Transitioning Into and Out of Problem Drinking Across Seven Years*

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ABSTRACT. Objective: The extent to which problem drinkers transition into and out of problem drinking was examined using Markov modeling. **Method:** Study participants ($N = 1,350$) were randomly sampled from one county's general population and from consecutive admissions to public and private alcohol treatment programs in the same county, and they were assessed at 1-, 3-, 5-, and 7-year follow-ups. At baseline, all met the criteria for problem drinking. Individuals were classified as "problem drinkers" if they reported at least two of three criteria (heavy episodic drinking, social consequences, dependence symptoms according to the Diagnostic and Statistical Manual of Mental Disorders, Fourth

Edition) during the prior 12 months. **Results:** Although all possible patterns were observed, a latent Markov model with heterogeneous transitions and five patterns fit the data. The sampling frame and baseline alcohol severity related to pattern. **Conclusions:** The data indicate that, although they do change over time, problem drinkers on the whole are more likely either to remain problem drinkers or to cease to be problem drinkers than they are to move into and out of problem-drinking status. Once they transition out of problem drinking, they are more likely to remain nonproblem drinkers. (*J. Stud. Alcohol Drugs*, 71, 210-218, 2010)

ONE OF THE UNRESOLVED QUESTIONS in alcohol-related research is that of behavioral stability among adult drinkers. To what extent will they alter their drinking? What is the probability someone will change his or her drinking behavior, and what factors influence this probability? Does this probability change over time? These questions have clinical significance because relapse is common and affects the efficacy and cost of treatment. Positive change is the goal of treatment, and community interventions are difficult to accomplish. If we understood how often and how likely changes in drinking behavior occur, and what factors influence these changes, more targeted and effective interventions could be developed, and family members of problem drinkers would have a better idea of what to expect. Demonstrating that individuals effectively move out of problem drinking may help reduce the stigma associated with alcohol problems and encourage problem drinkers to seek help. This study addressed one aspect of the stability of problem drinking by estimating the probability that a problem drinker from a representative sample would

transition into and out of problem drinking, and whether that probability of change varies over 7 years.

Stability in problem drinking using a trajectories-based approach

Improvements in longitudinal methods have made possible understanding changes in drinking behaviors and outcomes. A key finding from this research is that alcohol consumption is not necessarily a stable behavior, especially among heavy drinkers (Kaskutas et al., 1997; Doll et al., 1994; Schuckit et al., 1997; Sesso et al., 2000; Skog and Duckert, 1993; Walton et al., 2000). Witkiewitz and Marlatt (2004) refer to relapse as a dynamic process in which drinkers move between drinking and nondrinking states. However, others suggest that there is the question of the degree of stability in drinking status. Using pooled data from three studies to assess stability, Kerr et al. (2002) found that heavy drinkers displayed far less stability than both moderate drinkers and those who abstained.

This question of stability in drinking has also been raised in research on "natural recovery." As many as 75% of problem drinkers remit without formal treatment (Sobell et al., 1996), but it is not known how stable that remission is. In a follow-up of 167 "natural remitters," Bischof et al. (2007) observed few individuals displaying what they termed "unstable natural remission." In a fairly recent review, Rumpf et al. (2007) concluded that untreated remission from alcohol dependency tends to be quite stable. However, the probabil-

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ity that a particular individual will change was not directly studied.

Trajectory versus transition

Although prior studies have focused on changes in drinking behavior in samples or subsamples, they have not considered an *individual's* likelihood of change, which can lead to a misinterpretation of behavior. For example, if 20% of a sample are heavy episodic drinkers at one assessment and 10% at a following assessment, a declining trajectory would describe the data. However, one would not know whether all 20% had stopped heavy episodic drinking and a different 10% started, or whether half of the 20% had stopped heavy episodic drinking. This information is not available, even from the more statistically sophisticated and innovative methods now being used, such as latent growth curve models.

To address this shortcoming, a few studies have focused less on identifying the clusters of common drinking pathways over time and have focused more on the transitions themselves. Wells et al. (2006) used logistic regression and transition matrices to characterize transitions into and out of abuse or dependence (based on Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition [DSM-IV], criteria; American Psychiatric Association, 2000). Although the classifications of no abuse or dependence were the most stable in this study of young adults initially assessed at ages 18-21, the investigators found noticeable changes into and out of abuse and dependence diagnoses. Jackson et al. (2001), also looking at just young adults, examined the changes into and out of "large-effect drinking," subjectively defined as drinking to achieve a psychological effect, such as feeling drunk. Both gender and family history were related to the probability of changing out of "heavy effect" drinking. Finally, Jackson et al. (2006), using only two time points, noted high rates of stability in the diagnosis of alcohol DSM-IV dependence from young to middle adulthood. In contrast, Guo et al. (2000) observed less stability and differing patterns of change in children who were followed to age 21.

Markov modeling

The probability of a person transitioning into and out of a category (e.g., abstinent vs. not) can be estimated and interpreted with Markov modeling. Competing models, defined by the assumptions made regarding the observed responses, are successively fit to the data. For example, models are based on whether the state being modeled is observed or latent and whether the transition patterns are observed or latent (Langeheine and van de Pol, 2002). Markov models assume the current state is all that is needed to predict the future, and the models differ in their assumptions regard-

ing the latent nature of the measure and pattern. Transition probabilities can be homogeneous between time points or heterogeneous (i.e., differing). The ultimate goal is to find a model that best fits the observed data without overfitting (see Kaplan, 2008, for a recent review).

We used latent transition analysis (Graham et al., 1991), a flexible form of Markov modeling wherein both measurement and transitions are latent. A few alcohol-related studies have applied latent transition analysis to their data (Guo et al., 2000; Jackson et al., 2001; Lynch et al., 2008; Mitchell et al., 2008). They have also been applied in settings outside of alcohol research (e.g., cigarette smoking) (Hughes et al., 2005; Martin et al., 1996; Schumann et al., 2006; Velicer et al., 1996).

Study goals

To better understand this open question of problem-drinking stability, transitioning into and out of problem drinking was modeled via Markov modeling in a cohort of problem drinker adults interviewed over the course of 7 years. We addressed three questions: (a) Do the respondents change problem-drinking status over time? (b) How likely are such transitions? (c) Is the probability of change the same from assessment to assessment, and are particular characteristics of the drinker related to change?

Method

Participants

The sample has served as the basis for several longitudinal studies, including Alcoholics Anonymous (Bond et al., 2003; Humphreys et al., 1998; Kaskutas et al., 2003, 2004, 2005), cost and insurance (Alexandre et al., 2006; Schmidt and Weisner, 2005), and treatment (Polcin and Weisner, 1999; Room et al., 2004; Weisner and Matzger, 2002, 2003; Weisner et al., 2003). This work, in particular, expands on two studies of drinking behavior itself (Delucchi et al., 2004, 2008), which examined trajectories of change but not transitions. Sampling and data collection methods are summarized here; more details are found in Weisner and Matzger (2002) and in Weisner et al. (2002).

Data collection procedure

In-person interviews of a randomly selected general population sample of untreated problem drinkers (general population sample) and all individuals entering the county's public and private chemical dependency programs (treatment sample) were conducted in 1995 and 1996. Follow-up interviews, conducted 1, 3, 5, and 7 years after baseline, used computer-assisted telephone interviewing. Baseline respondents were tracked every 3 months using postcard mail-

ings and telephone check-ins. Respondents not reached by telephone using standard follow-up protocols were referred to a fieldwork agency for further searching.

The general population sample of problem drinkers ($n = 672$) was assembled by telephone screening interviews using random digit dialing methods and computer-assisted telephone interviewing, with a probability sample of 13,394 individuals ages 18 and older. Those who met problem-drinking or dependence criteria (see *Measures* section) and had not received alcohol or drug treatment during the previous 12 months were recruited for an in-person baseline interview. Informed consent was obtained from all participants. The response rate was 70%, and follow-up rates from baseline by telephone assessment were 93%, 91%, 88%, and 86% for the 1-, 3-, 5-, and 7-year follow-ups, respectively.

The treatment sample ($n = 926$) included consecutive admissions in the 10 public and private programs that met the following criteria (Kaskutas et al., 1997): (a) they had at least one new intake per week, (b) drugs other than alcohol were not the primary focus (e.g., methadone maintenance programs were not included), and (c) they offered first-line treatment entry (i.e., aftercare programs were excluded). Data collection for the treatment sample was conducted by trained interviewers independent of the agencies. To avoid a potential treatment effect from measuring research subjects' perceptions of their problems, structured in-person interviews were conducted before the end of their third day of residential treatment or third outpatient visit. Informed consent was obtained, and participation was independent of receiving agency services. The overall response rate for individuals in all programs was 80% (Kaskutas et al., 1997).

To adjust the baseline treatment sample to represent its proportionate size and case mix among new intakes, weights were created that accounted for differences in the length of the interviewing period in each agency (to equally represent across agencies the number of individuals who would have entered during a given time period) and sampling fraction within agencies. Weights were also adjusted for program, sex, and ethnicity. They ranged from 0.41 (for White women in one private program) to 2.84 (for White men in one public detoxification program) (Kaskutas et al., 1997; Tam, 1997). The analysis reported here incorporated those sampling weights in the estimation procedure. The response rate was 80%, and follow-up rates were 78%, 75%, 72%, and 67% for the 1-, 3-, 5-, and 7-year follow-ups, respectively.

Measures

Demographic characteristics. Descriptive measures at baseline included age, ethnicity, income, gender, and marital status. Alcohol severity was represented by the Alcohol Severity Composite from the Addiction Severity Index instrument, which ranges from 0, indicating no alcohol-related problems, to 1.0 (McLellan et al., 1980).

Problem drinking. Individuals were classified as "problem drinkers" if they reported at least two of the following three criteria during the previous 12 months: (a) drinking five or more drinks in a day at least once a month for men (three or more drinks in a day weekly for women), (b) having one or more alcohol-related social consequences (from a list of eight), and (c) possessing one or more alcohol dependence symptoms (from a list of nine). This measure is consistent with the predominant alcohol epidemiology approach, and similar measures have been used in a wide variety of published studies (Institute of Medicine, 1990; Schmidt et al., 1998; Weisner, 1990; Weisner and Schmidt, 1992; Wilsnack et al., 1991). The measure of alcohol-related social consequences covers a range of ways that individuals with alcohol problems come to the attention of others in the community (Hilton, 1987; Weisner, 1990; Weisner and Schmidt, 1992; Weisner et al., 1995), including drinking-driving arrests, public drunkenness arrests, other alcohol-related criminal arrests, traffic accidents when drinking, nontraffic alcohol-related accidents, confrontations about an alcohol-related health problem by a medical practitioner, serious alcohol-related family problems caused by respondents' drinking, or confrontations about an alcohol-related job problem in the workplace. Alcohol dependence items included the nine criteria from the DSM-IV, Text Revision, used in clinical and general population research (American Psychiatric Association, 2000; Caetano and Weisner, 1995; Weisner et al., 2001). The intent in using this measure is not to represent a construct but rather to indicate drinking and related problems that signal a person being at risk or having a problem (i.e., the kind of things that often get people into trouble).

Covariates. It is not known if factors that have been found to be related to drinking behaviors are also related to the probability of an individual changing problem-drinking status. This form of analysis, however, generally cannot handle many covariates; therefore, a judicious selection, both to control for and to test for effect, was required. Two factors found to be associated with change in drinking in prior studies were included here: (a) family history of alcohol problems (Chassin et al., 2004; D'Amico et al., 2005; Jackson and Sher, 2006; Jackson et al., 2001; Walden et al., 2007; Warner et al., 2007) and (b) gender (Costanzo et al., 2007; Jackson et al., 2001, 2006; Needham, 2007). The family history risk indicator was constructed as a binary marker, which was set to 1 if the respondent indicated that at least one of his or her parents or grandparents had a problem with alcohol and otherwise was set to 0. A third measure related to drinking behavior, having attended Alcoholics Anonymous in the previous year, was also included (Kaskutas et al., 2009).

For methodological reasons, three potentially confounding covariates were also included and tested for effect: (a) alcohol severity at baseline, as measured by the Addiction Severity Index severity composite; (b) the sampling frame

of the participant, general population or treatment; and (c) age, because drinking tends to decline with age (Eigenbrodt et al., 2001; Karlamangla et al., 2006; Moore et al., 2005; Moos et al., 2004). In the preliminary analysis, models that included age as a continuous covariate did not converge; therefore, age was collapsed into a three-category measure: (a) <30, (b) 30-50, and (c) >50.

Data analysis

Because all participants were problem drinkers at baseline, transitions were modeled from the first postbaseline assessment onwards yielding 1,350 respondents, with at least one postbaseline assessment, for analysis. All were included in parameter estimation, regardless of the number of postbaseline assessments. Standard summary statistics were used to describe the full sample, and four Markov models of increasing complexity were fit to the data. The first, a basic model that does not make assumptions of latent parameters, would provide the simplest model of the data if it fit the best. Next, the conflicting findings of stability and lack of stability in the literature led us to fit a so-called Mover-Stayer model. This Markov model assumes that two probability chains exist: (a) one allowing for change in problem-drinking status over time and (b) one not (i.e., zero probability of change). The third model was a latent Markov model. To test for a more flexible version of the Mover-Stayer model, a model was fit, also with two probability chains but where the probabilities are nonzero for both chains. Finally, each model was estimated twice: (a) once assuming homogeneous transition probabilities and (b) once assuming heterogeneous transitions. That is, the probability of a given transition is the same

from 1 year to the next or varying over time. The final result was a set of eight models.

The models were tested for overall fit using the likelihood ratio chi-square test and the Bayesian Information Criteria. Although not a measure of fit, the entropy index, which summarizes the orderliness of the result, was also recorded. After the most parsimonious model was identified, a second model that included the four covariates described previously was estimated. Sampling weights were used in all analyses; SAS Version 9.2 (SAS Institute Inc., Cary, NC) was used for descriptive statistics and data manipulation, and all models were fit using Mplus Version 5.1 (Muthén and Muthén, Los Angeles, CA).

Results

Ages ranged from 18 to 86, with a mean age of 37; participants reported an average of about four drinks per day in the year before baseline (1,472.6 drinks per year; Table 1). More than 60% were White, more than 60% were male, and only 35.5% had more than a high school education; 42% came from the general population sample.

In all models estimated, there was no relationship between problem-drinking status at each assessment and whether a person was assessed at Year 7 (vs. lost to follow-up). However, there were several baseline measures related to attrition. In general, those who were present at the final assessment were more likely to be younger, to be female, to drink less, and to engage in heavy episodic drinking less often at baseline than those not assessed at Year 7. They did not differ on their age at first alcohol use, their ethnicity, their income, or whether there were relatives who had alcohol-related prob-

TABLE 1. Demographic measures of respondents at baseline assessment

Variable	General population (<i>n</i> = 672) %	Treatment (<i>n</i> = 926) %	Total sample (<i>N</i> = 1,598) %
Ethnicity			
White	71.3	58.0	63.6
Black	8.1	27.3	19.3
Hispanic	12.9	6.5	9.1
Other	7.8	8.1	8.0
Education			
<High school	13.5	19.8	16.7
High school graduate	42.5	51.4	42.8
>High school	44.0	28.9	35.5
Income < \$25,000	31.3	52.2	43.4
Male, %	61.1	60.9	61.0
Never married	29.3	39.7	33.7
	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>
Age of respondent	34.8 (12.64)	38.7 (11.09)	37.0 (11.92)
<i>N</i> drinks, yearly	1,107.7 (1,226.9)	1,738.8 (1,848.57)	1,472.6 (1,645.12)
Per year ≥5 men, ≥3 women	108.5 (143.4)	171.6 (185.53)	145.0 (171.85)
Age at regular use	24.0 (8.52)	24.4 (10.66)	24.4 (9.81)
ASI alcohol severity	.20 (.15)	.37 (.32)	.29 (.28)

Note: ASI = Addiction Severity Index.

TABLE 2A. Observed percentages of nondrinkers and problem drinkers

Variable	Year 1	Year 3	Year 5	Year 7
Not PD, %	51.8	55.9	59.3	62.3
PD, %	48.2	44.1	40.7	37.7
Total <i>N</i>	350	360	261	197

Note: PD = problem drinking.

TABLE 2B. Transition percentages from assessment at Year *i* to Year *i* + 1, sample sizes, McNemar test *p* values and kappa coefficients

			McNemar			
	Year 3		<i>n</i>	<i>p</i>	κ	[95% CI]
Year 1	Not	PD				
	Not PD	73.9	647	.013	.38	[.33, .43]
	PD	36.0	605			
Year 3	Year 5					
	Not	PD				
	Not PD	78.6	691	.054	.45	[.40, .50]
	PD	34.3	533			
Year 5	Year 7					
	Not	PD				
	Not PD	81.9	687	.018	.48	[.43, .54]
	PD	34.1	481			

Note: PD = problem drinker.

lems. However, more severe respondents tended to drop out earlier.

The percentage of problem drinkers by assessment is displayed in Table 2a. By Year 1, the percentage of respondents no longer meeting the criteria for problem drinking was 51.8%, rising to 62.3% by Year 7. Table 2b displays the percentages of the transitions from Time *i* to Time *i* + 1 and indicates clearly that some of the respondents were moving into and out of problem-drinking status from assessment to assessment. For example, 26.1% of those not problem drinkers at Year 1 had become problem drinkers at Year 3, whereas 36% of the Year 1 problem drinkers were no longer in that category. The *p* values for McNemar's test on each of those 2 × 2 tables indicate significant change from one assessment to the next, although the Year 3-to-5 transition did not quite reach the .05 cutoff (*p* = .054). The associated κ statistics

provide an index of the strength of the relationship, which increased over time from .38 to .48.

All 16 (i.e., 2⁴) possible patterns over the four assessments—such as problem drinker at Year 1 and not at Years 3, 5, and 7—were observed. The three most common patterns were (a) not a problem drinker at all four follow-up assessments (41.2%), (b) problem drinker at all assessments (31.2%), (c) and problem drinker only at Year 1 (10%). The stability of the percentage transitioning out of problem drinking at Years 3, 5, and 7 is noteworthy (34%-36%).

Table 3 summarizes the fit of the models. The latent Markov model with heterogeneous transition probabilities was the only model with a likelihood ratio *p* value greater than .05 (*p* = .2306), indicating the model fit the observed data. The Bayesian Information Criteria values did not vary a great deal, and the entropy index was similarly consistent, except for the latent Markov models in which the values for both indices were less than the other models. Given this, the latent Markov model with heterogeneous transition probabilities was selected for further examination. The five estimated latent patterns for this model are shown in Table 3, and the transition probabilities are displayed in Figure 1.

Table 4 indicates that five patterns capture the underlying structure of the observed paths. The two nonchanging paths, problem drinker or not a problem drinker at all assessments, labeled "1" and "5" in the table, were most common. Two of the remaining three patterns showed movement out of problem drinking. The transition probabilities shown in Figure 1 reflect this stability, with the greatest probabilities associated with not changing status from one assessment to the next. The probability of not changing also increased to the point where a nonproblem drinker at the Year 5 assessment had almost no chance of becoming a problem drinker by the Year 7 assessment. The transition probabilities associated with the diagonal arrows, consistent with the latent patterns, indicate one is more likely to move from problem drinker to nonproblem drinker than the opposite.

Finally, a latent Markov model with heterogeneous transition probabilities was refit to include estimates of effects of the three control and three test covariates on the probability of membership in the latent classes. The overall model *p*

TABLE 3. Summary model statistics for four Markov models under two assumptions of homogeneity of transition probabilities

Model	Homogeneous ^a	<i>L</i> ²	<i>df</i>	<i>p</i>	BIC	Entropy
Markov	Yes	125.745	12	<.0001	6,268.9	.911
	No	114.204	8	<.0001	6,286.4	.912
Mover-Stayer	Yes	40.364	10	<.0001	6,198.9	.846
	No	22.723	6	.0009	6,209.5	.849
Latent Markov	Yes	18.808	10	.0428	6,176.5	.698
	No	8.104	6	.2306	6,194.9	.714
Two chain	Yes	19.889	8	.0108	6,192.1	.853
	No	3.816	0	—	6,233.5	.908

Notes: BIC = Bayesian Information Criteria. ^a"Yes" indicates the model included homogeneous transition probabilities, and "no" indicates the model allowed for heterogeneous transition probabilities.

FIGURE 1. Estimated transition probabilities from the final latent Markov model

TABLE 4. Latent class patterns over six years with number of respondents classified to each pattern

Pattern	Year 1	Year 3	Year 5	Year 7	<i>N</i> (%)
1	—	—	—	—	593 (42%)
2	—	—	PD	PD	28 (2%)
3	PD	—	—	—	185 (13%)
4	PD	PD	—	—	77 (5%)
5	PD	PD	PD	PD	542 (38%)

Notes: PD = problem drinker; “—” indicates not problem drinker.

value was no longer greater than .05, indicating a lack of fit, and the entropy index declined to .56.

Although tests for none of the three covariates of interest reached the .05 cutoff, all three *p* values were less than .10: (a) sex (*p* = .093), (b) family history (*p* = .071), and (c) Alcoholics Anonymous attendance (*p* = .052). This suggests these relationships exist but are not especially strong. Of the three control covariates, age was not significantly related to latent class (*p* = .129), but both greater severity (*p* < .001) and being in the treatment sampling frame were related to latent class (*p* < .001).

Discussion

Taken together, these data indicate that problem drinkers, although they do change over time, are fairly stable in their drinking behavior and that they are more likely to remain either a problem drinker or not than they are to repeatedly move into and out of problem-drinking status. As the cross-classifications shown in Table 2 indicate, the percentage of respondents classified as problem drinkers over 7 years of assessment tends to gradually decline, and the change is statistically significant. At the same time, the size of the diagonal proportions—compared with the off-diagonal ones—indicates that change is not the norm, and this tendency toward stability is reflected by the kappa coefficients.

Furthermore, the final model indicates that 5 of the 16 observed patterns efficiently capture the underlying data, and the 2 dominant patterns are ones with no change over time. The transition probabilities are the strongest indicators of how stable this behavioral classification is, with the chance of not changing from time *i* to time *i* + 1 not dropping below 80%. The fact that a model with heterogeneous change parameters fits better than a homogeneous one does suggest that the probabilities do shift; but, as can be seen, the change is not great and is in a favorable direction. Thus, one is more likely to remain not a problem drinker or move out of problem-drinking status than to transition into problem drinking.

With the addition of the covariates, the overall model fit was no longer acceptable, but the associated significance levels suggest some interesting relationships. Despite the wide range of ages in the sample, and although one may speculate that changes at different ages carry different meanings, the probability of those changes apparently does not vary much by age. All three main covariates—(a) sex, (b) family history, and (c) Alcoholics Anonymous attendance—had *p* values between .05 and .10 and indicate that their relationships to the transitions may not be large but probably cannot be dismissed altogether. That the other two covariates, alcohol severity and sampling frame, were related is not surprising. Respondents who were initially interviewed as they entered a treatment program were more likely to be nonproblem drinkers later, which reflects the efficacy of treatment and Alcoholics Anonymous and may also be related to having hit a low point from which they can only improve.

This study benefits from several strong aspects of the design. It follows a large number of participants who were all problem drinkers when first sampled across four assessments over 7 years. Heavy drinkers are not just a small fraction of the total sample, which overall is diverse; it is not restricted to young adults, and includes both population-based and

clinical (public and private) samples. Furthermore, the measurement of the variable of interest, problem drinking, was based on more than a single measure and has clinical and real-world relevance.

Several clinical implications emanate from the study. It is clinically helpful to understand the different patterns of individual patients over time and what may affect these patterns. It is particularly compelling to patients and families to know that if individuals manage to move from being to not being a problem drinker—and remain so for the following year—their chances of sustaining such an outcome are very good. This can be an important motivator for individuals to remain in treatment and work harder on their initial recovery. Thus, the statistically significant trend of gradually having fewer problem drinkers is important for health policy because it provides support for such treatment.

With assessments every other year after the first, it is possible that changes occurred between assessments, although the data suggest that is not too likely. Another confound that cannot be completely controlled for is study attrition. It is possible that the estimated transition probabilities are biased to the extent that they are influenced by the variables related to time in the study, for example, primarily age, sex, and severity. This concern is mitigated, however, by the lack of any evidence that attrition was related to problem-drinking status at any of the interviews.

Although representative of the county from which they were drawn, this sample might not fully reflect the wider population of problem drinkers. Also, in this work, we defined problem drinking as a discrete stage rather than defining it by severity level. Not everyone within a category, such as dependent or problem drinker, is identical to all other members (Nagin, 1999). The tradeoff, however, between having finer levels of gradation when using a continuum—such as problem severity versus the usually more interpretable results from the use of a simple classification—is a fair price to pay.

Another tradeoff is that, although one of the strengths of this design is having a sample that includes a full range of adult ages, it also raises a question about the meaning of the findings in relationship to life span. It is not clear to what extent the shifting meaning of changes in drinking over the 7 years clouds these data. Therefore, to transition into a risky level of drinking at the tails of the distribution—such as at ages 23 and 70—probably means something different than those in their middle years. More detailed analysis of transitions in specific age groups is a topic for future research.

Finally, we point out that Markov models are not trivial to fit. One of the reasons Markov models have seen limited use in alcohol research is that they require a relatively large amount of data—binary measures contain a limited amount of information. Our attempts to use smaller subsamples (not shown), for example, failed. As described previously, they are also limited in the number of covariates one can study

simultaneously, which places limits on the practical number of covariates one can test but also forces the researcher to select those variables carefully.

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