

Trajectories of drug use among French young people: Prototypical stages of involvement in illicit drug use

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Abstract

Aims: This study investigated patterns and trajectories of substance use, with a special focus on illicit drugs other than cannabis. It examined both patterns and trajectories of use among a general population-based sample. **Methods:** We used data from the 2011 French ESCAPAD survey of French 17-year-olds to assess exposure and age of initiation of 14 licit and illicit drugs (N=23,882). Latent class analysis (LCA) and survival analyses were performed. **Results:** The results of the LCA showed that patterns of illicit drug use clearly distinguished between two groups of other illicit drugs: 1) amphetamines/speed, cocaine, ecstasy/MDMA, magic mushrooms, poppers, and solvents; 2) crack/freebase, GHB/GBL, heroine, LSD, and ketamine. Survival analyses highlighted that trajectories involved the first group before the second one. **Conclusions:** Prototypical drug use patterns and trajectories should include a distinction between two groups of illicit drugs. Preventive actions should focus on young people in their early teens, since very young users are more likely to progress to illicit drug use, and further studies should include this distinction instead of aggregating other illicit drugs into a single category.

Keywords

General population-based sample, patterns of drug use, stages of drug use

Introduction

Drug use among young people is a major public health concern since it is associated with several detrimental consequences. It is important, therefore, to understand how young people use drugs in order to help substance use prevention.

The first stages of involvement in drug use are well known (Kandel, 1975; Kandel et al., 2006). As described in several countries, young people commonly start with alcohol, move on to tobacco, then use cannabis, and finally use other illicit drugs (Fergusson et al., 2006; Kandel, 2002; Pentz & Li, 2002; Wagner & Anthony, 2002; Willner, 2001; Woodcock et al., 2015; Yamaguchi & Kandel, 1984).

Trajectories of the illicit use of drugs other than cannabis have only been investigated to a lesser extent in previous studies. Indeed, the use of several other illicit drugs may vary according to the context (e.g. availability, price, trends), and therefore the order in which other illicit drugs are used after cannabis is not uniform across different societies (Hays et al., 1986; Windle et al., 1989). Previous studies on drug use trajectories often aggregated illicit drugs other than cannabis

into a single group (Kandel & Yamaguchi, 2002). Unfortunately, studies examining the relevance of aggregating all illicit drugs other than cannabis into a single category are scarce. A recent study examined this issue, including a wide range of illicit drugs other than cannabis, and identified two categories of other illicit drugs instead of one: “middle-stage” drugs (i.e. uppers, hallucinogens, and inhaled drugs) and “final-stage” drugs (i.e. heroin, ketamine, GHB/GBL, research chemicals, crystal meth, and spice) (Baggio et al., 2014). However, that study among young Swiss men in their twenties was unable to show any progression within the sequence of drug use. That study thus highlighted stable patterns of drug use in young adulthood, but not trajectories.

Thus, the present study's aims were threefold. By focusing on drug use patterns, the first aim was to test whether there was a difference between middle- and final-stage drugs in a sample of French teenagers. The second aim was to examine trajectories of drug use. We hypothesized that chronological trajectories would follow a typical progression of first alcohol, second tobacco, third cannabis, fourth middle-stage drugs, and fifth final-stage drugs. Finally, by focusing on subgroups of heavy drug users, the third aim was to test whether the prototypical trajectory identified for the general population also fitted these atypical young people.

Methods

Participants and procedures

The data for this study come from the seventh ESCAPAD survey (Survey on Health and Behaviour), a cross-sectional survey designed to estimate drug use prevalence in France and carried out regularly by the French Monitoring Centre for Drugs and Drug Addiction in association with the National Service department. It took place during the national defense preparation day, a 'one-day session of civic and military information' compulsory for all French 17 years old adolescents. ESCAPAD data collection took place in March 2011 in all the civilian or military centres across the national territory and overseas. The survey has obtained the Public Statistics general interest seal of approval from the National Council for Statistical Information, the approval of the ethics commission of the National Data Protection Authority (CNIL), and the questionnaire follows the recommendations of the European Monitoring Centre for Drug and Drug Addiction. A complete description of the methodology has been published elsewhere (Beck et al., 2006; see also Spilka et al., 2012).

In 2011, 32 249 French adolescents were surveyed. Missing values (gender, age missing, and with more than half the variables missing) were list wise deleted. The response rate exceeded 98% for socio-demographic and drug use questions. The final sample comprised 25 527 French teenagers aged 17 living in France metropolitan. This study focused on the 23 882 drug users (1645 non-users were not included, 6.4%).

Measures

Substance use

Lifetime use of alcohol, tobacco, cannabis, magic mushrooms, poppers, solvents, ecstasy/MDMA, amphetamines/speed, LSD, crack/freebase, cocaine, heroin, ketamine, and GHB/GBL was assessed. Ages at which initiation to each substance occurred were also recorded. Latent class analysis was used to identify groups of drug users (see below).

Atypical/heavy drug users

Three subgroups of drug users were used to assess heavy drug use and atypical drug use: (1) alcohol users subject to repeated drunkenness (ten times or more within the previous year, $n = 2888$); (2) cannabis dependent users (assessed using the cannabis abuse screening test, CAST, Legleye et al., 2007, 2011, $n = 1485$); and (3) injecting drug users ($n = 98$).

Statistical analyses

The first statistical analyses carried out were descriptive statistics for substance use. Next, latent class analysis (LCA) was performed to derive groups of individuals sharing common patterns of substance use. The parameters' estimation was performed with Maximum Likelihood estimation with robust standard errors (MLR) with a logit link. Models with different numbers of latent classes were compared in order to assess the optimal number of classes, using the Bayesian

information criterion (BIC), sample-size adjusted BIC (ABIC), and Akaike information criterion (AIC). Lower values indicated a better fit (Raftery, 1995). The Lo–Mendel–Rubin likelihood ratio test (LMR LRT) indicated whether a model with k classes is better than a model with $k-1$ classes (Lo et al., 2001), and a significant p value indicated that the model with $k - 1$ classes has been rejected in favor of the model with k classes.

The following step involved survival analyses to study trajectories of drug use. Seventeen-year-old participants may not have had the time to progress in the drug course yet, and it was unknown whether these participants will initiate it later. Survival analyses were set up to analyze these kinds of censored data (Lee & Wang, 2008; Singer & Willett, 2003). The Kaplan–Meier estimator was used to estimate the survival function for the groups identified by the LCA. Groups of users were created according to the classes identified by the LCA. Different Kaplan–Meier survival curves were drawn for each group of drug users, and the mean survival time for each group was calculated (i.e. their mean age of first drug use). For groups referring to several drugs, the earliest age of onset was reported. Significant differences between survival curves were assessed using the Breslow test. Five survival analyses were performed, one for each group of drugs. We also performed comparisons of the ages of initiation between the five groups of drugs. For each group of drug users, we computed adjacent paired t -tests.

Finally, mean ages at first use and paired t -tests for age at initiation were computed for the three subgroups of atypical/heavy drug users (regular drunkenness, cannabis dependent users, injecting drug users) to see whether their trajectories fitted those of the general sample. Analyses were carried out using Mplus version 6 (LCA) and SPSS version 21 (descriptive statistics and survival analyses).

Results

The mean age of the participants was 17.38 ± 0.26 years. The sample contained 50.3% of girls. Descriptive statistics for substance use are provided in Table 1. Most participants had initiated alcohol (91.2%) and tobacco (68.1%) use. A total of

Table 1. Descriptive statistics for substance use.

	Lifetime use (%, n)	Age of initiation among users (mean, SD)
Alcohol	91.2 (23,270)	13.77 (2.25)
Tobacco	68.1 (17,380)	14.12 (1.78)
Cannabis	41.2 (10,526)	15.36 (1.21)
Solvents	5.4 (1,368)	14.95 (1.12)
Crack/freebase	0.7 (186)	15.58 (1.89)
GHB/GBL	0.5 (120)	15.52 (2.35)
Heroin	0.7 (188)	15.64 (1.95)
Ketamine	0.5 (117)	15.73 (2.39)
Poppers	8.6 (2,184)	15.99 (1.12)
Magic mushrooms	3.2 (825)	15.99 (1.47)
Ecstasy/MDMA	1.7 (429)	16.03 (1.46)
Cocaine	2.8 (703)	16.04 (1.34)
Amphetamines/speed	2.1 (536)	16.05 (1.33)
LSD	1.2 (302)	16.14 (1.44)

Table 2. Comparisons of different latent class analysis models.

Model	AIC	BIC	ABIC	LRM <i>p</i> value
One-class	125 093.72	125 206.86	125 162.37	–
Two-class	110 288.15	110 522.90	110 430.34	<0.001
Three-class	104 515.98	105 271.54	105 131.71	<0.001
Four-class	104 102.93	104 579.71	104 392.21	<0.001
Five-class	103 561.58	104 159.56	103 924.39	<0.001
Six-class	103 414.38	104 133.58	103 850.74	0.597
Seven-class	103 283.07	104 123.48	103 792.97	0.183

41.2% had used cannabis. The other most prevalent illicit drugs used were poppers (8.6%), solvents (5.4%), magic mushrooms (3.2%), and cocaine (2.8%).

Pattern of drug use: LCA

The optimal number of classes was assessed by running analyses from a one-class model to a seven-class model (Table 2). AIC, BIC, and ABIC kept decreasing as the number of classes increased, except for BIC, which increased between the six- and seven-class models. However, the generally consistent decrease was very low for the six- and seven-class models in comparison to the five-class model. The LMR LRT displayed highly significant *p* values until the comparison of the five- and six-class models, for which the *p* value was 0.030. Since a large sample size can handle the extraction of additional latent classes, we selected the five-class model; it displayed a highly significant difference from the four-class model, but only small differences in all the fit indices when using the six-class model.

Table 3 shows the results of the five-class model selected, corresponding to the five different patterns of drug use.

The first latent class group was labeled “alcohol users”, since it included participants with a high probability of alcohol use (1.00), and low probabilities of other substance use (≤ 0.008). The second latent class group was labeled ‘alcohol and tobacco users’ because participants in this class displayed

high probabilities of alcohol (0.936) and tobacco (0.958) use. Other substance use probabilities were lower (0.250 for cannabis use; ≤ 0.019 for other illicit drug use).

The third latent class group was labeled “alcohol, tobacco, and cannabis users”, with high probabilities of use for these three substances (0.998, 0.984, and 0.937, respectively) and low probabilities for other illicit drug use (0.187 for poppers; .101 for solvents; ≤ 0.043 for other illicit drug use).

The fourth latent class group was labeled “alcohol, tobacco, cannabis, and middle-stage drug users”, with participants having significant probabilities of using many drugs (0.992 for alcohol; 0.987 for tobacco; 0.980 for cannabis, and from 0.311 to 0.473 for middle-stage drugs, namely amphetamine/speed, cocaine, ecstasy, LSD, poppers, and solvents), but low probabilities of using others illicit drugs (0.190 for LSD; ≤ 0.098 for other final-stage drugs).

Finally, the fifth latent class group was labeled “all-drug users”, including high probabilities for the use of all drugs, including both middle-stage drugs (from 0.698 to 0.970) and final-stage drugs (from 0.551 to 0.952 for crack/freebase, GHB/GBL, heroine, LSD, and ketamine). The most prevalent group was the third latent class of “alcohol, tobacco users and cannabis users” (39.54%). The least prevalent group was “all-drug users” (latent class 5) with 0.03% of participants.

Trajectories of drug use: Survival analyses

The mean ages at which participants had initiated each class of substance was calculated using the survival curves, and they are reported in Table 4.

For alcohol use (column 1, Table 4), the difference between the mean ages of alcohol initiation was non-significant for whether participants had experienced tobacco or not (14.05 and 14.16, respectively, $p = 0.271$). Conversely, cannabis users had experienced alcohol earlier (13.61) than alcohol and tobacco users ($p < 0.001$). The result was the same for middle-stage drug users; they had initiated alcohol before the

Table 3. Five-class model of substance use.

	Latent classes				
	1-class	2-class	3-class	4-class	5-class
Probability of substance use					
Alcohol	1.00	0.936	0.998	0.992	1.00
Tobacco	0.000	0.958	0.984	0.987	0.941
Cannabis	0.008	0.250	0.937	0.980	0.848
Poppers	0.002	0.019	0.187	0.473	0.790
Magic mushrooms	0.000	0.002	0.043	0.417	0.764
Cocaine	0.000	0.000	0.030	0.399	0.970
Solvents	0.000	0.016	0.101	0.347	0.698
Amphetamine/speed	0.009	0.002	0.015	0.329	0.907
Ecstasy	0.001	0.000	0.006	0.311	0.925
LSD	0.000	0.000	0.005	0.190	0.952
Heroin	0.000	0.000	0.004	0.098	0.766
Ketamine	0.000	0.000	0.000	0.055	0.754
Crack/freebase	0.000	0.000	0.009	0.071	0.593
GHB/GBL	0.000	0.000	0.005	0.039	0.551
Percentage of latent class membership (n)	26.02 (6,231)	30.85 (7,368)	39.54 (9,442)	3.26 (778)	0.03 (81)

High probabilities are highlighted in bold.

Table 4. Mean ages of substance initiation for different groups of users (Kaplan–Meier estimator).

		Substances				
		Alcohol	Tobacco	Cannabis	Middle-stage drugs	Final-stage drugs
Group of drug users	Alcohol (<i>n</i> = 6,084)	14.05 ^a	–	–	–	–
	Tobacco (<i>n</i> = 6,6775)	14.16 ^a	14.56 ^{a *** (2)}	–	–	–
	Cannabis (<i>n</i> = 7,050)	13.61 ^{b (1)}	14.04 ^{b ***}	15.54 ^{a ***}	–	–
	Middle-stage drugs (<i>n</i> = 3,641)	13.09 ^c	13.57 ^{c ***}	15.03 ^{b ***}	15.66 ^{a ***}	–
	All drugs (<i>n</i> = 432)	12.89 ^c	13.12 ^d	14.78 ^{c ***}	15.15 ^{b ***}	15.81 ^{***}

One column = one survival analysis (Kaplan–Meier estimator).

^{a,b,c,d} Different letters indicate significant differences ($p < 0.05$) between the survival curves for each substance (Breslow test), comparisons in columns.

Example (1): cannabis users experienced alcohol before tobacco and alcohol user group members, but after middle-stage and all-drugs user group members.

*** Indicates a significant difference ($p < 0.001$) between initiation ages for each group of drug users (paired *t*-tests, comparisons between adjacent means), comparisons along lines. Example (2): tobacco users experienced tobacco significantly later than alcohol.

three aforementioned groups (13.09, $p < 0.001$). There was no difference between middle-stage drug users and all-drug users in the initiation of alcohol ($p = 0.124$).

For tobacco use (column 2, Table 4), the group of alcohol users was excluded from the analysis because these participants had never used tobacco. There was a significant difference between each group of drug users. For example, all-drug users experienced tobacco before middle-stage drug users (at 13.12 and 13.57, respectively, $p < 0.001$).

A similar pattern was found for cannabis users (column 3, Table 4); cannabis users had initiated cannabis later than middle- and final-stage drugs users (15.54, $p < 0.001$), and middle-stage drug users had first experienced cannabis later than all-drug users (15.03 and 14.78, respectively, $p = 0.013$).

Finally, all-drug users had first experienced middle-stage drugs earlier than middle-stage drug users (15.15 and 15.66, respectively, $p < 0.001$; see column 4, Table 4). All-drug users had, on average, first experienced final-stage drugs at 15.81 (column 5, Table 4).

Paired *t*-tests showed that for each group of drug users, the initiation to earlier stage substances occurred a significant time earlier (e.g. middle-stage drug users were first initiated to alcohol, then tobacco, then cannabis, and finally middle-stage drugs, $p < 0.001$ for all comparisons). The only non-significant difference was all-drug users first initiations to alcohol and tobaccos.

Trajectories among heavy/atypical drug users

Table 5 summarizes the results for the three subgroups of heavy/atypical drug users. For all of them, trajectories first

included alcohol and tobacco (no significant differences for dependent cannabis users and injecting drug users), then cannabis ($p < 0.001$), afterwards middle-stage drugs ($p < 0.001$), and lastly final-stage drugs ($p < 0.001$).

Discussion

This study's first aim was to test whether there was a difference between "middle-stage" and "final-stage" drugs by examining substance use patterns among a representative sample of French 17-year-old young people.

The results showed that their patterns of drug use included five different patterns of drug use: alcohol users only; alcohol and tobacco users; alcohol, tobacco, and cannabis users; alcohol, tobacco, cannabis, and middle-stage drugs users; and all-drug users (including alcohol, tobacco, cannabis, middle-stage drugs, and final-stage drugs). Middle-stage drugs included amphetamine/speed, cocaine, ecstasy/MDMA, magic mushrooms, pop-pers, and solvents. Final-stage drugs included crack/freebase, GHB/GBL, heroin, LSD, and ketamine. Most of these substances corresponded to the previous classification of middle-stage and final-stage drugs developed by Baggio et al. (2014) (middle-stage drugs being hallucinogens/magic mushrooms, ecstasy, cocaine, poppers, solvents, speed, salvia divinorum, other hallucinogens, and amphetamines/methamphetamines; final-stage drugs being crystal meth, heroin, ketamine, GHB/GBL, research chemicals, and spice). Even though the drugs investigated in France were not exactly the same as those investigated in Switzerland, the results seemed robust,

Table 5. Mean ages of substance initiation for three subgroups of heavy drug users.

		Substances				
		Alcohol	Tobacco	Cannabis	Middle-stage drugs	Final-stage drugs
Subgroup of heavy drug users	Repeated drunkenness (≥ 10 /year) <i>n</i> = 2888	12.90 (<i>n</i> = 2751)	13.46 ^{***} (<i>n</i> = 2705)	14.90 ^{***} (<i>n</i> = 2323)	15.57 ^{***} (<i>n</i> = 1184)	15.83 ^{***} (<i>n</i> = 132)
	Cannabis dependent users <i>n</i> = 1485	12.94 (<i>n</i> = 1368)	12.89 (<i>n</i> = 1457)	14.39 ^{***} (<i>n</i> = 1432)	15.41 ^{***} (<i>n</i> = 810)	15.76 ^{***} (<i>n</i> = 140)
	Injecting drug users <i>n</i> = 98	12.20 (<i>n</i> = 82)	12.23 (<i>n</i> = 83)	13.67 ^{***} (<i>n</i> = 67)	14.64 ^{***} (<i>n</i> = 63)	15.40 ^{***} (<i>n</i> = 43)

***Indicates a significant difference ($p < 0.001$) between initiation ages for each subgroup of heavy drug users (paired *t*-tests, comparisons between adjacent means), comparisons along lines.

strongly supporting the existence of two different classes of illicit drug use.

The second aim was to examine the trajectories of drug use. The hypothesis of a chronological trajectory following a typical progression of first alcohol, second tobacco, third cannabis, fourth middle-stage drugs, and fifth final-stage drugs, was supported. Indeed, the results of the survival analyses showed that the patterns of drug use identified in the first part of the analyses followed a chronological order of initiation. Therefore, the present study's results replicated some well-known findings, above all that trajectories begin with alcohol, then move to tobacco, then cannabis, and finally other illicit drugs (Fergusson et al., 2006; Kandel, 1975, 2002; Pentz & Li, 2002; Wagner & Anthony, 2002; Willner, 2001; Woodcock et al., 2015; Yamaguchi & Kandel, 1984). Moreover, they highlighted a difference in the age of initiation between middle-stage and final-stage drug users. Indeed, users of final-stage drugs had initiated all the other substances at a younger age than the other groups of drug users (except for alcohol, initiated at the same age by middle-stage and final-stage drug users). The middle-stage drug users group displayed the second youngest age of initiation for other substances (alcohol, tobacco, cannabis, and middle-stage drugs). Clearly, therefore, illicit drug users (other than cannabis users) started to use other substances earlier than those who had not progressed to them. This result was important because it underlines the need to prevent substance use initiation at an early age.

An additional aim was to test whether this prototypical trajectory highlighted among a general population-based sample also fitted young people who had heavy/atypical substance use, such as repeated drunkenness, cannabis dependence, or injecting drug use. The results showed that the trajectory previously described also fitted those of young people with heavy/atypical substance use. Young heavy drug users also started with alcohol, then moved to tobacco, afterwards to cannabis, then to middle-stage drugs, and finally to final-stage drugs. The main difference was that their ages of initiation occurred very early: from 12 years old for alcohol use to 15 years old for final-stage drug use.

Overall, these results provided information about methodological choices regarding classification of illicit drugs other than cannabis. Other illicit drug use can be separated into two categories related to different patterns and trajectories of drug use. In past practices, these illicit drugs have often been aggregated into a single category (Kandel & Yamaguchi, 2002). The results of this study actually justified this method to some extent, since aggregating illicit drugs into two separate classes appeared as relevant. For example, there were some important differences between middle- and final-stage drugs. Indeed, young people who had moved on to middle- and final-stage drug use initiated the first substances in their trajectories very early: around 13–15 years old for middle-stage drug users, and 12–14 years old for final-stage drug users. It is obvious that illicit drug use does not begin with the spontaneous use of all drugs, and that progression and intensification occur. The use of two separate classes instead of a single class is a step further to take this phenomenon into account, and more studies are needed to investigate drug use patterns and

trajectories among other sample of participants and a large extent of illicit drugs.

This study's main limitation is that its participants were only 17-year-olds. They may simply have been at the beginning of their drug use trajectories, and therefore had not yet initiated some drugs, especially middle- and final-stage drugs. Further studies with older French young people may include more final-stage drug users. A second limitation was that the study focused on initiation; it did not take into account whether young people were light or heavy drug users. Progression along the drug use trajectory often depends upon frequent or heavy drug use, and more investigations are needed in order to properly consider this variable. A last shortcoming was that the sample was a population-based sample, and therefore that most of the French teenagers will probably never initiate other illicit drugs. Studies on sample of heavy drug users are needed to investigate patterns and trajectories of illicit drug use.

Conclusion

To conclude, this study showed that prototypical drug use patterns and trajectories should include a distinction between two groups of illicit drugs (other than cannabis), namely middle-stage drugs and final-stage drugs, experienced later in the drug course. This finding replicated those of a previous study among another large sample of older young people in Switzerland, and therefore showed that this distinction was robust, even if the order of other illicit drugs had been described previously as varying across different countries. The results were also robust for atypical young people who were heavy substance users. Preventive actions should focus on young people in their early teens, since very young initiators are more likely to progress to middle- and final-stage drug use, and further studies should include this distinction instead of aggregating other illicit drugs into a single category.

Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

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