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Stages in Adolescent Involvement in Drug Use

Abstract. *Two longitudinal surveys based on random samples of high school students in New York State indicate four stages in the sequence of involvement with drugs: beer or wine, or both; cigarettes or hard liquor; marihuana; and other illicit drugs. The legal drugs are necessary intermediates between nonuse and marihuana. Whereas 27 percent of high school students who smoke and drink progress to marihuana within a 5- to 6-month follow-up period, only 2 percent of those who have not used any legal substance do so. Marihuana, in turn, is a crucial step on the way to other illicit drugs. While 26 percent of marihuana users progress to LSD, amphetamines, or heroin, only 1 percent of nondrug marihuana users and 4 percent of legal drug users do so. This sequence is found in each of the 4 years in high school and in the year after graduation. The reverse sequence holds for regression in drug use.*

Although marihuana is usually considered as the first step in drug use, such a view is both arbitrary and inadequately documented (*1*). Previous attempts to ascertain sequences of drug use over periods of time have been inferential and based either on interrelations in patterns of use at one point in time, or on retrospective reports in which subjects are asked to recall what drugs they used in the past and the order in which they used them (*2*). Direct delineation of sequences of drug use requires prospective longitudinal studies in which the drug use histories of the same individuals are examined over a period of time.

I now present data from two longitudinal surveys based on random samples of high school students in New York State, and I find that drug use does not begin de novo with marihuana, but with legal drugs: beer or wine at first, and cigarettes or hard liquor subsequently. Some of the youths who smoke or drink continue on to use marihuana, and some of the marihuana users progress further to use one or more other illicit drugs. On the basis of these data, I propose a model for involvement in drug use based on a sequence of four well-defined stages: beer or wine; hard liquor or cigarettes; marihuana; and other illicit drugs (*3*).

Data on sequences of use over time were derived from two longitudinal cohorts of adolescents: (i) a two-phase random sample of adolescents representative of public secondary school students in New York State, who were surveyed in their classrooms with the use of structured, self-administered questionnaires, in the fall and spring of one academic year at an interval of 5 to 6 months (N = 5468); and (ii) the senior class members from the same 18 sample schools, who were contacted a third time 5 to 9 months after their graduation from high school (N = 985) (*4*). At each of the three times, adolescents indicated (i) whether they had ever used and (ii) used within the past month, each of 14 legal and illegal substances. At times 2 and 3, adolescents were also asked about the use of each drug during the interval between the current survey and the preceding one.

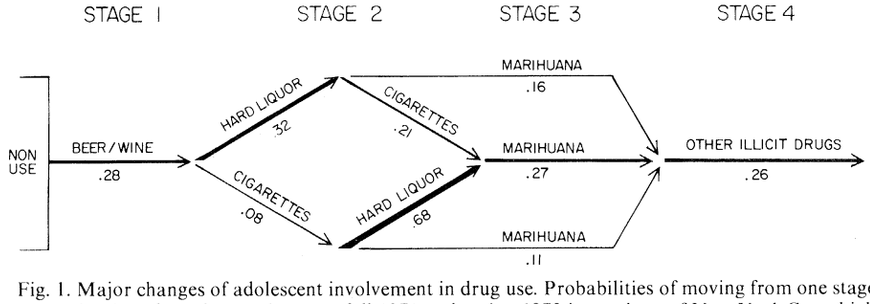

Fig. 1. Major changes of adolescent involvement in drug use. Probabilities of moving from one stage to another based on changes between fall 1971 and spring 1972 in a cohort of New York State high school students, 14 to 18 years old. Youths who started using more than one drug within the follow-up interval were distributed in a sequential order which reproduced the proportions of known exclusive starters of each drug.

The first suggestion of stages in drug use came from the earlier scalogram analyses of data from the first survey of the total high school sample (*5, 6*). The results indicated that adolescent drug use behavior fitted a valid Guttman scale (*5, 6*). The patterns of all the drugs ever used could be arranged according to a well-defined cumulative and one-dimensional hierarchical order with seven steps: (i) nonuse; (ii) legal drugs only (beer, wine, cigarettes, or hard liquor); (iii) cannabis (marihuana, hashish); (iv) pills (ups, downs, tranquilizers); (v) psychedelics (LSD, other psychedelics); (vi) cocaine; and (vii) heroin. Any response that deviates from this order is called an error. Thus, an error occurs when a respondent has used a drug ranked high on the scale (such as heroin), but has not used a lower ranked drug (such as pills). The scale had coefficients of reproducibility of .98 and of scalability of .64 (*7*). The fit of the data with the Guttman scale model implied that youths at any one step have used the drug at that particular level as well as all lower ranked drugs, but they have not used any of the higher ranked drugs. Since these earlier findings were based on data gathered at a particular time, no time order among the usage patterns could be established. Direct evidence for the existence of stages requires longitudinal data.

Although Guttman scaling has been used solely to rank responses at a single time, I have used it here for analyzing movement from one step to another during an interval of time. The power of the approach resides in the fact that Guttman scaling provides, for each respondent, a complete and unambiguous summary of cumulative patterns of drug use up to a particular point in time (or during a specified period). Therefore, it can clearly show subsequent progressions or regressions from these patterns, as well as the extent to which changes follow the cumulative steps specified in the scale, an important criterion for determining the existence of stages in drug use.

In each cohort, the patterns of all the drugs ever used by an adolescent at the time of the initial interview were defined in terms of the seven-step Guttman scale classification described above, and were related to the adolescent's subsequent pattern of use during the follow-up interval. Drug use in the interval was also classified in terms of a Guttman scale, independently of drug use patterns at the initial interview. Results for the total high school cohort (Table 1) are completely rep-

licated in the cohort of graduated seniors (not shown). Data below the diagonal indicate progression; those above, regression. Changes follow the steps outlined by the Guttman scale and tend to involve only adjacent categories. Progression follows the sequence from nonuse to legal drugs to cannabis to pills to psychedelics to cocaine to heroin. Among adolescents who regress, the same sequences are generally followed in reverse. Thus, illegal drug users do not regress directly to nonuse, but only to lower categories of illegal drugs or to legal drugs. The higher the starting level of use, the less the tendency to retain a cumulative pattern of use over time (Table 1). Of the youths (42 percent) who are still using heroin by time 2, more than half (23 percent) discontinued their use of some of the drugs at a lower step during the follow-up period.

Drug use starts with legal drugs, which are a necessary stage between nonuse and illegal drug use. A direct progression from nonuse to illegal drug use practically never occurs. Of those in the total high school sample who were nonusers in the fall (time 1), 36 percent progressed to legal drugs during the subsequent 5 months and 1 percent started to use legal drugs and cannabis. Only 1 percent of the nonusers went directly to illegal drugs without prior experience with a legal drug. The trends in regression are similar. Illegal drug users do not regress directly to nonuse, but only to lower categories of illegal drugs or to legal drugs. The same findings apply to the sample of graduated seniors.

Sequences of change involving adolescents in our samples who were already using legal drugs at the initial interviews demonstrate that marihuana use is a crucial step in the induction into illicit drug use. Within each of the follow-up periods, most of the legal drug users who progress go only to marihuana. Marihuana is a crucial stage prior to the use of other illicit drugs, such as LSD, pills, or heroin. Only 2 or 3 percent of the legal drug users in each cohort progress directly to these other illicit drugs without first trying marihuana (see distribution of error types in Table 1 for the high school cohort). By contrast, the further progression from marihuana to other illicit drugs is not rare: 26 percent in a 5- to 6-month period among the high school students (Table 1); 16 percent among the graduated seniors.

Because of the crucial role played by the legal drugs, and the large number of youths who have used these drugs (82 percent), I examined in detail the sequences of change over the follow-up intervals for each of the specific substances included in the legal drug classification. Exclusive users of legal drugs at time 1 were differentiated into five groups according to whether they were currently (in the past 30 days) using only one of the three legal drugs, or any two in combination, or all three (Table 2). The majority of nonusers who start using a legal drug start with beer or wine (*8*). Two to three times as many beer and wine users progress to hard liquor as progress to cigarettes. Furthermore, while more than half the cigarette smokers

Table 1. Subsequent drug use in the total high school sample grouped according to the initial Guttman patterns. Drug use in the follow-up interval between time 1 (fall 1971) and time 2 (spring 1972) is classified in terms of a seven-step Guttman scale, independently of drug use patterns at the initial interview.

Drug use between T1 and T2	Guttman pattern of drugs ever used as of fall 1971 (T1): (i) None (%)	(ii) Legal (%)	(iii) Cannabis (%)	(iv) Pills (%)	(v) Psychedelics (%)	(vi) Cocaine (%)	(vii) Heroin (%)
True Guttman pattern							
(i) None	*62*	10					
(ii) Legal	36	*79*	19	11	8		
(iii) Cannabis	1	7	*55*	32	18	6	16
(iv) Pills		2	9	*33*	15	6	10
(v) Psychedelics			5	8	*33*	26	10
(vi) Cocaine				3	7	*33*	11
(vii) Heroin			1	1	1	1	*19*
Error*	1	2	11	12	18	28	34
Total percent	100	100	100	100	100	100	100
Total *N*	(482)	(2911)	(558)	(307)	(250)	(40)	(40)
Error according to highest step in interval*							
(iii) Cannabis			*1*				
(iv) Pills	1	1	3	*3*	4	6	
(v) Psychedelics		1	4	7	*7*	9	1
(vi) Cocaine			2	2	3	*8*	10
(vii) Heroin			1		4	5	*23*
Total percent	1	2	11	12	18	28	34

*Pattern of use does not follow the cumulative order of the Guttman scale; respondents did not use all the drugs below the highest-ranked drug they used. Summation of percentages of true Guttman scale types and those in error, for each drug listed in rows, shows the highest drug level at which adolescents with different initial patterns of use remained or to which they moved during the follow-up interval. For example, a total of 12 percent (9 percent + 3 percent) moved from cannabis at time 1 to pills at time 2.

Table 2. Subsequent use of legal and illegal drugs among previous nonusers and exclusive users of legal drugs in two cohorts of New York State adolescents. T_2 to T_3 represents the interval between the spring of 1972 and the winter of 1972-1973.

Period and use	Current use among exclusive legal drug users at initial surveys: Never used any (%)	Not current* (%)	Beer/ wine only (%)	Cigarettes only (%)	Cigarettes + beer/ wine (%)	Liquor + beer/ wine† (%)	Cigarettes + liquor + beer/ wine (%)
New York State total high school panel sample: fall, 1971 (T1)							
T1 to T2							
None	64	11	13	22	1	1	
Beer, wine	30	78	83	44	93	94	97
Cigarettes	11	14	14	68	75	21	75
Liquor	10	56	33	32	68	88	90
Cannabis‡	2	5	4	16	16	11	27
Other illicit drugs§	1	2	2	7	6	4	11
Total *N*≥	(467)	(694)	(731)	(70)	(356)	(429)	(342)
Graduated seniors panel sample: at end of senior year, 1972 (T2)							
T2 to T3							
None	58	58	14			4	2
Beer, wine	31	33	84		94	93	94
Cigarettes	6	38	14		81	19	76
Liquor	18	17	41		56	84	90
Cannabis‡	6		11		18	18	29
Other illicit drugs§	2		2		6	2	4
Total *N*≥	(62)	(8)	(103)	(5)	(16)	(206)	(91)

*Have all used cigarettes or hard liquor or both. †Includes 5 percent who were not currently using beer or wine. ‡Marihuana or hashish. §Methedrine, other amphetamines, barbiturates, tranquilizers, LSD, other psychedelics, cocaine, heroin.

subsequently start to drink hard liquor, a few of the adolescents who start hard liquor right after beer and wine subsequently start to smoke. No youths in either cohort progress from beer and wine to illicit drugs without also taking up hard liquor or cigarettes on the way. Progression to marihuana appears predominantly among adolescents who have already used tobacco or hard liquor; the effects of the two are independent and additive.

The types of changes and the sequences in patterns of change are strikingly similar in both cohorts and are found in all grades in high school, in both sexes, and are independent of family educational background and race (data not presented).

Although the data show a clear sequence in drug use, a particular drug does not invariably lead to other drugs higher up in the sequence. Many youths stop at a particular stage and do not progress further; many regress to lower drugs. However, the data do establish that patterns of use are likely to follow certain paths. Four stages in progression are diagrammed in Fig. 1. Estimates of the proportion of youths progressing through each stage are based on data from the high school cohort (*9*). The model in Fig. 1 is supported by the fact that few drug users proceed to a drug at a particular stage without first trying the preceding one. In addition, different factors are related to drug use behavior at each of the stages (*10*). These stages are probably culturally determined. The extent to which they are can be determined only by comparative and cross-cultural studies.

The identification of these stages in drug use behavior has important implications for studying the factors that predict, differentiate, or result from drug use. Whereas most studies compare youths within a total population on the basis of their use or nonuse of a particular substance, my results suggest a different strategy. Since each stage represents a cumulative pattern of drug use and generally contains fewer adolescents than the preceding stage in the sequence, comparisons must be made among members of the restricted group of respondents who have already used the drug or drugs at the preceding stage or stages, and those who have not. Unless this is done, the attributes identified as apparent characteristics of a particular class of drug users may actually reflect characteristics important for involvement in drugs at the preceding level (*11*).

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1. For detailed critiques, see E. Goode, *Drugs in American Society* (Knopf, New York, 1972); L. Grinspoon, *Marihuana Reconsidered* (Harvard Univ. Press, Cambridge, 1971); B. Johnson, *Marihuana Users and Drug Subcultures* (Wiley, New York, 1973); J. Kaplan, *Marihuana—The New Prohibition* (New World, New York, 1970). The view that marihuana is the first drug in drug use is arbitrary and derives from the fact that other substances, such as alcohol and tobacco, often are not regarded as drugs, probably because they are legal. [H. Nowlis, *Contemp. Drug Prob.* **1**, 3 (1971–1972); National Commission on Marihuana and Drug Abuse, *Drug Use in America: Problem in Perspective*, (Government Printing Office, Washington, D.C., 1973)].
2. C. Ball, C. D. Chambers, M. Ball, *J. Crim. Law* **59**, 171 (1968); C. Chambers, *An Assessment of Drug Use in the General Population* (New York State Narcotic Control Commission, Albany, 1971); D. Glaser, J. A. Inciardi, D. V. Babst, *Int. J. Addict.* **4**, 145 (1969); B. Johnson, *Marihuana Users and Drug Subcultures* (Wiley, New York, 1973); L. Johnston, *Drugs and American Youth* (Survey Research Center, Michigan, 1973); M. A. Lavenhar, E. A. Wolfson, A. Sheffet, S. Einstein, D. B. Louria, in *Student Drug Surveys*, S. Einstein and S. Allen, Eds. (Baywood, Farmingdale, New York, 1972), p. 33; L. Robins, H. Darvish, G. Murphy, in *The Psychopathology of Adolescence*, J. Zubin and A. Freedman, Eds. (Grune & Stratton, New York, 1970), p. R. Weppner and M. H. Agar, *J. Health Soc. Behav.* **12**, 10 (1971).
3. These stages involve movement from one type of drug use to another, and not movement (or increased involvement) within a specific drug class, as has been described for alcohol [E. M. Jellinek, *Q. J. Stud. Alcohol* **13**, 673 (1952)] or heroin [I. Chein, D. L. Gerard, R. S. Lee, E. Rosenfeld, *The Road to H* (Basic Books, New York, 1964); I. Alksne, L. Lieberman, L. Brill, *Int. J. Addict.* **2**, 221 (1967); A. Wickler, *Br. J. Addict.* **57**, 73 (1961)]. The specific number of stages that are identified is somewhat arbitrary and depends on the classification of drug behaviors considered in a particular analysis.
4. Usable questionnaires were obtained from 8206 adolescents at time 1 and 7250 at time 2. The samples at each wave have been weighted to reflect the variable probabilities of selection of schools and homerooms and the response rates in each school. The follow-up, after the students were graduated from high school, was carried out by mail and by telephone, and produced a response rate of 69 percent. By means of self-generated identification code numbers [D. Kandel, *Science* **181**, 1067 (1973)], 66 percent of the high school students sampled in the fall (time 1) could be matched to themselves in the spring (time 2), and 60 percent of the seniors surveyed in the spring (time 2) could be matched to themselves after graduation (time 3). Thus, legal and ethical considerations in drug research dictate the use of a record linkage scheme in which a substantial portion of the students surveyed cannot be matched to themselves over time. Since unmatched cases contain a higher proportion of drug users than matched ones, the high school panel sample from time 1 to time 2 was weighted to reproduce the frequency of marihuana use observed at time 1 in the total cross-sectional sample.
5. L. Guttman, in *Measurement and Prediction*, S. A. Stouffer, L. Guttman, E. A. Suchman, P. S. Lazarsfeld, S. A. Star, J. A. Clausen, Eds. (Wiley, New York, 1950), p. 60.
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7. The index of reproducibility reflects the ability of scale scores to predict the scores of individuals on each of the items included in the scale. The lower acceptable limit is .90 (*5*). The number of drug use responses classified as errors in the scale fell well within acceptable limits, as reflected in the high value (.98) of the index of reproducibility. The index of scalability adjusts the reproducibility criterion by the minimal and maximal degrees of reproducibility possible given the item marginals. The acceptable lower limit is [H. Menzel, *Public Opinion Q.* **17**, 268 (1953)].
8. A very small group of former nonusers starts exclusively with cigarettes or hard liquor: 5 and 2 percent, respectively, in the high school cohort.
9. For those youths who start to use more than one legal drug within the follow-up periods, the order in which they try the various legal drugs is not known. These multiple legal drug starters were distributed into a sequential order on the assumption that the proportion using a particular legal drug first in that group within the follow-up interval reproduced the proportion of known exclusive starters of that drug.
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11. D. Kandel and R. Faust, *Arch. Gen. Psychiatry* **32**, 923 (1975).
12. This work was supported by National Institute on Drug Abuse research grant DA-00064. R. Faust participated in the earlier stages of the analysis. S. Paton assisted in the preparation of the tabulations. I thank E. Kandel for critical reading of the manuscript.

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Pattern Discrimination After Lesions of the Visual Cortex

Dru *et al.* (*1*) recently reported that "self-produced locomotion" during the interoperative interval between two-stage lesions of the "visual cortex" spared the capacity of rats to reacquire a preoperatively learned pattern discrimination. While we are inclined to agree that interoperative experience may be an important variable in recovery of function after serial lesions, we are concerned that the lesions that Dru *et al.* depicted in their report do not permit the conclusion that "recovery of pattern vision after sequential removal of visual cortex is probably a consequence of functional reorganization of brain areas not primarily responsible for visual capacity."

In our opinion, the largest and smallest lesions shown in their figure 1 represent damage to areas 2 and 7, possibly areas 1, 3, 4, and 39, and only the anterior portions of areas 17 and 18, according to the topography of Krieg (*2*). In any case, their figure appears to show considerable sparing of primary and secondary visual cortex. Furthermore, the classical criterion of demonstrating total degeneration of the lateral geniculate body was omitted from the study. As long ago as 1939, Lashley (*3*) showed that rats with only 2 percent of the geniculo-striate system intact could solve visual discrimination problems similar to the one employed by Dru *et al.*

Based on the evidence from Lashley's investigations, we find it difficult to accept the above-stated conclusion of Dru *et al.* There is sufficient evidence to indicate that recovery of function after serial lesions of structures of the central nervous system is a viable phenomenon (*4*); however, before concluding that "extravisual" structures take over the function of visual cortex, Dru *et al.* should present detailed evidence for complete degeneration of the lateral geniculate body. In addition, if they wish to demonstrate that their effect is related to *inter*operative experience, animals with