



“Gateway hypothesis” and early drug use: Additional findings from tracking a population-based sample of adolescents to adulthood

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ABSTRACT

To evaluate the consistency of the relationship between early drug use in adolescence and illegal drug use in adulthood as proposed in the “gateway theory” and to determine whether pre-existing depressive symptoms modifies this relationship. We used contractual data from the National Longitudinal Study of Adolescent to Adult health data spanning a 14 year period. We assessed the relationship between gateway drugs at baseline (age 11–20 years) and drug use in adulthood using generalized estimating equation (GEE) regression models. Gateways drugs used in early adolescence were significantly associated with marijuana use, illegal drugs and cocaine in older adolescence, but over time these relationships were not consistent in adulthood. Changes in the pattern of psychoactive drug use were important predictors of drug use in adulthood. A history of higher depressive symptoms was associated with higher frequencies of psychoactive drug use over time. Users of mental health services in adolescence were less likely to use drugs in older adolescence and in adulthood. Relationships between early drug use and later drug use in adulthood cannot be solely explained by the gateway hypothesis. Collectively, adolescent drug prevention and treatment programs should apply theory-based and evidence-proven multisectoral intervention strategies rather than providing a brief counseling on individual's behaviors. This evidence should include understanding that changes in behavior should involve broader analyses of the underlying social context for drug use and in particular the role of the community social norms in driving a group's behaviors.

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1. Introduction

The concept of “gateway hypothesis” has been studied since the 1970s (Kandel, 1975; Kandel and Faust, 1975) as the theory suggests that an adolescent's early experimentation with alcohol or tobacco or cannabis escalates to more addictive illicit drugs later in adulthood (Lynskey et al., 2003). Most commonly used illicit substances include heroin/opioids, cocaine and or amphetamines and their designer drug analogs, considered illegal by the criminal justice system in the United States and other jurisdictions. Early onset or drug experimentation has been elaborated and characterized in distinct pathways in the substance abuse and dependence literature. Overall, the theory has had mixed results showing both a link or sequence of licit drug use to illicit drug use (Guxens et al., 2007; Guxens et al., 2007; Korhoene et al., 2010; Lessem

et al., 2006; Mayet et al., 2012) and no association (Mackesy-Amiti et al., 1997; Golub and Johnson, 1994).

Although the concept has also been a subject of considerable scholarly and political discourse in western societies, a review of the literature often shows less consensus on research and policy relevance among investigators. An earlier series of studies (Kandel, 1975; Kandel and Faust, 1975; Kandel et al., 1992) among adolescents showed the existence of a significant and a clearly defined sequence of drug use onset starting with licit substances (alcohol, cigarette) and progression to illicit drugs (cocaine, marijuana, methamphetamine, and heroin) through adulthood. Recently, Kandel and Kandel (2014), have demonstrated the GH with animal studies and their findings showed that use of one drug enhances effects of the other drugs — a process hypothesized as due to the priming of the neural circuitry of the brain. Fergusson et al. (2006) analyzed a population-based data on cannabis use and progression to other illicit drugs among a 25-year longitudinal study of 1265 birth cohorts from Christchurch, New Zealand. The investigators found strong evidence for causal model of GH, in which earlier use of cannabis was hypothesized as causing increased use of other illicit drugs. In addition, numerous prior studies have failed to disconfirm causal links of gateway effects in human populations (Kandel, 2002; Gundy and Rebellon, 2010; Morral et al., 2002). However, a cross-

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country comparison of the GH by [Degenhardt et al. \(2010\)](#) found background prevalence of the gateway drugs or their availability as the major driving factor for drug use progression across countries analyzed. Another study analyzing a sample of adolescents from South Florida showed that marijuana gateway effect is contingent on context of age ([Gundy and Rebellon, 2010](#)). In spite of these, it is still unclear the extent to which a cohort of adolescents at different developmental stages experience gateway drug use (tobacco, alcohol, marijuana) as determinants of later illicit drug use during and prior to adulthood.

Consistent with the theory, research in the substance abuse literature has focused on age of onset of substance used as a proximate determinant of future drug use and dependence in adulthood ([Chen et al., 2009](#); [Behrendt et al., 2009](#); [Trenz et al., 2012](#); [Mayet et al., 2012](#)). [Trenz et al. \(2012\)](#) found early onset of alcohol at age 15 but not cigarette or marijuana among adolescents as a risk factor for injection drug use in adulthood. An earlier study by [Chen et al. \(2009\)](#), reported clinical manifestation of drug dependence and other health problems among adolescents' early onset (11–17 years) of drug use compared with adult (18+) recent users. Likewise, [Lynskey et al.](#), report that among discordant twins, individuals starting cannabis use before age 17 were at increased risk of illicit drug use and drug dependence. [Mayet et al. \(2012\)](#) found that among 17-year olds participating in a military exercise in France, initiating one drug increased the risk of initiating the other drug use, consistent with the gateway theory. However, the risk of an experimenter becoming a daily user of tobacco was higher for initial tobacco users than cannabis. A recent follow-up study by [Mayet et al. \(2012\)](#) found daily tobacco use among adolescents as strongly associated with cannabis initiation and other illicit drugs. However, deviations to these patterns of drug use have been also observed in studies and hypothesized to be linked to an underlying mental health condition of respondents ([Degenhardt et al., 2010](#)). One study of cross national comparisons of 17 countries found prior drug use and age of onset as the most dominant factors determining drug dependence ([Degenhardt et al., 2010](#)). In addition, there were considerable variations of early onset of drug use among similar age cohorts in different countries. Unfortunately the prospective relationship between early drug onset in adolescence and drug use transition in adulthood was not evaluated.

Although the evidence suggests that substance use dependence may also occur with the initial drug experimentation of commonly available legal substances ([Kirby and Barry, 2012](#)), continual use over time may increase the likelihood of developing risks for substance use disorders ([Deza, 2015](#)) and other substance-related illnesses. In this regard, [Midanik et al. \(2007\)](#), reported that simultaneous alcohol and cannabis use was related to increased prevalence rates of other social consequences including problem behaviors, alcohol dependence and depression. A twin-study of young women by [Agrawal et al. \(2009\)](#), found that women's initial use of tobacco and cannabis simultaneously was more likely to experience higher rates of DSM IV cannabis abuse but not dependence. The possibility of other addictive drugs (codeine and other prescription drugs) and substances (hallucinogens, inhalants, ecstasy, amphetamines) resulting in poor health sequelae due to initial drug experimentation has been noted in some studies ([Fairman, 2015](#); [Deza, 2015](#)). This is important considering the extent of initial substance use or use combinations could lead to more widespread illegal drugs or addictive behaviors over time, replications of these findings in a nationally representative sample of adolescents transitioning to adulthood are needed to understand the continuum of progression of drug use over the life course (from adolescence to adulthood).

Despite a great uncertainty about the gateway theory, with few exceptions ([Behrendt et al., 2009](#); [Fergusson et al., 2006](#)) there has been remarkably less rigorous empirical assessment with a population-based sample, prospectively assessing the impact of early drug use on later drug use as well as related mental health conditions (depressive symptoms). Data from longitudinal studies will allow for additional questions to be explored including how changes in drug use over time

from early adolescence to adulthood might be related to earlier onset of drug use and a pattern of individual drug use trajectories during transition to adulthood. Sequence of drug initiation may be due to several factors including effects of one drug use on another, familial and demographic and psychosocial characteristics or a combination of different factors ([Guerra et al., 2000](#)). In addition most of these studies did not control for current substance use, a factor which is an important determinant for fully understanding how earlier drug use or non-drug use may change over time from adolescence to young adulthood.

The aim of this study is to evaluate the impact of early substance use on later illicit drug use while accounting for concurrent drug use over a relatively longer period among a cohort of adolescents transitioning to adulthood, and to determine the extent to which these relationships conform to the GH. Our analyses here examine the relationship between early gateway drug use and future illicit drug use among a cohort of adolescents, and to determine whether causal or non-causal inferences are warranted. We anticipate gateway drug use among our sample to escalate to illicit drug use in adulthood and we expect this relationship to be non-causal. Our hypothesis is that any gateway relationship in adulthood reflects spurious effects of underlying depressive symptoms and age as well as modifying influences of these factors (age and depressive symptoms). Second, we were also interested in investigating the relationship between early drug use onset in adolescence and substance use in adulthood taking into account the existing concurrent mental health status of individuals at each developmental stage. To the extent that gateway associations to illicit drug use among older adolescence or adulthood is causal, we evaluate the stage (older adolescence or adulthood) at which this relationship is likely to significant and if it has short or long term effect in adulthood. We hypothesize that the gateway relationship to adult drug use is transient only among older adolescence and the relationship is modified by depressive symptoms reported in older adolescence.

2. Materials and methods

The study sample was generated from the National Longitudinal Study of Adolescent to Adult Health (Add Health). The Add Health study is a national longitudinal survey of school-based representative sample of students in grades 7–12 in 1994 academic year in the United States. The cohort from this study were selected and interviewed in 1994–95 school year as in-home samples (79% response rate as a proportion of selected in-home sample) for Wave I ($N = 20,745$). This sample has been followed over time with three further in-home interviews in 1996 Wave II (11–21 years, response rate 88.6%; $N = 14,738$), Wave III 2001–2002 (aged 18–26 years, response rate 77.4%; $N = 15,197$) with the most recent data occurring in Wave IV 2007–08 (aged 24–32 years, response rate 80.3%; $N = 15,701$). Our analysis used the restricted Add Health datasets, and the detailed description of the study design is found in other publications ([Bearman et al., 1997](#); [Nkansah-Amankra et al., 2012](#)). In this analysis, we used a total sample of 11,194 observations with complete survey weights and information across all four waves. The study was approved by the Institutional Review Board (IRB) of Central Michigan University.

2.1. Outcome measures

We used the following illegal substances from Waves II to IV as our outcome measures: marijuana, illicit drugs (Add Health instrument gathered information specifically on heroin, amphetamines, LSD, PCP, ecstasy, speed, ice to assess the illicit drugs variable) and cocaine. At each wave of data collection, participants were asked if they had used each of the above substances in the past 30 days. We created a two-level outcome measure for each psychoactive substance used from older adolescence (Wave 2) to adulthood (Waves 3 and 4). Respondents reporting not using a substance served as the reference.

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