Developmental Pathways to Alcohol Abuse and Dependence in Young Adulthood*

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ABSTRACT. *Objective:* To determine if people who were diagnosed with alcohol abuse or dependence (AAD) at age 21 had different developmental patterns of alcohol use in adolescence than non-AAD individuals. *Method:* An ethnically diverse urban sample of 808 children was surveyed at age 10 in 1985 and followed prospectively to age 21 in 1996. AAD at age 21 was assessed following DSM-IV criteria. Latent Transition Analysis (LTA) was used to identify four statuses of alcohol use (nonuse, initiation only, current use only, heavy episodic drinking), as well as transition probabilities between these four statuses from elementary school to middle school and from middle school to high school among the AAD and non-AAD group. *Results:* The prevalence of alcohol use statuses during elementary school was similar in the two groups.

Differences in alcohol use emerged in middle school and became more pronounced in high school. In middle school, AAD individuals were more likely to have initiated or been current drinkers than non-AAD individuals. However, the two groups did not differ in the prevalence of heavy episodic drinking in middle school. In high school, most AAD individuals were in the heavy episodic drinking status (54%), while most non-AAD individuals were in the initiation only (33%) or current use only (34%) statuses. *Conclusions:* These findings suggest preventive intervention targets for different developmental periods. Alcohol abuse and dependence at age 21 may be prevented by delaying alcohol initiation, by reducing current use in middle school and by reducing heavy episodic drinking in high school. (*J. Stud. Alcohol* 61: 799-808, 2000)

ALCOHOL IS THE MOST commonly used psychoactive drug among adolescents. The 1999 Monitoring the Future national survey of secondary-school students found that approximately 52% of 8th-grade students, 71% of 10th-grade students and 80% of 12th-grade students had used alcohol in their lifetimes (Johnston et al., 2000). Alcohol consumption and heavy episodic drinking (i.e., having five or more drinks in a row) tend to be higher during young adulthood than at any other period across the lifespan (Hilton, 1991; Johnston et al., 1998; Wilsnack et al., 1984). For some adolescents, moderate alcohol use appears to be positively related to psychosocial functioning and adjustment (Labouvie, 1990; Maggs, 1997; Marlatt, 1987; Silbereisen and Noack, 1988); for others, however, it leads to serious adjustment and alcohol problems later in life (e.g., alcohol abuse and dependence) (Hill et al., 2000; Kandel, 1980; Newcomb and Bentler, 1988; White, 1987). In fact, al-

cohol abuse and dependence are most prevalent among young adults, estimated to be at 16% among those aged 18-29 (Grant et al., 1994).

It has been suggested that one goal of alcohol research is to adequately map out the developmental courses for different types of drinkers (Zucker, 1979; Zucker et al., 1995). Within Zucker's developmental framework of the course of alcoholism, the onset of "caseness" in alcohol abuse and dependence is best understood as a threshold phenomenon: Alcoholism gradually develops over time through a process in which previous symptomatic manifestations of alcohol problems come to display greater intensity, frequency or regularity. This framework is similar to a hierarchic model of progression. It makes no assumption of an automatic progression from one stage to the next, nor does it assume a particular pathway is irrevocable. However, the particular pathways in alcohol use that lead to abuse and dependence remain to be detailed.

A number of studies have associated early onset of alcohol use with subsequent misuse of alcohol (Hawkins et al., 1997; Pedersen and Skrandal, 1998; Rachal et al., 1982). Early onset of alcohol use has been found to be associated with the early onset of alcohol abuse and dependence (Andersson and Magnusson, 1988; von Knorring et al., 1985) and increased lifetime prevalence of alcohol abuse and dependence (Chou and Pickering, 1992; Grant and Dawson, 1997). In addition, early onset of alcohol and tobacco use is a risk factor for the initiation of illicit drug use (Kandel, 1975; Kandel et al., 1992; Yamaguchi and Kandel, 1984).

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Labouvie et al. (1997) found that age of first alcohol or cigarette use did not predict alcohol use at age 20. They also found that age of onset of alcohol or cigarette use was not a significant predictor of use intensity or use consequences at age 30. Labouvie and White (1998) concluded from analyses of the same data set that age of onset by itself and onset sequences by themselves were not predictive of alcohol abuse and dependence in young adulthood. Instead, they found that a model describing both individual trajectories in age of onset and use intensity over time predicted later abuse or dependence.

York (1995) analyzed retrospective data on lifetime alcohol intake histories among a sample of social drinkers and recovering alcoholics, finding that alcoholics reported drinking regularly earlier than controls and drank more per occasion when they started to drink regularly. Some research shows that frequent heavy episodic drinking during late adolescence and young adulthood increases the likelihood of concurrent and long-term problems with alcohol (Blane, 1979; Hill et al., 2000; Hilton, 1991; Zucker, 1987).

In sum, existing empirical studies have found that earlier age of first use and regular use of alcohol, greater alcohol use intensity in terms of frequency and quantity, and more frequent heavy drinking are associated with later alcohol problems of abuse and dependence. However, information is lacking regarding the time-specific variation in the relationship between adolescent alcohol use and later abuse and dependence. In addition, few studies have examined the question of discontinuity of alcohol use during adolescence and how discontinuity affects risk of later abuse and dependence. Finally, many previously reviewed studies treated alcohol use outcomes as continuous data.

Models featuring stage sequences have some important strengths in cases in which it is appropriate to think of the underlying phenomenon in discrete terms. One strength is that stage sequence models can account for initial status (a problem for many continuous data approaches) by allowing examination of the probability of transitioning to a particular stage conditional upon initial stage membership. Another strength is that examining the prevalence of stages and incidence of stage transitions provides a detailed look at change over time that is difficult to obtain in continuous data analy-

ses. A stage-based approach, in particular, can show very clearly whether a given stage is particularly prevalent at certain times or for certain subgroups, whether individuals in a certain stage are more or less likely to undergo a transition and whether there are qualitative differences between groups. Thus, this stage model provides an excellent tool to examine Zucker's developmental hypotheses about alcoholism. From a program or policy point of view, a stage-based approach can point very clearly to the developmental periods in which interventions are most likely to be effective, and what behaviors should be the focus of action at which times.

Figure 1 shows four possible stages of alcohol use among adolescents. Between two time points an individual may change from being a nonuser of alcohol to being an initiator (someone who has tried alcohol but is not currently using); an initiator could later become a current user (someone who is currently drinking alcohol, but with no heavy episodic drinking); and a current user could later become a heavy episodic drinker. It is also possible that a heavy episodic drinker may stop and become simply a current drinker. In a similar manner, a current drinker may stop drinking, reverting to the status of an initiator. The possibility of reversals of this type is denoted in Figure 1 by double-headed arrows. This stage model of alcohol use incorporates several important features of alcohol use that have not been included in previous studies. It characterizes patterns of alcohol use in terms of onset of use (initiation or not), how recent the use is (current use or not) and use intensity (heavy episodic drinking or not). It also, importantly, permits the study of developmental patterns of alcohol use in terms of progression, regression and stability.

The present study uses prospectively collected data to compare patterns of alcohol use during adolescence of those who abused or were dependent on alcohol at age 21 (the AAD group) and those who did not meet criteria for alcohol abuse or dependence at age 21 (the non-AAD group). The similarities and differences in the developmental stages of alcohol use, and the transitions between these stages of alcohol use during adolescence are compared for the two groups. This study explores the developmental patterns in alcohol use during adolescence that predict alcohol abuse and dependence in young adulthood.

FIGURE 1. Stages in alcohol use

Method

Participants

The participants in this study are 808 students who participated in the Seattle Social Development Project (SSDP). These participants were recruited in the fall of 1985 from all fifth-grade students (1,053 total) attending 18 Seattle elementary schools serving high-crime neighborhoods. From these fifth-grade students, 808 (77%) consented to take part in a longitudinal study. Of the 808 students, 412 (51%) were male; 372 (46%) were white, 195 (24%) were black, 170 (21%) were Asian American, 71 (9%) were of other ethnic backgrounds. About half (52%) of the students were from low-income families as measured by eligibility for the free school-lunch program in grades 5, 6 or 7. Of the total, 42% reported only one parent present in the house in 1985.

Assessments

The multiethnic urban panel has been tracked and interviewed over an 11-year period through 1996 when participants were 21 years old. Students and their caretakers were surveyed at recruitment in the fall of fifth grade (mean age = 10 years), in the spring of the fifth-grade year, and annually thereafter in the spring of each year through 1991. Participants, but not their caretakers, were interviewed again in the spring of 1993 and in 1996 (mean age = 21). The youth assessments elicited detailed information on the participants' alcohol involvement, including age of onset, frequency of use and frequency of heavy episodic drinking. Annual participation rates were consistently high, averaging over 94% of the original sample during the last five waves of interviews. Nonparticipation at each of the assessment waves was not related to gender, age-10 lifetime use of tobacco or alcohol, or delinquency. Neither was it consistently related to ethnicity.

Measurements

Alcohol use in childhood and adolescence was measured by three manifest items: ever use of alcohol (including a sip or two), current use of alcohol (defined as having used alcohol at least once in the last month) and heavy episodic drinking (defined as having had five or more drinks in a row at least once in the last month). These three items were available at eight survey time-points from ages 10 to 18, except that the heavy episodic drinking items were first asked in the age-13 survey. Items from surveys at age 10, 11 and 12 were used to measure alcohol use in the elementary-school period (two "yes" answers yields a "yes" for the entire period). Items from surveys at ages 13 and 14 were used to measure alcohol use in the middle-school period (any "yes" answer yields a "yes" for the entire period). Items from surveys at

age 15, 16 and 18 (two "yes" answers yields a "yes" for the entire period) were used to measure alcohol use in high school. Although a question on heavy episodic drinking was not asked until seventh grade (i.e., not during the elementary-school period), the heavy episodic drinking variable during the elementary-school period was coded as nonheavy episodic drinking for all participants. This is because the prevalence of heavy episodic drinking was extremely low in the age-13 survey (3%). Among all 808 cases, there were 766 cases who had answered "yes" to the "ever use" question at least once in the elementary-school (ages 10, 11 and 12), middle-school (ages 13 and 14) and high-school (ages 15, 16 and 18) periods and in the 1996 survey (age 21). They constitute the study sample. Nondrinkers across the entire period are excluded from the analysis.

The present study uses the DSM-IV diagnostic criteria for alcohol abuse and dependence (American Psychiatric Association, 1994) to provide a meaningful, clinically relevant and significant outcome measure. Measurement items were drawn from the Diagnostic Interview Schedule (Robins et al., 1981) to determine those meeting criteria for alcohol abuse and dependence. A dichotomized, combined measure of alcohol abuse and dependence is used in this article. It compares individuals who met criteria for a diagnosis of alcohol abuse or dependence (AAD) with those who used alcohol but did not meet criteria for abuse or dependence (non-AAD) at age 21. For the present article, we were concerned with studying people who had a diagnosable alcohol-related disorder (either abuse or dependence) at age 21. Given the size of the study sample, we did not attempt to further divide this group into alcohol abuse only and dependence subgroups, although this is an interesting topic for future studies. In this study sample, there were significantly more males than females who were AAD (37.3% vs 18.8%, $p < .001$). However, differences in the percentages of AAD by ethnicity (whites: 30.6%; blacks: 26.0%; Asian Americans: 22.3%; all other ethnicity: 34.4%) or by poverty status (yes: 26.6%; no: 29.9%) were not significant at $p = .05$.

In this study, missing data were handled using the multiple imputation program NORM developed by Schafer and Olsen (1997). This approach results in less bias than alternative procedures (e.g., listwise deletion or mean substitution) (Graham et al., 1997; Little and Rubin, 1987; Schafer, 1997). All analyses and the results reported below are the average of the results based on five imputed data sets.

Statistical method

Latent Transition Analysis (LTA; Collins et al., 1997, 2000; Collins and Wugalter, 1992; Graham et al., 1991; Hyatt and Collins, 2000) is used to compare the stages of alcohol use during adolescence in the two groups. LTA is a method for testing models of stage-sequential development. LTA shares with covariance structure modeling the idea that

there is a latent quantity that has been measured by several manifest indicators. In the case of LTA, the latent quantity is stage-sequential development and the manifest indicators are discrete variables. Other methods of studying individual differences in development over time (e.g., hierarchical linear model and latent growth analysis; see Muthén and Curran, 1997 for a review) do not permit the examination of the stage-sequential model depicted in Figure 1.

LTA is rooted in latent class theory (Dayton and Macready, 1976; Goodman, 1974; Lazarsfeld and Henry, 1968). Latent class theory is based on the idea of a discontinuous latent variable that divides a population into various mutually exclusive latent classes. The items in an instrument are manifest indicators of the qualitative latent variable. For example, a latent variable might divide a population into alcohol drinkers and nondrinkers. One feature of LTA models is that they model dynamic latent variables, involving movement through a series of "latent statuses" over time. Movement among latent statuses is summed up in a "transition probability matrix."

Consider the stage-sequential model of alcohol use depicted in Figure 1. At any given time, an individual will be a member of either the "ever use of alcohol" or of the "never use of alcohol" latent class; a member of either the "current alcohol use" or the "noncurrent alcohol use" latent class; and a member of either the "heavy episodic drinking" or the "nonheavy episodic drinking" latent class. Using these three manifest items, four conceptually and practically possible latent statuses can be identified: (1) nonuse (never use of alcohol, noncurrent use, nonheavy episodic drinking); (2) initiation only (ever use of alcohol, noncurrent use, nonheavy episodic drinking); (3) current use only (ever use of alcohol, current use, nonheavy episodic drinking); and (4) current use and heavy episodic drinking (ever use of alcohol, current use, heavy episodic drinking). Another conceptually possible latent status, heavy episodic drinking only (ever use of alcohol, noncurrent use, heavy episodic drinking), is not practically possible because, by definition, in this study all heavy episodic drinkers were current drinkers. For the same reason, the latent status of current use and heavy episodic drinking will be simply referred to as "heavy episodic drinking."

A group of parameters are estimated in an LTA analysis by means of the EM algorithm (Dempster et al., 1977). The ρ parameters represent the probability that an individual responds "yes" to a particular item, conditional on membership in a particular latent status. The estimated ρ parameters serve two roles. First, they define the latent statuses. For example, Latent Status 1 involves "never use of alcohol." The probability of responding "yes" to each manifest item, given membership in Latent Status 1, is low. In addition, the ρ parameters reflect measurement precision. Reliable measurement is reflected in measurement parameters that are close to zero or one. For example, a probability of respond-

ing "yes" that is equal to zero for those in Latent Status 1 indicates that membership in this latent status completely determines the response to all three manifest items and indicates that this is a perfectly reliable indicator of this latent status. A probability that approaches 0.5 for a "yes/no" item indicates an item response that is poorly determined by latent status membership.

The δ parameters represent the proportion in each latent status at a particular time point. For example, they would represent the proportion of individuals in the latent statuses of nonuse, initiation only, current use only and heavy episodic drinking.

The τ parameters are elements of the latent transition probability matrix. It represents transitions between latent statuses from one occasion to another. The following is a general representation of a transition probability matrix, in which $\tau_{b|a}$ represents the probability of membership in Latent Status b at Time 2, conditional on membership in Latent Status a at Time 1.

$$\begin{array}{c} \text{Time 1} \end{array} \begin{array}{c} \text{Time 2} \\ \left[\begin{array}{cccc} \tau_{1|1} & \tau_{2|1} & \tau_{3|1} & \tau_{4|1} \\ \tau_{1|2} & \tau_{2|2} & \tau_{3|2} & \tau_{4|2} \\ \tau_{1|3} & \tau_{2|3} & \tau_{3|3} & \tau_{4|3} \\ \tau_{1|4} & \tau_{2|4} & \tau_{3|4} & \tau_{4|4} \end{array} \right] \end{array}$$

In this example, $\tau_{4|3}$ represents the probability of membership in heavy episodic drinking status at Time 2, conditional on membership in the current use only status at Time 1. In other words, it addresses the question, "if an individual starts out in current use only status (Status 3) at Time 1 of measurement, what is the probability that at the second time point of measurement, the individual will be in heavy episodic drinking status (Status 4)?" Note that because the elements of the matrix are conditional probabilities, each row adds up to 1.

In order to compare the parameters for two or more groups, an LTA model can be estimated in a manner analogous to multiple-group factor analysis in LISREL (Joreskog, 1971; Joreskog and Sorbom, 1984). All the above parameters are estimated separately within each group and it is customary to constrain the measurement parameter values to be equal across groups (Graham et al., 1991) in order to ensure that the latent statuses have identical interpretations in each group.

In LTA models, fit is measured by the likelihood-ratio goodness-of-fit statistic, G^2 (Read and Cressie, 1988). Significance testing rests on the assumption that G^2 is approximately distributed as a chi-square with degrees of freedom equal to one less than the number of response patterns minus the number of estimated parameters. It is possible to conduct a nested chi-square test by comparing a model with a group of parameters free against another model with the same

parameters constrained or fixed to specific values. Although the parameter constraint approach described above can help to assess the model's fit, the current LTA program does not have the ability to conduct hypothesis testing on specific parameters. An alternative approach is illustrated in Graham et al. (1991). The number of subjects in a certain category/status can be estimated from the marginal status probabilities and the known sample sizes. Therefore, it is possible to generate contingency tables and use chi-square tests to perform specific hypothesis testing.

LTA has some important limitations. Because it is a contingency table model, it is limited with respect to the number of variables and times that can be included in a single analysis. The addition of manifest indicators and (especially) times increases the size of the contingency table, sometimes producing a table of unwieldy proportions and creating problems with model selection. Another limitation is that in the current version of the LTA software used in this analysis (Collins, 1998), there are no standard errors for individual parameter estimates. A new release of the program with this capability will be available soon. Despite these limitations, the ability of LTA to examine competing stage-sequential models, while controlling for measurement error, provides an important methodology for substance use research.

Results

Comparing alcohol use in the elementary-school period

The initial model (Model 1) followed the diagram in Figure 1 with some parameter restrictions. It contained four latent statuses at the three time periods: nonuse, initiation only, current use only and heavy episodic drinking. Whether the respondent met DSM-IV diagnostic criteria of alcohol abuse or dependence was used as the grouping variable (i.e., the AAD and non-AAD group). The measurement parameters of latent status were constrained to be equal across time and groups. At any particular time point and within each group, all low response probabilities were constrained to be equal, and all high response probabilities were constrained to be equal. The prevalence of the heavy episodic drinking status in the elementary-school period (Time 1) was set to zero for both groups since we had predetermined the prevalence of heavy episodic drinking to be zero in the entire sample at that time. All possible transitions (i.e., forward, backward or unchanged) were allowed, with two restrictions. First, no backward transitions from more advanced latent statuses to the nonuse latent status were allowed. Therefore, these transition probabilities were fixed at zero across all three time periods and two latent classes. Second, the transition probabilities from the latent status of heavy episodic drinking at Time 1 to the latent statuses of initiation only and current use only at Time 2 were set to be zero across two groups, because the prevalence of the heavy episodic drinking latent status at

Time 1 was set to be zero. Last, the probabilities of staying at heavy episodic drinking status from Time 1 to Time 2 were constrained to be 1 across both groups. For Model 1, $G^2 = 433.865$, 984 df.

Model 2 retained all the parameter constraints in Model 1 and added some additional ones (i.e., the prevalence of alcohol use in four latent statuses in the elementary-school period [Time 1] was constrained to be equal across both groups). For Model 2, $G^2 = 434.830$, 985 df. Because Models 1 and 2 are nested models, direct comparison of the fit of these two models was carried out. The difference in G^2 was 0.965 with 1 degree of freedom. With a chi-squared distribution, this G^2 difference was not significant at $p = .05$. Therefore, among those who had ever used alcohol by age 21, the AAD and non-AAD individuals did not differ significantly in their drinking patterns in the elementary-school period.

Comparing overall transition probabilities between alcohol use statuses

The fact that the AAD and non-AAD groups were not significantly different in their drinking behaviors in the elementary-school period suggests that the differences in drinking behavior between the two groups emerged later in their "drinking careers." The two groups may have had different patterns of transition among the latent statuses from elementary school (Time 1) to middle school (Time 2) and/or from middle school to high school (Time 3). To examine this possibility, we modified Model 2 by constraining the transition probabilities from Time 1 to Time 2 to be equal across two groups, yielding Model 3. The transition probabilities from Time 2 to Time 3 remained to be freely estimated for both groups. For Model 3, $G^2 = 450.963$, 992 df. The difference in G^2 between the constrained Model 3 and the unconstrained Model 2 is 16.133 with 7 degrees of freedom. The difference in G^2 is significant at $p < .05$. This indicates that, overall, the transition probabilities from elementary school to middle school in alcohol use statuses were significantly different among the AAD and non-AAD groups.

We constrained the transition probabilities from Time 2 to Time 3 to be equal across two groups while allowing those from Time 1 to Time 2 to be freely estimated for both groups in Model 4. For Model 4, $G^2 = 503.248$, 994 df. Compared to Model 2, the difference in G^2 is 68.418 with 9 degrees of freedom, $p < .001$. This suggests that, overall, the transition probabilities from middle school to high school in alcohol use statuses also differed significantly between the AAD and non-AAD individuals. The results indicate that the AAD and non-AAD individuals started to move into very different drinking trajectories during the transition from elementary to middle school, and the different movement persisted through the transition from middle school to high school. The next question of interest concerned whether these different transitions between alcohol use statuses affected the subsequent

TABLE 1. The measurement (ρ) parameter estimates for Model 2

Latent status	Measured items		
	Ever use	Current use	Heavy episodic drinking
Nonuse	0.007	0.007	0.007
Initiation only	0.934	0.007	0.007
Current use only	0.934	0.934	0.007
Heavy episodic drinking	0.934	0.934	0.934

Notes: Values indicate probability of saying "yes" to the item conditional on latent status membership. Values in bold should be close to 1.0. Other values should be close to 0. The measurement parameters of latent status were constrained to be equal across time and groups. At any particular time point and within each group, all low response probabilities were constrained to be equal and all high response probabilities were constrained to be equal.

prevalence of alcohol use statuses in middle school and high school.

Comparing patterns of adolescent alcohol use

Comparison of G^2 in Models 1, 2, 3 and 4 showed that Model 2, which allows differences in transition probabilities from elementary school to middle school and from middle school to high school for the AAD and non-AAD groups, fits the data best. Because LTA's parameter constraint method is limited in testing hypotheses regarding specific parameters, we used Model 2 as the final model and used the contingency table approach to test specific parameter hypotheses.

The measurement parameters (the ρ parameters). Table 1 provides the ρ parameter estimates for Model 2. They suggest good reliabilities. For the first latent status (nonuse), all of the parameter estimates should be, and are, near zero, indicating that the probability of saying "yes" to any item is very low given membership in the nonuse latent status. The initiation only latent status also has good measurement parameter estimates: The probability of saying "yes" to the ever

use item is near unity (0.93), and the probability of saying "yes" is near zero (0.007) for the other two items (current use and heavy episodic drinking). The current use only and heavy episodic drinking statuses also had very good measurement parameter estimates.

Group differences in alcohol use prevalence during each time period (the δ parameters). The panel on the left side of Table 2 (Predicted probability) contains the unconditional probabilities of membership in each latent status at three development periods for both groups. Note that the prevalence of alcohol use in the elementary-school period was identical across the two groups. This was because we constrained the unconditional probabilities in each latent status in the elementary-school period to be equal across the two groups in Model 2.

In the study sample, 218 individuals met DSM-IV alcohol abuse or dependence diagnostic criteria, and 548 individuals did not meet the diagnostic criteria. Given the estimated unconditional probability of membership in each latent status, we can calculate the predicted number of individuals in each alcohol use status at three developmental periods for both groups. The results are presented in the panel on the right side of Table 2 (Predicted number of individuals). In each of the middle-school and high-school periods, a 2×4 contingency table allows a chi-square test of the group difference in the percentages of people in the four alcohol use statuses. The test indicates that AAD and non-AAD individuals started to differ in alcohol use during the middle-school period ($\chi^2 = 10.31$, 3 df, $p < .05$). A test of the high-school period contingency table shows that the two groups also differed significantly in alcohol use during high school ($\chi^2 = 79.04$, 3 df, $p < .001$).

During the middle-school period, the percentage in nonuse status was somewhat higher in the non-AAD group than for those in the AAD group (28.3% vs 20.9%), and this differ-

TABLE 2. Unconditional probability (the δ parameters) and predicted number of individuals in each latent status of alcohol use at three developmental periods for Model 2

	Predicted probability			Predicted number of individuals		
	Elementary (Time 1)	Middle (Time 2)	High (Time 3)	Elementary (Time 1)	Middle (Time 2)	High (Time 3)
Group 1: No abuse/dependence at age 21 ($n = 548$)						
Nonuse	0.485	0.283 ^a	0.103 ^c	266	155	57
Initiation only	0.181	0.406	0.331 ^d	99	222	181
Current use only	0.334	0.269 ^b	0.339 ^e	183	147	186
Heavy episodic drinking	0.000	0.042	0.226 ^f	0	23	124
Group 2: Abuse/dependence at age 21 ($n = 218$)						
Nonuse	0.485	0.209 ^a	0.022 ^c	106	46	5
Initiation only	0.181	0.362	0.169 ^d	39	79	37
Current use only	0.334	0.362 ^b	0.268 ^e	73	79	58
Heavy episodic drinking	0.000	0.066	0.542 ^f	0	14	118

Note: Probabilities with the same superscript are significantly different from one another.

ence was significant ($\chi^2 = 4.16$, 1 df, $p < .05$). In addition, the percentage in current use only latent status was lower in the non-AAD group than in the AAD group (26.9% vs 36.2%; $\chi^2 = 6.64$, 1 df, $p < .01$). However, the prevalence in initiation only status and heavy episodic drinking status were not significantly different between the two groups in the middle-school period. These data indicate that current drinking in middle school is a behavioral predictor of later abuse and dependence. Heavy episodic drinking during the middle-school period, which was relatively rare in this sample, did not predict later abuse and dependence.

During the high-school period, non-AAD individuals were significantly more likely to be in the following latent statuses than were AAD individuals: (1) nonuse status (10.3% vs 2.2%; $\chi^2 = 13.78$, 1 df, $p < .001$); (2) the initiation only status (33.1% vs 16.9%; $\chi^2 = 19.75$, 1 df, $p < .001$); and (3) current use only status (33.9% vs 26.8%; $\chi^2 = 3.87$, 1 df, $p < .05$). As a result, significantly more AAD individuals than non-AAD individuals were in the heavy episodic drinking status during high school (54.2% vs 22.6%; $\chi^2 = 71.61$, 1 df, $p < .001$). The specific drinking behavior that appears to predict risk for later alcohol abuse or dependence during the high-school period is heavy episodic drinking.

Comparing specific transition probabilities between alcohol use statuses

Table 3 presents the estimated transition probabilities between four latent statuses across three developmental periods for these two groups. We have seen that, overall, the transition probabilities from Time 1 to Time 2 and from Time 2 to Time 3 were significantly different between these two groups from the comparisons of Model 2 to Models 3 and 4. Below we used the contingency table approach to examine specific parameter hypotheses on group differences.

As noted earlier, differences in the predicted probabilities in the four alcohol use latent statuses emerged in the middle-school period when the probability of being a current user of alcohol, in particular, was significantly lower among the non-AAD group than among the AAD group. The following hypothesis testing focused on the group differences in the transition probabilities related to current use only status in middle school. First, the probability of progressing from a nonuse status at Time 1 to a current use status at Time 2 was significantly lower in the non-AAD group than in the AAD group (15.7% vs 25.1%; $\chi^2 = 4.45$, 1 df, $p < .05$). Second, the probability of regressing from current use status to initiation only status was significantly higher in the non-AAD group than in the AAD group (53.6% vs 33.3%; $\chi^2 = 8.64$, 1 df, $p < .01$). In contrast, the transition probability from initiation only status at Time 1 to current use only status at Time 2 and the probability of staying at current use only status were not significantly different between the two groups. Thus, the AAD individuals were more likely than the non-AAD individuals to have progressed from being a nonuser to a current user during the elementary-school to middle-school transition. They were also less likely to have stopped use once they had reached the current use status in the elementary-school period.

The second transition occurred from the middle-school period to the high-school period. We have seen that the AAD group had a significantly higher probability of being in the heavy episodic drinking status during high school than the non-AAD group. We conducted several chi-square tests examining the group differences in the transition probabilities related to the heavy episodic drinking status in high school. In the transition from middle school to high school, the percentages who made the following transitions were significantly higher in the AAD group than in the non-AAD group: (1) progressing from nonuse status to heavy episodic

TABLE 3. Comparisons of transition probabilities (the τ parameters) between latent statuses of alcohol use across three developmental periods for Model 2

Latent status at an earlier time point	Elementary school (Time 1) to middle school (Time 2) transition Latent status at Time 2				Middle school (Time 2) to high school (Time 3) transition Latent status at Time 3			
	Nonuse	Initiation only	Current use only	Heavy episodic drinking	Nonuse	Initiation only	Current use only	Heavy episodic drinking
Group 1: No abuse/dependence at age 21 ($n = 548$)								
Nonuse	0.584	0.244	0.157 ^b	0.015	0.364	0.298	0.239	0.099 ^c
Initiation only	0.000	0.598	0.366	0.037	0.000	0.440	0.348	0.212 ^d
Current use only	0.000	0.536 ^a	0.379	0.085	0.000	0.237	0.448	0.315 ^e
Heavy episodic drinking	0.000	0.000	0.000	1.000	0.000	0.109	0.246	0.645 ^f
Group 2: Abuse/dependence at age 21 ($n = 218$)								
Nonuse	0.432	0.298	0.251 ^b	0.019	0.103	0.263	0.306	0.329 ^c
Initiation only	0.000	0.586	0.387	0.027	0.000	0.279	0.258	0.463 ^d
Current use only	0.000	0.333 ^a	0.510	0.157	0.000	0.035	0.292	0.673 ^e
Heavy episodic drinking	0.000	0.000	0.000	1.000	0.000	0.000	0.072	0.928 ^f

Note: Probabilities with the same superscript are significantly different from one another.

drinking status (32.9% vs 9.9%; $\chi^2 = 14.48$, 1 df, $p < .001$); (2) progressing from initiation only status to heavy episodic drinking status (46.3% vs 21.2%; $\chi^2 = 18.22$, 1 df, $p < .001$); (3) progressing from current use only status to heavy episodic drinking status (67.3% vs 31.5%; $\chi^2 = 26.71$, 1 df, $p < .001$). In addition, the AAD individuals were more likely to stay at heavy episodic drinking status than the non-AAD individuals (92.8% vs 64.5%; $\chi^2 = 3.76$, 1 df, $p = .05$). In other words, they were less likely to stop heavy episodic drinking during high school once they started to engage in heavy episodic drinking in middle school. In sum, those who developed alcohol abuse or dependence problems at age 21 were more likely to have started and/or maintained heavy episodic drinking during high school.

Discussion

This article examined alcohol use during childhood and adolescence among two groups of individuals: those who met DSM-IV diagnostic criteria for alcohol abuse or dependence at age 21 and those who had used alcohol by age 21 but did not meet either alcohol abuse or dependence diagnostic criteria at age 21. Those who never drank alcohol were excluded from these analyses. Data were from a prospective longitudinal study of a multiethnic urban sample of individuals followed from age 10 to age 21. All information on drinking behavior was collected prospectively, before information on alcohol abuse or dependence was obtained. Because the study sample was from an urban population, the conclusions may not be generalizable to the national population of all young adults.

The goal of this article is to identify possibly different developmental patterns of alcohol use between AAD and non-AAD individuals during adolescence. Prior research has shown that such factors as attention deficit disorder, conduct disorder, family history of alcohol dependence and some social demographic characteristics affect alcohol use, abuse or dependence (for reviews see Hawkins et al., 1992; Mrazek and Haggerty, 1994; Schuckit, 1999; Sher, 1994). Future studies examining these factors as they are related to alcohol use patterns and alcohol abuse and dependence in young adulthood will provide a more complete understanding of the developmental etiology of alcohol abuse and dependence.

The hierarchic model of the development of alcoholism (Zucker, 1979; Zucker et al., 1995) specifies an escalating progression of greater intensity and frequency of drinking. The results from this study provide empirical evidence of this progression, adding developmental information about the progression leading to alcohol abuse and dependence. Many previous studies have indicated the importance of early onset of alcohol use in developing future alcohol problems. The present findings are consistent with several others (e.g., Labouvie and White, 1998; Labouvie et al., 1997; York,

1995) in indicating that patterns of alcohol use after initiation (i.e., current drinking in middle school and heavy episodic drinking in high school) influence the course of development of alcohol abuse and dependence. This study has shown that such a progression is neither automatic nor irrevocable.

Alcohol abuse and dependence develop over a period of time. It is important to distinguish future problem alcohol users from normative drinkers, before a clinical disorder is fully manifested (Zucker et al., 1995). This study suggests that key behavioral differences in drinking patterns emerge during middle school. The data indicate that preventing drinking during the middle-school years could reduce risk for later alcohol abuse and dependence. In addition, the present data indicate the importance of heavy episodic drinking during high school as a behavioral precursor of future alcohol abuse and dependence. The 1999 Monitoring the Future Study (Johnston et al., 2000) shows that, over time, changes in heavy episodic drinking usually parallel the changes in perceived risk and disapproval in heavy episodic drinking among high school students. However, the study also indicates that the majority of twelfth graders did not view heavy episodic drinking on weekends as carrying a great risk, and only 63% of them disapproved or strongly disapproved of heavy episodic drinking. A major focus for preventive intervention should be to reduce heavy episodic drinking during the high-school years, perhaps through changing norms about the perceived risk and social acceptability of heavy episodic drinking.

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