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**Assessing the “Gateway Hypothesis”
Among Middle- and High- School Students in Tennessee**

Tae Choo
Assistant Professor of Criminal Justice Administration
Middle Tennessee State University
Murfreesboro, TN 37132
(615) 898-2264
tmchoo@mtsu.edu

Sunghoon Roh
Assistant Professor
Department of Political Science & Criminal Justice
Appalachian State University
Boone, NC 28608-2107
(828) 262-6345
rohs@appstate.edu

Matthew Robinson
Associate Professor of Criminal Justice
Appalachian State University
Boone, NC 28608
(828) 262-6560
robinsnmb@appstate.edu

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Abstract

The current study examines the applicability of the “gateway hypothesis” to drug use patterns of secondary school students from a non-metropolitan area in Tennessee. The data were collected from students in the 8th, 10th, and 12th grades at three secondary schools, using self-administered questionnaires under supervision of teachers. Although there is some support for the gateway hypothesis in our data, there is also evidence that what differentiates those who move from initial marijuana use to use of harder drugs are risk factors unique to individuals and their environments, consistent with the predictions of theories such as problem behavior theory. Implications for various interpretations of the gateway hypothesis are discussed.

Introduction

The “gateway hypothesis” posits a sequence of illicit drug use that begins with experimentation with alcohol and tobacco, moves on to early marijuana use, and then continues on with use of harder drugs such as cocaine and heroin. The latter drug use can lead to criminal careers to support drug habits. The gateway hypothesis underlies much of current U.S. drug policy; even the most recent version of the President’s National Drug Control Strategy states that “using marijuana has been found to increase the risk for abuse and dependency on other drugs such as heroin and cocaine later in life” (Office of National Drug Control Policy, 2007: 5).

The Office of National Drug Control Policy (ONDCP) – the federal agency of accountability in the drug war – has long claimed that marijuana is a gateway drug, and cites as evidence the fact that most users of hard drugs like cocaine and heroin first used marijuana. There are, in fact, at least seven interpretations of the data (MacCoun, 1998). Of the seven interpretations of the data, five of them can be considered unique theories of a gateway effect.

The first theory asserts that marijuana use is a warning sign for the likelihood of future use of other illicit drugs (Boyum & Reuter, 2005). While it is true that most users of harder drugs first use marijuana, it is also true that most users of marijuana never move on to harder drugs. That is, it is not typical for marijuana users to go on to harder, more dangerous, and more expensive drugs (Golub & Johnson, 2002). Thus, utilizing marijuana consumption to predict future use of other illicit drugs would most often lead to false positives. Further, those marijuana users who do go on to eventually use other illicit drugs may be significantly different than those who do not, based on genetic propensity and numerous social and environmental conditions (Agrawal et al., 2004a, 2004b; Robinson, 2004; Hall & Lynskey, 2005). This suggests it might be the user and the contexts in which drugs are used that is the problem rather than the drug marijuana.

The second theory – similar to the first – states that marijuana use almost always precedes the use of other drugs, and that it is marijuana use itself that is responsible for use of

other drugs. The notion that illicit drug use often begins with marijuana is well-supported by research (Ellickson, Hays, & Bell, 1992; Golub & Johnson, 2001). However, since marijuana is the most available illicit drug according to surveys of high school youth, the most widely used illicit drug in the United States, and easily the least harmful of the major illicit drugs, it is logical that illicit drug use would begin with marijuana (Robinson & Scherlen, 2007).

If initiation into drug use was due to the nature of marijuana – i.e., the psychopharmacological effects of the drug on the brain and on human behavior – it would justify placing blame on the drug itself. However, much evidence suggests there is no causal relationship between marijuana use and eventual use of other illicit drugs (Morral, McCaffrey, & Paddock, 2002). This is because other factors, such as individual propensities and environmental opportunities, largely determine which marijuana users will go on to use harder drugs (Boyum & Reuter, 2005).

The third theory is more specific and states that experimentation with marijuana reduces the *perceived risks* of use of other illicit drugs. The logic of this theory is that, upon initiation of marijuana use, individuals who do not experience the negative outcomes they may expect to result from smoking marijuana, may become emboldened to take the next step to the use of other drugs. Although this makes sense, it may be so only because of exaggerated threats of marijuana promulgated by ONDCP and other agencies (Robinson & Scherlen, 2007). That is, to whatever degree people's experiences with marijuana use do not match the horrific outcomes predicted by ONDCP, we should expect users to also question the validity of claims related to the risks of other drugs. Under these circumstances, continued use of illicit (and harder) drugs would be more likely. In this scenario, the blame would not fall on the nature of the drug marijuana, but would rather more logically fall on how its harms are exaggerated by drug control agencies.

The fourth theory states that experimentation with marijuana somehow lures the intoxicated user toward experimentation with other illicit drugs, due to impaired thinking of the person under the influence of marijuana. This theory posits that it is the condition of being

“high” – the actual psychopharmacological effect of the drug on the brain – that contributes to the use of other drugs. Interestingly, longitudinal research has shown that the first steps in drug use are alcohol and tobacco, two legal drugs that are widely celebrated in American society and inappropriately advertised to young people. Users under the influence of at least one of these drugs – alcohol – are more likely to experiment with other substances, including, but not limited to, marijuana. Thus, the first likely step in the path toward drug abuse and addiction is the legal drug alcohol, although other studies find it to be tobacco (Chen et al., 2002; McCambridge & Strang, 2005; Biederman et al., 2006). Since young people who smoke their first cigarettes typically start under the legal age of 18 years, and those who drink alcohol almost always start before the legal age of 21 years, initiation into illegal drug use (i.e., marijuana, cocaine, heroin) actually tends to begin with a different form of illegal drug use (i.e., underage use of tobacco and alcohol).

The fifth theory states that use of an illegal substance like marijuana brings users into contact with sellers of harder drugs. This may be true, as people who sell marijuana may also sell other drugs (Office of National Drug Control Policy, 2006). ONDCP has utilized this same logic to link illicit drugs to crime: ONDCP explains that there are “crimes associated with a drug-using lifestyle” which result from drug users purchasing drugs from, as well as hanging out with, drug dealers who are typically involved in other crimes. This gateway effect is largely due to the illicit nature of marijuana, and could be reduced if users were not forced by law to obtain their drug via illegal means.

In this paper, we assess the applicability of the gateway hypothesis to drug use patterns of secondary school students from a non-metropolitan area in Tennessee. The primary purposes of the paper are to determine if drug use follows the sequence predicted by the gateway hypothesis (i.e., alcohol and tobacco, marijuana, then harder drugs such as cocaine and heroin) and to attempt to determine if early marijuana use itself can be blamed for later use of harder drugs. In our conclusions, we refer back to the five theories introduced above.

Literature Review

The concept of licit drug use as a precursor for illicit drug use was first introduced in the 1970s (Hamburg, Kraemer, & Jahnke, 1975; Kandel, 1975). The gateway hypothesis emerged during the 1980s and suggested that licit drugs, such as tobacco or alcohol, served as “gateway drugs” for other illicit drugs (e.g., marijuana, cocaine, and heroin). Kandel (2002: 4) wrote that the gateway hypothesis is “based on ... sequencing of initiation of use between drug classes, and association in the use of drugs such that use of a drug lower in the sequence increases the risk of using drugs higher in the sequence.” Kandel also stated “the basic premise of the developmental stage hypothesis is that involvement in various classes of drugs is not opportunistic but follows definite pathways; an individual who participates in one drug behavior is at risk of progressing to another.” The progressive sequencing from licit to illicit drugs, and the drug use pathways, is often referred to as the “gateway sequence.”

A number of early studies tested the gateway hypothesis, with findings that supported the gateway sequence. Both longitudinal and cross-sectional studies conducted with general populations in the U.S. and internationally supported a sequence of drug use progression, beginning with licit drugs (both alcohol and cigarettes), followed by illicit drug use (such as marijuana), and ultimately other “hard” drugs (Goldstein et al, 1975; Kandel, 1975; Kandel & Faust, 1975; Gove and Geerken, 1979; Adler & Kandel, 1981; Kaplan, Martin, & Robbins, 1984; Kandel, Yamaguchi, & Chen, 1992; Kandel & Yamaguchi, 1993; Kandel & Yamaguchi, 1999).

A 1994 report – “Cigarettes, Alcohol, Marijuana: Gateways to Illicit Drug Use,” published by The National Center on Addiction and Substance Abuse (CASA) – presented a comprehensive national analysis of drug use “among children and adults, as experimenters and regular users.” The report revealed consistent relationships between the use of licit drugs and marijuana, and subsequent use of other illicit drugs, regardless of the age, sex, ethnicity, or race of individuals involved. Earlier, Mills and Noyes (1984) found that drug use progression was a

cumulative process, meaning that as the progression of drug use advanced, users would simply add a new drug to their list.

More recent research has supported the gateway sequence. For example, one study of thousands of adolescents found that marijuana users were twice as likely as non-users to use illicit drugs as young adults. Although shared environmental factors mediated much of the relationship between adolescent marijuana use and drug use as a young adult, the association remained even when controlling for familial and other factors (Lessem et al., 2006). Another study, using data from the National Youth Survey, could not discount the possible causal influence of marijuana on other illicit drug use even after controlling for factors predicted by strain, social bonding, and differential association theories (Rebellion and Gundy, 2006).

Not all research supports the gateway hypothesis. A study of inner-city, predominantly lower-class, New York City heavy drug users, found that only 33% of drug users followed the gateway theory sequence (i.e., alcohol use/abuse to marijuana use/abuse to hard drug use/abuse) (Mackesy-Amiti et al., 1997). Golub & Johnson's (1994) research found that a majority of drug users examined from the general population were experimental users, and thus relatively few individuals proceeded to regular use of hard drugs (e.g. cocaine or heroin).

Other recent research calls into question assumptions related to the gateway hypothesis (Kandel, 2003). Most significantly, studies consistently show that variations in individual level factors (e.g., genetic make-up, personality traits) and environmental factors (e.g., drug availability, peer influences) help explain why young people initiate drug use and move on to additional forms of drug use later in life (Robinson, 2004).

Problem behavior theory (Jessor et al., 1973; Jessor and Jessor, 1997) suggests that what may explain progression from one drug to the next is not only the nature of the first drug used, but also factors in the various systems of which a person is part. That is, factors unique to some individuals, their key reference groups (e.g., peers and families), community specific factors (e.g., levels of poverty and social disorganization in a neighborhood), organizational factors (e.g.,

schools, religion), and so forth, interact to increase the risks of antisocial behavior including drug use and abuse. Similarly, the main assertion of “integrated systems theory” is that numerous factors at various levels of analysis – from cell to society – impact the likelihood of antisocial behavior, including drug use (Robinson, 2004).

Genetic variability accounts for some amount of drug use behaviors (Agrawal et al., 2004a, 2004b; Hall & Lynskey, 2005), as well as the likelihood of addiction (Collier, 2006; MacCoun, 2006). Other individual level factors, such as deviance proneness, are related to drug use (Tarter et al, 2006), as are other personality variables (e.g., impulsivity, negative emotionality, rebelliousness, low self-esteem, poor scholastic achievement, truancy, decreased academic aspirations and a lack of motivation) (Donovan & Jessor, 1983; Donovan & Jessor, 1985; Jessor et al., 1973; Johnston, 1973; Mellinger et al., 1976; Kandel et al., 1978; Smith & Fogg, 1978; Jessor and Jessor, 1997).

Group level factors relevant for drug use among adolescents include peer drug use, parental attitudes and behaviors, and lifestyle patterns (e.g., frequently going out at night) (Kokkevi et al., 2007). Numerous research findings reveal the influence of peer groups as the most dominant factor for an adolescent’s initiation and recent use of drugs (Brook et al., 1983; Kaplan et al., 1984; Johnson, et al. 1987; Bahr, et al. 1998; Garnier & Stein, 2002). However, family variables have also been identified as important (Kandel, 1990; Hawkins, Catalano, & Miller, 1992). For example, Hawkins, Catalano, & Miller (1992) recognized four characteristics within the family that influence an adolescent’s drug use: 1) bonding with family; 2) family management practices; 3) family conflict; and 4) family drug use.

Community level factors relevant for drug use behaviors include drug availability in neighborhoods and the popularity of specific drugs (Reid, Elifson, and Sterk, 2007; Tarter et al, 2006). For example, Jang & Johnson (2001) examined neighborhood disorder and drug use and found a significant influence of environmental factors on adolescents’ drug use.

We can group variables useful for predicting drug use into four categories: 1) demographic (gender, race, geographic location); 2) interpersonal (peers and family) (Oetting & Donnermeyer, 1998); 3) intrapersonal (sex, religiosity, lower grades, educational aspirations, minor delinquent activities, and the use of other legal drugs) (Margulies, Kessler & Kandel, 1977); and 4) social environment (neighborhoods and schools) (Oetting & Donnermeyer, 1998).

As the review of the numerous studies above shows, there are many factors relevant for explanations of why individuals begin utilizing drugs, as well as why they progress from relatively minor illicit drugs to harder drugs. Yet, the implications for the gateway hypothesis remain unknown. Our research may shed some light on to the issue of why some youth initiate drug use and move on to harder drugs, and why some do not. Further, since our research is conducted in a non-metropolitan area, it offers an analysis of drug use trends in rural America, where most Americans live (Paulsen and Robinson, 2004).

Methods

Data and sample

Most research into the gateway hypothesis has used nationwide or statewide surveys of metropolitan areas. In our analysis, we test whether the gateway sequence applies to a non-metropolitan area. This study was initially prepared to assist in developing a blueprint of drug control and prevention programs for youths in a single community: Murfreesboro, Tennessee, located in Rutherford County. Murfreesboro has around 84,000 residents, and Rutherford County is inhabited by approximately 213,000 people.

The study is based on data from the second-annual survey on the use of Alcohol, Tobacco, and Other Drugs (ATOD) at three county schools: one middle and two high schools in the non-metropolitan city. It was sponsored by the Community Anti-Drug Coalition of Murfreesboro, Tennessee (CADCOM).

The survey was conducted in three public middle and high schools and consisted of 869 students from the 8th, 10th, and 12th grades. The participation rate was 40.2% among all students enrolled in those schools. Most participating students (95.3%) were aged between 12 and 18 years. Eight hundred and one participants indicated grade level, and included 215 8th graders (26.8%), 365 10th graders (45.6%), and 221 12th graders (27.6%). The grade representation showed an over-sampling of 8th graders and under-sampling of 12th graders compared to the total enrollment; 20% of 8th grade, 46% of 10th grade, and 34% of 12th grade. In response to race/ethnicity, 76.7% of the 862 respondents were White, and 13.3% African American; other minority groups were smaller in size: Hispanic/Spanish/Latino (2.6%), Asian or Pacific Islander (4.4%), American Indian/Native Indian, Eskimo or Aleut (1.3%), or other mixed race (1.5%). The racial proportion was very similar to that of total enrollment. Among total number of enrolled students, 76% were Whites, 16.6% were African Americans, and 7.4% were other minorities. In terms of gender, 57.5% were female and 42.5% were male. The sample slightly over-represented female students compared to total enrollment ratio of 50.3% of females. The majority (96.9%) of respondents spoke English.

The administered survey questionnaire was a modified version of the “Community that Cares Survey” (similar to the “Monitoring the Future” survey). Some questions measuring protective factors were omitted to focus on risk factors. Family risk factors that included several family variables were added (i.e., history of drug use among family members, parents’ educational level, and parents’ marital status).

The questionnaire measured use of alcohol, cigarettes, and nine other drugs. Alcohol use was defined as “had more than a few sips of beer, wine, or hard liquor (such as vodka, whiskey, or gin).” Cigarette use was defined as “any experience involving smoking a cigarette.” Other drugs included were: 1) Smokeless tobacco (chew, snuff, plug, dipping tobacco, chewing tobacco); 2) Inhalants (sniffed glue, breathed the contents of an aerosol spray can, or inhaled other gases or sprays in order to get high); 3) marijuana (grass, pot) or hashish (hash, hash oil); 4)

Ecstasy; 5) Methamphetamine (meth, crystal meth, crank); 6) LSD (acid) or other psychedelics; 7) Club drugs: Rohypnol, GHB, Peyote, PCP, or Ketamine; 8) Cocaine; and 9) Heroin.

To collect data, a self-report survey questionnaire was administered to the participating schools. Before conducting the survey, CADCOM personnel contacted administrators in the Rutherford County middle and high schools to gain permission for the survey research. After receiving support from the school administrators, a permission slip was distributed to students in those middle and high schools to give to parents. The survey was administered only to students who returned the permission slips with parental or guardian consent for participation. The survey was conducted within the classroom, and was supervised by both teachers and CADCOM personnel.

Data analysis

We examined the risk of marijuana use and hard drug use over time using Cox Proportional Hazard Regression. Cox regression can consider the amount of time taken for a critical event (e.g., a marijuana use and hard drug use in the current study) to occur, and can take into account censored cases for which the critical event has not yet occurred or may never occur (Tabachnick and Fidell, 2001). Cox regression also enables testing the effect of an independent variable upon time for event occurrence, while holding other variables constant (Cox and Oakes, 1984). The current study attempts to test the gateway hypothesis by investigating an independent effect of prior licit use and prior marijuana use upon the hazard of taking hard drugs, while taking into account other rival variables, including school commitment, peer influence, neighborhood influence, and family influence.

Cox regression treats a hazard rate as the dependent variable. The hazard rate is a risk of the terminal event occurrence per unit time for a case that has survived up to that time. The dependent variables of this study are a risk of marijuana use (“Marijuana use”) and risk of hard drug use (“Hard drug use”), which were measured by the ages of the first marijuana use and the

first use of any type of hard drug. Students who have not used either marijuana or any type of hard drugs are classified as censored cases for each dependent variable.

The independent variables include: 1) ATOD use prior to marijuana use (“prior licit”), 2) marijuana use prior to hard drug use (“prior marijuana”), and 3) sequential use of ATOD and marijuana prior to hard drug use (“prior licit to marijuana”). “Prior licit” was measured by the onset ages of alcohol, cigarettes, and smokeless tobacco. Cases were dichotomized by whether or not the earliest onset age of any use of alcohol, cigarettes, and smokeless tobacco preceded the age of the first marijuana use. Similarly, “prior marijuana” was coded “yes” if the initial use of marijuana use occurred before the first use of any hard drug, including Ecstasy, Methamphetamine, LSD, club drugs, cocaine, and heroin. Finally, the full gateway sequence from ATOD use to hard drug use mediated by marijuana use was measured by “prior licit to marijuana.”

Five groups of control variables were included in the analysis, based on the risk factors discussed in the literature review: 1) Demographics (gender and race); 2) School commitment (GPA and “Have you skipped school?”); 3) Peer influence (“Do you have a best friend who smokes marijuana or uses drugs?” and “Will your marijuana or drug use be seen cool by your friends?”); 4) Neighborhood factors (knowledge of any adult using marijuana or drugs, crime/drug selling within the community; and 5) Family variables (the family structure and parents’ drug use). Table 1 shows the description of all the variables included in the analysis.

Given the relevant variables included in each domain of the control variables, we suspected multicollinearity. The zero-order correlations are .13 for GPA and school skip, .32 for friend use and friend attitudes, .24 for neighborhood crime and neighborhood marijuana use, .29 for neighborhood crime and neighborhood drug use, and .49 for father drug use and mother drug use. None of them exceeds .50, which do not seem to cause a major concern for multicollinearity (See the Appendix for the correlation matrix).

[Insert Table 1 about here]

Results

The hazard function for marijuana use is displayed Figure 1. The plot illustrates the probability of smoking marijuana as a function of age. Overall hazard probability increases with age. Further, the amount of increase is greater for older students than for younger students.

Figure 2 shows the hazard function for hard drug use. Like marijuana use, the risk of drug use increases gradually as age increases. While the amount of increase in the risk of marijuana use is greatest between the ages of 15 and 16 years, the largest increase in the risk of drug use occurs from 14 to 15 years. This is consistent with evidence from national samples that illustrate drug use initiation in early adolescence.

[Insert Figure 1 and 2 about here]

Table 2 shows the result of Cox regression for risk of marijuana use. The first model includes three predictors: prior licit, gender, and race. Then, additional models were created by adding control variables to examine changes in coefficients as well as the goodness-of-fit. The order for entering the control variables followed the order of the survey questions. The goodness-of-fit in the models was assessed in two ways. First, the significance of the overall models was tested using the likelihood-ratio statistic that compared -2 Log Likelihood (-2LL) for the null model with that for the other models. Second, a chi-square test was conducted for the change in -2 LL from the previous model, to examine how the model was improved by the addition of variables. The significance tests for the overall models rejected the null hypothesis that all the coefficients equal zero. The change in -2 LL for the previous model was also significant in all models. While the addition of the family variables resulted in the smallest (but statistically significant) change ($\chi^2=17.93$, $df=7$, $p= .01$), the peer influence variables best improved the

model ($\chi^2=160.85$, $df=2$, $p=.00$). This finding is consistent with the large body of research showing peer influences to be important for explaining drug initiation.

[Insert Table 2 about here]

The first model shows that prior licit use is positively associated with the risk of later marijuana use. However, neither gender nor race was significantly related with the dependent variable. The hazard ratio for “prior licit” was 1.56 [$e^{.44}$], meaning that the risk of marijuana use was 1.56 times greater for a student who has a prior experience with licit drugs. Yet, the significant association between prior licit drug use and the risk of later marijuana use disappeared once the school commitment variables were included.

Model 2 shows that a lower GPA and truancy (school skip) predict a higher risk of marijuana use. The relative risk of marijuana use increased by a factor of 1.50 [$e^{.41}$] as GPA decreases by one level (e.g. from mostly A to mostly B). Additionally, the risk of marijuana use was 2.69 times greater for students who skipped school at least once than those who had never skipped, which represented a 169% increase [$(2.69-1)/1 * 100$] in the hazard rate. This is consistent with previous studies showing the importance of school level variables.

In Model 3, the peer influence variables and school commitment variables were found to be significant covariates. The strongest predictor for the risk of marijuana use is a best friend who smokes marijuana, with a 764% increase in the hazard rate if a student has such a friend. The risk of marijuana use is 1.77 times greater for the comparison group who believed their marijuana use would be seen cool by their peers than for the reference group. This is consistent with previous studies showing the importance of peer influences on behavior.

Model 4 added two neighborhood variables: “adult marijuana (ADULT_MJ)” and “neighborhood crime (NEIGH_CRIM)”. Both variables revealed a significant and positive association with the risk of marijuana use; if a student knew adult(s) who smoked marijuana or

lived in a neighborhood with crime and drug selling, the risk of marijuana use increased by 3.38 times and 1.61 times, respectively, as compared to the counterparts. While the school commitment and peer influence factors still remained significant after the introduction of the neighborhood variables, the association between race and the risk of a marijuana use was significant in this model. Being a non-white decreased the hazard rate by 30%. This change from the previous models can be understood from the positive correlation between race and the neighborhood variables. Non-white students were more likely to live in neighborhoods where contact with marijuana-smoking adults would occur (see the correlation matrix in the Appendix).

The neighborhood variables functioned as suppressors between race and the risk of a marijuana use. In other words, the association between race and the risk of a marijuana use was suppressed because of the positive correlation between marijuana use and the neighborhood and the positive correlation between race and the neighborhood variables. Once the neighborhood variables were controlled, however, the relationship between race and the marijuana risk became significant. These findings are consistent with previous studies showing the importance of neighborhood factors on drug use rates in communities.

Model 5 included all the predictors. The addition of the family variables did not result in much change in the relationships between the risk of marijuana use and the predictors in the previous model. Of the family variables, living with both parents showed a significant association with marijuana risk, but the other dummy-coded variables did not show any significant relationship with the dependent variable. The risk of marijuana use for students living with both parents was .47 times smaller than that for those who lived with a father only, a mother only, or others. This represented a 53% decrease in the hazard rate. This is consistent with previous studies showing family structure variables and drug use.

Table 3 shows the results of Cox regression for the risk of hard drug use. Prior use of marijuana, controlled only by gender and race, was significantly related with risk of hard drug use. Students with prior marijuana use showed a greater risk of hard drug use than those who had not

smoked marijuana. Prior marijuana use increased the hazard rate by 358%. This is consistent with the gateway hypothesis. Unlike the results for the risk of marijuana use, the association between prior marijuana use and the risk of hard drug use remained significant, even after the addition of the school commitment variables. Holding GPA and truancy constant, the risk of hard drug use is still 2.88 times greater for the group with prior marijuana use than for the reference group, although low GPA and school skipping increased the risk of hard drug use. In our sample, school variables do not explain away the relationship between early marijuana use and subsequent harder drug use.

[Insert Table 3 about here]

When the peer influence variables were introduced in Model 3, the significant relationship between prior marijuana use and the risk of hard drug use disappeared, suggesting a spurious relationship between marijuana and harder drug use. However, school commitment variables remained significant. The risk of hard drug use was 4.58 times greater for students with a best friend who used hard drugs, and 2.88 times greater for students who thought their use of hard drugs was perceived as “cool” by their peers as compared to each reference group. Model 4 revealed that knowing adult(s) who used hard drugs significantly increased the risk of hard drug use by students. Unlike the previous result for the risk of marijuana use, the neighborhood condition of crime and drug selling was unrelated with the risk of harder drug use. Furthermore, the introduction of the neighborhood variables did not make race a significant predictor.

The final model showed that the addition of the family variables hardly improved the model. The change in -2LL from Model 4 was not significant ($\chi^2=6.01$, $df=7$, $p= .54$). None of the family variables were significantly related with the risk of hard drug use. Only four predictors were found to be significantly related with the risk of hard drug use: GPA, a best friend using

hard drugs, perception of hard drug use being perceived as cool, and knowing adult(s) that used hard drugs.

Finally, an examination in the change in the risk of hard drug use by the gateway sequence from prior licit use to prior marijuana use was employed (see Table 4). Prior marijuana use was simply replaced with sequential use of licit drug and marijuana ("PRIOR_LIMJ") in the previous Cox Regression Analysis shown in Table 2. Results were similar to the findings in the previous analysis with prior marijuana use. If students used ATOD and then moved to marijuana use, the hazard of using hard drugs later was 3.55 times greater than the reference group. The significant relationship, however, disappeared as the peer influence variables were added in the model. Like the previous Cox regression results, the risk of hard drug use in the final model was found to increase as a student received a lower grade in school, had a best friend using hard drugs, thought use of hard drugs perceived as cool by peers, and knew adult(s) who used hard drugs.

[Insert Table 4 about here]

Conclusions and Implications for Theory

This study examined students' drug use pathways from secondary public schools in Murfreesboro, Tennessee to assess the gateway hypothesis. The results were mixed. We found that prior experience with mild drugs was associated with later use of stronger drugs (i.e., from alcohol to tobacco to marijuana and from marijuana to hard drugs). We also found evidence of a gateway sequence from licit drug use to marijuana and later use of hard drugs. However, these correlations were found to be contingent upon other variables, especially peer influences. Furthermore, a significant number of students who experienced licit drugs did not proceed toward the next level or further. It is the same case for students who smoked marijuana at an early age. About half of the total sample, and more than half from the high school subgroup, initiated drug use with licit drugs. Among those, only 15% progressed to marijuana and 3.5% proceeded to hard

drugs. Thus, 85% did not progress to marijuana and 96.5% did not progress to harder drugs. This was in direct opposition to the gateway hypothesis holding that marijuana use is responsible for the later use of harder drugs.

In terms of the five theories identified at the beginning of the paper, we conclude that our analysis is supportive of none of them. First, in our sample, marijuana use was not a warning sign for future drug use for the vast majority of those who used marijuana. Second, we cannot conclude that it is marijuana use itself that is responsible for use of other drugs. In this study, we found that the likelihood of drug use was related to numerous factors, including peer influences, school factors, neighborhood conditions, and family structure. While we could not assess the degree to which psychopharmacological effects of marijuana or perceived risk of marijuana use by students in our sample effected future drug use, there is enough evidence in our study to justify the conclusion that future drug use is likely produced by factors unique to individuals and their environments rather than to marijuana itself. Third, we also could not assess the effect of coming into contact with sellers of harder drugs; however, as we stated at the beginning, this is a factor created by prohibition.

Our analysis of drug use in a non-metropolitan area supports the main contention of problem behavior theory and integrated systems theory. There is evidence that factors unique to respondents' personality and perceived environment are significantly related to the likelihood of drug use. This is not supportive of any of the gateway theories, and suggests that what is responsible for later and harder drug use is not marijuana per se, but rather, is factors unique to individuals and their environments.

However, several methodological limitations of this study require cautious interpretation of the findings. First, the age range of the study sample is limited between 8th and 12th grade. The effect of licit use upon the use of marijuana or hard drugs may appear after 12th grade. The observation time in this study may not be long enough to find out a potential long-term effect of the licit use. Second, the variability of dependent variables is limited probably because of the

short observation period and the low response rate. Less than 10% of the sample said that they had used at least one type of hard drug, and about 28% had used marijuana. Limited variability in the dependent variables could hinder the detection of an association with predictors. Third, given the specific area where the sample was drawn (a suburb in Tennessee), the study findings are limited in generalizability. The findings in the current study might be generalized to locales with similar socioeconomic characteristics. Fourth, some parents may not consent to the survey for fear of being reported to law enforcement agencies if youths or their parents use drugs. The dropout from the study may bias the sample as well and likely lowers the representativeness of the sample. Finally, we approximate a longitudinal study in a cross-sectional survey by asking a retrospective question about the onset age. The responses may be inaccurate because of faulty memories.

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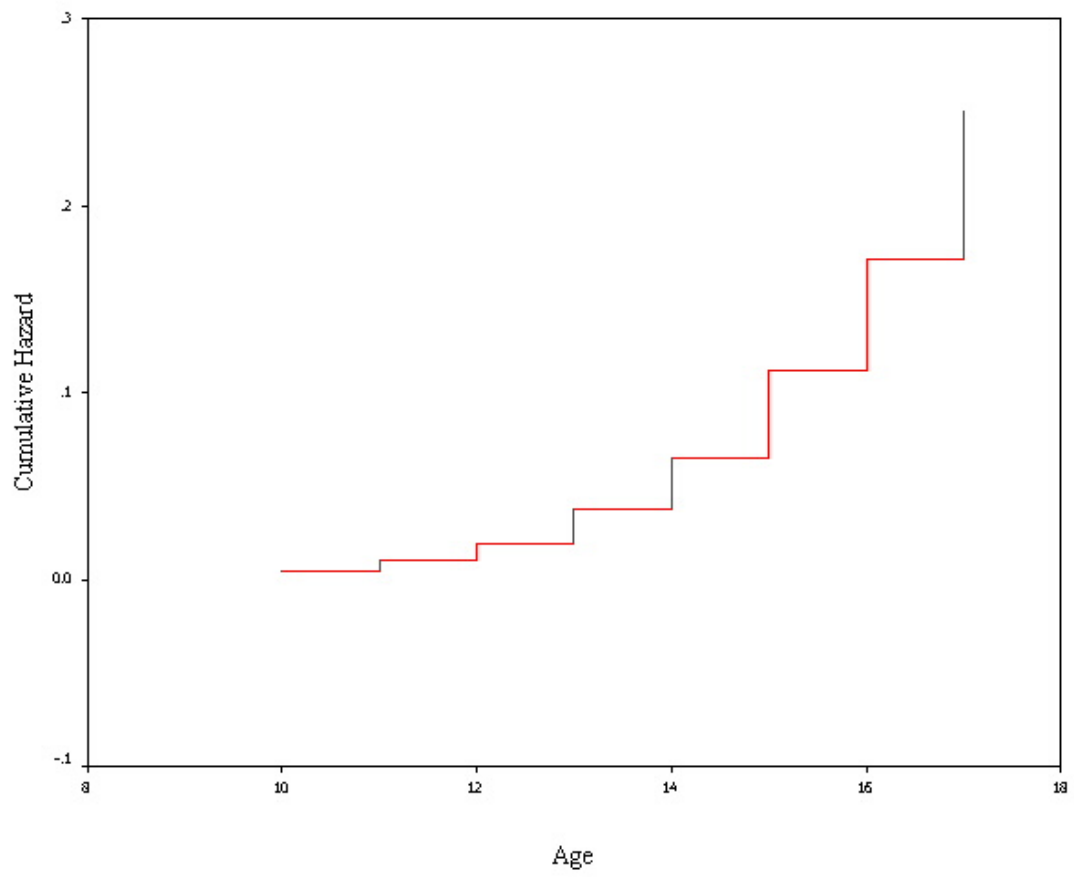


Figure 1. Cox hazard function for marijuana use.

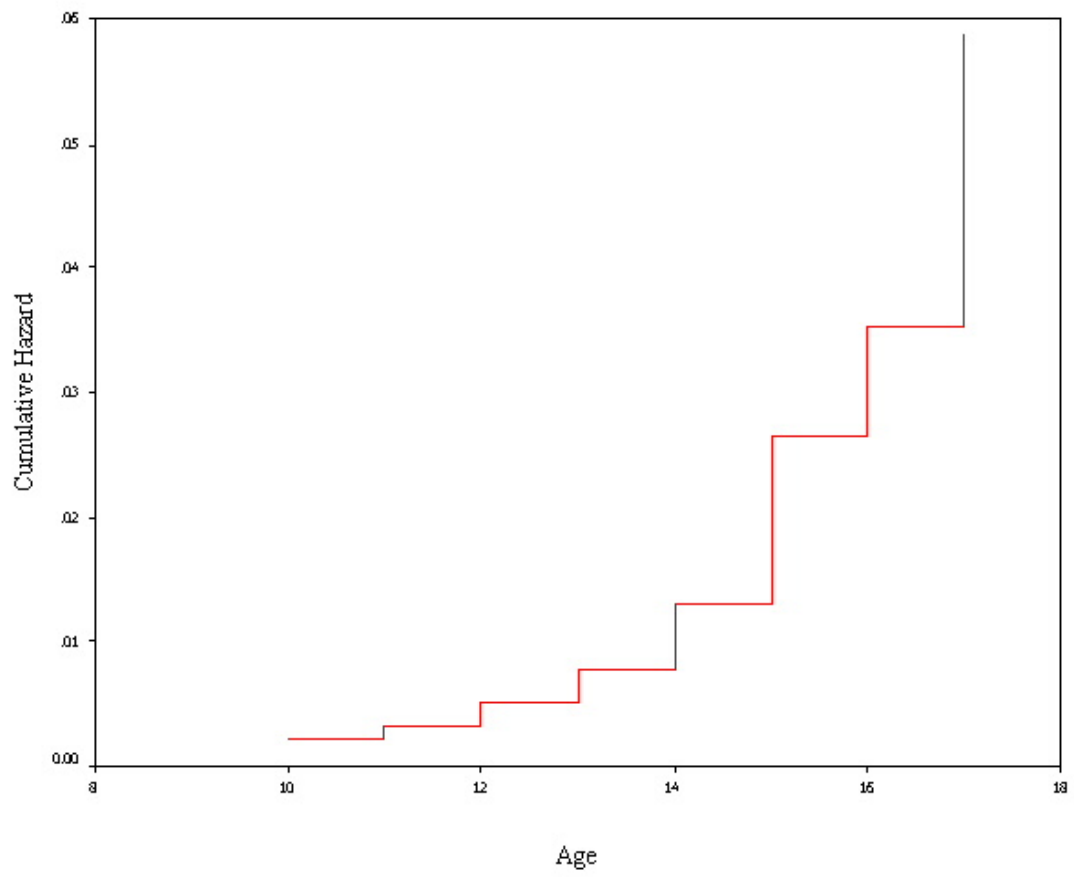


Figure 2. Cox hazard function for hard drug use.

Table 1: Description of Variables

<i>Variables</i>		N	%
Marijuana use	Yes (event cases)	239	28.1
	No (censored cases)	611	71.9
Hard drug use	Yes (event cases)	80	9.3
	No (censored cases)	777	90.7
Prior licit	Yes	388	45.8
	No	459	54.2
Prior marijuana	Yes	187	22.1
	No	660	77.9
Prior licit to marijuana	Yes	111	13.1
	No	736	86.9
Gender	Male	365	42.5
	Female	494	57.5
Race	White	661	76.7
	Non-white	201	23.3
School skip	Yes	271	31.4
	No	591	68.6
GPA	Mostly As	260	30.2
	Mostly Bs	339	39.3
	Mostly Cs	207	24.0
	Mostly Ds	34	3.9
	Mostly Fs	22	2.6
Friend marijuana	Yes	394	46.3
	No	457	53.7
Friend drug	Yes	175	20.4
	No	682	79.6
Cool marijuana	Yes	228	26.8
	No	624	73.2
Cool drug	Yes	131	15.4
	No	717	84.6
Adult marijuana	Yes	420	49.2
	No	434	50.8
Adult hard drug	Yes	240	28.2
	No	612	71.8
Neighborhood crime	Yes	129	15.1
	No	723	84.9
Family structure	Both parents living	639	75.5
	Father only living	26	3.1
	Mother only living	148	17.5
	Other living	33	3.9
Father drug abuse	Yes	66	7.8
	No	716	85.0
	Don't know	60	7.1
Mother drug abuse	Yes	55	6.6
	No	743	89.4
	Don't know	33	4.0

Table 2: Cox Proportional Hazard Model for the risk of marijuana by prior licit use

Variables	Model 1			Model 2			Model 3			Model 4			Model 5			
	B	Wald	Exp(B)	B	Wald	Exp(B)	B	Wald	Exp(B)	B	Wald	Exp(B)	B	Wald	Exp(B)	
PRIOR_LICIT (1=yes)	.44	10.05**	1.56	.12	.66	1.13	-.12	.69	.89	-.20	1.94	.82	-.14	.88	.87	
GENDER (1=male)	-.08	.37	.92	-.13	.80	.88	-.05	.14	.95	-.19	1.77	.83	-.16	1.25	.85	
RACE (1=non-white)	.05	.10	1.06	.03	.03	1.03	-.14	.64	.87	-.36	4.14*	.70	-.38	4.33*	.69	
GPA				.41	34.60**	1.50	.38	31.36**	1.47	.36	26.09**	1.44	.33	19.94**	1.40	
SKIP (1=yes)				1.00	48.34**	2.69	.47	10.87**	1.61	.40	7.79**	1.50	.37	6.64*	1.45	
FRIEND_MJ (1=yes)							2.16	74.71**	8.64	1.79	49.86**	6.00	1.81	51.65**	6.13	
COOL_MJ (1=yes)							.57	16.49**	1.77	.34	5.46*	1.40	.35	5.94*	1.42	
ADULT_MJ (1=yes)										1.22	30.76**	3.38	1.18	29.03**	3.27	
NEIGH_CRIM (1=yes)										.48	8.24**	1.61	.42	6.05*	1.53	
FAMILY (vs. lives with other)														10.80*		
PARENT (1=lives with parents)														-.77	6.60*	.47
F_ONLY (1=lives with father)														-.08	.04	.92
M_ONLY (1=lives with mother)														-.64	3.72	.53
DAD_DR (vs. don't know)														.57		
YES (1=drug by father)														.17	.21	1.19
NO (1=no drug by father)														-.01	.00	.99
MOM_DR (vs. don't know)														2.36		
YES (1=drug by mother)														.10	.06	1.11
NO (1=drug by mother)														-.27	.56	.76
-2 Log Likelihood (Overall)		$\chi^2=10.57, df=3, p=.01$		$\chi^2=100.60, df=5, p=.00$			$\chi^2=252.25, df=7, p=.00$			$\chi^2=289.96, df=9, p=.00$			$\chi^2=314.18, df=16, p=.00$			
-2 Log Likelihood (Change)				$\chi^2=86.31, df=2, p=.00$			$\chi^2=160.85, df=2, p=.00$			$\chi^2=47.04, df=2, p=.00$			$\chi^2=17.93, df=7, p=.01$			

Note: PRIOR_LICIT=prior use of licit drugs; SKIP=School skip; FRIEND_MJ=Best friend smoke marijuana; COOL_MJ=Cool if smoke marijuana; ADULT_MJ=Know adults who smoke marijuana; NEIGH_CRIME=Crime/drug selling in the neighborhood; FAMILY=Family structure; DAD_DR=Father drugs abuse; MOM_DR=Mother drugs abuse.

* $p \leq .05$. ** $p \leq .01$.

Table 3: Cox Proportional Hazard Model for the risk of hard drug by prior marijuana use.

Variables	Model 1			Model 2			Model 3			Model 4			Model 5		
	B	Wald	Exp(B)	B	Wald	Exp(B)	B	Wald	Exp(B)	B	Wald	Exp(B)	B	Wald	Exp(B)
PRIOR_MJ (1=yes)	1.52	35.34**	4.58	1.06	15.14**	2.88	.44	2.24	1.56	.25	.74	1.29	.17	.30	1.18
GENDER (1=male)	-.36	1.88	.70	-.46	2.98	.63	-.48	3.31	.62	-.39	2.13	.68	-.32	1.33	.73
RACE (1=non-white)	-.31	.83	.73	-.36	1.08	.70	-.23	.42	.80	-.46	1.60	.63	-.53	1.94	.59
GPA				.55	20.70**	1.73	.38	10.93**	1.47	.34	7.22**	1.40	.32	6.17*	1.37
SKIP (1=yes)				.73	6.99**	2.06	.60	4.49*	1.82	.52	3.41	1.68	.45	2.45	1.56
FRIEND_DR (1=yes)							1.52	24.13**	4.58	1.18	13.80**	3.25	1.20	13.83**	3.31
COOL_DR (1=yes)							1.06	15.80**	2.88	1.15	16.48**	3.15	1.22	17.46**	3.40
ADULT_DR (1=yes)										1.47	23.35**	4.34	1.43	20.96**	4.19
NEIGH_CRIM (1=yes)										-.07	.05	.94	-.13	.16	.88
FAMILY (vs. lives with other)														1.00	
PARENT (1=lives with parents)													.25	.18	1.28
F_ONLY (1=lives with father)													.65	.76	1.92
M_ONLY (1=lives with mother)													.14	.04	1.15
DAD_DR (vs. don't know)														.08	
YES (1=drug by father)													-.08	.02	.92
NO (1=no drug by father)													.05	.01	1.05
MOM_DR (vs. don't know)														3.36	
YES (1=drug by mother)													.44	.28	1.60
NO (1=drug by mother)													-.47	.42	.62
-2 Log Likelihood (Overall)	$\chi^2=46.07, df=3, p=.00$			$\chi^2=74.27, df=5, p=.00$			$\chi^2=177.72, df=7, p=.00$			$\chi^2=210.42, df=9, p=.00$			$\chi^2=314.18, df=16, p=.00$		
-2 Log Likelihood (Change)				$\chi^2=26.22, df=2, p=.00$			$\chi^2=61.28, df=2, p=.00$			$\chi^2=27.01, df=2, p=.00$			$\chi^2=6.01, df=7, p=.54$		

Note: PRIOR_MJ=prior use of marijuana; SKIP=School skip; FRIEND_DR=Best friend use drugs; COOL_DR=Cool if use drug; ADULT_DR=Know adults who use drugs; NEIGH_CRIME=Crime/drug selling in the neighborhood; FAMILY=Family structure; DAD_DR=Father drugs abuse; MOM_DR=Mother drugs abuse.

* p ≤ .05. ** p ≤ .01.

Table 4: Cox Proportional Hazard Model for the risk of hard drug by the gateway sequence of prior licit drugs and marijuana use.

Variables	Model 1			Model 2			Model 3			Model 4			Model 5			
	B	Wald	Exp(B)	B	Wald	Exp(B)	B	Wald	Exp(B)	B	Wald	Exp(B)	B	Wald	Exp(B)	
PRIOR_LIMJ (1=yes)	1.27	25.79**	3.55	.90	12.48**	2.46	.36	1.79	1.43	.16	.35	1.29	.23	.67	1.25	
GENDER (1=male)	-.39	2.24	.68	-.49	3.46	.61	-.45	2.88	.64	-.38	2.04	.68	-.30	1.21	.73	
RACE (1=non-white)	-.32	.88	.73	-.35	1.01	.71	-.18	.25	.84	-.44	1.45	.63	-.50	1.73	.60	
GPA				.59	24.54**	1.81	.39	11.26**	1.48	.35	7.76**	1.40	.32	6.33*	1.37	
SKIP (1=yes)				.90	11.53**	2.46	.69	6.62*	2.00	.56	4.23*	1.68	.47	2.85	1.59	
BF_DR (1=yes)							1.59	28.07**	4.93	1.23	15.94**	3.25	1.19	14.39**	3.30	
COOL_DR (1=yes)							1.04	14.90**	2.82	1.14	16.11**	3.15	1.22	17.24**	3.36	
ADULT_DR (1=yes)										1.48	23.50**	4.34	1.42	20.52**	4.13	
NEIGH_CRIM (1=yes)										-.07	.05	.94	-.12	.14	.88	
FAMILY (vs. lives with other)														1.00		
PARENT (1=lives with parents)													.16	.08	1.17	
F_ONLY (1=lives with father)													.61	.67	1.83	
M_ONLY (1=lives with mother)													.09	.02	1.09	
DAD_DR (vs. don't know)														.05		
YES (1=drug by father)														-.08	.01	.92
NO (1=no drug by father)														.02	.00	1.02
MOM_DR (vs. don't know)															3.63	
YES (1=drug by mother)														.50	.35	1.64
NO (1=drug by mother)														-.45	.38	.64
-2 Log Likelihood (Overall)	$\chi^2=32.80, df=3, p=.00$			$\chi^2=71.38, df=5, p=.00$			$\chi^2=179.08, df=7, p=.00$			$\chi^2=210.99, df=9, p=.00$			$\chi^2=226.81, df=16, p=.00$			
-2 Log Likelihood (Change)				$\chi^2=36.34, df=2, p=.00$			$\chi^2=65.23, df=2, p=.00$			$\chi^2=27.15, df=2, p=.00$			$\chi^2=6.77, df=7, p=.45$			

Note: PRIOR_LIMJ=prior sequential use of licit drugs and marijuana; SKIP=School skip; FRIEND_DR=Best friend use drugs; COOL_DR=Cool if use drug; ADULT_DR=Know adults who use drugs; NEIGH_CRIME=Crime/drug selling in the neighborhood; FAMILY=Family structure; DAD_DR=Father drugs abuse; MOM_DR=Mother drugs abuse.

* $p \leq .05$. ** $p \leq .01$.

APPENDIX: Correlation Matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.Marijuana use	1	.48**	.19**	.85**	.62**	-.02	-.03	.22**	.38**	.58**	.34**	.41**	.20**	.49**	.31**	.20**	-.10**	.10**	.02	.16**	-.13**	.12**	-.17**
2.Hard drug use		1	.13**	.28**	.24**	-.04	-.03	.20**	.26**	.31**	.32**	.44**	.35**	.29**	.33**	.16**	-.020	.07*	-.02	.23**	-.18**	.23**	-.20**
3.Prior licit			1	.15**	.42**	.02	-.00	.20**	.15**	.30**	.13**	.17**	.05	.27**	.16**	.04	-.04	.02	.04	.04	-.05	.01	-.04
4.Prior marijuana				1	.73**	-.02	-.04	.19**	.32**	.48**	.27**	.30**	.15**	.41**	.22**	.10**	-.07	.10**	-.00	.10**	-.07*	.12**	-.11**
5.Prior licit to marijuana					1	-.02	-.04	.14**	.20**	.36**	.19**	.23**	.10**	.30**	.20**	.04	-.00	.11**	-.05	.05	-.02	.06	-.07
6.Gender						1	-.04	.15**	-.06	-.02	-.02	-.05	-.00	.04	-.11**	.04	.01	.01	-.03	-.03	.02	-.07	.03
7.Race							1	.13**	.01	.05	.03	.01	.01	.14**	.14**	.19**	-.16**	.00	.12**	.05	-.13**	.04	-.06
8.GPA								1	.13**	.17**	.08*	.17**	.10**	.22**	.15**	.15**	-.14**	.09**	.09**	.12**	-.18**	.13**	-.15**
9.School skip									1	.36**	.20**	.21**	.13**	.25**	.15**	.05	-.08**	.04	.06	.12**	-.07*	.11**	-.10**
10.Friend marijuana										1	.32**	.46**	.16**	.48**	.26**	.15**	-.05	.07*	.01	.11**	-.08*	.12**	-.11**
11.Cool marijuana											1	.31**	.65**	.31**	.23**	.21**	-.03	.00	.01	.17**	-.15**	.13**	-.10**
12.Friend drug												1	.32**	.32**	.30**	.18**	-.02	.07*	-.01	.18**	-.16**	.12**	-.09**
13.Cool drug													1	.19**	.19**	.23**	-.01	.00	-.01	.15**	-.12**	.11**	-.09**
14.Adult marijuana														1	.50**	.24**	-.13**	.04	.09*	.20**	-.21**	.15**	-.16**
15.Adult hard drug															1	.29**	-.15**	.06	.08*	.29**	-.30**	.18**	-.20**
16.Neighborhood crime																1	-.11**	.02	.07	.21**	-.24**	.18**	-.19**
17.Both parents living																	1	-.31**	-.81**	-.16**	.19**	-.09**	.09**
18.Father only living																		1	-.08*	.00	.03	.02	-.01
19.Mother only living																			1	.10**	-.14**	-.01	.03
20.Father drug abuse(yes)																				1	-.70**	.49**	-.37**
21.Father drug abuse (no)																					1	-.36**	.53**
22.Mother drug abuse (yes)																						1	-.77**
23.Mother drug abuse (no)																							1

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).