# The Relation between Heavy Alcohol Use and Bar Patronage: A Latent Growth Model*

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**ABSTRACT.** *Objective:* Random effects latent growth (LG) models were used to study the relation between changes in heavy alcohol use and changes in the frequency of bar patronage over a 3-year period. Previous research has identified a close link between alcohol use and bar patronage, but these cross-sectional findings limit inferences about possible temporal ordering. LG models are highlighted and compared with the more traditional but restricted cross-lagged models. *Method:* Three annual measures of heavy alcohol use and frequency of bar patronage were administered to a sample of 3071 adults (62% male) who participated in the National Longitudinal Study of Youth from 1982 to 1984. Background variables included age, gender, ethnicity and marital status. *Results:* Heavy alcohol use and bar patronage were characterized by negative longitudinal growth trajectories and there was significant individual variability in these changes over time. Changes in heavy alcohol use closely paralleled corresponding changes in bar patronage. Finally, the Time 1 measures of each construct were inversely predictive of subsequent changes over time in the second construct. *Conclusions:* These findings suggest that heavy alcohol users tended to continue to patronize bars, and bar patronage tended to encourage continued heavy alcohol use. This relation was particularly strong for singles and males. Compared to more traditional cross-lagged models, LG modeling appears to be a much stronger analytic technique for studying growth over time. It is recommended that LG models be used for future studies of change in alcohol use over time. (*J. Stud. Alcohol* **57:** 410-418, 1996)

THE INCLUSION of questions in U.S. national surveys concerning tavern patronage in the 1960s and 1970s (Clark, 1966, 1981; Fisher, 1981) and in Canada in the 1980s (Single and Wortley, 1993) provides important information regarding the demographic characteristics of tavern patrons and drinking patterns. For instance, Clark (1981) found that young single men, followed by young single women, had the highest frequency of tavern patronage. He also noted that heavier drinkers are more in force in taverns than are other drinking groups and that the frequency of tavern patronage is related to the amount of drinking and to the presence of alcohol-related problems.

While bars and taverns are patronized by heavier users of alcohol, other studies have also indicated that public drinking establishments are occasions for heavier drinking which are independent of demographic characteristics (Clark, 1985; Harford, 1975, 1985; Harford et al., 1980). For example, Stockwell and colleagues (1993) found that in a Western Australian sample, drinking on licensed premises was significantly associated with alcohol-related harm even after controlling for demographic factors. In a large New Zealand sample, Casswell and associates (1993) found that the quantity consumed in licensed establishments was strongly related to self-reported drinking problems. Single and Wortley's (1993) national study of Canadians found that one-fourth of drinking occurred in licensed establishments, and frequenting taverns and bars was associated with higher levels of drinking and drinking problems. Thus, evidence suggests that a large proportion of heavy drinking occurs within the setting of a licensed drinking establishment, and consuming alcohol in such an establishment is related to problem drinking outcomes.

Although these multinational large sample studies provide an excellent initial framework within which to study alcohol use and bar frequenting behavior, all of these studies are cross-sectional designs and are thus highly limiting in several ways. Most importantly, a strong case can not be made for the temporal ordering of events. Namely, do heavy drinkers simply frequent bars at a higher rate, does the frequenting of bars promote continued heavy drinking, or are alcohol use and bar patronage simply common indicators of a broader alcohol involvement construct? This is a critically important question, particularly when considering the implications for prevention and intervention efforts attempting to limit alcoholism and alcohol-related problems. The current study provides the first longitudinal examination of the relation between heavy drinking and bar patronage, and hopes to provide more definitive evidence regarding the potential temporal ordering of these constructs.

### *Latent growth models*

How to properly analyze longitudinal data has been a longstanding and hotly debated issue in the social sciences. Despite the sometimes critical importance of studying change over time, precisely how this is best accomplished is often uncertain. A broad class of analyses that has been in-

Received: March 13, 1995. Revision: July 20, 1995.

*This study was funded in part by National Institute on Alcohol Abuse and Alcoholism fellowship F32-AA05402-1 awarded to the first author.

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creasingly used for studying change over time is *random coefficient modeling*. These types of models have been developed and applied in biometrics (Laird and Ware, 1982; Rao, 1958), psychometrics (Meredith and Tisak, 1990; Tucker, 1958), education (Bryk and Raudenbush, 1992; Cronbach, 1976) and psychiatry (Gibbons et al., 1993). One recently developed type of random coefficient model is the *latent growth model* (LG) (McArdle, 1988; Meredith and Tisak, 1984, 1990; Muthén, 1991, 1992). LG modeling is designed to avoid many of the limitations associated with more traditional longitudinal data analytic strategies. LG modeling combines elements of repeated measures MANOVA, confirmatory factor analysis, and structural equation modeling to analyze changes in a construct over time. LG models analyze both the between-wave covariance matrix and the observed means of the measures over time. It is possible to model individual variation in growth of the construct over time and to identify potential factors that explain this variation. A key component is that, unlike more traditional auto-regressive cross-lagged (AR) models, LG models do not consider the repeated measures of the construct to be "causes" of themselves (that is, the Time 1 measure *causing* the Time 2 measure) (Dwyer, 1983), but instead consider the repeated measures to be multiple indicators of an underlying latent growth factor. This latter conceptualization is often a much more realistic reflection of the actual growth process under study.

There are several advantages to modeling change over time using a latent growth framework. First, the estimation of individual differences in parameter values are a primary focus of LG models. Conventional structural equation modeling has been criticized for being insensitive to individual differences in change (e.g., Rogosa, 1987). Second, LG models are highly flexible in the ability to model characteristics such as nonlinear growth, unequal or correlated error variance, and multiple indicator latent factors. Finally, LG models can be fully estimated using currently existing conventional structural equation modeling software such as LISCOMP (Muthén, 1987), LISREL (Jöreskog and Sörbom, 1989) and EQS (Bentler, 1989).

### *Study aims*

There are two primary aims of this study. The first is to examine the longitudinal relations between heavy drinking and bar patronage. Based upon the evidence that bars serve as settings which attract heavier drinkers and the assumption that the frequency of bar patronage will increase exposure to further heavy drinking networks, it is hypothesized that the frequency of bar patronage will be predictive of subsequent heavy drinking. It is further predicted that a bi-directional relation will exist such that heavy drinking will be predictive of continued frequenting of bars over time. Thus, we expect early heavy drinking will predict later bar patronage, and early bar patronage will predict later heavy drinking. Further, if such an association is found, we will test whether there are significant differences in the relative strength of the prospective predictions between constructs.

The second aim of this study is to describe and highlight the use of latent growth models to study change in heavy alcohol use and bar patronage over time. Additionally, LG models will be compared and contrasted with a more traditional auto-regressive cross-lagged panel analysis. We believe that latent growth modeling is an exciting and powerful new technique that is particularly well suited for studying changes in alcohol use over time. Although this new technology has been applied to the study of alcohol use (see, e.g., Duncan et al., 1994), we feel this technique is highly underutilized in the field of alcohol research. It is hoped that this study will serve as an illustrative example to guide others in the application of LG modeling to their own longitudinal data.

## Method

### *Subjects*

The data for this study were drawn from the National Longitudinal Survey of Youth (NLSY) of Labor Market Experience in Youth, a study which was initiated in 1979 by the U.S. Department of Labor in order to study the transition of young people into the labor force. The NLSY is a multistage, stratified, clustered probability sample of housing units drawn to be representative of the non-institutionalized U.S. population of young people aged 14-21 as of January 1, 1979, with supplemental samples of persons in the same age cohort who were serving in the military, Hispanics, blacks, and economically disadvantaged non-black, non-Hispanic youth. The 1979 panel included 12,686 respondents, 83% of whom remained in the study as of the 1989 annual interview.

Subjects who were 21 years of age or older as of 1982 were selected for the current analyses. This was done so that only subjects of legal drinking age were considered when examining the effects of bar patronage and heavy alcohol use. Additionally, subjects were excluded from the analysis if they reported no heavy alcohol use *and* no bar patronage at any of the three time points.[1] This selection resulted in a final sample of 3,071 subjects. The average age was 22.4 years, 38% of the subjects were female, 18% black, and 13% Hispanic, and the remaining 69% were Caucasian.

### *Measures*

*Ethnicity.* Two dummy coded variables were used to reflect subjects' ethnicity. One compared Hispanics to Caucasians, and the second compared blacks to Caucasians.

*Marital status.* Two dummy coded variables were used to assess marital status. The first compared subjects who were single for all three years between 1982 and 1984 (21% of sample) to those who were not. The second compared subjects married prior to 1982 and who had been divorced during any year between 1982 and 1984 (25% of sample) to those who had not.

TABLE 1. Means, standard deviations and zero-order correlations for all predictor and criterion variables

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Time 1 alcohol use | 1.0 | | | | | | | | | | | |
| 2. Time 2 alcohol use | .39 | 1.0 | | | | | | | | | | |
| 3. Time 3 alcohol use | .33 | .42 | 1.0 | | | | | | | | | |
| 4. Time 1 bar patronage | .47 | .23 | .14 | 1.0 | | | | | | | | |
| 5. Time 2 bar patronage | .22 | .43 | .19 | .36 | 1.0 | | | | | | | |
| 6. Time 3 bar patronage | .14 | .19 | .42 | .25 | .36 | 1.0 | | | | | | |
| 7. Gender | .20 | .24 | .24 | .07 | .08 | .09 | 1.0 | | | | | |
| 8. Age | −.02 | −.03 | −.05 | −.01 | −.04 | −.03 | .01 | 1.0 | | | | |
| 9. Hispanic | .01 | −.01 | .03 | −.07 | −.05 | −.04 | .01 | −.01 | 1.0 | | | |
| 10. Black | −.06 | −.05 | −.02 | −.10 | −.10 | −.07 | .05 | −.03 | −.18 | 1.0 | | |
| 11. Single | .04 | .02 | .04 | .09 | .08 | .11 | .01 | −.09 | −.01 | .20 | 1.0 | |
| 12. Divorced | −.06 | −.04 | .02 | −.09 | −.09 | −.06 | −.13 | .04 | .05 | −.03 | −.29 | 1.0 |
| Mean | 1.97 | 1.77 | 1.68 | 1.75 | 1.64 | 1.59 | 0.62 | 22.44 | 0.13 | 0.18 | 0.21 | 0.25 |
| Standard deviation | 1.76 | 1.73 | 1.71 | 1.28 | 1.29 | 1.33 | 0.49 | 1.11 | 0.33 | 0.38 | 0.41 | 0.43 |
| Skewness | 0.86 | 0.95 | 1.0 | 0.21 | 0.28 | 0.39 | −0.50 | 0.07 | 2.26 | 1.67 | 1.44 | 1.18 |

*Notes:* Absolute values of correlations greater than about $r = .03$, $p < .05$; absolute values greater than about $r = .04$, $p < .05$; statistics based on $N = 3{,}071$.

*Age and gender.* The age of the subject was measured in years as of 1982. Gender was measured using a dummy coded variable in which 0 reflected female and 1 reflected male.

*Bar patronage.* For the years 1982 through 1984, respondents were asked to indicate "how often in the last 30 days did you go to bars, taverns, or cocktail lounges" (none, once a month, 2-3 times a month, 1-2 times a week, several times a week, almost daily)? Although public drinking places encompass a variety of settings for the consumption of alcohol, population surveys generally use such generic categories as bars, taverns, pubs, cocktail lounges, etc. For ease of presentation, the current study will refer to all such licensed premises as "bars."

*Heavy drinking.* Identical measures of the frequency of heavier drinking were obtained for 1982, 1983 and 1984. Respondents were asked the frequency of occasions during the past month in which six or more drinks were consumed (never, once, 2-3 times, 4-5 times, 6-7 times, 8-9 times, 10 or more times).

## Results

Table 1 presents the means, standard deviations, zero-order correlations and univariate skewness coefficients for the six predictors and the Time 1, Time 2 and Time 3 measures of the two criteria. It can be seen that the mean levels of both heavy alcohol use and bar patronage show a decreasing trajectory over time. Additionally, heavy alcohol use and bar patronage are strongly positively correlated both within and across waves of measurement. Finally, neither the bar patronage nor heavy drinking measures reflected significant departures from multivariate normality (e.g., no measure of either construct exceeded a univariate skewness of 1.0 at any time point). Thus, no power transformations were required, and normal theory maximum likelihood was used for all analyses.

### *Examining growth over time*

Latent growth models were used to study change in the constructs over time. All models were estimated using LISCOMP (Muthén, 1987) based on the observed covariance matrix and column vector of means. The first step in the LG analyses was to test for the presence of change in heavy alcohol use and bar patronage over the three yearly assessments. Two LG models were estimated, one for heavy alcohol use and one for bar patronage. The basic LG model is comprised of two latent factors with the repeated measures of the construct over time as the indicators. Conceptually, this model can be viewed as a confirmatory factor analytic model. The first latent factor defines the *intercept* of the growth curve in which the factor loadings of the repeated measures are set to 1.0. This represents the starting point of the growth curve at Time 1. The second latent factor defines the *slope* of the growth curve, and represents the shape of the curve over time. The factor loadings of the repeated measures were set to represent the linear change that was observed in both constructs over time. The means of these intercept and slope factors represent the *group* growth parameters, and are overall measures of the intercept and slope for all subjects in the model. Finally, the variance of the latent factor reflects the variation of each individual subject around the overall group growth parameters. This can thus be considered a *random coefficients* model.

*Heavy alcohol use.* A two-factor LG model as described above was estimated for the three measures of heavy alcohol use, and this model was found to fit the observed data quite well ($N = 3{,}071$, $\chi^2 = 3.63$,1 df, $p = .06$; see Figure 1). The significant negative mean for the slope factor ($p < .05$) indicates that the overall group reported decreases in heavy alcohol use over time. The equally spaced factor loadings (0, 1, 2) indicate this decrease was linear. There was significant variance in both intercept and slope factors indicating that there was substantial individual variability about the group growth parameters. Finally, the negative correlation between the intercept and slope factors indicates that there was an inverse relation between initial status and change over time. Thus, as a whole, the sample was characterized by significant decreasing trajectories in heavy alcohol use over the three time points, and there was significant variability in the individual growth trajectories over time.

*Bar patronage.* A second two-factor LG model was estimated for the three measures of bar patronage, and this model also fit the observed data quite well ($N$ = 3,071, $\chi^2$ = 1.68,1 df, $p$ = .19; see Figure 1). The results for bar patronage were very similar to those found for heavy alcohol use. There was a significant positive mean for the intercept factor and a significant negative mean for the slope factor (indicating decreasing trajectories in bar patronage over time). There was also large variability in both the intercept and slope factors, as well as a negative correlation between the two factors. Thus, as with heavy alcohol use, the entire sample was characterized by decreasing trajectories in bar patronage over time, and there was large variability in the individual trajectories over time.

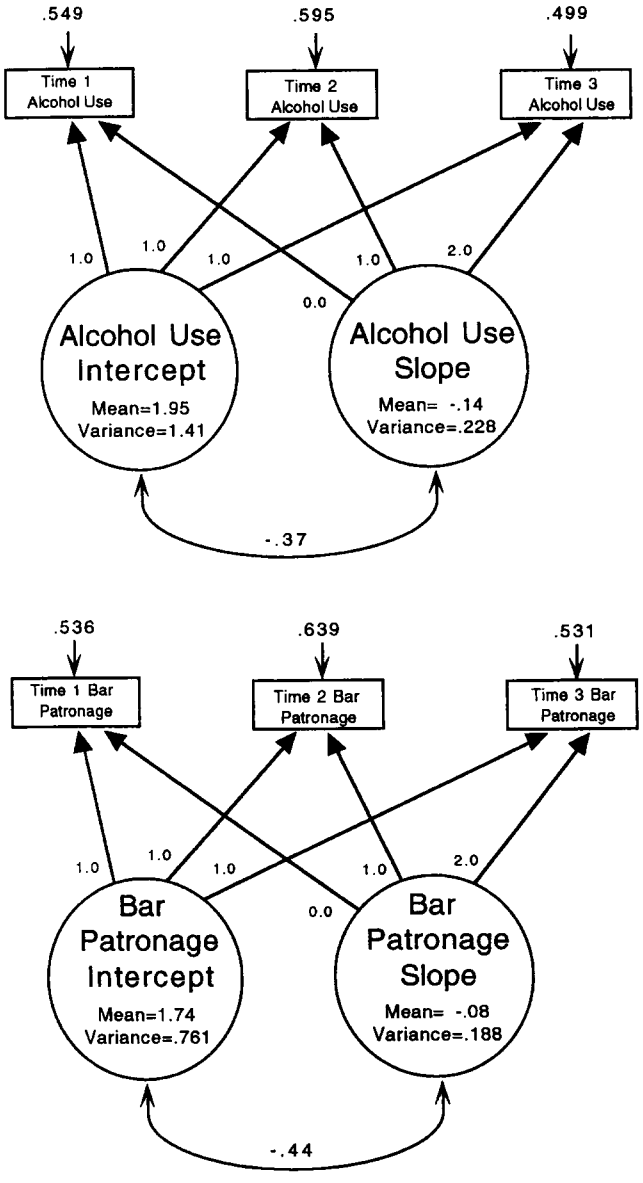


FIGURE 1. Two-factor latent growth models for heavy alcohol use and bar patronage. Note: alcohol use model ($N$ = 3,071, $\chi^2$ = 3.63,1 df, $p$ = .06), bar patronage model ($N$ = 3,071, $\chi^2$ = 1.68,1 df, $p$ = .19), repeated measure residuals and factor correlation are standardized; all factor loadings were set to predetermined values and thus not estimated; all parameters are significant at at least $p < .01$.

*Combined LG models*

The next step was to examine the interrelations between the heavy alcohol use and bar patronage growth models. The two individual LG models described above were thus estimated simultaneously (see Figure 2). This single model was then built upon hierarchically such that sets of parameters were introduced, and nested chi-square tests were used to determine the relative improvement in model fit due to the added parameters.

*Simultaneous growth models.* The first step was to estimate a model in which no additional parameters were estimated than those that were described for the individual growth models. As expected, this baseline model fit the observed data very poorly ($N$ = 3,071, $\chi^2$ = 1,867.68,11 df, $p < .000$). Correlations between the two intercept factors and the two slope factors were then added to the model. Both of these correlations were large and positive, and resulted in a significant improvement in model fit. The positive correlation between the intercept factors indicates that subjects

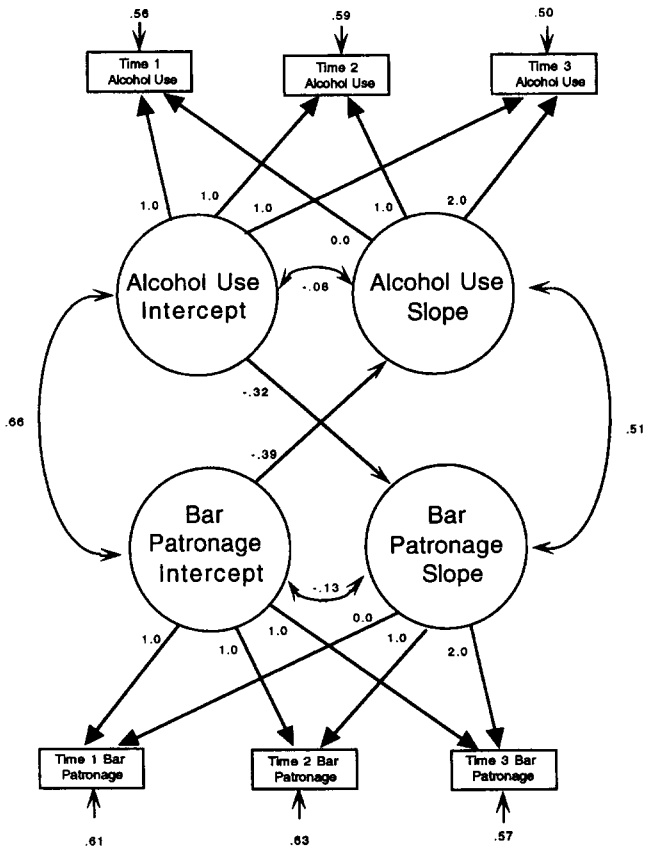


FIGURE 2. Final LG model of heavy alcohol use and bar patronage. Note: final model ($N$ = 3,071, $\chi^2$ = 16.1,16 df, $p$ = .45); all values are standardized; all parameters are significant at at least $p < .05$; all factor loadings are set to predetermined values; see Table 2 for regression parameters for six exogenous variables that are included in this model.

reporting higher levels of Time 1 heavy alcohol use tended to report higher levels of Time 1 bar patronage. Similarly, the positive correlation between the slope factors indicates that an individual's growth trajectory on heavy alcohol use was very similar to that same individual's growth trajectory on bar patronage. Thus, changes in heavy alcohol use were strongly correlated with changes in bar patronage.

Next, the residuals of the repeated measures were correlated within all three time periods between the two constructs (e.g., Time 1 heavy alcohol use residual with Time 1 bar patronage residual, etc.). These correlations represent shared variability within time period, but do not impose any contemporaneous casual structure. The addition of these three correlations also resulted in a significant improvement in model fit. Structural parameters were then estimated such that the intercept factor of heavy alcohol use predicted the slope factor of bar patronage, and the intercept factor of bar patronage predicted the slope factor of heavy alcohol use. Both of these regression parameters were large and negative in sign, and resulted in a significant improvement in model fit.

These regression parameters indicate that the initial level of heavy alcohol use inversely predicted subsequent changes in bar patronage, and the initial level of bar patronage inversely predicted subsequent changes in heavy alcohol use. Examination of the univariate means revealed that those starting low on the two constructs at Time 1 tended to increase over time, and those starting high at Time 1 tended to decrease over time (see Figure 3). Note that these negative relations also capture some element of a "floor effect." That is, subjects who reported higher levels of use at Time 1 had greater opportunity to decrease over time compared to those who reported lower initial levels of use. A key strength of LG modeling is the ability to capture and model both increasing and decreasing growth trajectories.

*Final model.* This final model fit the observed data quite well ($N$ = 3,071, $\chi^2$ = 4.38,4 df, $p$ = .36) and is presented in Figure 2. The two significant regression parameters between the growth factors indicate that the level at which an individual subject begins at Time 1 on one construct was inversely predictive of where that same subject will go over the three time periods on the second construct. Thus, lower bar patronage at Time 1 was predictive of increases in later heavy alcohol use whereas higher bar patronage at Time 1 was predictive of decreases in later heavy alcohol use. Similarly, lower heavy alcohol use at Time 1 was predictive of increases in later bar patronage whereas higher alcohol use at Time 1 was predictive of decreases in later bar patronage. Although a formal statistical test of the equality of the regression parameters is not possible, examination of the standardized coefficients suggests that the effect from bar patronage to alcohol use is somewhat stronger than the effect from alcohol use to bar patronage. Finally, the correlation between the two slope factors remained positive and significant even after the inclusion of the two regression parameters. This suggests that the relation between changes over time in heavy alcohol use and bar patronage can be further explained by other factors not included in the current model.

*Regressing the full LG model on six exogenous predictors*

The previous analyses served to better understand the shape and variability of growth within heavy alcohol use and bar patronage, and how initial status and growth in these two constructs related to one another over time. An added advantage of LG analysis is the ability to also model growth in constructs over time as a function of exogenous grouping variables. We were interested in how changes in heavy alcohol use and bar patronage related to several demographic measures. Thus, the final combined LG model depicted in Figure 3 was regressed upon six exogenous variables: age,

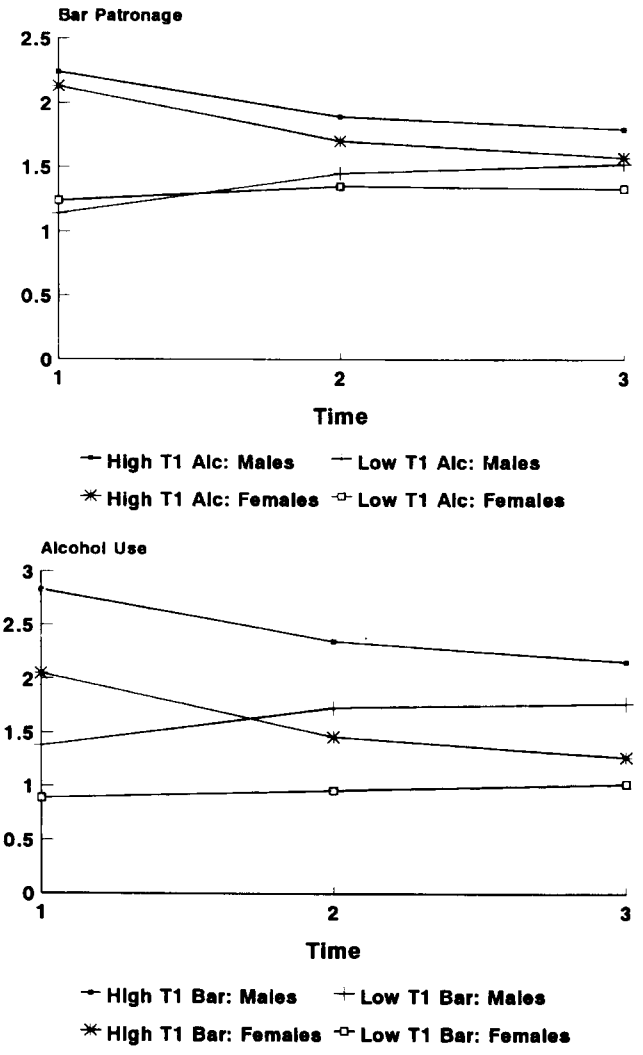


FIGURE 3. Univariate means of heavy alcohol use and bar patronage over time as a function of initial status and gender. Note: Alc = heavy alcohol use; Bar = bar patronage; T1 = Time 1; high and low groups were formed based on a median split of heavy alcohol use and bar patronage at Time 1.

gender, Hispanic (vs Caucasian), black (vs Caucasian), single for all three waves (vs non-single for any wave) and divorced any time during the three waves (vs not divorced anytime during the three waves).

The four latent growth factors were thus regressed on all six exogenous variables, and this model was found to fit the observed data quite well ($N$ = 3,071, $\chi^2$ = 16.1,16 df, $p$ = .45). Given the complexity of the model, a full figure is not provided. Instead, the regression parameters and $z$-ratios associated with the exogenous variables are presented in Table 2. Gender was significantly related to all four latent factors. The positive effects of gender on the two intercept factors indicates that males reported higher Time 1 levels of both heavy alcohol use and bar patronage. The positive effects of gender on the two slope factors indicates that males reported *more gradual* declines in heavy alcohol use and bar patronage over time. Age was only marginally related to bar slope ($p < .10$) such that older subjects reported slightly steeper decreases in bar patronage over time.

Compared to Caucasians, Hispanics reported lower Time 1 levels of bar patronage. Also compared to Caucasians, blacks reported lower levels of both Time 1 heavy alcohol use and bar patronage. Neither ethnic group was associated with differential changes in these constructs over time. Subjects who were single for all three time periods reported higher Time 1 heavy alcohol use, higher Time 1 bar patronage, and more gradual declines in heavy alcohol use and bar patronage over time (the bar patronage effect was only marginally significant, $p < .10$). Finally, subjects who were divorced during any of the three time periods reported lower Time 1 bar patronage and more gradual decreases in heavy alcohol use over time.

### *Multiple group analysis as a function of gender*

Although the main effect of gender was strongly related to all four growth factors, this does not provide insight into the possible interaction between gender and changes in alcohol use and bar patronage over time (Baron and Kenny, 1986). To test for this interaction effect, the original growth models depicted in Figure 1 were re-estimated using a multiple group framework with the groups defined by gender. Two growth models were estimated: one for heavy alcohol use and one for bar patronage.

*Heavy alcohol use.* The two factor, three indicator growth model presented in Figure 1 was estimated using the multiple group feature of LISCOMP. A baseline model was defined such that the model parameters were freely estimated *within* gender. Increasingly restrictive equality constraints were then imposed *across* gender, and chi-square difference tests were computed relative to the baseline model. The baseline model fit the observed data well ($N$ = 3,071, $\chi^2$ = 6.5,2 df, $p$ = .04). Nested chi-square tests indicated that neither the residuals of the repeated measures nor the factor variances were equal across gender. Males were characterized by significantly greater variability compared to females. An equality constraint imposed on the third factor loading was retained, indicating that the negative growth in alcohol use was of the same functional form for both males and females. An equality constraint imposed upon the mean of the intercept factor was rejected, indicating that males reported significantly higher initial levels of alcohol use compared to females. Finally, an equality constraint imposed on the mean of the slope factor was retained, indicating that males and females decreased in alcohol use at equal rates over time.

*Bar patronage.* The baseline multiple group model for bar patronage fit the observed data very well ($N$ = 3,071, $\chi^2$ = 1.7,2 df, $p$ = .43). Nested chi-square tests indicated that the residuals of the repeated measures were equal across gender, but that males were characterized by greater latent factor variability. As with heavy alcohol use, the functional form and rate of growth were equal across gender, but males were characterized by higher initial status.

In sum, both the shape of growth and rate of change over time in heavy alcohol use and bar patronage were equal across males and females although there were significant differences with regard to measures of variability and initial status.

### *Auto-regressive cross-lagged panel design*

Many readers may be more familiar with an analysis of this type of longitudinal data using an auto-regressive cross-

TABLE 2. Standardized regression parameters and $z$-ratios for six exogenous variables predicting latent intercept and slope factors

| Predictor variable | Alcohol use intercept | Alcohol use slope | Bar patronage intercept | Bar patronage slope |
|---|---|---|---|---|
| Gender | *.32 (12.31)* | *.13 (3.19)* | *.12 (4.25)* | *.16 (3.69)* |
| Age | −.03 (−1.05) | −.06 (−1.43) | −.01 (−0.04) | −.06 (−1.67) |
| Hispanic | −.04 (−1.38) | .01 (0.09) | *−.14 (−5.21)* | .03 (0.77) |
| Black | *−.14 (−5.21)* | .01 (0.01) | *−.23 (−8.11)* | −.01 (−0.23) |
| Single | *.06 (2.26)* | *.09 (2.08)* | *.16 (−.40)* | .08 (1.85) |
| Divorced | −.04 (−1.45) | *.13 (3.22)* | *−.08 (−2.93)* | .05 (1.32) |

*Notes:* First number is standardized regression coefficient, number in parenthesis is the ratio of the parameter estimate to standard error. Ratios exceeding 2.0 are in italic and reflect $p$ <.05.

lagged panel (AR) model (Dwyer, 1983). For comparative purposes, a repeated measures AR model was estimated using this same data (see Figure 4). Precisely the same subjects and measures were used for the AR model as were used in the LG model. The key difference was that the latent growth factors were not estimated, and instead change in the construct over time was modeled using the stability coefficients between time adjacent measures of heavy alcohol use and bar patronage. For example, Time 1 alcohol use predicted Time 2 alcohol use, and Time 2 alcohol use in turn predicted Time 3 alcohol use.

Like the LG model, the AR model was first estimated without the inclusion of the six exogenous variables. The initial model contained only time adjacent stabilities within construct as well as within time correlated disturbances. This model fit the data very poorly ($N$ = 3,071, $\chi^2$ = 220.7,8 df, $p$ = .000). Next, the prospective cross-lagged paths were added in which the variable of one construct was regressed upon the previous measure of the other construct (e.g., Time 1 alcohol use predicted Time 2 bar patronage). These four parameters led to a significant improvement in model fit. Finally, second-order derivatives (similar to modification indices or Lagrange multipliers) indicated the need to include paths predicting the Time 3 measure of the two constructs from the Time 1 measure of the same construct (e.g., Time 1 alcohol use predicted Time 3 alcohol use). This final model fit the observed data very well ($N$ = 3,071, $\chi^2$ = 3.48,2 df, $p$ = .18).

Both bar patronage and heavy alcohol use showed strong positive stabilities within construct over time. Whereas the LG analysis explicitly modeled the negative group growth trajectories over time, the positive relation in the AR model provides a more limited indication that subjects who were above the mean on alcohol use at Time 1 tended to be above the mean on alcohol use at Time 2, despite the overall negative trajectory of alcohol use and bar patronage over time. This is a salient example highlighting the inadequacy of studying growth over time without consideration of the corresponding mean structure. Next, there were positive prospective predictions of Time 2 heavy alcohol use from Time 1 bar patronage, and vice versa. However, there were no prospective predictions of either construct at Time 3 from the Time 2 measures. Thus, the AR model suggests that subjects using more alcohol at Time 1 tended to frequent bars at a higher rate at Time 2, and subjects who frequented more bars at Time 1 tended to drink more heavily at Time 2, but this prospective prediction did not hold for Time 2 to Time 3. In contrast, the LG model revealed a more complex *inverse* relation between initial status and continuous change over all three time periods, and not more limited "snapshot" views between just Time 1 and Time 2, or between just Time 2 and Time 3.

## Discussion

Random effects latent growth (LG) models were used to examine changes in heavy alcohol use and bar patronage over time, and to study the interrelations between these two constructs and several important demographic variables. Consistent with previous studies of this young adult age group (Johnston et al., 1991), both heavy alcohol use and bar patronage were characterized by downward growth trajecto-

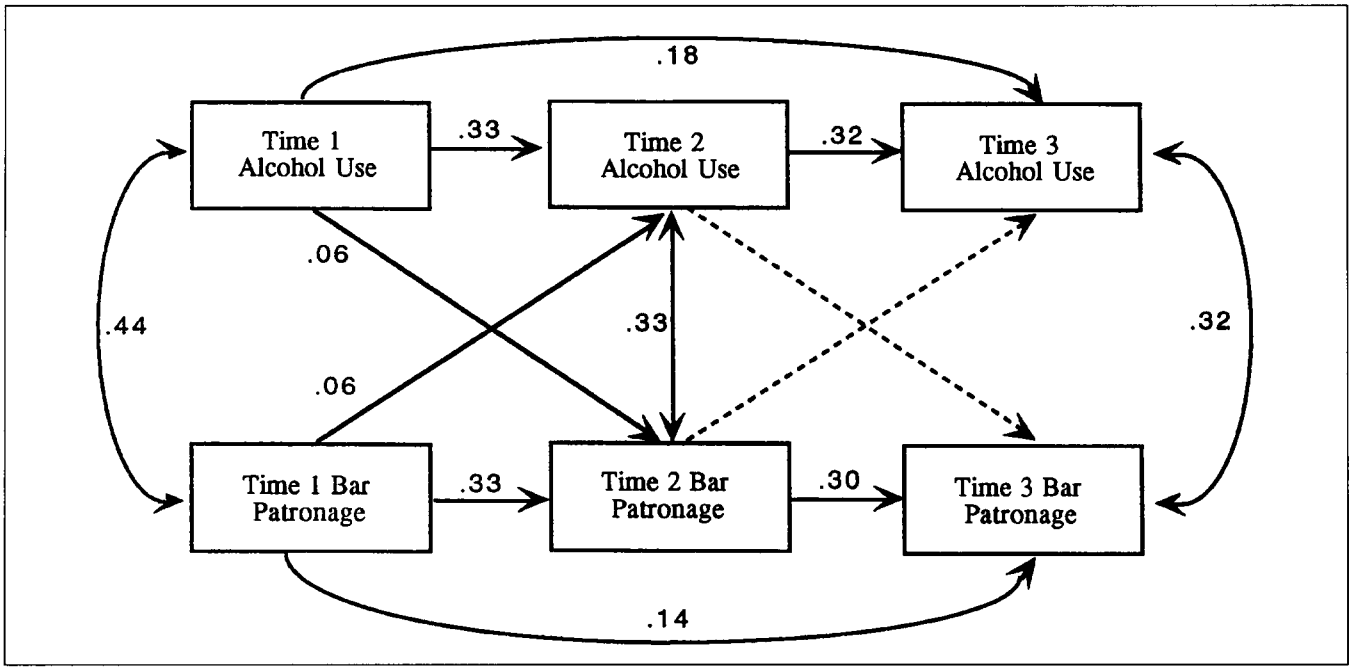


FIGURE 4. Final auto-regressive model of heavy alcohol use and bar patronage. Note: final model ($N$ = 3,071, $\chi^2$ = 3.48,2 df, $p$ = .18); all values are standardized; all parameters are significant at at least $p < .05$; dashed lines were estimated but not significantly different from zero.

ries over time. This supports the notion that problem drinking often peaks in the early 20s, and then decreases over time (Fillmore, 1987). The inclusion of the demographic variables indicated that there were also important subgroup differences in these changes over time. For example, although males reported higher levels of both Time 1 heavy alcohol use and bar patronage, they also reported *smaller* decreases in these constructs over time. Whereas females reporting a higher initial status on heavy alcohol use and bar patronage showed steeper subsequent decreases in these constructs over time, males who reported higher initial levels tended to continue drinking and frequenting bars at an elevated rate. Thus, although the overall group was characterized by decreasing levels of heavy alcohol use and bar patronage, there were important subgroup differences in these behaviors as well.

The latent intercept and slope factors for heavy alcohol use and bar patronage were highly positively correlated. Subjects with a higher score on the heavy alcohol use intercept were strongly associated with a higher score on the bar patronage intercept, and an individual's growth trajectory on heavy alcohol use was very similar to their corresponding growth trajectory on bar patronage. A significant inverse prospective relation was found between the initial status on one construct and the slope of the second construct. This relation reflects two effects. First, higher scores on the intercept factor of one construct were predictive of subsequent decreases over time on the second construct, while lower scores on the intercept factor of one construct were predictive of subsequent increases over time on the second construct. Second, subjects reporting higher scores at Time 1 had more opportunity to decrease over time compared to those who reported lower scores. Thus, although subjects who reported higher alcohol use at Time 1 tended to decrease at a faster rate, most of these subjects were still drinking at higher levels at the final measurement period compared to those who reported lower levels of initial use.

Finally, the relation between Time 1 bar patronage and changes in heavy alcohol use appeared to be stronger compared to the relation between Time 1 heavy alcohol use and changes in bar patronage. This finding is consistent with Skog's (1980) social interaction theory which posits that changes in individual drinking levels are closely linked to collective social forces. Thus, public drinking establishments may not only be settings that are associated with higher levels of heavy drinking and alcohol-related problems, but may also serve to perpetuate heavy drinking behavior over time. Although our findings are based on observational data which restricts the strength of the causal inferences that can be drawn, the results do suggest that interventions targeted at limiting bar patronage may lead to later decreases in heavy alcohol use, especially for males and singles.

*Comparison of LG and AR models*

For comparative purposes, a more traditional autoregressive cross-lagged (AR) panel model was estimated on the very same data. There were several key differences in the inferences and assumptions made by this AR model in comparison to the LG model. First, the AR model revealed strong positive prospective predictions within both bar patronage and heavy alcohol use (e.g., Time 1 alcohol use positively predicted Time 2 alcohol use, etc.). This is a rather limited statement indicating that subjects who reported higher alcohol use at Time 1 tended to report higher alcohol use at Time 2, and this obscures the overall *decreasing* group trajectories of both of these constructs over time. Whereas this general downward trajectory is not identified in any of the AR analyses, the LG analysis explicitly models this negative growth over time.

Next, the AR model supported positive prospective prediction across alcohol use and bar patronage from Time 1 to Time 2 (e.g., Time 1 alcohol use predicted Time 2 bar patronage, and vice versa), but this relation was *not* found from Time 2 to Time 3. This finding highlights yet another limitation of the AR design. In an AR framework, change in a construct at one time point is independent of change in the construct at an earlier time point (McArdle and Epstein, 1987). In this case, the prediction of Time 3 bar patronage from Time 2 alcohol use is independent of changes in either bar patronage or alcohol use at Time 2. In contrast, the LG model treats change as a unitary continuous process over time, not as a series of stepwise predictions (as in the AR model). Thus, a single growth curve is estimated across all time points, and individual variability about this curve is examined as a function of other explanatory variables. We believe this conceptualization is a much more realistic portrayal of the overall growth of these constructs over time.

In sum, we feel there are several key advantages to using an LG approach to modeling growth over time. An LG modeling framework allows: (1) simultaneous examination of both intra- and inter-individual differences in growth over time; (2) treatment of growth as a single continuous process; (3) concurrent estimation of complex heterogenous growth curves; (4) incorporation of multiple indicators on error-free latent factors allowing examination of "true" change over time (e.g., Willett and Sayer, 1994); and, finally, (5) estimation of most types of LG models using currently available structural modeling software. We feel LG models are particularly promising in the study of the prediction and correlates of change in alcohol use over time.

*Study limitations and directions for future research*

As with any study, there are several limitations that should be considered prior to the generalization of the findings. First, as stated earlier, these data are purely observational, and great care is warranted when inferring true causal relations between alcohol use and bar patronage. Second, single item self-report measures were used for both alcohol use and bar patronage, and more objective and multiple measures of these constructs might reveal differential findings. Third, the inclusion of just three time points limits the functional forms of growth that can

be studied. Additional time points would allow consideration of more complex forms of growth as well as increased power to detect effects (Muthén and Curran, 1994). Finally, given the model complexity, many other likely determinants of heavy alcohol use and bar patronage were omitted from the model (e.g., coping, stress, personality, family history, etc.). It would be of great interest to explore potential mediators of the bi-directional prospective effects of heavy alcohol use and bar patronage, particularly with regard to likely points for optimal intervention and prevention.

## Note

1. All of the growth models were also estimated using the full sample ($N$ = 6,104) that included both abstainers and nonabstainers. Although inclusion of the abstainers decreased the average levels of heavy alcohol use and bar patronage, no differences were detected in either the patterns of growth or in the prediction of initial status or change over time. Thus, although we chose to present the models based only on the nonabstainers, no interpretive changes arise when including both abstainers and nonabstainers.

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