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Cocaine use trajectories of club drug-using young adults recruited using time-space sampling

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Abstract

Cocaine is the most widely used club drug. Yet, little is known about how patterns of cocaine use vary over time among young adults of diverse gender and sexual identities. This study used latent class growth analysis to identify trajectories of cocaine use over a year and explored individual and substance use factors associated with these trajectories. A sample of 400 young adults (mean age = 23.9 years) with recent club drug use were recruited from New York City bars and nightclubs using time-space sampling. Participants completed quantitative measures at baseline, 4-, 8- and 12-months follow-up. A 4-class model fit the data best. Patterns were: *Consistent use* (48%), *Inconsistent use* (14%), *Decreasing Likelihood of use* (28%), and *Consistent non-use* (11%). Those most likely to be in the *Consistent use* class had the highest frequency of baseline club drug dependence (χ^2 (3, 397) = 15.1, $p < .01$), cocaine dependence (χ^2 (3, 397) = 18.9, $p < .01$), recent alcohol use (χ^2 (3, 397) = 12.48, $p < .01$), and drug sensation-seeking (χ^2 (3, 397) = 9.03, $p < .01$). Those most likely to be in the *Consistent Non-use* class had the highest frequency of baseline marijuana use (χ^2 (3, 397) = 2.71, $p < .05$). Contrary to hypotheses, there were no differences in most-likely trajectory class by gender/sexual-orientation, age, ethnicity, education,

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employment status, or income. Findings highlight the diversity of cocaine use patterns over time among young adults, and the personal and substance use characteristics that are associated with each.

Keywords

cocaine; club drugs; young adults; trajectory analysis

1. Introduction

Club drugs, substances associated with rave and club cultures, emerged during the 1990s and remain in use by young adults into the 21st century. These drugs include cocaine, methylenedioxymethamphetamine (MDMA, or "ecstasy"), methamphetamine (crystal meth), ketamine ("Special K"), d-lysergic acid diethylamide (LSD), and *gamma*-hydroxybutyrate (GHB) and its derivatives (Ramo, Grov, Delucchi, Kelly, & Parsons, 2010). Cocaine is the most widely used club drug (Kelly, Parsons, & Wells, 2006), and its use is ubiquitous, particularly in New York City (Community Epidemiology Work Group, 2006), where it is used in many different venues, including private residences, bars, concerts, nightclubs, and circuit parties (Lee, Galanter, Dermitis, & McDowell, 2003; Mattison, Ross, Wolfson, Franklin, & The San Diego HIV Neurobehavioral Research Center Group, 2001; Riley, James, Gregory, Dingle, & Cadger, 2001). It is becoming increasingly clear that patterns of cocaine involvement are heterogeneous, having multiple pathways which have not been well classified among club drug users to date. Further, many club drug users are highly likely to use multiple illicit substances, a pattern of use associated with more profound immediate and long-term consequences (Fendrich, Wislar, Johnson, & Hubbell, 2003; Kelly & Parsons, 2008; Lankenau & Clatts, 2005; Parsons, Halkitis, & Bimbi, 2006; Verduin, et al., 2007). Understanding longitudinal patterns of cocaine use as they relate to other substance use will aid in prevention and intervention efforts with young adults who attend nightclubs and other venues where alcohol and drugs might be combined (e.g., Palamar, Mukherjee, & Halkitis, 2008).

Person-centered analytic approaches are useful to help describe and understand patterns of substance use. For example, recent work by our group (Ramo, et al., 2010) used latent class analysis to classify club drug users by types of club drugs used using cross-sectional data. We found three main patterns: Primary cocaine users (42% of sample), Mainstream users (44% of sample) who were likely to have used cocaine, MDMA and to a lesser extent ketamine recently, and Wide-range users (14% of sample) who were likely to have used cocaine, MDMA, methamphetamine, and ketamine recently. Primary cocaine users were significantly less likely to be heterosexual males and had higher educational attainment than the other two classes. Wide-range users were less likely to be heterosexual females, more likely to be gay/bisexual males, dependent on club drugs, had significantly greater drug and sexual sensation seeking, and were more likely to use when experiencing physical discomfort or pleasant times with others compared to the other two groups. It is important to extend these analyses longitudinally, in order to better characterize patterns of cocaine use and understand which factors, both drug use and personal characteristics, can predict problematic cocaine use.

Some work has evaluated cocaine use over time. Findings generally tend to indicate that use decreases over young adulthood, consistent with the developmental and maturation milestones such as getting married and starting a family. Epidemiological data indicate that rates of past-month cocaine use peak in the early 20s and show continued reductions through the 20s and 30s. For example, National Survey on Drug Use and Health data in 2009 show

that in 2009, rates of past-month cocaine use are highest among those age 21 and 22 at 2%, and reduce to 1% from ages 25 to 34 (Substance Abuse Mental Health Services Administration, 2010). An examination of cocaine use in young adulthood by delinquency groups in adolescence, showed that all groups who used cocaine as teens had reduced likelihood of cocaine use through their 20s and 30s (Hamil-Luker, Land, & Blau, 2004). Further, an analysis of adolescents who had continued to use cocaine through young adulthood ("users;" 72%) compared to those who had stopped ("stoppers;" 28%) indicated that "stoppers" were more likely to be married and have children (White & Bates, 1995). Although the groups had similar patterns of substance and alcohol use in adolescence, 6 years later, those who were still using cocaine had higher frequencies of alcohol, marijuana, and other drug use. Studies that have analyzed polydrug use over time have generally corroborated findings that changes in substance use happen at developmentally important stages such as leaving home and starting families (Anderson, Ramo, Cummins, & Brown, 2010).

However, questions remain regarding patterns of cocaine use among individuals who are not legally able, in most states, to follow traditional models of leaving home and starting families, such as gay and lesbian-identified young adults, and whether polydrug use can help elucidate which pattern someone will follow. Some work has analyzed cocaine use trajectories in gay or bisexual men. Palamar and colleagues (2008) identified patterns of cocaine use among 355 powder cocaine-using gay and bisexual men in New York City. The majority of cocaine users decreased use over a year of assessment, and men who reported using cocaine to avoid physical discomfort or to enhance pleasant times with others were more likely to decrease their frequency of use. It is unclear whether longitudinal patterns of cocaine use differ across sexual identity groups, or how these patterns relate to other substance use in more diverse samples. A greater understanding of how young adults of varying sexual identity groups use cocaine over time, and the individual characteristics associated with such use remain important foci for prevention and intervention efforts with this age group.

The present study describes and examines the latent trajectories of cocaine use over one year as they relate to sociodemographic characteristics and other substance use among a sample of club-going young adults in New York City. We hypothesized that there would be multiple patterns of cocaine use (i.e., at least two latent trajectories of use over a year), and that use of other drugs (tobacco, alcohol, marijuana, other club drugs) at baseline would be more strongly associated with heavier patterns of cocaine use. Based on previous literature, we further hypothesized that gay, lesbian, and bisexual-identified individuals would demonstrate heavier patterns of cocaine use compared to their heterosexual-identified counterparts (Beatty, et al., 1999; Cochran, Ackerman, Mays, & Ross, 2004; Kelly, et al., 2006; Parsons, Halkitis, et al., 2006; Parsons, Kelly, & Wells, 2006), and Asian-Americans would have less frequent patterns of cocaine use than members of other ethnic groups (Palamar, et al., 2008). Those with heavier patterns of cocaine use throughout a year were also expected to have greater likelihood of cocaine and other club drug dependence, higher levels of sexual and drug sensation seeking (Palamar, et al., 2008; Ramo, et al., 2010), greater levels of life stress and lower levels of coping skills (Fava, Ruggiero, & Grimley, 1998; McMahon, 2001), and to have higher levels of use when experiencing unpleasant emotions, physical discomfort, conflict with others, social pressures to use, and pleasant times with others (Palamar, et al., 2008; Ramo, et al., 2010) compared to those who were less likely to use cocaine. There were no specific a priori hypotheses as to the associations between cocaine use trajectories and educational attainment, current student status, stability of employment, or income.

2. Methods

Data for this study were taken from the *Club Drugs and Health Project*, a study of health issues among young adults (ages 18–29) involved in New York City dance club scenes. The project was designed to examine the patterns and contexts of club drug use and its associated risks among club-going young adults with the intent of assessing the potential for prevention and education efforts. The six specific club drugs of interest were cocaine, MDMA, ketamine, GHB, methamphetamine, and LSD. The assessments utilized in the study were designed to capture a broad understanding of drug use among club-going young adults as well as basic information on other health issues relevant to this population.

2.1 Participants and procedures

Time-space sampling (MacKellar, Valleroy, Karon, Lemp, & Janssen, 1996; Muhib, et al., 2001; Stueve, O'Donnell, Duran, Sandoval, & Blome, 2001), a probability-based method, was used to systematically generate a sample of club-going young adults attending any of 223 dance clubs, bars and lounges in New York City as well as special events throughout the city. A random digit generator was used to sample venues from a list of enumerated dance clubs for random nights of the week. At each venue, field staff approached club patrons during 3-hour shifts selected with random start times (ranging from 9 p.m. to 3 a.m.). Detailed recruitment procedures are described elsewhere (Parsons, Grov, & Kelly, 2008).

During field recruitment, staff approached potential participants, asking them to complete a brief survey that lasted less than 5 minutes, and for which they received no compensation. If the patron consented, trained staff members administered the brief surveys using hand-held devices. If a patron refused, recruitment staff noted the participant's gender, and approximated age and race and ethnicity (for the purposes of tracking refusals). There were no significant differences between those who refused to participate and those who were briefly interviewed in age, gender, or ethnicity (see Parsons, et al., 2008 for a more detailed description and analysis of recruitment procedures). Field staff were instructed not to administer surveys to anyone who was visibly impaired by intoxicants.

Eligibility criteria for the larger *Club Drugs and Health* project were embedded in the brief field survey. To be eligible for the longitudinal study, individuals had to be between the ages of 18 and 29 and report the use of any of the six club drugs listed previously at least three times in the previous year and at least once in the prior three months. Of those surveyed in the field, 427 gay and bisexual men, 414 lesbian and bisexual women, 659 heterosexual men, and 465 heterosexual women were eligible for, and invited to join, the longitudinal study. Two transgendered individuals who were enrolled in the longitudinal study were not included in the analyses for the present study (N = 400). Staff explained the larger project to eligible individuals, distributed recruitment materials with project contact information, and collected contact information from the individual. Participants were rescreened via phone and scheduled for a later in-person assessment at our research site. During their baseline assessment, project staff first evaluated participants for potential intoxication and then completed informed consent procedures. Participant assessments consisted of qualitative in-depth interviews and a survey administered through Audio-Computer-Assisted Self-Interview (ACASI) software program. ACASI is a questionnaire system that allows research participants to answer sensitive personal questions on a computer. The system uses voice recordings so that participants hear (through headphones) and see (on the screen) each question and response list. Participants enter their responses directly into the computer using a keyboard or mouse. Employing a stratified quota schema, 100 gay and bisexual men (23% of those found eligible), 100 lesbian and bisexual women (24% of those found eligible), 100 heterosexual men (15% of those found eligible), and 100 heterosexual women (22% of those found eligible) were enrolled in the project (N = 400). Following their baseline visit, the 400

participants completed face-to-face assessments every 4 months for a year. Participants were compensated $50 for the baseline assessment, $30 for the 4 and 8 month assessments, and $50 for the 12 month assessment. The Institutional Review Board at Hunter College approved all procedures.

Of the 400 participants enrolled in the longitudinal study, 303 (76%) completed the 4 month assessment, 285 (71%) completed the 8 month assessment, and 327 (82%) completed the 12 month assessment. Sixty three percent of participants completed all 4 assessments, 15% completed three assessments, 13% completed two assessments, and 10% completed only the baseline assessment. Missingness at 4, 8, or 12 month timepoints was not associated with age, gender, sexual orientation, ethnicity, or cocaine use at baseline. As the data analytic procedure used here (LCGA) is able to tolerate missing data so long as data are missing at random, the full N of 400 was used to estimate model parameters. Intake demographics, substance use patterns and substance use diagnoses of participants are presented in Table 1.

2.2 Measures

Demographics—At baseline, participants self-reported their gender, ethnicity, race, and sexual orientation from a list of possible choices: male, female; Latino or Non-Latino; White, Black, Asian/Pacific Islander, or mixed/another ethnicity; and gay/lesbian/queer, bisexual, or heterosexual. They were also asked to provide their date of birth (from which their age was computed), level of education, current school enrollment, their annual income (<$10K, $10K-20K, >$30K), and employment status (full-time, part-time, unemployed). Student and employment status were independently coded such that if a student was working full-time they would be counted as both a "current student" and also "employed full-time." If the student was a full-time student with no outside employment, then s/he was categorized as "current student" and also "unemployed."

Drug Use—At baseline, 4, 8, and 12 month assessments, participants were asked how many times they had recently used (past four months) cocaine, each of five other club drugs: MDMA, Ketamine, GHB, methamphetamine, and LSD; as well as cigarettes, alcohol, and marijuana.

Club Drug Dependence—Symptoms of club drug dependence were measured at baseline using a modified version of the Composite International Diagnostic Interview (CIDI; Kessler & Ustun, 2004). The CIDI is a widely used measure that assesses the criteria of the ICD-10 and DSM-IV classification systems into questions and compiled the responses into diagnosis. The original measure has demonstrated good test-retest reliability and validity as measured by comparison with clinical and non-clinical measures (Ustun, et al., 1997). Traditionally, this measure is used for a specific drug (e.g., "In the past 12 months, did your use of *cocaine* ever interfere with your work at school, a job, or at home?"). To prevent participant fatigue, we modified the questions to read "club drugs" (e.g., "… did your use of *club drugs* ever interfere with your work … ?"). A-CASI prompted participants with a reminder that club drugs were defined as any of the six drugs of interest to the study. Those participants demonstrating symptoms of dependence (i.e., they answered "yes" to three or more items) were asked, "Which of the six club drugs gives you the most problems?" More information on dependence in this sample has been reported elsewhere (see Parsons, et al., 2008). For the present study, we evaluated whether an individual exhibited three or more symptoms of either club drug dependence broadly (y/n) or cocaine dependence specifically (y/n) at baseline.

Sensation Seeking—At baseline, two sensation seeking scales were used to ascertain levels of sensation seeking specific to both drug use and sexuality: the 11-item Sexual

Sensation Seeking Scale (α = .812) and the 8-item Substance Use Sensation Seeking Scale (α = .832), adapted by Kalichman et al. (1996). Items on both scales were placed on a 4-point Likert-type response format ranging from 1 ("not at all like me") to 4 ("very much like me"). Scores for each scale were computed by calculating the sum of all items in each scale.

Life Stress and Coping—The 12-item Rhode Island Stress and Coping Inventory (RISCI) was used at baseline to assess past month life stress and ability to cope with such stress in two moderately correlated factors (Fava, et al., 1998). Items were scored on a 5-point Likert-type scale from 1 ("never"), to 5 ("frequently"). We computed stress (7-items) and coping (5-items) scales by summing items. Scales showed good reliability in our sample (stress scale: α = .88; coping scale: α = .87).

Substance Use Situations—The 35-item Inventory of Drug Taking Situations (IDTS) was used at baseline to assess the situational contexts underlying club drug use (Turner, Annis, & Sklar, 1997). Individuals are asked to rate the extent to which they use club drugs in 35 situations, on a 5-point Likert-type scale from 1 ("never") to 5 ("always"). Five factor-analytically derived scales were used for the present study: Unpleasant Emotions (α = .92), Physical Discomfort (α = .61), Conflict with Others (α = .87), Social Pressures (α = .80), and Pleasant Times with Others (α = .73).

2.3 Analytical strategy

We used latent class growth modeling (LCGM; Muthén, 2001; Nagin, 2005) to construct latent models of cocaine use over the 1-year assessment period using Mplus version 6 (Muthén & Muthén, 2010). LCGM is a multilevel modeling technique to identify unobserved ("latent") subpopulations which may exist in longitudinal data. For a given model, parameter estimates include (1) class membership or posterior probabilities used to classify individuals into most likely latent class and (2) class-specific conditional response probabilities (CRPs), or probabilities that individuals within a particular class have responded "yes" to a target item (e.g., cocaine use) at a given timepoint. Based on the patterns of the estimated conditional probabilities, meaningful labels or definitions of the latent classes can be made.

LCGM can model the influence of covariates such as baseline characteristics (e.g., sex, age, other club drug use), while simultaneously determining the class structure (Muthèn & Muthèn, 2000). Since the inclusion of covariates sometimes changes the classification (e.g., number of cases classified into each class), it has been recommended that latent class determination and covariates be included simultaneously (Muthèn, 2004; Nagin, 1999; Roeder, Lynch, & Nagin, 1999).

Model fit was evaluated using four criteria. First, the Lo–Mendel–Rubin likelihood ratio (LMR LR) test, based on a correctly derived distribution rather than a chi-square distribution, is very helpful for making LCGM model comparisons (Lo, Mendell, & Rubin, 2001). A low *p*-value for a LMR LR test indicates that a given model has to be rejected in favor of a model with at least one additional class. Second, the Bayesian information criterion (BIC; Raferty, 1995) statistic balances two components: maximizing the likelihood and keeping the model parsimonious. A low BIC value indicates a better model fit, and as such, the model with the lowest BIC is generally preferred (Muthèn & Muthèn, 2000). The entropy value, while not a true measure of fit, was also considered. Ranging from 0 to 1, entropy is a measure of the clarity of classification. Although there is no clear cut point for the entropy value to ensure a minimum level of good classification, entropy values that are close to 1.0 indicate that a model has clearly identified individuals following different trajectory types and it can be a useful summary measure (Celeux & Soromenho, 1996;

Muthèn & Muthèn, 2000; Ramaswamy, DeSarbo, Reibstein, & Robinson, 1993). Finally, the sample sizes of the smallest class and the class structures of each solution were examined as measures of model usefulness in practice.

For the present study, we first fit a series of latent class trajectory models of one- to five-classes using cocaine use frequency (days using in past 120) at baseline, 4mo, 8mo, and 12 mo follow-up). Multiple starting values were used and missingness was handled in MPlus using Full-Information Maximum Liklihood, assuming data were missing at random. Based on the best fitting model, we fit three more models with the same number of classes including the covariates for which we had the strongest a priori hypotheses: (i) time-varying covariates of presence or absence of use of each of the five other club drugs (ecstasy, ketamine, LSD, GHB, and methamphetamine) at all four timepoints; (ii) time-varying covariates of presence or absence of use of *any* of the five club drugs at all four timepoints; and (iii) a model with use (presence/absence) all other club drugs at baseline.

3. Results

3.1 Demographic and substance use characteristics

Baseline sample characteristics are presented in Table 1. The average age of club drug users at baseline was 23.9 (SD = 2.7) years, and the majority of the sample was White and either enrolled in college or had a college degree. The sample was fairly evenly distributed among the three income groups. Cigarettes, alcohol, marijuana, and cocaine were the most frequently used substances, among users of each of these substances. Cocaine use averaged slightly over 4 days per month at baseline. A majority of the sample met club drug dependence criteria at baseline. Of those who met criteria for dependence on a club drug (n = 254), a majority of participants indicated the drug causing the biggest problem was cocaine (n = 145, 57%), followed by ecstasy (n = 41, 16%), methamphetamine (n = 25, 10%), and LSD (n = 13, 5%). Noting that the standard deviation of mean frequency of cocaine use at baseline was large relative to the mean, we further examined the distribution of cocaine use across the four assessment timepoints (Figure 1). Cocaine use was extremely skewed at all four timepoints, with the most frequent value at 0, the next most frequent value at 1.

3.2 Model selection

As planned, we first fit LCGA models of one- to five classes using cocaine use frequency as the target variable. However, in all models, n's in the smallest class were small (range: 5 to 19). Given this and the noted skewness of the data we refit the same models but used a binary indicator of use (cocaine use/no-use). Latent classes were more well-populated and trajectory profiles were very similar to those obtained using frequency data suggesting that the frequency of use offered little additional information. Model fit statistics for the one- to five-class solutions based on the binary measure, without any covariates, are presented in Table 2. While the BIC was slightly lower for the 2- and 3-class solutions (1168, and 1183, respectively) than the 4-class solution (1205), the LMR LR test favored the 4-class solution over the 3-class solution (p = .0037). As there were 40 individuals assigned to the smallest class in both the 3- and 4-class solutions, and examination of the 4-class solution yielded an additional meaningful class, the 4-class solution was deemed the best-fitting model.

Once we determined that the 4-class model had the best fit, we re-fit multiple additional 4-class models adding the use of other club drugs as covariates. The first model with time-varying covariates of use (presence/absence) of the five other club drugs at all four timepoints yielded no estimates for some of the parameters, likely because club drug use was so rare over the year in this sample. For the second model with time-varying covariates

of any other club drug use (presence/absence) at all four timepoints, the likelihood did not replicate. For the third model with use (presence/absence) of the five other club drugs at baseline, the likelihood replicated and results are presented in Table 2. Compared to the 4-class solution without any covariates, the model with covariates had a larger BIC value, and a non-significant LMR LR value. For these reasons, we rejected the model with covariates in favor of the 4-class model with no covariates.

3.2.1 Quality of classification—Table 3 shows the average individual posterior probabilities for being assigned to a specific latent class. The values on the diagonal are high, and the values off the diagonal are low. This indicates a good quality of classification. The entropy value of 0.66 was lower than that for the 2- and 3-class solutions, although the classes were more easily interpretable for the 4-class model compared to the other two.

3.2.2 Latent class probability and class definitions—Conditional response probabilities for the 4-class solution are presented in Figure 2. Classes were identified as follows: *Consistent use* (47.7% of sample) were those individuals who were highly likely to have used cocaine at all four assessment timepoints; the *Inconsistent use* class (13.6%) was made up of individuals who were likely to have used cocaine at baseline, did not use at the 4-month assessment, and then were likely to have used again at the 8- and 12-month timepoints. Those in the *Decreasing likelihood of use* class (27.9%) were very likely to have used at the baseline and 4-month timepoints, and less likely to have used at the 8- and 12-month timepoints. Finally, the *Consistent non-use* class (10.8%) was made up of individuals who were not likely to have used cocaine at any of the assessment timepoints.

3.3 Correlates of cocaine use trajectories

Using ANOVA and chi-square analyses post hoc, we examined socio-demographic and substance use correlates of cocaine use trajectories. Results are presented in Table 4. Compared to the other three classes, those most likely to be in the *Consistent use* class had the highest frequency of baseline club drug dependence criteria (χ^2 (3, 396) = 15.1, $p < .01$), cocaine dependence criteria (χ^2 (3, 396) = 18.9, $p < .01$), recent alcohol use (χ^2 (3, 396) = 12.48, $p < .01$), and drug sensation-seeking (χ^2 (3, 396) = 9.03, $p < .01$). Those most likely to be in the *Consistent non-use* class had the highest frequency of baseline marijuana use (χ^2 (3, 396) = 2.71, $p < .05$). Contrary to hypotheses, there were no differences in most-likely trajectory class by gender/sexual-orientation, age, race and ethnicity, level of education, current study status, employment status, or income.

4. Discussion

This study found four main patterns of cocaine use over a year in a diverse sample of club drug-using young adults, highlighting the long-term diversity of cocaine use in this population. The choice to favor a 4-class solution above a 3-class solution was based primarily on three of the main evaluation criteria (LMR LR test, minimal sample size and interpretability of classes in practice). However, the BIC favored a 3-class solution, suggesting that there may be other ways to select the best-fitting model than what was chosen. The process of model selection in LCGA is somewhat subjective, which is why multiple criteria are often used, and replication of these analyses is needed to support findings presented here. Initial results comparing cocaine use classes to club drug dependence criteria at baseline highlight the validity of the solution found here. A 2011 study of a sample of men who have sex with men highlighted a similar 4-class pattern of stimulant drug use across 6 years, with *No use, Increasing use, Decreasing use, and Consistent use* patterns (Lim, et al., in press).

Over time, the majority of this sample maintained cocaine use, using at least once in each four-month period across a year. This finding contrasts somewhat with other longitudinal investigations of cocaine use frequency showing that heterosexual individuals (3 years; White & Bates, 1995) and gay and bisexual men (1 year; Palamar, et al., 2008) tend to decrease use over time. Our sample was made up of those who had recently used club drugs, a large majority of whom had used cocaine (90% at baseline), suggesting that young adults who use cocaine are not likely to change their behavior naturally over the course of a year. It also highlights that while a reduction in cocaine use and increase in ecstasy use are both national and New York state-wide phenomena (Substance Abuse and Mental Health Services Administration, 2006, 2010), cocaine is still most common among young adults frequenting bars and nightclubs in New York. Further, the highly skewed distribution of cocaine use at each timepoint in our sample, which is perhaps characteristic of cocaine users more generally, precluded our ability to model frequency of use. Instead, we evaluated the cessation or continuance of use over time, which nonetheless identified multiple patterns. Existence of *Inconsistent use* and *Decreasing likelihood of use* patterns demonstrated that for some individuals, use did tend to fluctuate over time. These patterns could be reflective of a maturation out of substance use for some individuals, consistent with developmental milestones of emerging adulthood and consistent with other longitudinal examinations of substance use patterns among young adults (e.g., Anderson, et al., 2010). Although not directly verifiable within the present study, decreasing and consistent non-use could also be consistent with an assessment effect such that some participants who were assessed at baseline were surprised by the amount of club drug use they reported, and changed their behavior as a result (Sanders, 1986). This has strong implications for future research and intervention evaluation.

4.1 Cocaine use trajectories and other drug use

Contrary to hypotheses, frequency of club drug use at baseline did not distinguish cocaine use trajectories over one year. Cross sectional findings at baseline demonstrated that 42% of the sample was highly likely to use cocaine but no other club drugs (labeled Primary Cocaine users; Ramo, et al., 2010), suggesting that for many cocaine users, cocaine is the only club drug that they use. The present study extends these findings longitudinally, and highlights that consistency in cocaine use is not necessarily associated with other club drug use.

Club drug use did differ by other substances such as alcohol and marijuana. Alcohol and cocaine are commonly used in conjunction with one another (e.g., Grov, Kelly, & Parsons, 2009), and when used together metabolize as a third, new, drug: cocaethylene. This combination is associated with significant morbidity and mortality as well as high cost of health care (Coffin, et al., 2003; Grant & Harford, 1990; McCance-Katz, Kosten, & Jatlow, 1998; Vanek, et al., 1996). Our findings indicate that use of both cocaine and alcohol is associated with a more consistent course of cocaine use over time, and therefore prevention and intervention efforts should directly address use of these two substances among young people. However, clearly some drugs are more risky for cocaine use than others, with marijuana associated with a less frequent cocaine use trajectory over a year. This may be reflective of variability in drug preference, given the different effects of cocaine (a stimulant) and marijuana, which has many effects other than CNS stimulation.

4.2 Cocaine use trajectories and demographic characteristics

Consistent with Palamar et al. (2008), there were no differences among cocaine using classes by demographic characteristics in the present study. Other studies have demonstrated differences in the extent of cocaine use by race and ethnicity (e.g., Asians are known to use less than other ethnicities; Braun, Murray, Hannan, Sidney, & Le, 1996). However, in the

present study, we examined presence or absence of cocaine use among those who use cocaine, and there may not have been enough variability on cocaine use to detect ethnic differences in patterns of use.

We also did not find any differences in cocaine use trajectories by gender or sexual orientation, which contrasts with findings that gay and bisexual identified young adults tend to use club drugs more often than their heterosexual counterparts in cross-sectional studies (Kelly & Parsons, 2008). Inclusion criteria for the present study included recent (past 4-month) club drug use, which may have masked demographic differences that exist between those who use club drugs and those who do not. It is possible that, when a sample is restricted to recent club drug users, gender and sexual orientation are not relevant in examining drug use longitudinally. Further, it is possible that the heterosexual emerging adults in our study are delaying the adoption of more adult responsibilities - such as marriage and families - and thus we failed to find differences which have been attributed to such developmental milestones (Anderson, et al., 2010; Hamil-Luker, et al., 2004). Studies examining frequency of cocaine use have found some differences in demographic characteristics (e.g., Braun, et al., 1996), and thus further work should be completed with larger samples that allow for examination of frequency of cocaine use at each timepoint.

4.3 Cocaine use trajectories and other individual characteristics

Baseline life stress or ability to cope with stress were not associated with 1-year cocaine use trajectories. The stress-vulnerability model of addiction relapse suggests that an individual's susceptibility to the negative impact of stressful life events is determined by psychosocial risk and protective factors (e.g., Brown, Vik, Patterson, Grant, & Schuckit, 1995). However, findings on the association between life stress, coping and cocaine use have been mixed, with Hall and colleagues finding that stress did not predict relapse to cocaine in adults and coping only did with Caucasian adults (Hall, Havassy, & Wasserman, 1991). Our study followed a diverse sample of young adults involved in the nightlife scene in New York City. Perhaps these individuals' drug use was not distressing enough to have the stress-vulnerability model apply to them. It might also be that these participants are continually adjusting their stress and ability to cope with stress such that baseline levels were less relevant at follow up assessments.

Higher scores on the drug-sensation-seeking scale, and using when experiencing physical discomfort or in pleasant times with others were associated with more severe cocaine use trajectories. This is consistent with findings from our cross-sectional examination of club drug patterns in this sample (Ramo, et al., 2010). Findings for drug sensation-seeking are consistent with findings that those with sensation-seeking personality traits are attracted to stimulants such as cocaine (Gerra, et al., 2004), and that sensation-seeking motivations are associated with relapse in dependent individuals (Kasaraba, Anglin, Khalsa-Denison, & Paredes, 1998). Palamar and colleagues (2008) found similar associations between situational antecedents of cocaine use over the course of one year among gay men. Club-drug users who frequent bars and nightclubs appear to use as a means of social lubrication, with cocaine use tied to pleasant social contexts. For those who use consistently over the course of a year, cocaine use is often triggered by social situations and through the avoidance of physical discomfort (e.g., being tired).

4.4 Limitations

This study has limitations. First, data were self-reported and are subject to recall bias. Second, although highly skewed cocaine use frequencies are perhaps characteristic of users, the data did not allow for examination of frequencies of cocaine use beyond dichotomous patterns (use/non-use) in trajectory analyses. Future studies with larger sample sizes should

attempt to replicate these trajectories of cocaine use. Further, since this was primarily a cocaine-using sample, other club drug use limited the examination of polysubstance use that we could examine over time. Finally, the diversity of the sample, coupled with our probability based recruitment approach, allows for generalizability with respect to gender and sexual orientation; however, the trajectories found here may not generalize to young adults who are not socializing in bars and clubs, those who are in treatment for cocaine or other club drug use, and those who refuse participation in research studies.

5. Conclusions

This study was the first to examine longitudinal patterns of cocaine use among a diverse sample of young adult club drug users. The sampling strategy used in the *Club Drugs and Health Project* purposely oversampled gay and lesbian-venues to stratify by gender and sexual orientation and contextualize club drug use across multiple sociocultural contexts. The use of cocaine, while common, was relatively infrequent, supporting the argument that some drug seeking behavior is instrumental in obtaining non-drug seeking goals, and therefore may be instrumental rather than strictly addictive (Muller & Schumann, in press). The use of cocaine over time in our study was primarily associated with alcohol and marijuana use, drug sensation-seeking, and triggers such as experiencing pleasant times with others and physical discomfort. Future longitudinal investigations should examine polysubstance use over time among young adult club drug users, and ideally identify the onset of use of club drugs as they relate to other substance use. Trajectories of polydrug use are complex (Halkitis, Palamar, & Mukherjee, 2007), and cocaine use tends to be initiated before the use of other club drugs (Halkitis & Palamar, 2008); thus, these complexities are further dependent on where these participants reside in their drug careers. Future longitudinal studies to investigate emergence into adulthood are necessary to capture predictors of cocaine use before it begins. This study discovered immediate antecedents to cocaine use, but future studies should investigate antecedents to initiation of use. This will allow us to observe users' drug careers in a fuller perspective and will additionally allow us to gain a better understanding of use over time.

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Substance Abuse Mental Health Services Administration. Detailed Data Table 1.13B - Cocaine Use in Lifetime, Past Year, and Past Month, by Detailed Age Category: Percentages, 2008 and 2009. SAMHSA; Rockville, MD: 2010. Retrieved from http://oas.samhsa.gov/NSDUH/2k9NSDUH/tabs/Sect1peTabs1to46.htm#Tab1.13B

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Research Highlights

- We used latent class growth analysis to identify trajectories of cocaine use over a year
- A 4-class model fit the data best
- Those in the “Consistent Use” class had the highest baseline club drug dependence
- Those in the “Consistent Non-use” class had the highest frequency of baseline marijuana use
- Findings highlight the diversity of cocaine use patterns over time among young adults

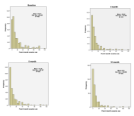

Figure 1.
Histograms of cocaine use frequency at four timepoints (days using in past 4 months).

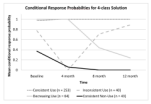

Figure 2.
Conditional Response Probabilities for 4-Class solution (% using in past 4 months).

Table 1

Baseline characteristics of young adult club drug users (N = 400)

Characteristic	
Race/Ethnicity: % (n)	
Asian/Pacific Islander	4.0 (16)
Latino/a	19.3 (77)
African-American	6.5 (26)
White	61.8 (247)
Mixed/other	8.5 (34)
Education: % (n)	
Some high school	3.3 (13)
High school diploma	8.0 (32)
Some college	17.0 (68)
Enrolled in college	24.0 (96)
Bachelor's degree	41.5 (166)
Graduate school/degree	6.3 (25)
Current enrolled in school: % (n)	29.8 (119)
Employment status: % (n)	
Full-time	43.8 (175)
Part-time	33.3 (133)
Unemployed	23.0 (92)
Income: % (n)	
<$10K	31.2 (125)
$10K-30K	32.7 (131)
>$30K	36.2 (144)
Drug Use: Mean Days/month, past 4 months (SD)	
Cocaine	16.8 (22.8)
MDMA	3.0 (8.1)
Ketamine	0.8 (2.7)
GHB	0.4 (6.1)
Methamphetamine	1.0 (5.9)
Cigarettes	60.9 (50.2)
Alcohol	46.0 (30.1)
Marijuana	39.4 (42.4)
Dependence: % (n)	63.5 (254)
Sexual sensation-seeking: M (SD)	26.5 (6.4)
Drug sensation-seeking	17.9 (4.2)
Stress: M (SD)	18.2 (6.1)
Coping: M (SD)	18.4 (3.7)
Club Drug Use Situations: *M* (SD)	
Unpleasant Emotions	19.8 (8.4)
Physical Discomfort	8.9 (2.9)

Characteristic	
Conflict with Others	15.4 (6.3)
Social Pressure	10.5 (4.1)
Pleasant Times with Others	15.9 (3.8)

Table 2

Model comparison

Model	BIC	LMR LR p-value	N in smallest class	Entropy
1-class	1303.2			
2-class	1168.0	<.0001	82	.76
3-class	1183.7	.0005	40	.82
4-class	1204.9	.0037	40	.66
5-class	1234.8	.9445	16	.66
4-class with club drug use covariates	3139.3	.3235	39	.83

Table 3

Mean class assignment probability by class (N = 400)

	Class 1	Class 2	Class 3	Class 4
Class 1 (*n* = 253)	.75	.04	.20	.01
Class 2 (*n* = 40)	.01	.96	.00	.04
Class 3 (*n* = 64)	.00	.02	.93	.05
Class 4 (*n* = 43)	.01	.13	.01	.85

Table 4

Sociodemographic characteristics and substance use by trajectory class (N = 400)

	***Consistent use* (47.7%)**	***Inconsistent use* (13.6%)**	***Decreasing Likelihood of use* (27.8%)**	***Consistent Non-use* (10.8%)**
Sexual orientation/Gender (%)				
Lesbian/bisexual females	26.1	22.5	28.1	16.3
Heterosexual females	23.7	27.5	23.4	32.6
Gay/bisexual males	24.9	30.0	25.0	20.9
Heterosexual males	25.3	20.0	23.4	30.2
Mean age (SD)	24.0 (2.7)	23.3 (2.7)	24.0 (2.5)	23.4 (3.2)
Race/ethnicity (%)				
White	62.1	62.5	64.1	55.8
African-American	7.9	2.5	7.8	0.0
Hispanic/Latino	18.2	20.0	14.1	32.6
Asian/Pacific-Islander	3.6	2.5	6.3	4.7
Mixed/other	8.3	12.5	7.8	7.0
Education (%)				
Some HS	2.8	0.0	3.1	9.3
HS diploma	9.9	2.5	4.7	7.0
Some college	14.6	17.5	23.4	20.9
Enrolled in college	22.5	35.0	20.3	27.9
BA	43.5	40.0	42.2	30.2
Graduate school	6.7	5.0	6.3	4.7
Current student (%)	27.7	37.5	26.6	39.5
Employment (%)				
Full-time	45.1	42.5	45.3	34.9
Part-time	33.6	32.5	29.7	37.2
Unemployed	21.3	25.0	25.0	27.9
Income (%)				
<10k	28.6	33.3	29.7	46.5
10k-30k	32.1	30.8	39.1	27.9
>30k	39.3	35.9	31.3	25.6
Mean past 4-month substance use frequency (SD):				
Tobacco	63.4 (49.3)	46.7 (49.6)	63.4 50.5)	55.3 (54.7)
Alcohol	**51.0 (31.7)**	**35.7 (21.8)**	**47.9 (30.2)**	**23.3 (21.8)**
Marijuana	**39.9 (42.4)**	**24.1 (32.3)**	**39.6 (44.7)**	**50.5 (44.6)**
Ecstasy	3.5 (9.2)	2.1 (4.8)	2.7 (7.3)	2.0 (2.5)
Methamphetamine	0.7 (2.3)	1.0 (4.4)	1.4 (7.7)	2.3 (13.7)
Ketamine	0.9 (2.8)	0.4 (1.3)	0.6 (2.2)	1.2 (3.5)
GHB	0.6 (7.6)	0.1 (0.6)	0.2 (1.3)	0.2 (0.8)
LSD	1.1 (3.9)	0.7 (2.0)	0.3 (1.4)	1.8 (3.9)
Club Drug Dependence Diagnosis (%)	**70.0**	**50.0**	**59.4**	**44.2**

	***Consistent use* (47.7%)**	***Inconsistent use* (13.6%)**	***Decreasing Likelihood of use* (27.8%)**	***Consistent Non-use* (10.8%)**
Cocaine Dependence Diagnosis (%)	**43.1**	**25.0**	**32.8**	**11.6**
Drug sensation-seeking [*M* (SD)]	**18.7 (4.1)**	**16.2 (3.6)**	**17.0 (4.2)**	**16.2 (4.0)**
Sexual sensation- seeking [*M* (SD)]	26.5 (6.3)	26.9 (7.1)	26.5 (5.8)	26.4 (7.0)
Life Stress [*M* (SD)]	18.4 (6.1)	19.2 (6.8)	17.4 (5.9)	17.1 (6.4)
Coping	18.4 (3.7)	18.7 (3.0)	17.8 (4.0)	18.4 (3.9)
Use Situations				
Unpleasant Emotions	20.5 (8.8)	17.7 (6.7)	19.2 (8.1)	18.0 (7.8)
Physical Discomfort	**9.4 (3.1)**	**7.9 (2.0)**	**8.5 (2.6)**	**7.9 (2.6)**
Conflict with Others	15.9 (6.7)	13.8 (5.0)	14.9 (5.4)	14.5 (5.9)
Social Pressure	10.8 (4.1)	10.1 (4.3)	10.5 (4.7)	9.7 (3.3)
Pleasant Times with Others	**16.3 (3.6)**	**15.6 (4.1)**	**15.3 (3.8)**	**14.6 (4.3)**

Note. Bold text indicates significant F or chi-square at $p < .05$ level.