Patterns of Drug Use from Adolescence to Young Adulthood: II. Sequences of Progression

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Abstract: Major pathways of progression among legal, illegal, and medically prescribed psychoactive drugs from adolescence to young adulthood are described. The data are based on a follow-up cohort of former adolescents representative of high school students in grades 10 and 11 in New York State who were reinterviewed nine years later at ages 24–25. Various models of progression are tested for their goodness of fit. The patterns formerly observed in adolescence involving progression from one class of legal drug (either alcohol or cigarettes) to marijuana to the use of other illicit drugs appear in the transitional period into young adult, with an additional stage, that of prescribed psychoactive drugs. Some differences appear between men and women, with cigarettes more important for women than for men in the total progression. (*Am J Public Health* 1984; 74:668–672.)

Introduction

Stages of involvement in legal and illegal drugs have been described for adolescents. Adolescents are very unlikely to experiment with marijuana without prior experimentation with one of the alcoholic beverages or with cigarettes; very few try illicit drugs other than marijuana without prior use of marijuana, as documented in particular by our own earlier work[1–5] and the work of Jessor,[6] O'Donnell and his colleagues,[7–10] Johnston,[11] Huba and Bentler,[12–15] and others.[16–21] To date, the empirical support for the concept of stages in drug use derives from cross-sectional data[4–10,12,14–18] or from a short-term longitudinal follow-up.[1,3] No results have been reported that are based on a follow-up of young people over several years with a detailed monitoring of their drug behavior past the period of risk for initiation into the relevant drugs. Such data are presented in this paper for a cohort of former high school students who were followed into young adulthood, at ages 24 to 25. By that age, the period of risk for initiation to the legal drugs, to marijuana, and to most other illicit drugs, with the exception of cocaine, is over, as reported in the first article of this series in this issue of the Journal.[22]

In investigating pathways of progression among drugs, we address two related issues: 1) whether the pattern of progression observed in adolescence over a short-term interval—i.e., from the use of at least one class of licit drug (alcohol or cigarettes), to the use of marijuana, to the use of other illicit drugs including the non-medical use of drugs available by prescription—holds when the same cohort of individuals is followed to young adulthood; and 2) whether the use of medically prescribed psychotropic drugs can be characterized as a later stage of progression.

Methods

Samples and Field Procedures

The analyses are based on a follow-up in 1980–1981 of two cohorts representative of adolescents formerly enrolled in grades 10 and 11 in public secondary schools in New York State. Of the 1,626 former adolescents targeted for reinterviewing, 81 per cent (n = 1,325) were interviewed. The average age at time of the reinterview was 24.7 years. The sampling design and interview schedule are described elsewhere.[22,23] An unusual component of the interview schedule consisted of two charts designed to reconstruct on a monthly basis the respondents' drug and life histories as of September 1971, the date of the initial high school survey. Detailed information was collected on the histories of use of 12 drugs. While age of onset was ascertained for all users of each drug, even if earlier than 1971, the detailed retrospective drug histories were obtained for drugs used a minimum of 10 times. This restriction was imposed in order to eliminate drug experimenters and improve the recall of drug experiences.

The data were obtained through personal household interviews that took an average of two hours to administer. The interview schedule consisted almost exclusively of structured items with closed response alternatives.

Analytical Strategies: Modified Guttman Scaling

Five drug classes were distinguished: 1) alcohol, including beer, wine or distilled spirits; 2) cigarettes; 3) marijuana, including hashish; 4) other illicit drugs, including psychedelics, cocaine, heroin and non-prescribed use of stimulants, sedatives, minor tranquilizers, major tranquilizers, antidepressants, and methadone; and 5) prescribed psychotropic drugs, including minor tranquilizers, sedatives, and stimulants.

Analyses of progression were based on year and month of onset ascertained for each drug used lifetime 10 or more times. The earliest drug used within a class of drugs determined the age of onset for the class. Major pathways of progression were identified from the ordering of initiation among the five classes of drugs.

A modification of Guttman scaling was applied to these longitudinal drug use data to ascertain the proportions of the sample falling in scale types for selected models of progression. A specific cumulative order was hypothesized to represent the scale type, and the proportion of persons classified in the scale type beyond that expected from the marginals was estimated. In contrast to traditional Guttman scaling, the temporal order of events rather than cross-sectional cumulative features of attributes were analyzed, and statistical procedures were developed to identify the efficiency of various cumulative models in fitting the data. For a given model of stages of progression, the observed

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proportion of individuals who could be classified in the scale type was calculated,* although, as in Guttman scaling, not all individuals were required to reach the highest stage in the progression.

In testing the fit of a model of progression, not only the observed proportion of individuals in the scale type but also the expected proportion not due to chance is important, as discussed in the Appendix. For a given specification of scale and non-scale types, and the assumption that the non-scale type can occur only by chance, the maximum likelihood estimates of six parameters is obtained (see Appendix). One parameter, C, is a constant representing the total frequency of persons whose pattern of progression, which may or may not end in the scale type, occur by chance, i.e., the random type group; the other five parameters, r_i, r_j, r_k, r_l, and r_m, represent the marginal probabilities of initiation for each class of drugs among persons in the random type group. The expected proportion of persons in the scale type not by chance is given by (N−C)/N, where N is the sample size. The likelihood ratio chi-square statistic (X_{LR}^2) associated with maximum likelihood estimation, the observed proportion of persons in the scale type, and the expected proportion of persons in the scale type not by chance are used to assess the goodness of fit of the models of stages of progression.

Results

Independence of Initiation into Different Drugs

Under the assumption of independence, the expected distribution of the number of drugs used is calculated from the observed proportions of persons who used each class of drugs at least 10 times in their lives. These observed proportions for alcohol are 97 per cent for men and 92 per cent for women; for cigarettes 65 per cent and 63 per cent, respectively; for marijuana 64 per cent and 61 per cent; for other illicit drugs 27 per cent and 12 per cent; and, for prescribed psychoactive drugs 10 per cent and 14 per cent. Observed frequencies of number of classes of drugs used at least 10 times ever, expected frequencies, and the ratio of observed to expected frequencies establish a clear pattern of deviation from independence of initiation. The numbers of persons who never used any of the drugs in their lives and of persons who used all five classes of drugs are five to nine times higher than expected.** Users of one class of drugs and of four classes are 1.3 to 1.8 times higher than expected, while users of two or three classes of drugs are 0.7 to 0.8 times less frequent than expected. If a person uses a particular drug, he/she is likely also to initiate the use of other drugs.

Steps of Progression

Based upon earlier work on adolescents[1] and more recent analyses on time of onset of various drugs from adolescence to young adulthood,[22] the following sequence of progression was tested: alcohol, cigarettes, marijuana, other illicit drugs, and prescribed psychoactive drugs. In order to substantiate this hypothesized sequential model and to uncover major additional steps of progression through patterns that do not fit the model, the proportions of persons in the more frequent pattern of transition for each pair of drugs were calculated. These proportions are given by sex in Table 1, separately for cases where at least one class of drugs in the pair was used 10 times or more and for cases where both classes of drugs in the pair were used. If only one drug was used, it was counted as occurring first. The first proportions reflect differences in the probabilities of occurrence of the two drug events; the second proportions indicate the ordering propensity, with no confounding of differences in probabilities of occurrence.

Except for three pairs (alcohol and cigarettes, cigarettes and marijuana, and other illicit drugs and prescribed psycho-

*A fairly large number of ties occur in the initiation of two or more classes of drugs: a tie of two events for 151 persons, two pairs of ties for four persons, a tie of three events for 27 persons, and other higher order ties for two persons. Ties occurred because some persons reported an age instead of a year and a month of onset for drugs initiated prior to the initial survey in September 1971. Except for two extreme cases with a tie of more than three events, persons with ties were not dropped from the calculations of observed and expected proportions of persons in the model-type, because these persons frequently reported other untied events. For the remaining 182 cases, proportional probabilities instead of equal probabilities of ordering among the tied events were assumed by taking as weights the probabilities of ordering among non-tied two or three events observed in the total sample.

**Data are available on request from the authors.

TABLE 1—Pairwise Comparisons of the Order of Initiation among Five Classes of Drugs Used 10 Times or More

Drug Used Earlier	Drug Used Later	Relative Proportion of Specified Ordering[a]: Among persons who used at least one class of drugs — Male	Female	Among persons who used both classes of drugs — Male	Female
Alcohol	Cigarettes	.80	.70	.70	.55
Alcohol	Marijuana	.92	.90	.88	.83
Alcohol	Other illicit drugs	.99	.98	.95	.93
Alcohol	Prescribed psychoactive drugs	.99	.98	.92	.90
Cigarettes	Marijuana	.60	.70	.67	.72
Cigarettes	Other illicit drugs	.89	.94	.86	.91
Cigarettes	Prescribed psychoactive drugs	.95	.91	.85	.84
Marijuana	Other illicit drugs	.98	.94	.95	.87
Marijuana	Prescribed psychoactive drugs	.95	.87	.80	.75
Other illicit drugs	Prescribed psychoactive drugs	.82	.56	.69	.53

[a] $f(i,j)/(f(i,j) + f(j,i))$ where $f(i,j)$ is the frequency of cases where class i precedes class j. $f(i,j)$ in columns 1 and 2 includes persons who used only drug i.

active drugs), each drug in a pair precedes the other in more than 85 per cent of the cases for both sexes (Table 1, columns 1 and 2). Ordering propensity restricted to those who have used both drugs in a pair, eliminating thereby the confounding of differences due to probabilities of occurrence, is not greatly different from that observed among those who have used one or both drugs, although the proportions are lower (Table 1, columns 3 and 4).

Tests of Specific Sequential Models

To identify stages of progression beyond pairwise comparisons of two events, the modified Guttman scale analysis of stages described earlier was carried out. The model that assumes independence and no ordering is defined as Model I. Model Q, the first model to be tested, was suggested by the results in Table 1 and hypothesizes unidirectional pairwise orderings with transitions over 85 per cent. No clear ordering is hypothesized between the uses of alcohol and tobacco cigarettes, tobacco cigarettes and marijuana, and other illicit drugs and prescribed psychoactive drugs. Model Q is defined as follows:

Model Q: —alcohol precedes marijuana
—alcohol, cigarettes and marijuana precede other illicit drugs
—alcohol, cigarettes and marijuana also precede prescribed psychoactive drugs

Model Q fits the data for 82 per cent of the men (76 per cent not by chance) and 79 per cent of the women (68 per cent not by chance).

Three deviant patterns of progression, relatively more frequent than others, involve modifications in the role of a legal drug in drug progression which weaken the original model, as specified below.

Condition A: Use of cigarettes does not have to precede the use of other illicit drugs.
Model QA: —alcohol precedes marijuana
—alcohol and marijuana precede other illicit drugs
—alcohol, cigarettes and marijuana precede prescribed psychoactive drugs
Condition B: If the use of cigarettes precedes the use of marijuana, the use of alcohol does not have to precede the use of marijuana
Model QB: —either alcohol or cigarettes precedes marijuana
—alcohol, cigarettes and marijuana precede other illicit drugs
—alcohol, cigarettes and marijuana also precede prescribed psychoactive drugs
Condition C: The uses of alcohol and either cigarettes or marijuana but not both may precede the use of prescribed psychoactive drugs
Model QC: —alcohol precedes marijuana
—alcohol, cigarettes and marijuana precede other illicit drugs
—alcohol and either cigarettes or marijuana precede prescribed psychoactive drugs

These conditions may also be combined. Models that incorporate two conditions each (Model QAB, QAC and QBC) are discussed below.

Tests of comparisons between pairs of hierarchical models were made. Results for males are presented in Table 2.*** Although all models apparently fit the data well, the tests of goodness of fit are not reliable (except for tests comparing any two hierarchical models) because there are many zero observations in the error-type patterns of progression implied by each model.

Among men, Model QA, which hypothesizes that cigarettes do not have to precede other illicit drugs, improves Model Q substantially, while modifications represented by Models QAB or QAC do not. Model QA, which classifies most parsimoniously 87 per cent of the men (82 per cent not by chance), characterizes patterns of drug progression among men.

Among women, conditions B and C rather than condition A improve the fit of Model Q. Model QB improves the fit of Model Q most significantly in terms of the chi-square test and the increase in the proportion of persons in the scale type not by chance. Model QBC, described below, further improves slightly the fit of Model QB and most parsimoniously characterizes the pattern of drug progression among women. The model fits the data for 86 per cent of the women (77 per cent not by chance).

Model QBC: —either alcohol or cigarettes precede marijuana
—alcohol, cigarettes and marijuana precede other illicit drugs
—alcohol and either cigarettes or marijuana precede prescribed psychoactive drugs

***The results for females are available on request from the authors.

TABLE 2—Tests on the Fit of Models of Drug Use Progression among Men (N = 620)

	Proportion of Persons in the Scale Type					
	Observed	Expected Not by chance	X^2_{LR}	df	α	$X^2_{LR}H/X^2_{LR}I$
1. Model I[a]	—	—	1077.14	320	.000	100.0
2. Model Q	.819	.762	318.88	299	>.400	29.6
Q vs I	—	—	758.26	21	.000	70.4
3. Model QA	.871	.817	218.58	296	>.500	20.3
QA vs Q	.052	.055	100.30	3	.000	9.3
4. Model QB	.846	.795	299.72	293	>.500	27.6
QB vs Q	.027	.033	19.16	6	.004	2.0
5. Model QC	.839	.788	281.06	290	>.500	26.1
QC vs Q	.020	.026	37.82	9	.000	3.5
6. Model QAB	.897	.854	195.72	290	>.500	18.2
QAB vs QA	.026	.037	22.86	6	.001	2.1
7. Model QAC	.893	.842	184.33	283	>.500	17.1
QAC vs QA	.022	.025	34.25	13	.001	3.2

[a]Model I assumes no scale type patterns; Model H = hypothesized model.

Summary and Conclusions

There are clear temporal developmental stages in the use of licit and illicit drugs from adolescence through young adulthood, when the period of risk for initiation into drugs, terminates except for the prescribed psychoactive drugs. For men, the pattern of progression is one in which the use of alcohol precedes marijuana; alcohol and marijuana precede other illicit drugs; and alcohol, cigarettes and marijuana precede the use of prescribed psychoactive drugs. Eighty-seven per cent of men (82 per cent not by chance) are characterized by this pattern. For women, the pattern of progression is one in which either alcohol or cigarettes precedes marijuana; alcohol, cigarettes, and marijuana precede other illicit drugs; alcohol and either cigarettes or marijuana precede prescribed psychoactive drugs. Eighty-six per cent of women (77 per cent not by chance) share this pattern. Slight differences appear between men and women in elaborations of the model. The most striking difference is the greater importance of cigarettes among women than among men in the sequence of drug involvement. Cigarettes can precede marijuana in the absence of alcohol use among women, whereas alcohol, even in the absence of cigarettes, consistently precedes marijuana use among men. Cigarettes must precede other illicit drugs among women, but not among men. Finally, among women but not among men, prescribed psychoactive drugs can be initiated in the absence of prior experimentation with marijuana if cigarettes have been used, with alcohol consistently a prior stage for both sexes. Another sex difference is the greater importance of alcohol than of cigarettes for men than for women as an experience prior to marijuana use.

These findings advance our understanding of sequential patterns of drug involvement beyond that gained from earlier analyses based on adolescents. The sequence of involvement into drugs progresses from the use of at least one legal drug, alcohol and/or cigarettes, to marijuana; and from marijuana to other illicit drugs, and/or to prescribed psychoactive drugs. While the patterns described during adolescence hold for the transitional period into young adulthood, the use of prescribed psychoactive drugs has been identified as a further step in the sequence. In addition, sex differences in patterns of progression had not been previously reported nor investigated on a firm statistical basis. The new analyses point to a sex difference in the more important role of tobacco cigarette use in the progression of drug involvement among women than among men. The evidence for the existence of patterns of progression is stronger than could be derived from prior analyses of Guttman scaling of cross-sectional data or of short-term longitudinal data. Indeed, the exact timing of drug initiation, although elicited retrospectively, was ascertained in a cohort that has been followed through the period of highest risk for initiation to legal and illegal drugs (but not for prescribed psychoactive drugs). In addition, the relative fit of alternative models could be subjected to statistical tests, an option not available for Guttman scaling tests.

The existence of sequential stages of progression, however, does not necessarily imply causal linkages among different drugs since the observed sequences could simply reflect the association of each class of drugs with different ages of initiation and/or individual attributes rather than the specific effect of the use of one class of drug on the use of another. Furthermore, it is important to keep in mind that although a clear developmental sequence in drug involvement has been identified, use of a drug at a particular stage does not invariably lead to the use of other drugs higher up in the sequence. Many youths stop at a particular stage and do not progress further. In addition, the particular sequence of progression that has been identified may be determined partly by secular trends. This can only be ascertained by studies of different cohorts and different cultures. Comparative studies, however, indicate that similar stages appear in other Western societies.[4]

The extent to which the use of a particular drug leads to the use of drugs higher up in the sequence is discussed in the next article in this series in this issue of the Journal.[24]

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APPENDIX

Certain patterns of progression are more likely to occur than others simply because of differences in the probabilities of initiation among classes of drugs. The *expected* proportion of individuals in a scale type not due to chance is derived from the assumption that two latent subpopulations exist in the total sample: 1) individuals in the scale type not by chance; and 2) a random-type group of individuals whose pattern of progression occurs by chance, including some in the scale type and some not. This two-subpopulation model is analogous to the mover-stayer model in mobility research, with the estimation of the expected proportion of individuals in the model type not by chance conceptually identical to the calculation of the immobility index.[25] The estimation of the proportions of these two expected subpopulations makes it possible to decompose the observed proportion of persons in the scale type into two components: 1) one expected by chance; and 2) one not expected by chance. The estimation method, originally outlined by Goodman,[26] utilizes the concept of quasi-independence. In the present context, quasi-independence implies that, except for specified scale-type patterns of progression, the frequencies of other patterns of progression depend only on the chance occurrence of initiation of the five classes of drugs. Chance occurrence implies independence of initiation among the five classes of drugs and no ordering propensity, i.e., equal probability of occurrence for each permutation of a combination of initiated drugs.

The expected marginal probabilities of initiation in the latent random-type group are neither equal to the probabilities of initiation of the five classes of drugs for the total sample nor equal to those among the observed non-scale type persons, and need to be estimated by the procedure described below. Since there are five classes of drugs, six parameters need to be estimated.

Let us denote by $i,j,k,l,$ and m the five classes of drugs, by $f_{i(jklm)}$ the observed frequency of initiation of i without initiations of $j,k,l,$ and m, by $f_{jk(ilm)}$ the observed frequency of initiations of j and k in this order without initiations of $i,l,$ and m, by $f_{ikm(jl)}$ the observed frequency of initiations of $i,k,$ and m in this order without initiations of j and l, etc. The parameter C is the constant representing the total frequency of persons in the random-type group; the other five parameters, $r_i,r_j,r_k,r_l,$ and r_m, represent the marginal probabilities of initiation for each class of drugs among persons in the random-type group. For example, in the initiation of three classes of drugs, the expected frequency of initiation of $i,j,$ and k without initiation of l and m, $F_{ijk(lm)}$, can be expressed as follows:

$$F_{ijk(lm)} = Cr_ir_jr_k(1-r_l)(1-r_m)/3!$$
if sequence (i,j,k) is not in the scale type,
$$= f_{ijk(lm)}$$
if sequence (i,j,k) is in the scale type.

Similar expressions hold for any order of zero to five classes of initiated drugs.

The maximum likelihood procedure based on an iterative proportional adjustment of frequencies for quasi-independence models was used to estimate these six parameters for each specification of scale and non-scale types.

XI International Congress for Tropical Medicine and Malaria to Meet in Calgary in September 1984

The XI International Congress for Tropical Medicine and Malaria will be held in Calgary, Alberta, Canada, September 16–22, 1984.

With some 5,000 delegates in attendance from the world-over, the objectives of the congress are to review current knowledge of major diseases of the tropics in terms of prevention, control and treatment.

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