

Soft Drug Sequencing among a Sample of Alabama Youth: A Longitudinal Analysis

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In testing a modified version of Kandel's (1975) drug sequencing hypothesis, the study addressed two current weaknesses in the drug sequencing literature, namely, the empirical ambiguity of the role of cigarette initiation in drug sequencing and the lack of temporal ordering in the initiation of multiple drugs. It was expected that of the American youth who initiated soft drug use, alcohol was the first drug initiated. Among the subsample of juveniles who went onto use other soft drugs, it was expected that cigarette onset occurred next. Finally, it was expected that a small proportion of alcohol and cigarette initiates would go on to initiate marijuana use. This hypothesis was tested using secondary, longitudinal data derived from 283 youth who completed Waves 1-9 of the Mobile Youth Survey. Guttman scalogram analysis was utilized to arrive at the results. Articulated are the findings, which yielded no statistical support for the hypothesized sequence. Also discussed are the implications that the results have for school drug prevention programs.

Keywords: stage theory, drug Initiation, youth drug use, drug sequencing, soft drugs

Alcohol, cigarette, and marijuana (i.e., soft drugs) use remain three of the most prevalent forms of drug use among youth in the U.S. (Johnston, O'Malley, Bachman, & Schulenberg, 2007). Although initiation rates have declined in the U.S. recent years, current soft drug initiation levels are still very high compared to those observed in the early 1990s. Today, as many as 75% of American 12th grade students have initiated alcohol use, nearly 50% have initiated cigarette use, and slightly more than 40% have initiated marijuana use (Johnston et al., 2007). National, cross-sectional data also suggest that soft drug involvement is hierarchical and sequential in nature. Among U.S. adolescents who initiate all three drugs, alcohol tends to be initiated first by many youth, followed by cigarettes, and then marijuana (Office of Applied Studies, 2005).

Kandel's (1975, 2002) stage theory constitutes the sole theoretical statement concerning the time-ordered and hierarchical phenomenon of drug involvement.

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The theory contains two components: a drug sequencing hypothesis, the focus of the current research, and a number of propositions concerning why progression in the hypothesized drug sequence occurs. According to the drug sequencing hypothesis, drug involvement is a continuum that is comprised of three discrete stages. Involvement begins with the most socially acceptable drugs, alcohol or cigarettes (Stage 1), proceeds to marijuana use (Stage 2), and finally to illegal, hard drugs (Stage 3), the least socially acceptable psychoactive drugs. This sequence is hierarchical in nature, whereby movement from one stage to the next is experienced by successively fewer numbers of individuals. Although less developed than the drug sequencing proposition, Kandel argued that progression in the sequence is determined by drug-specific risk factors that uniquely predict the use of a given drug at one stage, but not the initiation of other drugs at other stages.

Empirical research generally supports Kandel's drug sequencing hypothesis (Kandel, 1975; Ellickson, Hayes, & Bell, 1992; Howell, 2010). However, two glaring gaps in the literature are worthy of attention. Empirical ambiguity exists with respect to the role and importance of cigarette initiation. A number of past tests never examined cigarette initiation separately from alcohol initiation (Golub & Johnson, 2001, 2002), while several studies never considered the role of cigarette initiation in the sequence (Martin, Kaczynski, Maisto, & Tarter, 1996). Further, some research suggests that cigarette initiation does not constitute a distinct stage in Kandel's drug sequence (Huba, Wingard, & Bentler, 1981), while a limited number of cross-sectional and longitudinal findings suggest that alcohol initiation occurs prior to cigarette initiation (Ellickson et al., 1992).

Second, the bulk of prior studies used Guttman scalogram analysis to test Kandel's drug sequencing hypothesis. Since most of this research used cross-sectional data (see Howell, 2010), the temporal ordering in the initiation of multiple drugs was not assured; Guttman scale, infers, but does not ensure, that temporal ordering in the initiation of multiple drugs exists (Menzel, 1953). Only three past longitudinal Guttman tests took advantage of prospective data (Kandel, 1975; Andrews, Hops, Ary, Lichtenstein, & Tildesley, 1991; Ellickson et al., 1992).

In order to address current weaknesses in the drug sequencing literature, namely, the empirical ambiguity of the importance and role of cigarette initiation and the lack of assurance of the temporal ordering in the initiation of multiple drugs, the current study used longitudinal data on cigarette initiation, alcohol initiation, and marijuana initiation to test a modified version of Kandel's (1975) drug sequencing hypothesis. Drawing upon past

research, it was hypothesized that among youth who initiate soft drug use, the most common hierarchical pattern of initiation was one in which alcohol initiation occurs prior to cigarette initiation, and cigarette initiation occurs prior to marijuana initiation.

Method

The hypothesis was tested with secondary, longitudinal, self-report data derived from the Mobile Youth Survey (MYS). The MYS is a community-based, longitudinal, multiple cohort survey of youth ages 9-19 years who reside in 13 impoverished neighborhoods in the Mobile, Alabama, USA, metropolitan statistical area (Bolland, 2007). Approximately 73% of the residents in this statistical area lived beneath the poverty level; the median household income was reported to be \$5,000. About 95% of the residents in the targeted neighborhoods identified as African-American and roughly half ($n = 7$) of the 13 targeted neighborhoods constituted public housing.

Since its' inception in 1998, the MYS aims to monitor the prevalence and incidence of antisocial attitudes and behaviors and inform attendant prevention interventions (Bolland, 2007). The 406-item instrument is administered on an annual basis in public buildings (e.g., schools and churches) that are located in respective neighborhoods. Both active parent/guardian and juvenile informed consent were secured prior to youth participation.

Over 8,000 youth have participated in the MYS since 1998. The survey's sampling frame was derived as follows. Housing authorities in the Mobile, Alabama, USA, metropolitan statistical area provided the research team with a list of households in the cities of Mobile and Prichard in which children and adolescents 10-18 years were listed on the lease. While the target age was between 10 and 18, ten-year-olds who had birthdays prior to August 30 and 19-year-olds whose birthdays were after June 1 were also allowed to participate in the study. Of the households with youth, 50% were selected and contacted. As there was no list available for those living in non-public housing neighborhoods, half of the residences were selected and contacted to determine if there were youth residing in a household. Youth from non-targeted communities were also recruited into the study by means of responding to posted fliers and word of mouth. For the present study, self-report responses from a subsample of the MYS participants, 297 youth, were utilized. These juveniles constituted those MYS participants who were 9-11 years of age when they began participation in the MYS in 1998 (Wave 1) and who were followed annually until 2006 (Wave 9).

In order to test the hypothesis, three dichotomous variables, alcohol initiation, cigarette initiation, and marijuana initiation were developed using three items on the 1999-2005 MYS that ask respondents to notate whether they have initiated each respective soft drug. In particular, youth who notated initiating a given soft drug were ascribed a “1” (initiation) for that particular drug, while those who notated that they “never used” the given drug were coded a “0” (abstention). Guttman scalogram analysis was used to test the hypothesis. The overarching purpose of this analytic technique is to determine whether scale items (e.g., individual types of soft drugs) capture progressively higher levels of a unidimensional, latent construct (e.g., soft drug involvement).

Scale Development

Following common convention (Ellickson et al., 1992), scalogram analysis was restricted to youth who provided useable initiation data for all three soft drugs. Specifically, analysis was restricted to youth who were either 9, 10, or 11 years at Wave 1 and who provided data on whether they initiated each soft drug during Wave 1 and subsequent Waves. Initiation data for juveniles who had missing data on one or more items was excluded.

Among respondents who notated an age of initiation for two soft drugs, the ages at which these drugs were initiated were taken into account in coding their response patterns. A “1” was used to signify the drug that was initiated first and a “2” to signify the drug that was initiated second. Finally, response patterns for juveniles who self-reported initiation data for all three soft drugs also reflected the temporal order in which these drugs were initiated. Drug initiation ties occur when two or more drugs are initiated at the same biological age. Following other researchers (Yamaguchi & Kandel, 1984), respondents with three-way ties (i.e., biological age ties for all three soft drugs), were excluded from analysis, since it is not possible to identify any sequencing pattern in soft drug initiation. Since 14 respondents self-reported three-way ties, employing this elimination procedure reduced the sample for the current study by roughly 5%, from 297 youth to a final sample of 283 juveniles.

All Guttman scales contain some error, so two coefficients were used in evaluating how much deviation from a perfect scale is tolerable. The *coefficient of reproducibility* (CR) indicates how well one can reproduce (or predict) a youth’s scale item responses given only knowledge of the respondent’s scale score (McIver & Carmines, 1982). With CR ranging from 0-1, a $CR \geq .90$ constitutes the minimum standard of acceptability (Guttman,

1950). The *coefficient of scalability* (CS) reflects the degree to which responses to scale items can be predicted given only knowledge of the marginal frequencies (Smith, 1968). Hence, as a second measure of scalability, the CS does not take into account scale scores, but takes into account the marginal frequencies of scale item responses. Ranging from 0 to 1, an indicator of scalability is $CS \geq .60$.

Results

Sample Descriptives

Of the 283 juveniles included in the analysis, about 37% ($n = 104$) reported two-way drug initiation ties. Specifically, 24% ($n = 67$), 7% ($n = 19$), and 6% ($n = 18$) reported the same biological age for alcohol and cigarettes, cigarettes and marijuana, and alcohol and marijuana initiation, respectively. Following the lead of other researchers (Yamaguchi & Kandel, 1984), these two-way ties were broken, whereby the proportion of cases initiating each soft drug was calculated using the temporal initiation data from the untied cases. Taking these initiation proportions into account, youth who reported alcohol-cigarette ties were deemed as having had initiated alcohol first. Youth who had cigarette- marijuana ties were noted as having had initiated cigarettes first, and juveniles who reported alcohol-marijuana ties were deemed as having initiated alcohol first.

With these two-ties broken, the useable sample can be described as follows. Roughly 22% ($n = 62$) were complete abstainers (from all three drugs), while 78% ($n = 221$) of the sample initiated at least one soft drug. Among the soft drug initiates, 93% ($n = 206$), 71% ($n = 157$), and 47% ($n = 103$) reported alcohol, cigarette, and marijuana initiation, respectively.

Drug Initiation Sequences

Table 1 presents the soft drug sequencing behavior among the 221 youth who reporting initiating one or more soft drugs. These sequences take into account the temporal ordering of initiation. The majority of the soft drug initiates were polydrug initiates. Specifically, 0.9% ($n = 2$) of soft drug initiates reported marijuana initiation only, 5.4% ($n = 12$) of initiates indicated cigarette initiation only, and 21% ($n = 47$) of initiates only initiated alcohol use.

Table 1

Temporal Ordering in Soft Drug Sequences

Observed Sequences	<i>n</i>	% of Soft Drug Initiates (<i>n</i> = 221)	% of Sample (<i>N</i> = 283)
<i>Began with Alcohol Initiation...</i>	181	81.9	63.9
Alcohol → Cigarettes → Marijuana	58	26.2	20.4
Alcohol → Cigarettes	52	23.5	18.4
Alcohol only	47	21.2	16.6
Alcohol → Marijuana → Cigarettes	7	3.1	2.4
Alcohol → Marijuana	17	7.6	6.0
<i>Began with Cigarette Initiation...</i>	35	15.8	12.4
Cigarettes → Alcohol → Marijuana	11	4.9	3.8
Cigarettes → Alcohol	8	3.6	2.8
Cigarettes only	12	5.4	4.2
Cigarettes → Marijuana → Alcohol	1	0.5	0.4
Cigarettes → Marijuana	3	1.4	1.1
<i>Began with Marijuana Initiation...</i>	6	2.7	2.1
Marijuana → Alcohol → Cigarettes	3	1.4	1.1
Marijuana → Alcohol	1	0.5	0.4
Marijuana → Cigarettes → Alcohol	1	0.5	0.4
Marijuana → Cigarettes	1	0.5	0.4

The soft drug initiation sequence outlined in the hypothesis was supported, from a percentage frequency perspective. As illustrated in Figure 1, the hypothesized sequence was found to be the most common, with transitions in the sequence (i.e., cumulation in drug initiation) experienced by successively smaller numbers of youth. Taking into account the temporal ordering of initiation, the majority (82%) of soft drug initiates began soft drug use with alcohol. Comparatively, only 15.8% of initiates began soft drug use with cigarettes.

The second drug most commonly initiated was cigarettes. Among those who initiated two or three soft drugs (*n* = 163), 69% (*n* = 112) initiated cigarettes second, compared to 14% (*n* = 23) and 17% (*n* = 28) who initiated alcohol and marijuana use second, respectively. Among the 134 alcohol

initiates who initiated a second drug, 82% ($n = 110$) initiated cigarette use. Finally, a total of 81 youth (28.6% of the sample) initiated all three soft drugs. Of these polydrug initiates, 85% ($n = 69$) initiated marijuana last, with roughly 72% ($n = 58$) of these youth exhibiting the hypothesized soft drug initiation sequence.

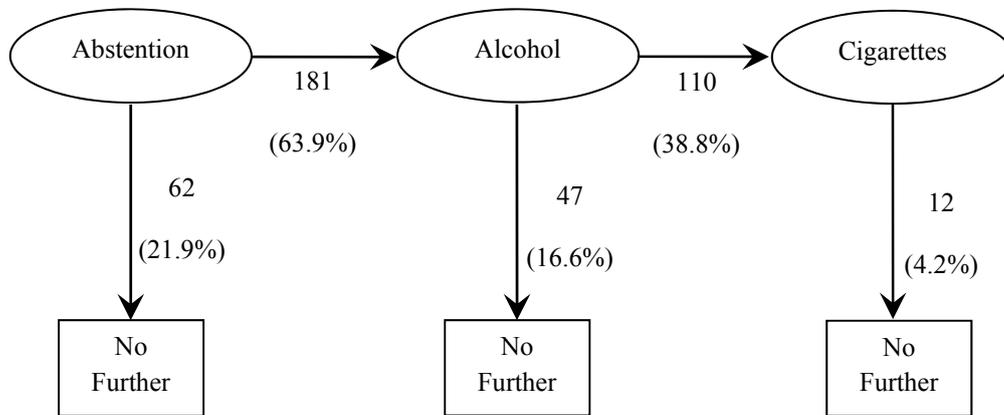


Figure 1. This transition diagram depicts the hypothesis, the most common soft drug initiation sequence found in the data ($N = 283$).

Although the hypothesized soft drug initiation sequence was the most common, a proper test of this hypothesis required that the CR and CS be calculated. A CR of .84 was produced, a value that falls just shy of the .90 minimal acceptability benchmark offered by Guttman (1950). A CR of .84 means that not only can one predict with 84% accuracy the scale item responses of a given youth simply by knowing that respondent's scale score, but the initiation sequence outlined in the hypothesis also can be predicted with 84% accuracy given knowledge of youths' scale scores. The CS for the hypothesized soft drug initiation sequence was 0.470, a value that does not meet the minimal scalability benchmark of 0.600 suggested by Menzel (1953) and, therefore, indicates that the soft drug scale items are not very scalable. In other words, this coefficient means that 47% of the total possible errors actually were not errors, but were responses consistent with those hypothesized. In sum, these indices indicate that although the most common soft drug initiation sequence identified in the data was that which was hypothesized, the CR and CS fell short of the threshold for minimal acceptability.

Discussion

The purpose of the study was to test a modified version of Kandel's (2002) sequencing hypothesis using longitudinal data from American youth. In particular, it was hypothesized that the most common hierarchical pattern of soft drug initiation among youth is one in which alcohol initiation occurs prior to cigarette initiation, and cigarette initiation occurs before marijuana initiation. This hypothesis was rejected, as the CR value (.84) obtained for the temporal ordering scale fell just shy of the minimum acceptability benchmark (CR = .90), while the CS value (.47) produced did not meet the minimum value of acceptability (CS = .60).

In testing the hypothesis (alcohol > cigarette > marijuana initiation), the current study made two general contributions to the literature. First, there is some empirical ambiguity with respect to the sequencing of alcohol and cigarette initiation. Some studies have found that cigarette initiation precedes alcohol initiation, while other research obtained the opposite results (see e.g., Huba et al., 1981). The current study aimed to provide some clarity on this issue. Second, through a review of prior investigations of soft drug sequencing, it became evident that the bulk of the extant research that used Guttman scalogram analysis did not ensure the temporal ordering of polydrug initiation. Guttman scalogram analysis only infers temporal ordering in drug initiation sequences. Since the element of time clearly is evident in Kandel's hypothesis, the current research addressed this literature gap, by utilizing age of initiation data in testing the hypothesis.

While the hypothesis was rejected on statistical grounds, given that the CR and CS values did not meet the minimum values of acceptability, the descriptive findings of our research suggest that the results *favor* the hypothesized sequence. The most common soft drug initiation sequence was alcohol > cigarettes > marijuana. In general, these soft drugs tended to be initiated at discrete biological ages, with alcohol use initiated prior to cigarettes, and cigarette use initiated prior to marijuana use. Descriptive data also indicated that this soft drug sequence contains some cumulative and hierarchical properties, as each successive transition in this sequence was experienced by fewer youth. For example, more juveniles initiated alcohol use only than initiated alcohol and cigarettes, while more youth also initiated both alcohol and cigarette use than all three soft drugs.

This descriptive support for the hypothesis not only underscores the importance for future research is further reinforced when several theoretical and empirical issues are considered. On the theoretical front, the results

provide evidence for the internal validity of Kandel's sequencing proposition, in finding that the initiation of legal drug use tends to occur prior to marijuana initiation. Further, the findings generally converged with those from four longitudinal, prospective studies (Kandel, 1975; Andrews et al., 1991; Ellickson et al., 1992; Hawkins, Hill, Guo, & Battin-Pearson, 2002), in indicating that alcohol initiation typically occurs prior to cigarette initiation for most adolescents who initiate legal drug use. In turn, cigarette initiation tends to occur prior to marijuana initiation among those adolescents who initiate marijuana use. Since these results from prior research are based upon soft drug initiation data from a sample of urban youth, and most investigations of the utility of Kandel's sequencing hypothesis utilized data from suburban and urban adolescents, the descriptive findings also tend to cross-validate the findings of previous research using urban samples of youth. However, given the low CS and CR values that we obtained, it is suggested that future research cross-validate our findings using a similar longitudinal sample.

Drug Prevention Implications

In recent years in the U.S., the drug prevention budgets of American public schools have become constrained (Pentz, 1996; Drug Strategies, 1999; Carnevale Associates, 2006, 2007). Given this, it appears reasonable, from both an economic and empirical perspective, that a potentially promising way to prevent or delay adolescent involvement in soft drug use may be to focus the bulk of attention on preventing (or delaying) alcohol initiation. The descriptive findings from our study lend credence to this policy proposal.

A number of evaluations of school-based drug prevention programs also support this approach to soft drug prevention, in finding that directing explicit efforts toward preventing or delaying alcohol initiation among youth, particular among early adolescents, can prove beneficial in indirectly working toward preventing (or delaying) cigarette and marijuana initiation (Botvin, Griffin, Diaz, Scheier, Williams, & Epstein, 2000; Hawkins et al., 2002). In directing efforts to prevent alcohol initiation, for example, the comprehensive, school-based drug prevention program, "Life Skills Training," has been shown to reduce alcohol incidence rates among 7th, 8th, and 9th grade students (Botvin, Baker, Renick, Filazzola, & Botvin, 1984), as well as prevent and delay cigarette, marijuana, and hard drug initiation for up to three years later (Botvin, Baker, Dusenbury, Tortu, & Botvin, 1990; Botvin, Baker, Dusenbury, Botvin, & Diaz, 1995; Botvin et al., 2000). Etiological research also suggests that directing prevention efforts toward targeting risk factors for alcohol initiation, particularly during the elementary

school years, may be an effective strategy for preventing progression in the soft drug sequence (Kandel, Yamaguchi, & Chen, 1992; Hawkins et al., 2002; Pentz & Li, 2002).

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