations by selected sample characteristics. The average age at baseline for participants in the study was 18.82 years (*SD* =1.81), 88% self-classified as of White/Caucasian race (*n*=939) and 56% were female (*n*=596). The sample consisted of a small number of students in other racial/ethnic groups. American Indian/Alaskan Native (*n*=4), Asian/Pacific Islander (*n*=31), African-American/Black (*n*=24), and Other (*n*=67); see Table 2. At baseline, situational temptation scores did not differ by experimental condition (t = -0.94, df= 1065, p = .3496). Females reported significantly lower temptation scores than males (*M*= 18.1 vs. *M*= 19.1, respectively, t= 2.33, df= 1065, p= .020). Asian Americans (*M*= 18.9, *SD*= 5.7) and White/Caucasians (*M*= 18.7, *SD*=5.6) reported the highest levels of situational temptations at baseline, while

Native Americans (M= 15.8, SD= 5.6), "Other" racial group (M= 16.0, SD= 5.1) and African Americans" (M= 14.6, SD= 6.6) reported the lowest temptations scores, respectively.

Bivariate correlations such as Pearson and Spearman correlation coefficients were used. Pearson's r was reported when the two variables were both on continuous scales. Spearman's r was reported when only one variable was continuous and the other was ordinal-ranked. In addition, the Wilcox z-test was used as a nonparametric statistic for non-normally distributed data. At baseline, temptations were significantly related to measures of alcohol intake; including average number of drinks per drinking day (r= .41, $p < .0001$), maximum number of drinks in the past 30 days (r= .44, $p < .0001$) and the number of heavy or "binge" drinking episodes (defined as exceeding 4 or 5 drinks per occasion for males and females respectively) during the past month (r= .44, $p < .0001$). The z-tests indicated that males compared to females, reported significantly more alcohol related problems during the previous 6 months (CAPS M_{male}= 4.26, M_{female}= 3.61, *Wilcoxon Z*= 2.90, $p < .01$), more binge drinking episodes per month (M_{male}= 4.13, M_{female}= 2.99, *Wilcoxon Z*= 4.00, $p < .0001$), having more drinks on average in a typical drinking day (M_{male}= 5.09, M_{female}= 3.39, *Wilcoxon Z*= 10.69, $p < .0001$), and higher maximum number of drinks in the previous 30 days (M_{male}= 8.14 , M_{female}= 4.69, *Wilcoxon Z*= 11.28, p= <.0001).

The CAPS variable was dummy-coded and total problem scores were reclassified as CCAPS to aid the descriptive comparisons of problems. Students who reported no alcohol problems at baseline were used as the reference group. Table 2 shows the sample characteristics and descriptive statistics for each level of CCAPS.

The reference group (CCAPS0= "No problems") contained approximately 23% of the sample and reported the lowest temptations scores (*M*= 13.9, *SD*= 4.9). The high problems group also contained approximately 23% of the sample. Figure 2 shows the box-plot for baseline temptations scores were linearly associated with the CCAPS variable.

Unconditional Models

Full information maximum likelihood estimation was used to estimate the growth curve models in Mplus 7. There were 33 response-patterns where missingness in the data occurred and 33% attrition rate at the final wave of data collection. The following section describes the results from the baseline model and the proceeding steps of the unconditional and conditional GCMs. The models were constructed with and without the random effect term included in the models. The model fit statistics for the fixed effects and mixed-models results and the LLRT are shown in Table 3.

Baseline (intercept only) unconditional model.

The baseline model estimated just the intercept in the model, which is the average score of situational temptations at baseline. The model was restricted to just this parameter, therefore the random effect term in the model was estimated to be zero. Table 3 shows the model fit statistics for the baseline model. The overall model fit was poor (χ^2= 4054.87, df= 20, CFI= 0.0, RMSEA= .44 and SRMR= .54). The subsequent random intercept model included the random effect on the intercept to estimate individual differences at baseline. The addition of the random effect resulted in better overall model fit statistics (χ^2= 276.85, *df*= 19, CFI= .94, RMSEA= .11, SRMR= .07) but the fit of the model was poor. The LLRT indicated that the random intercept model was statistically significantly better model than the baseline model ($\Delta\chi^2$ = -3778.02, *df*=1, *p*<.001).

Unconditional Linear Model

The linear slope was evaluated to estimate the average rate of change over six time points. The model fit statistics are shown in Table 3. The LLRT significance test indicated that adding the fixed linear slope to the model resulted in a better statistical model than the random intercept only model ($\Delta\chi^2$ = -9.108, Δ*df*=1, *p*< .01). Adding the random effect to account for random variation in the slope led to good model fit (χ^2= 143.05, *df*=16, *p*<.01; CFI=.97, RMSEA=.09, SRMR= .06). The random linear slope model was statistically significantly better than the fixed linear slope model ($\Delta\chi^2$ = -124.69, Δ*df*= 2, *p*< .01). Furthermore, the regression coefficient for the linear slope was statistically significant (*b*=.203, *SE*= .082, *p*< .001) *(data not shown).* This indicated that there was a small significant positive linear increase in the sample's mean scores over time.

Figure 3 shows the unadjusted estimates for situational temptations scores at each wave starting from baseline to the 24 months wave. The line revealed that the overall increase in temptations was positive but non-linear over time. This provided sufficient visual evidence that the growth curve of temptations was in fact curvilinear over time. Hence, the GCM analysis proceeded by testing different polynomials to estimate the curvilinear growth curve of temptations.

Unconditional Quadratic Model

The LLRT test indicated that the fixed quadratic slope model was a statistically better model than the random linear model (see table 3). The fixed quadratic slope model had the random error term on the quadratic slope constrained to zero. The model fit the data well (χ^2= 110.33, *df*= 15, CFI= .98, RMSEA= .08 and SRMR= .07). The random quadratic model also fit the data well (χ^2= 80.09, *df*=15, *p*< .01; CFI=.97, RMSEA=.09, SRMR= .06). Interestingly, the chi-square and SRMR statistics decreased, but the CFI and RMSEA increased. In addition, the LLRT results indicated that the random quadratic model was a better model than the fixed quadratic model ($\Delta\chi^2$ =-30.24, Δdf=3, *p*<.001).

Figure 4 shows the unconditional model quadratic growth trajectory for the entire sample. The standard error bars (68% C.I.) indicated the precision of the growth curve parameter estimates for each wave of the study. The regression coefficient estimate for linear slope (*b*=1.44 *SE*=.237, *p*=.000) and quadratic growth curve slope were statistically significant (*b*=-.618, *SE*=.112, *p*< .000). The estimates indicated that the average linear increase in overall scores from baseline to the final time point was positive and the average growth peaked, somewhere between 6 to 12 months, and the growth from the apex of the growth curve was in the opposite direction over the next 12 to 18 months.

Although the model fit statistics for the fixed-effects and mixed-effects models were both well suited for these data, these results indicated that the best model of temptations needed to account for random variation in change in the rate of change over time. These results are consistent with the literature that suggests that that the growth trajectories of student’s temptations to drink would be nonlinear and declining over time. However, in order to test for differences in the growth rates during and after treatment, the piecewise model was examined next.

Unconditional Piecewise Model

Based on the GCM findings from the previous models, the fixed piecewise model included the random effects on the intercept and the first slope. The model had respectable model fit statistics (χ^2=169.47, *df*=15, *p*< .05; CFI= .96, RMSEA=.10, SRMR=.05). The random effect term for the second slope was added in the random piecewise model, which led to excellent model fit (χ^2=38.08, *df*=12, *p*< .05; CFI= .99, RMSEA=.045, SRMR=.013). The LLRT was used to test the nested piecewise models. The results indicated that the random piecewise model was statistically better than the fixed Piecewise model ($\Delta\chi^2$ =-131.396, Δ*df*=3, *p*<.001). Additionally, non-nested model comparisons between the piecewise and quadratic model were evaluated. The ΔAIC (-124.40), ΔBIC (-110.43) and ΔCFI (.03) and provided further evidence that the piecewise model was statistically the best unconditional model. Therefore, the random piecewise model was selected as the best unconditional GCM of situational temptations.

Figure 5 shows the unconditional Piecewise model with two line segments that were postulated to represent different intervals of time. Based on the recommendations of Wold (1974), the location of the spline knot that connected the two line segments was at (or near) the inflection point of the change curve. The first slope denoted the intervention period from baseline (0 months) to 6 months. The random Piecewise model's unstandardized regression coefficient estimates for the linear slope during intervention period was positive and statistically significant from baseline to 6-months (*b*=1.834, *SE*=.277, *p*< .001) *(data not shown)*. The second slope denoted the post-intervention period between 12, 18, & 24-months. The regression coefficients for the second slope was negative and was marginally statistically significant (p<.06) between 6 months to 24 months (b=-.145, SE=.08) *(data not shown).*

Conditional GCM Results

As shown above, the piecewise model with terms for estimating the fixed and random effects for initial status and the slopes for the intervention (t_1) and post-intervention (t_2) time periods was found to be best fitting unconditional model of the growth of situational temptations for these data. The second step of this analysis compared a series of models to evaluate the contribution of conditional variables to the piecewise growth model. Table 5 displays the results from the comparison of a sequence of increasingly complex conditional models. Selection of the best conditional model was based on comparison of the results of LLRT tests and AIC and BIC statistics. The best fitting conditional model found revealed that Treat and CCAPS were significant moderators of situational temptations over time, but none of the higher order interaction terms significantly contributed to the fit of the model. The unadjusted results from three separate growth curve analyses for each of the conditional variables is shown in Table 4. Statistically significant predictors and moderators of situational temptation from Table 4 were then entered simultaneously into a multivariable GCM and the statistically significant predictors and moderators were retained in the final model, shown in Table 6.

Treatment

As shown in Table 4, treatment was not statistically significantly related to temptations at baseline (b= .216, SE= .336, p= .52) or during the treatment phase (b= .085, SE= .549 p= .877), although during the 6 to 24 month post-treatment period, a small but statistically significant reduction in situational temptations was observed for participants in the treatment group (b= -.317, SE= .159 p< .05). These results suggest that the average score of temptations grew over the first six months, regardless of which condition students were placed in. However, there was a small significant difference found in the second slope, indicating that the treatment led to lower temptations scores, on average, relative to the control group.

Female

Female was evaluated first as the only predictor in the GCM then again in the models with the other factors. In the results from single predictor unadjusted model shown in Table 4, females at baseline had significantly lower situational temptations score than males (b= -0.85, SE= .337, p< .01), but gender was not a moderator of growth in situational temptations during either the intervention or post-intervention periods. However, when controlling for the effects of Treat and/or CCAPS in the multivariable conditional models, Female was not significant (Table 6). In addition, the LLRT indicated the final model was statistically better with Female trimmed from the model. Since temptations did not differ by treatment group at baseline this finding suggests that the observed baseline gender difference may be due to the gender differences the rate of alcohol related problems during the three months prior to baseline. The findings indicate that the growth trajectories of temptations would not be altered or change across time based on small differences between men and women's average scores at baseline.

College alcohol-related problems

In contrast, the level of baseline alcohol problems as measured by CCAPS was significantly related to situational temptations at baseline and over time in both unadjusted and adjusted models (Tables 4 and 6). Students who experienced a score of 1 or greater had significantly higher baseline situational temptation scores. After controlling for the effects of treatment and gender, those in the Low (b= 3.626, SE= .385 p< .000), Moderate (b= 6.173, SE= .417 p< .000) and High (b=8.546, SE= .415 p< .000) levels of CCAPS had significantly higher temptations to drink at baseline, compared to the no problems reference group (CCAPS=0) (Table 6). Additionally, as shown in Table 6, the Moderate (CCAPS2) and High (CCAPS3) groups decreased their temptations during the intervention phase (b= -1.66, SE= .810, p< .05) and the post-intervention phase (b= -1.55 SE= .815, p= .06), respectively). The results indicated students with moderate and high levels of alcohol-related problems at baseline situational temptations had greater reductions in temptations relative to their peers who had no alcohol related problems at baseline.

Final GCM Model

Table 6 shows the statistical significant fixed effect parameter estimates for the final model. The full multivariable model that was initially evaluated included the growth parameters, all of the predictors and the two and three-way interaction terms. None of the three-way interactions in the saturated model was significant, and were not reported in any of the tables. Taken together, the final model results indicated that the average change in temptations was different during each phase of the intervention. Finally, moderate and high levels of college alcohol-related problems were significantly associated with higher temptations scores.

CHAPTER 4

Discussion

The present study investigated the growth of situational temptations over two years of early college and examined the extent to which treatment, gender and alcohol-problems influenced the growth of temptations over time. The quadratic and piecewise growth trajectories supported the hypothesis that the growth was nonlinear over time, however, the Piecewise model was the best statistical GCM. An important finding from the conditional models was that treatment was associated with the growth of temptations, which is in line with other research that found small reductions in temptations to drink in samples of alcoholics (Witkiewitz, 2013). These findings are also consistent with other research that found situational temptations to smoke decreased over several years following TTM interventions (DiClemente, Prochaska, & Gibertini, 1985; Prochaska, Velicer, Guadagnoli, Rossi, & DiClemente, 1991). The differences that were found between students that received and those who did not receive any feedback were not very large. In fact, the absolute difference between the groups' average scores was less than a 1 point. Nonetheless, the finding that the TTM feedback reports led to a small but statistically significant reduction in temptations is a promising result because of what this could entail for clinicians that provide feedback to their clients.

This study found that students who reported moderate alcohol problem levels $p < .05$) or high levels of problems (p=.07) lowered their temptations during the intervention period. One plausible explanation for the reduction in that the reduction in temptations may be due to regression to the mean, which refers to the statistical phenomenon that if a variable is at the extreme at the first measurement it will be closer to the average at a subsequent measurements. That is, the finding that temptations scores were reduced for students in the highest two CCAPS groups at the 6 month time point, may simply be due to random statistical variation. Another explanation is that students who had high temptations at the beginning could have reduced their temptations based on their experiences with drinking during the first few weeks of school. Further, students who came to college with many alcohol related problems may have reduced their temptations to drink because of alcohol-related negative consequences experienced during the school year and had an immediate impact on how tempted they were to drink by themselves or with their peers. The latter explanation is partially supported by the evidence from this study. The moderate and high CCAPS groups had significantly decreased growth in temptations scores during the first six months of the study (b=-1.16, se=.81 and b=-1.06, se=.24, respectively), and smaller but non-significant reductions in their temptations scores during the post-intervention period (b=1.55, se=.82 and b=-0.41, se=.24, respectively).

Contrary to my expectations, gender was not related to the growth of temptations nor was it supported in the final GCM. Gender differences in drinking are attributed to rates of alcohol absorption, elimination and impairment. Some studies report gender differences related to treatment (Borsari et al., 2007; Carey et al., 2007), however, the results from this study find no evidence that gender was a moderator of the treatment effect on situational temptations; the test of the gender x treatment x time interaction was not statistically significant. Therefore, I concluded that treatment was equally effective for men and women. These results are consistent with studies that that have found no gender differences in the effectiveness of brief gender tailored alcohol interventions (Bischof, Rumpf, Meyer, Hapke, & John, 2005; Lojewski et al., 2010).

Although the growth of temptations was significantly mitigated by personalized feedback after a period of initial growth, the clinical significance of these findings may not be important. With that said, consider that the average growth of temptations was less than a full point and consider that the average increase in temptations was also less than a full point in the control group. What this may suggest is that temptations to drink takes a long time to change and that for the most part, students' temptations to drink will increase slightly and gradually level-off. Therefore, college administrations should consider investigating other important cognitive factors that are susceptible to change like Self-Efficacy, Resistance or Barriers to drinking to consider the distal effect of these variables on risky drinking.

Model Limitations

It is important to note that the line plot in Figure 4 indicated that the average growth trajectory for the entire sample peaked at or near the end of the first year of college. The growth then leveled off and began to decrease over the following year. This model indicated that the increase in temptations over the first year would change and the trajectory of growth would appear to flatten out over time. In contrast, the Piecewise model in Figure 5 assumed the growth changed right at the six month time point. These models forced the average rate of change to fit the curve, however, the proclivity of both types of polynomials it that they alter the verticality of the slope(s) of change. In other words, these models may suggest students' temptations will increase and that personalized feedback has a supplementary effect 18 months after treatment, but these models make assumptions about the growth that may not be replicated in other samples.

Study Limitations

The results of this study should be considered in light of several limitations. The first limitation was that the entire sample was used to construct the unconditional GCMs. Although the large sample size was a strength of the current study, the sample data should have been partitioned into complementary subsets. Then cross-validating techniques on several smaller datasets would be able to compare the statistical models to the results obtained with the full sample. By skipping this step, in theory, could have increased the probability of having committed a type 1 error. Type 1 errors can lead to the improper rejection of the null hypothesis or the competing models.

The second limitation was that this study considered only a handful of moderator variables in this study. This is an important limitation insofar that all of the predictors in the models were either categorical or was polyotomized (CCAPS) into an ordinal-level variable based on the distribution of the CAPS quasi-continuous scale. Moreover, none of the covariates that were considered in this study measured alcohol consumption. More specifically, number of binge episodes and peak number of drinks should have been considered since these variables are strongly related to alcohol-related problems (Capone et al., 2007; Kavanagh, et al., 2009; Migneault, 1995; Nelson et al., 2009) and situational temptations is a mediator of risky drinking (Migneault, 1995; Maddock et al., 2000).

A third limitation of this study was the lack of close and/or equally spaced waves of data. An optimal design would have more assessments and data collection waves closer together and over a longer period of time. The additional time points would allow other equally plausible models to be evaluated as alternative explanations of the growth curve (Bullock, Harlow & Mulaik, 1994; Little, 2013; Singer & Willet, 2003). For instance, a cubic function could have been another plausible model that could have been examined.

Finally, another limitation was that no formal test of covariate 'missingness' was performed. Without a thorough evaluation of the problematic cases, transcription errors, omitted predictors, potential outliers and high-leverage cases could have biased the findings. While the FIML procedure was used in Mplus to provide some protection against covariate dependent missing data bias (Graham, 2003) it is possible that the type of missingness that occurred was missing completely at random (MCAR), missing at random (MAR) or covariate-dependent dropout (CDD), and could have biased the results.

One final limitation of this study is that regression diagnostics were not conducted for the statistical models. This means that the statistical assumptions of the normal linear mixed model used for the unconditional and conditional models were not systematically examined, so we do not know whether these assumptions were satisfactorily met, or whether these models were correctly specified, or if the parameter estimates and fit indices may be biased due to the influence of extreme cases. However, preliminary exploration of the univariate and bivariate characteristics of the variables and preliminary examination of the linear regression fixed estimates did not indicate any obvious distributional problems with the data. Nevertheless, without a thorough evaluation the linear mixed model assumptions and problematic cases for possible transcription errors and high-leverage cases, it is not known if, or to what extent the results presented in this thesis are biased in some way.

Future Directions

Future studies ought to consider using time-varying predictors in the GCM and include drinking outcomes in the model. For starters, including a baseline predictor such as the total number of drinks per week would explain more of the total variation at baseline and possibly the slopes as well. Static variables such as race and ethnicity or Greek life status are also important subgroups to consider in future studies.

Finally, alcohol use is both a psychological and physiological condition but most researchers rely on latent psychological factors to define alcohol misuse and some use technology to construct mappings of neurological structures in the brain and surveys. However, the problem with studying temptations is that the term has moderate overlap in different perspectives, which leads to some neurological studies that consider “cravings” to drink as temptations. Neurological researchers have hypothesized a biological explanation for cravings to drink. Chemical reactions in the brain stimulate neural pathways that cause behavior. Researchers have studied neural pathways neural pathways in the brain that are related to temptations and cravings to drink alcohol with functional magnetic resonance imaging (fMRI) machines. Recent fMRI studies have shown that substance cues and situational stressors can stimulate certain structures in the brain that lead to bothersome thoughts about drinking (Schmidt et al., 2011; Sinha et al., 2009).

The term cravings is more descriptive of alcohol dependence (Drummond et al., 2000; Witkiewitz, 2013) rather than immoderate alcohol use or risky drinking by college students. In contrast, the TTM's situational temptations construct measures cognitions about engaging in risky drinking when facing difficult situations (Grimley, Prochaska, Velicer, Blais, & DiClemente, 1994); the TRI measures cognitive resistance to drinking and temptations. The drawback of using either scale is that neither considers the neurotoxic effects of alcohol on the brain or how intoxication changes temptations to drink. fMRI research that includes the situational temptations scale, on the other hand, can measure biological and psychological factors of risky drinking.

To my knowledge, no prior research has been conducted to reduce a set of items on the situational temptation scale, RDS or TRI into a unified measure or model. It is important that behavioral-neuroscientists include biological measures and reliable inventories in their research studies so that a comprehensive scale can be developed and matched up against images from fMRI brain scans. To that end, it would be worthwhile for researchers to take advantage of new technology and continue investigating the interplay between cognitive functions and substance use.

TABLES

Table 1: Correlation Matrix of Repeated Measures of Situational Temptations

	Tempsm1	Tempsm2	Tempsm3	Tempsm4	Tempsm5	Tempsm6
Tempsm1	1					
Tempsm2	.734**	1				
Tempsm3	.729**	.809**	1			
Tempsm4	.681**	.731**	.766**	1		
Tempsm5	.670**	.678**	.728**	.785**	1	
Tempsm6	.611**	.643**	.694**	.756**	.782**	1

Note: **=Pearson correlation *r* is significant at the 0.01 level (2-tailed).

Table 2: Situational temptations score for selected sample characteristics by time

Variable			Time Point					
			BL	3 mo.	6 mo.	12 mo	18 mo	24 mo.
Group	Treatment	Mean	18.6	19.5	19.5	19.5	19.1	18.8
		SD	*5.8*	*6.2*	*6.2*	*6.2*	*6.0*	*5.7*
		N	*534*	*451*	*430*	*394*	*352*	*353*
	Control	Mean	18.3	19.3	19.1	19.6	19.3	19.6
		SD	*5.4*	*5.4*	*5.9*	*5.6*	*5.7*	*5.7*
		N	*533*	*462*	*432*	*415*	*364*	*370*
Gender	Male	Mean	18.9	19.8	19.4	19.7	19.4	19.4
		SD	*5.5*	*5.7*	*6.1*	*5.9*	*5.8*	*5.8*
		N	*471*	*406*	*380*	*353*	*319*	*306*
	Female	Mean	18.1	19.1	19.2	19.3	19.1	19.1
		SD	*5.7*	*5.9*	*6.0*	*5.9*	*5.9*	*5.7*
		N	*596*	*507*	*482*	*456*	*397*	*417*
Race	Native Am.	Mean	15.8	13.7	15.7	17.8	20.7	16.3
		SD	*5.6*	*5.5*	*6.7*	*9.5*	*7.8*	*6.9*
		N	*4*	*3*	*3*	*4*	*3*	*4*
	Asian/ PI	Mean	18.9	18.6	18.8	19.1	17.4	17.3
		SD	*5.7*	*6.3*	*6.3*	*6.0*	*5.0*	*6.5*
		N	*31*	*29*	*25*	*23*	*17*	*19*
	AA/Black	Mean	14.6	14.2	14.3	16.2	14.7	13.1
		SD	*6.6*	*6.7*	*6.0*	*8.0*	*5.8*	*5.6*
		N	*24*	*21*	*21*	*16*	*15*	*10*
	White	Mean	18.7	19.8	19.6	19.8	19.5	19.6
		SD	*5.6*	*5.7*	*6.0*	*5.8*	*5.8*	*5.6*
		N	*939*	*803*	*762*	*716*	*641*	*643*
	Other	Mean	16.0	16.8	17.3	17.1	16.6	16.0
		SD	*5.1*	*5.6*	*5.7*	*6.3*	*6.6*	*5.3*
		N	*67*	*55*	*50*	*48*	*39*	*45*
CAPS score	None (0)	Mean	13.9	14.1	13.0	14.2	13.7	13.3
		SD	*4.9*	*5.0*	*5.0*	*5.1*	*5.3*	*4.8*
		N	*241*	*178*	*174*	*168*	*139*	*152*
	Low <0 to <=3	Mean	17.4	18.1	18.5	19.0	17.9	18.5
		SD	*4.6*	*5.0*	*5.4*	*5.0*	*4.8*	*4.6*
		N	*340*	*249*	*229*	*224*	*195*	*201*
	Medium >3 and <=6	Mean	20.2	20.6	20.6	20.9	20.3	20.4
		SD	*4.4*	*4.2*	*5.0*	*5.1*	*4.3*	*4.5*
		N	*249*	*239*	*231*	*202*	*184*	*145*
	High >6	Mean	22.5	23.6	23.3	23.2	23.3	23.1
		SD	*4.9*	*4.9*	*4.8*	*4.7*	*4.9*	*4.3*
		N	*245*	*239*	*223*	*208*	*196*	*222*

Table 3. Unconditional growth curve model fit statistics and model comparison results

Growth Curve Model	χ^2 (df)	AIC	BIC	RMSEA	CFI	SRMR	Model Comparison	ΔCFI	$\Delta\chi^2$	Δdf	*p* value
1 Intercept Only	4054.87 (20)	32420.13	32454.94	0.44	0	0.54					
2 Intercept Only*	276.85 (19)	28644.11	28683.90	0.11	0.94	0.07	2 vs 1	0.94	-3778.02	1	0.000
3 Linear Slope	267.75 (18)	28637.01	28681.76	0.11	0.94	0.07	3 vs 2	0	-9.108	1	0.003
4 Linear Slope*	143.05 (16)	28516.31	28571.01	0.09	0.97	0.06	4 vs 3	0.03	-124.692	2	0.000
5 Quadratic Slope	110.33 (15)	28485.59	28545.26	0.08	0.98	0.07	5 vs 4	0.01	-32.724	1	0.000
6 Quadratic Slope*	80.09 (12)	28461.35	28535.30	0.07	0.98	0.03	6 vs 5	0	-30.238	3	0.000
7 Piecewise	169.47 (15)	28544.73	28604.41	0.10	0.96	0.05	-	-	-	-	-
8 **Piecewise***	38.08 (12)	28419.33	28493.93	0.05	0.99	0.01	8 vs 7	0.03	-131.396	3	0.000

Note: *Random Effects model; **Bold** denotes (Final Model).

Table 4. Unadjusted Parameters estimates for each moderator variable modeled separately

Moderator	Intercept	SE	Slope 1	SE	Slope 2	SE
Treatment: (Treat)	0.216	0.336	0.085	0.549	-0.317*	0.159
Gender (Female)	-0.85**	0.337	0.702	0.552	0.106	0.161
CCAPS0 (Ref)	N/A	N/A	N/A	N/A	N/A	N/A
CCAPS1	3.626***	0.385	-0.393	0.752	-0.187	0.219
CCAPS2	6.173***	0.417	-1.654*	0.81	-0.124	0.236
CCAPS3	8.546***	0.415	-1.537	0.814	-0.439	0.236

Note: *p<.05, **p<.01, ***p<.001.

Table 5. Comparison of Fit Statistics for Conditional Models

	Parsimony Model Fit Statistics		LLRT			
Model	AIC	BIC	Model Comparison	ΔX^2	Δdf	*p value*
(1) Piecewise	32420.13	32454.94				
(2) Piecewise + Gender	28417.82	28507.33	2 vs 1	-7.52	3	0.06
(3) Piecewise + CCAPS	28021.02	28140.34	3 vs 1	-416.32	9	0.00
(4) Piecewise + Treatment	28420.64	28510.14	4 vs 1	-4.70	3	0.19
(5) Piecewise + Treatment + Gender	28419.15	28523.58	5 vs 4	-7.48	3	0.06
(6) Piecewise + Treatment + Gender*	28422.87	28542.21	6 vs 5	-2.28	3	0.52
(7) Piecewise + Treatment+ CCAPS	**28022.32**	**28156.55**	**7 vs 4**	**-416.32**	**9**	**0.00**
(8) Piecewise + Treatment + CCAPS*	28032.28	28211.26	8 vs 7	-8.03	9	0.53
(9) Piecewise + Treatment+ Gender + CCAPS	28025.63	28174.78	9 vs 4	-419.01	12	0.00
(10) Piecewise + Treatment + Gender + CCAPS*	28052.79	28351.09	10 vs 9	-32.84	30	0.33

Note: *Interactions included in the model; **Bold** Indicates the final model.

Table 6. Final Multivariable Adjusted Model Regression Coefficients

Moderator	**Intercept**	**SE**	**Slope 1**	**SE**	**Slope 2**	**SE**
Treatment: (Treat)	0.027	0.28	0.087	0.549	-.327*	0.159
CCAPS0 (Ref)	N/A	N/A	N/A	N/A	N/A	N/A
CCAPS1	3.626***	0.385	-0.412	0.753	-0.166	0.219
CCAPS2	6.173***	0.417	-1.66*	0.81	-0.106	0.235
CCAPS3	8.546***	0.415	-1.554	0.815	-0.414	0.236

Note: *p≤.05; **p<.01, ***p<.001.

Figure 1: Distribution of Situational Temptations by Time Point

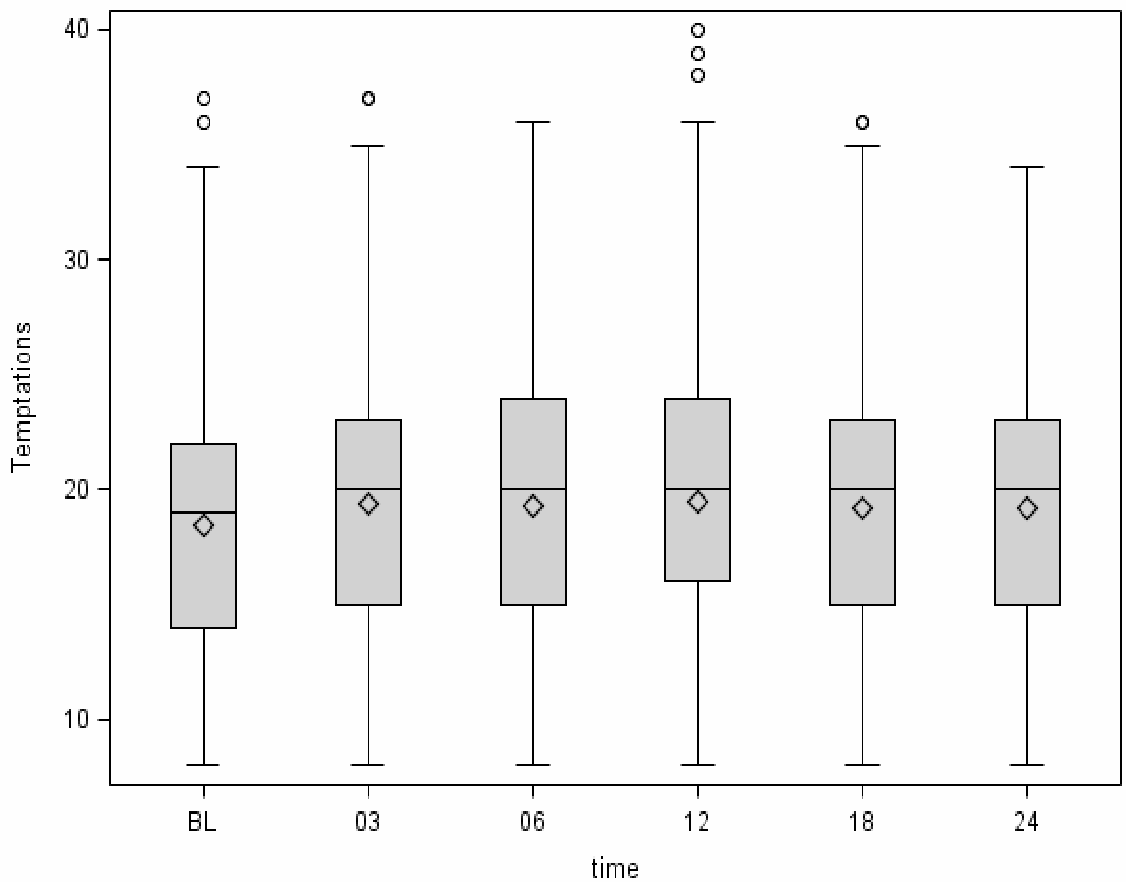


Figure 2: Baseline Situational Temptations by CAPS Score Group

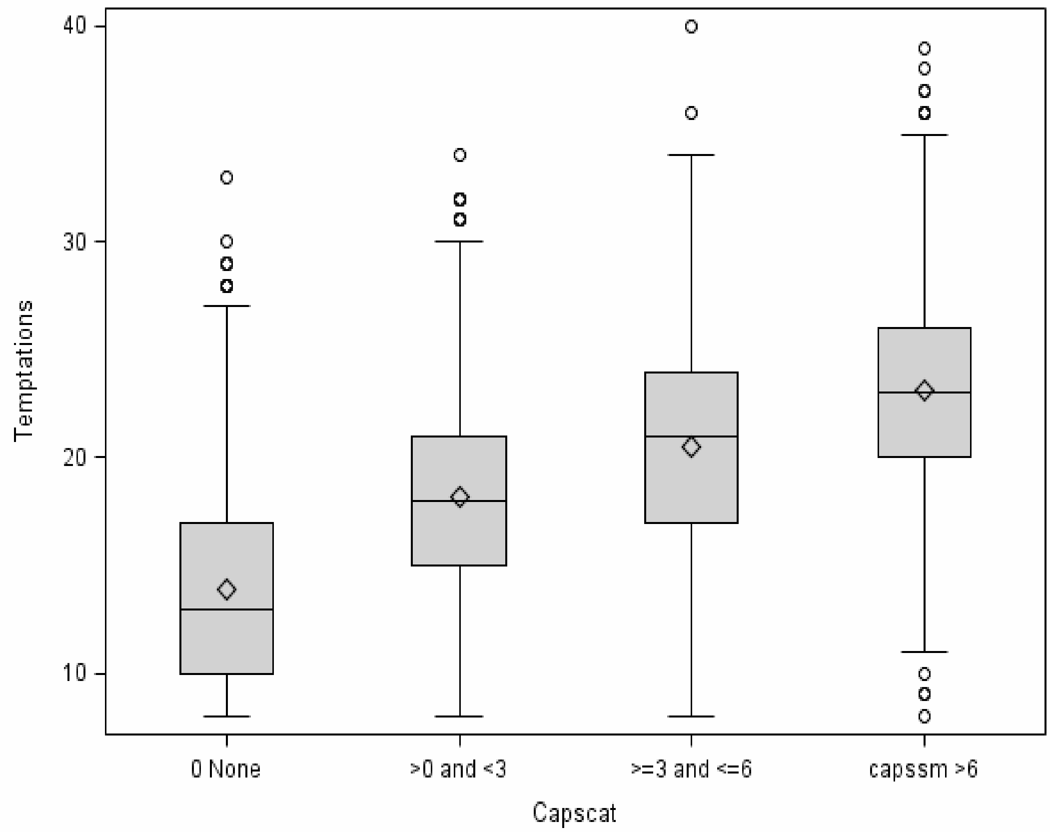


Figure 3. Unadjusted Estimated Means of Situational temptaions Plotted Over Time with Standard Error Bars

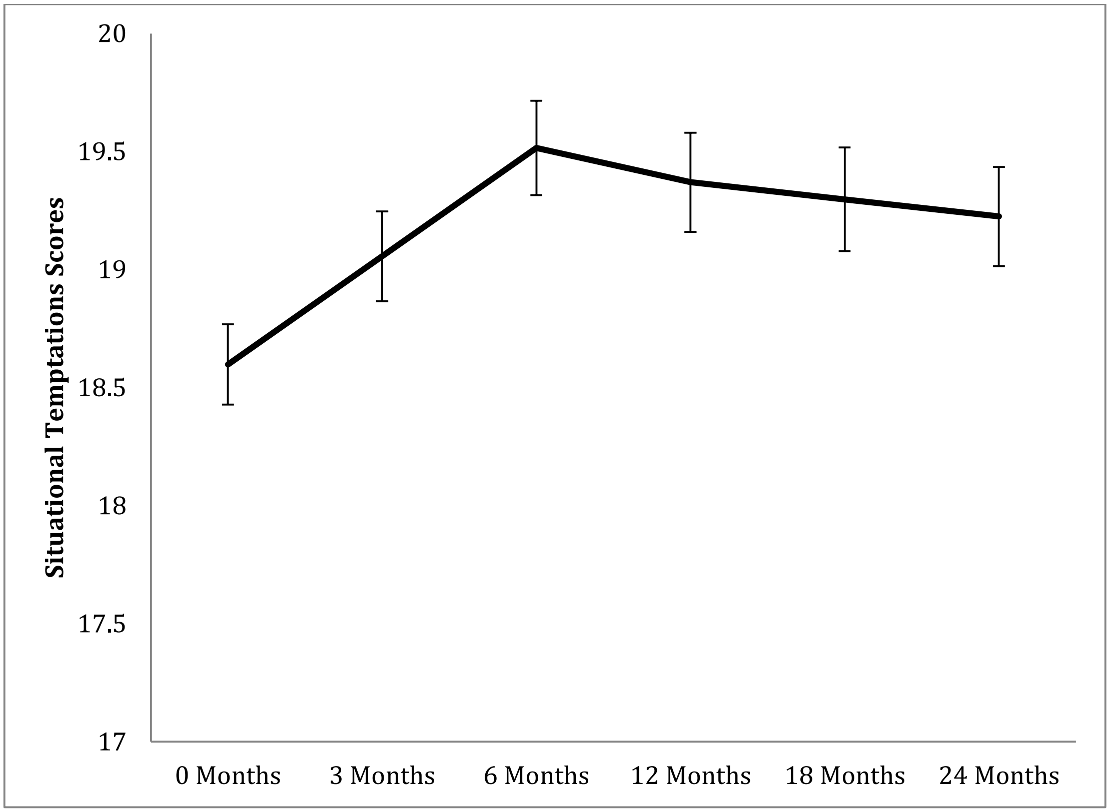


Figure 4. Uncondtional Quadratic Growth Curve Model of Situational Temptations with Standard Error Bars

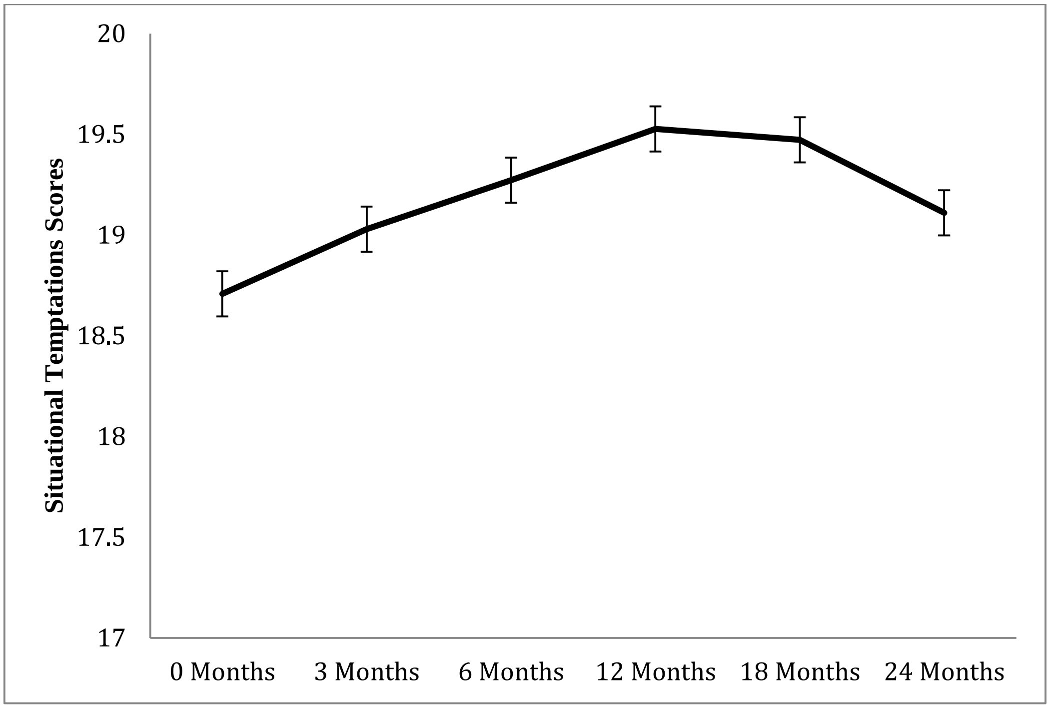
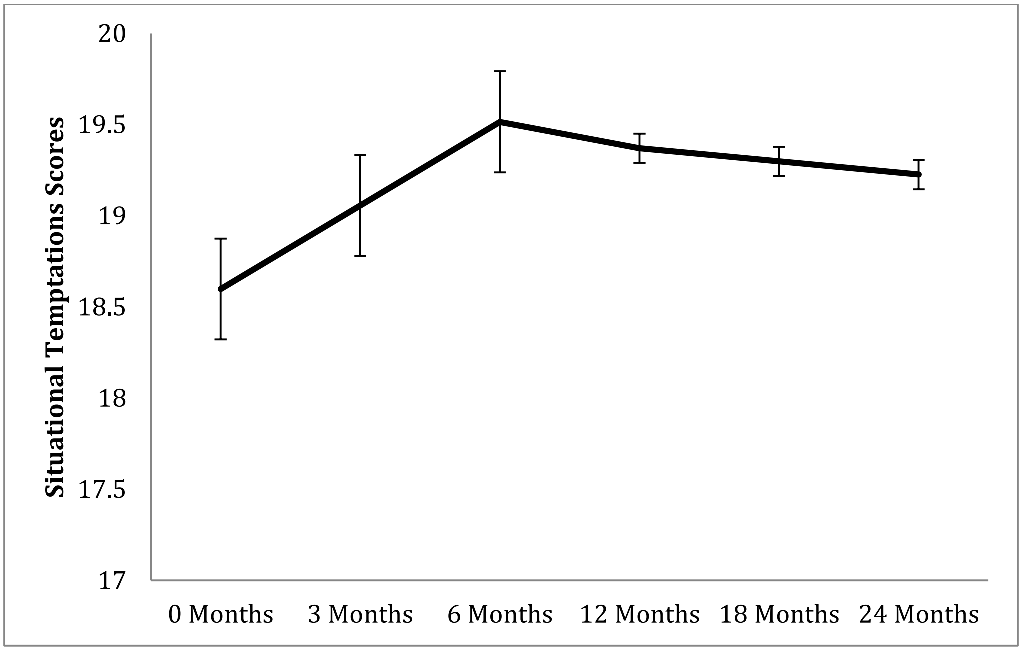


Figure 5. Uncondtional Piecewise Growth Curve Model with Standard Error Bars



APPENDIX A

Situational Temptations Scale

This scale was derived and adapted from an earlier 21-item situational temptations scale developed by Migneault (1995). The eight items are:

1. When I am feeling depressed.
2. When I am with others who are drinking a lot.
3. When I am excited.
4. When I am feeling shy.
5. When I am feeling angry.
6. When I am offered a drink.
7. When things are going really well for me.
8. When I am nervous about being socially outgoing.

For each situation, respondents were asked to rate "how tempted you are to drink a lot according to the following five point scale:

1. *Not at all tempted*
2. *Not very tempted*
3. *Somewhat tempted*
4. *Very tempted*
5. *Extremely tempted*

Maddock, J. E., LaForge, R. G., & Rossi, J. S. (2000). Short form of a situational temptation scale for heavy, episodic drinking. *Journal of Substance Abuse, 11*, 281-288.

Appendix B

College Alcohol Problems Scale

Study participants rated how often they experienced the following problems as a result of drinking alcoholic beverages within the six months on a 5-point Likert scale, with 1= Never/almost never to 5= Very often.

1. As a result of drinking, how often have you felt sad, blue or depressed?
2. As a result of drinking, how often have you engaged in unplanned sexual activity?
3. As a result of drinking, how often have you felt nervousness or irritability?
4. As a result of drinking, how often have you driven under the influence?
5. As a result of drinking, how often have you felt bad about yourself?
6. As a result of drinking, how often did you NOT use protection when engaging in sex?
7. As a result of drinking, how often did you have problems with appetite or sleeping?
8. As a result of drinking, how often were you involved in illegal activities associated with drug use?

(*Odd numbered items capture the dimension of alcohol related 'personal' problems and the even numbers capture the dimension of alcohol related 'social' problems*.)

Bibliography

Agostinelli, G., Brown, J. M., & Miller, W. R. (1995). Effects of normative feedback on consumption among heavy drinking college students. *Journal of Drug Education*, *25*(1), 31-40. doi: 10.2190/XD56-D6WR-7195-EAL3

Babor, T., & Higgins, P. (2001). Brief Intervention for Hazardous and Harmful Drinking: A Manual for Use in Primary Care. World Health Organization Geneva

Baer, J. S. (2002). Student factors: understanding individual variation in college drinking. *Journal of Studies on Alcohol, Supplement*(14), 40-53.

Barnett, N. P., Tevyaw, T. O., Fromme, K., Borsari, B., Carey, K. B., Corbin, W. R., . . . Monti, P. M. (2004). Brief alcohol interventions with mandated or adjudicated college students. *Alcoholism: Clinical & Experimental Research, 28*(6), 966-975

Bartholow, B. D., Sher, K. J., & Krull, J. L. (2003). Changes in heavy drinking over the third decade of life as a function of collegiate fraternity and sorority involvement: a prospective, multilevel analysis. *Health Psychology, 22*(6), 616.

Baumeister, R. F., & Heatherton, T. F. (1996). Self-regulation failure: An overview. *Psychological inquiry, 7*(1), 1-15.

Bentler, P. M. (1990). Comparative fit indexes in structural models. *Psychological bulletin, 107*(2), 238.

Bischof, G., Rumpf, H. J., Meyer, C., Hapke, U., & John, U. (2005). Influence of psychiatric comorbidity in alcohol-dependent subjects in a representative population survey on treatment utilization and natural recovery. *Addiction, 100*(3), 405-413.

Borsari, B., & Carey, K. B. (2000). Effects of a brief motivational intervention with college student drinkers. *Journal of Consulting & Clinical Psychology, 68*(4), 728-733. doi: 10.1037/0022-006X.68.4.728

Borsari, B., & Carey, K. B. (2001). Peer influences on college drinking: A review of the research. *Journal of Substance Abuse, 13*(4), 391-424. doi: 10.1016/S0899-3289(01)00098-0

Borsari, B., & Carey, K. B. (2005). Two brief alcohol interventions for mandated college students. *Psychology of Addictive Behaviors, 19*(3), 296-302. doi: 10.1037/0893-164X.19.3.296

Borsari, B., & Mastroleo, N. R. (2013). Brief feedback-focused interventions. In P. M. Miller, S. A. Ball, M. E. Bates, A. W. Blume, K. M. Kampman, D. J. Kavanagh, M. E. Larimer, N. M. Petry, P. De Witte, P. M. Miller, S. A. Ball, M. E. Bates, A. W. Blume, K. M. Kampman, D. J. Kavanagh, M. E. Larimer, N. M. Petry, & P. De Witte (Eds.), *Comprehensive addictive behaviors and disorders, Vol. 3: Interventions for addiction.* (pp. 3-11). San Diego, CA, US: Elsevier Academic Press.

Borsari, B., Murphy, J. G., & Barnett, N. P. (2007). Predictors of alcohol use during the first year of college: Implications for prevention. *Addictive Behaviors, 32*(10), 2062-2086. doi: 10.1016/j.addbeh.2007.01.017

Borsari, B., Murphy, J. G., & Carey, K. B. (2009). Readiness to change in brief motivational interventions: a requisite condition for drinking reductions? *Addictive Behaviors*, *34*(2), 232-235. doi: 10.1016/j.addbeh.2008.10.010

Bryk, A. S., & Raudenbush, S. W. (1992). *Hierarchical linear models: applications and data analysis methods*: Sage Publications, Inc.

Buckner, J. D., Eggleston, A. M., & Schmidt, N. B. (2006). Social anxiety and problematic alcohol consumption: The mediating role of drinking motives and situations. *Behavior Therapy, 37*(4), 381-391.

Bullock, H. E., Harlow, L. L., & Mulaik, S. A. (1994). Causation issues in structural equation modeling research. *Structural Equation Modeling: A Multidisciplinary Journal, 1*(3), 253-267.

Carey, K. B., Scott-Sheldon, L. A. J., Carey, M. P., & DeMartini, K. S. (2007). Individual-level interventions to reduce college student drinking: A meta-analytic review. *Addictive Behaviors, 32*, 2469-2494. doi: 10.1016/j.addbeh.2007.05.004

Capone, C., Wood, M. D., Borsari, B., & Laird, R. D. (2007). Fraternity and sorority involvement, social influences, and alcohol use among college students: a prospective examination. *Psychology of Addictive Behaviors, 21*(3), 316.

Cheung, G. W., & Rensvold, R. B. (2002). Evaluating goodness-of-fit indexes for testing measurement invariance. *Structural equation modeling*, *9*(2), 233-255.

Cole, D. A., & Maxwell, S. E. (2003). Testing mediational models with longitudinal data: questions and tips in the use of structural equation modeling. *Journal of abnormal psychology*, *112*(4), 558.

Collins, R. L., & Lapp, W. M. (1992). The Temptation and Restraint Inventory for measuring drinking restraint. *British journal of addiction*, *87*(4), 625-633.

Collins, S. E., Carey, K. B., & Sliwinski, M. J. (2002). Mailed personalized normative feedback as a brief intervention for at-risk college drinkers. *Journal of Studies on Alcohol*, *63*(5), 559-567.

Collins, R. L., George, W. H., & Lapp, W. M. (1989). Drinking restraint: Refinement of a construct and prediction of alcohol consumption. *Cognitive Therapy and Research*, *13*(5), 423-440.

Collins, R.L., & McNair, L.D. (2002). Minority women and Alcohol use. *Alcohol Research and Health*, 26(4), 251-256.

Cox, DR and Donnelly, CA (2011). *Principles of Applied Statistics*, New York, Cambridge University Press.

Curry, S., Southwick, L., & Steele, C. (1987). Restrained drinking: risk factor for problems with alcohol? *Addictive Behaviors*, *12*(1), 73-77.

Del Boca, F. K., Darkes, J., Greenbaum, P. E., & Goldman, M. S. (2004). Up close and personal: temporal variability in the drinking of individual college students during their first year. *Journal of Consulting and Clinical Psychology, 72*(2), 155.

DeSalvo, K. B., Fisher, W. P., Tran, K., Bloser, N., Merrill, W., & Peabody, J. (2006). Assessing measurement properties of two single-item general health measures. Quality of Life Research: An International Journal of Quality of Life Aspects of Treatment, Care & Rehabilitation, 15, 191-201.

DiClemente, C. C., Prochaska, J. O., & Gibertini, M. (1985). Self-efficacy and the stages of self-change of smoking. *Cognitive therapy and Research*, *9*(2), 181-200.

Duncan, T. E., Duncan, S. C., & Stryker, L. A. (2006). An introduction to latent variable growth curve modeling: Concepts, issues, and applications (2nd ed.). Mahwah, NJ: Erlbaum.

Drummond, D. C., Litten, R. Z., Lowman, C., & Hunt, W. A. (2000). Craving research: future directions. *Addiction, 95*(8s2), 247-255.

Gardner, D. G., Cummings, L. L; Dunham, R. B., & Pierce, J. L. (1998). Single-item versus multiple-item measurement scales: An empirical comparison. *Educational and Psychological Measurement*, 58, 898-915.

Graham, J. W. (2003). Adding missing-data-relevant variables to FIML-based structural equation models. *Structural equation modeling, 10*(1), 80-100.

Grimley, D., Prochaska, J.O., Velicer, W.F., Blais, L.M.., & DiClemente, C.C. (1994). The Transtheoretical Model of Change. In T.M. Brinthaupt &

R.P. Lipka (Eds.),*Changing the Self: Philosophies, Techniques, and Experiences*. Albany, New York: SUNY Press.

Greenbaum, P. E., Del Boca, F. K., Darkes, J., Wang, C.-P., & Goldman, M. S. (2005). Variation in the drinking trajectories of freshmen college students. *Journal of Consulting and Clinical Psychology, 73*(2), 229.

Group, P. M. R. (1993). Project MATCH (Matching Alcoholism Treatment to Client Heterogeneity): rationale and methods for a multisite clinical trial matching patients to alcoholism treatment. *Alcohol Clin Exp Res, 17*(6), 1130-1145.

Ham, L. S., & Hope, D. a. (2003). College students and problematic drinking: A review of the literature. *Clinical Psychology Review, 23*, 719-759.

Hatzenbuehler, M. L., Corbin, W. R., & Fromme, K. (2011). Discrimination and alcohol-related problems among college students: A prospective examination of mediating effects. *Drug and Alcohol Dependence, 115*, 213-220.

Heck, R. H., & Thomas, S. L. (2015). An Introduction to Multilevel Modeling Techniques: MLM and SEM Approaches Using Mplus: Routledge.

Herman, C. P., & Polivy, J. (1980). Restrained eating. *Obesity*, 208-225.

Hingson, R. W., Heeren, T., Zakocs, R. C., Kopstein, A., & Wechsler, H. (2002). Magnitude of alcohol-related mortality and morbidity among U. S. college students ages 18-24. *Journal of Studies on Alcohol, 63*(2), 136-144.

Hox, J., & Stoel, R. D. (2005). Multilevel and SEM approaches to growth curve modeling. *Wiley StatsRef: Statistics Reference Online*.

Hustad, J. T., & Borsari, B. (2010). Web-based screening and brief motivational intervention reduces alcohol use in heavy-drinking undergraduates at up to 6 months. *Evidence Based Medicine, 15*(1), 17-18. doi: 10.1136/ebm.15.1.17

Johnston, L., O'Malley, P. M., Bachman, J. G., & Schulenberg, J. E. (2013). Monitoring the Future National Survey Results on Drug Use, 1975–2011. *Institue for Social Research, the University of Michigan: Rockville, Michigan, USA*, *1*.

Jouriles, E. N., Brown, A. S., Rosenfield, D., McDonald, R., Croft, K., Leahy, M. M., & Walters, S. T. (2010). Improving the effectiveness of computer-delivered personalized drinking feedback interventions for college students. *Psychology of Addictive Behaviors, 24*(4), 592.

Kavanagh, D. J., May, J., & Andrade, J. (2009). Tests of the elaborated intrusion theory of craving and desire: Features of alcohol craving during treatment for an alcohol disorder. *British Journal of Clinical Psychology, 48*(3), 241-254.

Kenward, M. G., & Molenberghs, G. (1998). Likelihood based frequentist inference when data are missing at random. *Statistical Science*, 236-247.

Kline, R. B. (2006). Structural equation modeling: New York: The Guilford Press.

Laforge, RG. (2000) RO1AA12068 (P.I. Robert G. Laforge) " The CBARR data used in this thesis was supported from a grant entitled "A Proactive Individualized Program for College Drinkers" awarded in 2000 by the National Institute on Alcoholism and Alcohol Abuse of the National Institutes of Health.

Larimer, M. E., & Cronce, J. M. (2007). Identification, prevention, and treatment revisited: individual-focused college drinking prevention strategies 1999-2006. *Addict Behav, 32*(11), 2439-2468. doi: 10.1016/j.addbeh.2007.05.006

Larimer, M. E., Kaysen, D. L., Lee, C. M., Kilmer, J. R., Lewis, M. A., Dillworth, T., . . . Neighbors, C. (2009). Evaluating level of specificity of normative referents in relation to personal drinking behavior. *Journal of Studies on Alcohol and Drugs, Supplement*(16), 115-121.

Larimer, M. E., Lee, C. M., Kilmer, J. R., Fabiano, P. M., Stark, C. B., Geisner, I. M., . . . Neighbors, C. (2007). Personalized mailed feedback for college drinking prevention: a randomized clinical trial. *J Consult Clin Psychol, 75*(2), 285-293. doi: 10.1037/0022-006X.75.2.285

Lewis, B. A., & O'Neill, H. K. (2000). Alcohol expectancies and social deficits relating to problem drinking among college students. *Addictive Behaviors, 25*(2), 295-299.

Little, P. T. D. (2013). *Longitudinal structural equation modeling*: Guilford Press.

Lojewski, R., Rotunda, R. J., & Arruda, J. E. (2010). Personalized normative feedback to reduce drinking among college students: A social norms intervention examining gender-based versus standard feedback. *Journal of Alcohol & Drug Education, 54*(3), 19.

Maddock, J. E., LaForge, R. G., & Rossi, J. S. (2000). Short form of a situational temptation scale for heavy, episodic drinking. *Journal of Substance Abuse, 11*, 281-288.

Mastroleo, N. R., Oakley, W. C., Eaton, E. M., & Borsari, B. (2014). Response of heavy-drinking voluntary and mandated college students to a peer-led brief motivational intervention addressing alcohol use. *Journal of Substance Abuse Treatment, 47*(5), 321-328. doi: 10.1016/j.jsat.2014.06.005

Migneault, J. (1995). A Transtheoretical investigation of immoderate drinking in college. *Proquest Dissertations and Theses*.

Migneault, J. P., Velicer, W. F., Prochaska, J. O., & Stevenson, J. F. (1999). Decisional balance for immoderate drinking in college students. *Substance Use & Misuse, 34*(10), 1325-1346. doi: 10.3109/10826089909029387

Murphy, J. G., Hoyme, C. K., Colby, S. M., & Borsari, B. (2006). Alcohol Consumption, Alcohol-Related Problems, and Quality of Life Among College Students. *Journal of College Student Development, 47*(1), 110-121. doi: 10.1353/csd.2006.0010

Nelson, T. F., Xuan, Z., Lee, H., Weitzman, E. R., & Wechsler, H. (2009). Persistence of heavy drinking and ensuing consequences at heavy drinking colleges. *Journal of Studies on Alcohol and Drugs, 70*(5), 726-734.

Polivy, J., & Herman, C. P. (1985). Dieting and binging: A causal analysis. *American psychologist, 40*(2), 193.

Preacher, K., Wichman, A., Maccallum, R., & Briggs, N. (2008). Latent growth curve modeling, Review of statistical models for analyzing repeated measures data: SAGE, LA.

Prochaska, J., & DiClemente, C. (1982). Transtheoretical therapy: Toward a more integrative model of change. *Psychotherapy: Theory, Research ..., 19*, 276-288.

Prochaska, J. M., Prochaska, J. O., Cohen, F. C., Gomes, S. O., Laforge, R. G., & Eastwood, A. L. (2004). The Transtheoretical Model of Change for multi-level interventions for alcohol abuse on campus. *Journal of Alcohol & Drug Education*, *47*(3), 34-50.

Prochaska, J. O., Diclemente, C. C., & Norcross, J. C. (1997). In search of how people change: Applications to addictive behaviors. In G. A. Marlatt, G. R. VandenBos, G. A. Marlatt, & G. R. VandenBos (Eds.), *Addictive behaviors: Readings on etiology, prevention, and treatment.* (pp. 671-696). Washington, DC, US: American Psychological Association.

Prochaska, J. O., Velicer, W. F., Guadagnoli, E., Rossi, J. S., & DiClemente, C. C. (1991). Patterns of change: Dynamic typology applied to smoking cessation. *Multivariate Behavioral Research*, *26*(1), 83-107.

Quinn, P. D., & Fromme, K. (2011). Subjective response to alcohol challenge: a quantitative review. *Alcoholism: Clinical and Experimental Research*, *35*(10), 1759-1770.

Rossi, S. R., Greene, G. W., Rossi, J. S., Plummer, B. a., Benisovich, S. V., Keller, S., . . . Meier, K. S. (2001). Validation of decisional balance and situational temptations measures for dietary fat reduction in a large school-based population of adolescents. *Eating behaviors*, *2*, 1-18.

Ruderman, A. J., & McKirnan, D. J. (1984). The development of a restrained drinking scale: A test of the abstinence violation effect among alcohol users. *Addictive Behaviors*, *9*(4), 365-371.

Saunders, J. B., Kypri, K., Walters, S. T., Laforge, R. G., & Larimer, M. E. (2004). Approaches to Brief Intervention for Hazardous Drinking in Young People. *Alcoholism: Clinical & Experimental Research*, *28*(2), 322-329. doi: 10.1097/01.alc.0000113418.12889.08

Sayette, M. A., Shiffman, S., Tiffany, S. T., Niaura, R. S., Martin, C. S., & Shadel, W. G. (2000). The measurement of drug craving. *Addiction (Abingdon, England), 95*(Suppl 2), S189.

Schmidt, P., Helten, C., & Soyka, M. (2011). Predictive value of obsessive-compulsive drinking scale (OCDS) for outcome in alcohol-dependent inpatients: results of a 24-month follow-up study. *Subst Abuse Treat Prev Policy, 6*, 14.

Schumann, A., Meyer, C., Rumpf, H.-J., Hannöver, W., Hapke, U., & John, U. (2005). Stage of Change Transitions and Processes of Change, Decisional Balance, and Self-Efficacy in Smokers: A Transtheoretical Model Validation Using Longitudinal Data. *Psychology of Addictive Behaviors, 19*(1), 3-9. doi: 10.1037/0893-164X.19.1.3

Sher, K. J., & Rutledge, P. C. (2007). Heavy drinking across the transition to college: Predicting first-semester heavy drinking from precollege variables. *Addictive Behaviors, 32*(4), 819-835.

Sillice, M. A., Paiva, A. L., Babbin, S. F., McGee, H. A., Rossi, J. S., Redding, C. A., ... & Velicer, W. F. (2014). Testing demographic differences for alcohol use initiation among adolescents for the decisional balance and situational temptation prevention inventories. *Addictive behaviors*, *39*(9), 1367-1371.

Sinha, R., Fox, H. C., Hong, K. A., Hansen, J., Tuit, K., & Kreek, M. J. (2011). Effects of adrenal sensitivity, stress-and cue-induced craving, and anxiety on subsequent alcohol relapse and treatment outcomes. *Archives of general psychiatry, 68*(9), 942-952.

Sinha, R., & O'Malley, S. S. (1999). Craving for alcohol: findings from the clinic and the laboratory. *Alcohol and Alcoholism, 34*(2), 223-230.

Skinner, M. D., & Aubin, H.-J. (2010). Craving's place in addiction theory: contributions of the major models. *Neuroscience & Biobehavioral Reviews, 34*(4), 606-623.

Talbott, L. L., Martin, R. J., Usdan, S. L., Leeper, J. D., Umstattd, M. R., Cremeens, J. L., & Geiger, B. F. (2008). Drinking likelihood, alcohol problems, and peer influence among first-year college students. *American Journal of Drug and Alcohol Abuse, 34*(4), 433-440. doi: 10.1080/00952990802122655

van Geert, P., Laursen, B., Little, T., & Card, N. (2012). Dynamic systems. *Handbook of developmental research methods*, 725-741.

Velicer, W. F., DiClemente, C. C., Rossi, J. S., & Prochaska, J. O. (1990). Relapse situations and self-efficacy: An integrative model. *Addictive Behaviors, 15*(3), 271-283.

Walters, S. T., & Neighbors, C. (2001). Feedback interventions for college alcohol misuse: What, why and for whom? *Addictive Behaviors*, *26,* 1168-1182. doi: 10.1016/j.addbeh.2004.12.005

Walters, S. T., & Neighbors, C. (2005). Feedback interventions for college alcohol misuse: what, why and for whom? *Addict Behav, 30*(6), 1168-1182. doi: 10.1016/j.addbeh.2004.12.005

Wechsler, H., Lee, J. E., Nelson, T. F., & Kuo, M. (2002). Underage college students' drinking behavior, access to alcohol, and the influence of deterrence policies. *Journal of American College Health, 50*(5), 223-236. doi: 10.1080/07448480209595714

Wechsler, H., & Nelson, T. F. (2008). What we have learned from the Harvard School of Public Health College Alcohol Study: Focusing attention on college student alcohol consumption and the environmental conditions that promote it. *Journal of Studies on Alcohol and Drugs, 69*(4), 481-490.

Witkiewitz, K. (2013). Temptation to drink as a predictor of drinking outcomes following psychosocial treatment for alcohol dependence. *Alcoholism: Clinical and Experimental Research, 37*(3), 529-537.

Wood, P. K., Sher, K. J., & Rutledge, P. C. (2007). College student alcohol consumption, day of the week, and class schedule. *Alcoholism: Clinical and Experimental Research, 31*(7), 1195-1207.

Wold, S. (1974). Spline functions in data analysis. *Telemetrics*, *16*(1), 1–11.

Zakletskaia, L. I., Mundt, M. P., Balousek, S. L., Wilson, E. L., & Fleming, M. F. (2009). Alcohol-impaired driving behavior and sensation-seeking disposition in a college population receiving routine care at campus health services centers. *Accident Analysis & Prevention*, *41*(3), 380-386.

Zapolski, T. C., Pedersen, S. L., McCarthy, D. M., & Smith, G. T. (2014). Less drinking, yet more problems: Understanding African American drinking and related problems. *Psychological bulletin*, *140*(1), 188.