# Profiles of lifetime substance use are differentiated by substance of choice, affective motivations for use, and childhood maltreatment

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## ARTICLE INFO

## ABSTRACT

To develop personalized interventions and improve outcomes in substance-using populations, research is needed on the heterogeneity in substance use patterns and motivations that exists among adult substance users. This study took a person-centered approach to identify profiles of lifetime substance use and discern the psychosocial differences among them. To survey a spectrum of drug use severity, 1106 adults (43.4% women) were recruited from forensic and community samples. Participants reported on the frequency of lifetime substance use across multiple drug categories (sedatives, stimulants, marijuana, heroin, hallucinogens, misuse of prescription drugs) and alcohol use. Latent profile analysis was used to identify distinct profiles of substance use that were then compared on potential risk and maintenance factors for substance use. Four profiles of lifetime substance use emerged that diverged on severity of use and degree of mono vs. polysubstance use (*Recreational Marijuana Use, Heavy Multidrug Intoxication, Heavy Marijuana Use,* and *Heavy Opioid and Polysubstance Use)*. The profiles differed on affective motivations for substance use (e.g., using to cope vs. using to seek a thrill), age of use onset, drug-related functional impairment, and experiences of childhood maltreatment. Cognitive functioning did not differentiate the heavy substance use profiles. Results provide compelling initial evidence that lifetime patterns of use can be used to identify groups of substance users with distinct risk and maintenance factors. Results highlight affective motivations for substance use and maltreatment history as potential treatment targets and underscore the importance of studying polysubstance use in the context of the opioid epidemic.

## 1. Introduction

Person-centered approaches align closely with calls to understand diversity in the pathways to substance use and hold promise for developing personalized treatments based on individual vulnerabilities. Although substance use typologies are well-studied, existing research has predominantly examined single substances in isolation, focused on licit substances when studying multiple drug types, and studied adolescent and young adult samples. This research provides useful insight into subtypes of mono-substance users, those who use licit substances, and youth drug use, but it does not address potential heterogeneity among adult substance users, particularly those who engage in polysubstance use. A more inclusive and generalizable approach would be to classify individuals based on lifetime use across multiple substances, which is likely more reflective of distinct etiologies and

predictive of future substance use and related problems in living (Brecht, Huang, Evans, & Hser, 2008; Chassin, Pitts, & Prost, 2002). Thus, the goal of this study was to further knowledge of this understudied, yet important, topic by identifying dissociable profiles of lifetime substance use in a large sample of adults who endorsed a history of substance misuse, regardless of type or number of substances used.

The vast majority of studies to date have examined typologies of mono-substance users, such as identifying heterogeneity among individuals who primarily or exclusively use cannabis (Grant, Scherrer, Neuman, Todorov, Price, & Bucholz, 2006; Manning et al., 2019), opioids (Green, Black, Serrano, Budman, & Butler, 2011; Wu et al., 2011) or cocaine (Liu, Elliott, Serdarevic, Leeman, & Cottler, 2019). In contrast, few studies have applied a person-centered approach to identifying subtypes of substance-using adults, regardless of drug use type or severity. These include Bunting, Oser, Staton, and Knudsen (2020),

which found six unique profiles with varying 30-day (but not lifetime) levels of poly- and mono-substance use that distinguished justice-involved individuals. Another study of adults presenting to emergency rooms examined alcohol, cannabis, and tobacco use and identified five distinct classes, ranging from infrequent users to polysubstance users (Blow et al., 2011). Additionally, a study of adult primary care patients reported a low substance use disorder (SUD) subtype, a moderate to-bacco, alcohol, and cannabis SUD subtype, and a high tobacco, opioid, and cocaine SUD subtype (John et al., 2018). Studies such as these suggest a spectrum of severity, from infrequent to problematic use, and some specificity in the type of substance use among less severe users. However, existing studies have restricted analysis to single sample types (e.g., emergency rooms, justice-involved individuals) that may not fully capture a range of substance use severity, from recreational to prob-lematic, which limits the generalizability of their findings and may obscure typologies that emerge when greater diversity in substance use is represented.

The primary goal of this study was to distinguish profiles of sub-stance users across a range of substance types and severity levels in a diverse sample of adults. Although less commonly studied than in ado-lescents and young adults, substance use also is a significant problem among middle-aged and older adults (Mattson, Lipari, Hays, & Van Horn, 2017; Whiteford et al., 2013), and the number of middle-aged and older adults that use substances is projected to continue to increase (Salas-Wright et al., 2017). Thus, understanding heterogeneity in the profiles of adult substance users is a timely research question.

A secondary goal of the study was to examine clinically relevant correlates of adult substance use profiles by testing for differences in risk and maintenance factors that have been associated with problematic drug use in prior research. We specifically focused on risk factors that may differentiate chronic from recreational substance use trajectories. For example, we expected chronic profiles to report greater exposure to childhood maltreatment (Armour, Shorter, Elhai, Elklit, & Chris-toffersen, 2014; Thege et al., 2017) and an earlier age of initial drug use (Hser, Huang, Brecht, Li, & Evans, 2008) than recreational substance use profiles. We also anticipated that affective (approach and avoidance) motivations for substance use may differentiate profiles of chronic from recreational substance users, as higher levels of motivation to use sub-stances for coping and/or pleasure-seeking purposes have been found to be positively related to the severity of substance use disorders (Cooper, Kuntsche, Levitt, Barber, & Wolf, 2016; Miglin, Bounoua, Spielberg, & Sadeh, 2020). Additionally, cognitive dysfunction has been found to play a role in developing substance use disorders (Verdejo-García, López-Torrecillas, Aguilar de Arcos, & Pérez-García, 2005), so it was expected that lower levels of cognitive functioning in this study would be related to patterns of greater lifetime substance use. Thus, we selected these factors to confirm that the identified profiles show expected re-lations with key predictors of substance use and to provide initial insight into risk and maintenance factors that may differentiate adult profiles. Given that we did not know what profiles would emerge from the latent profile analysis, we did not have specific hypotheses about expected associations between the predictors and profiles beyond the chronic vs. recreational differences described above.

## 2. Material and Methods

### 2.1. Participants

Adults aged 18–67 ($M = 32.99$, $SD = 9.35$) years old who endorsed illicit drug use and/or misuse of prescription drugs on the *Risky, Impulsive, and Self-Destructive Behavior Questionnaire* (Sadeh & Baskin-Sommers, 2017) were analyzed in a pooled sample ($N = 1,106$). Data were collected from incarcerated men ($n = 317$), community adults with elevated substance use ($n = 199$), and an online crowdsourcing platform ($n = 590$). We purposefully recruited diverse samples to ensure a range of lifetime substance use was present in the pooled sample, including

pathological use common in justice-involved samples and recreational use that is common in community samples.

Men (55.5%) were represented at a higher rate than women (43.2%). Participants identified as White (72.9%), Black (20.0%), Asian (2.7%), or Other Race (4.4%), with 11.4% identifying as Hispanic/Latino. The majority earned a high school diploma or equivalent (51.9%), followed by an Associates or Bachelor's Degree (25.9%), graduate degree (8.8%), and less than high school (5.1%). Sample details are reported in Sup-plemental Materials.

### 2.2. Procedures

See Supplemental Materials.

### 2.3. Measures

#### 2.3.1. Substance Use

The *Risky, Impulsive, and Self-Destructive Behavior Questionnaire* (RISQ; Sadeh & Baskin-Sommers, 2017) assessed binge drinking, illicit drugs (sedatives, cocaine, marijuana, heroin, hallucinogens), misuse of prescription drugs, and using multiple drugs at once. For each item, participants reported on frequency of use, age of first use, and associated problems in living (e.g., hospitalization, legal trouble, problems at work/with relationships). Participants rated how much they agreed with the statement that they used a given drug to "*stop feeling upset, distressed, or overwhelmed*" and "*feel excitement, to get a thrill, or to feel pleasure*" from (0= "*Strongly Disagree*" to 4= "*Strongly Agree*") to index avoidance and approach motivations for drug use, respectively. Responses were binned to constrain the range of responses at the high end of the dis-tribution: 0/1–10/11–50/51–100/>100 times (Sadeh & Baskin-Sommers, 2017). Items on the RISQ were summed to create a lifetime frequency of substance use variable consisting of the drug and alcohol use items ($M/SD = 7.01/5.71$; Cronbach's alpha = 0.82). We also created variables to reflect the number of drugs that caused problems in living (6 items; $M/SD = 1.08/1.49$; Cronbach's alpha = 0.62), drug use approach motivations (6 items; $M/SD = 2.73/1.24$; Cronbach's alpha = 0.69), and drug use avoidance motivations (6 items; $M/SD = 1.94/1.40$; Cronbach's alpha = 0.76).

#### 2.3.2. Childhood maltreatment

On the Childhood Trauma Questionnaire (CTQ; Bernstein et al., 2003), participants rated experiences of maltreatment before age 18 from 1 *"Never True"* to 5 *"Always True"*. The CTQ is a widely used assessment of childhood maltreatment, has demonstrated convergent validity with independent ratings of maltreatment provided by primary therapists in psychiatric samples (Bernstein et al., 2003), and has a high agreement with interview-based assessments of child abuse (Lobbestael, Arntz, Harkema-Schouten, & Bernstein, 2009). A total score was created by summing the physical abuse ($M/SD = 8.74/4.59$), sexual abuse ($M/SD = 7.44/4.83$), and neglect subscales ($M/SD = 10.05/4.25$). The total score had good internal consistency (Cronbach's alpha = 0.89).

#### 2.3.3. Cognitive functioning

A subset of participants in the offline sample ($n = 317$; see Supple-mental Methods for details) completed the Color-Word Interference Test (Delis, Kaplan, & Kramer, 2001) to measure inhibitory control using the scaled scores for the inhibition ($M/SD = 9.61/3.08$) and inhibition/switching subtests ($M/SD = 8.99/3.42$). To assess working memory, the same participants completed the Digit Span Backwards test (Wechsler, 2008), quantified using the total score ($M/SD = 7.44/4.83$). Both tests of cognitive functioning are well-validated measures that show strong test–retest reliability and construct validity (Sattler & Ryan, 2009; Ste-phens, 2014).

## 2.4. Statistical analysis

We employed latent profile analysis (LPA), in Mplus (Muthén & Muthén, 2017), to identify profiles of lifetime substance use based on six types of substance use (opioids, cocaine, marijuana, psychedelics, binge drinking, prescription drug misuse), and using multiple substances at once. Selection of the optimal number of profiles was based on a combination of comparative model fit, interpretability, and consistency across samples. We tested models until increasing the number of classes did not improve model fit (i.e., based on the Bayesian Information Criterion and Lo-Mendell-Rubin-adjusted likelihood ratio test) (Lo, Mendell, & Rubin, 2001) and/or resulted in a loglikelihood value that was not replicated.

To assess consistency, we first conducted LPAs separately in the online, forensic, and offline samples. The purpose of this step was to test the configural similarity of the profiles of the samples that differed in method of data collection or demographic characteristics to ensure pooling the samples was justified. Configural similarity was considered to be established when the optimal solution for both groups included the same number of profiles (Morin, Meyer, Creusier, & Biétry, 2016). We also qualitatively evaluated the optimal solution in each sample to ensure they evidenced similar distinguishing characteristics. We did not quantitatively compare the optimal solutions derived in each sample, because we purposefully recruited samples that would differ on frequency of substance use in order to capture a spectrum of severity. Thus, we expected the size and indicator means for each profile to differ depending on the average severity of substance use in a particular sample. Once consistency was established, we pooled the samples and conducted a final LPA with sample type as a covariate to verify the optimal solution found in each group separately was also identified in the larger, pooled sample.

Finally, we classified participants into the profile with the highest posterior probability of class membership. Psychosocial differences between the profiles were evaluated in SPSS (v26.0) using one-way ANOVAs with Games-Howell post-hoc comparisons (based on the q-statistic - appropriate for unequal variances and sample sizes) and Chi-Square analyses.

## 3. Results

### 3.1. Profile identification

#### 3.1.1. Preliminary analysis

We conducted LPAs in the offline, forensic, and online samples, separately. Based on the LRT-a, model fit improved for solutions two through four in the offline and forensic samples and solutions two through five for the online sample (see Supplemental Table S1 for fit statistics). However, the loglikelihood for 5-class online solution was not replicated, and thus this solution was rejected. Across samples, the 4-class solution was selected as optimal based on the fit statistics (BIC and LRT-a) and convergence across the samples in the pattern of indicator loadings (described below for the pooled sample and displayed in Supplemental Fig. S1).

#### 3.1.2. Final pooled analysis

Next, we pooled the samples and conducted another set of LPAs with sample type as a covariate. Model fit improved for solutions with two through four profiles (see Table 1). The 5-class solution was rejected because the loglikelihood value was not replicated, the LMR-a was non-significant, and the class consisted of<5% of the sample. The 4-class solution had a smaller BIC than the remaining three solutions, higher entropy than the 3-class solution, and the LMR-a was significant. It was also the solution that best fit the data when the LPA was conducted separately by sample in terms of the number of profiles and the indicator loading patterns, leading us to select this solution as the optimal number of profiles. The average latent class probabilities for the most likely class

**Table 1**
Fit Statistics for models of lifetime substance use (N = 1106).

| Model | Log Likelihood | BIC | Entropy | LMR-A P Value |
|---|---|---|---|---|
| 2 Class | −11718.542 | 23598.280 | 0.937 | <0.0001 |
| 3 Class | −10765.782 | 21755.835 | 0.943 | <0.0001 |
| 4 Class | −10405.185 | 21097.718 | 0.954 | 0.0008 |
| 5 Class [a] | −10201.193 | 20752.812 | 0.958 | 0.1385 |

*Note.* BIC = Bayesian Information Criterion. LMR-A = Lo-Mendell-Rubin–Adjusted likelihood ratio test P-value. a = The best Log Likelihood value was not replicated, indicating that the solution may not be reliable.

membership were high for the 4-class solution, ranging from 0.95 to 0.99.

The profiles for the 4-class solution are depicted in Fig. 1. The first profile, *Recreational Marijuana Use (n = 444, 40.1%)*, described individuals with occasional cannabis use and binge drinking. The second profile, *Heavy Multidrug Intoxication (n = 188, 17.0%)*, reported the highest levels of using multiple substances at once, as well as heavy binge drinking, moderate marijuana, crack/cocaine, prescription drug misuse, and low levels of heroin use. The third profile, *Heavy Marijuana Use (n = 354, 32.0%)*, was defined by elevated rates of marijuana use (100$^+$ times on average), with relatively low levels of other substances. The fourth profile was distinguished by its elevated heroin use, prescription drug misuse, and cocaine/crack use relative to the other classes. This profile was labeled *Heavy Opioid and Polysubstance Use (n = 120, 10.9%)*.

### 3.2. Profile characteristics

Profile comparisons that were significantly different are reported in Table 2.

#### 3.2.1. First Use

Participants were asked to report on the developmental period during which they first used illicit drugs (see Fig. 2). Individuals in *Heavy Opioid and Polysubstance Use* were more likely to report first using illicit drugs in childhood than the other three profiles. Across all of the profiles, most individuals reported first using illicit drugs in adolescence. Only *Recreational Marijuana Use* had a substantial number of participants who endorsed first using illicit drugs in adulthood.

#### 3.2.2. Frequency and Impairment

Frequency of, and impairment from, drug use varied across the profiles. *Heavy Opioid and Polysubstance Use* reported the highest level of overall drug use on average, followed by *Heavy Multidrug Intoxication*, *Heavy Marijuana Use*, and *Recreational Marijuana Use*. A similar pattern emerged for impairment, with *Heavy Opioid and Polysubstance Use* reporting the most problems in living and *Recreational Marijuana Use* reporting the least.

#### 3.2.3. Motivations

Affective motivations for drug use (excluded alcohol use) differentiated the profiles marked by heavy patterns of use. *Heavy Opioid and Polysubstance Use* endorsed using drugs to avoid unpleasant emotions at higher levels than the other profiles. The tendency to use drugs to seek a thrill or achieve pleasant emotions was equivalent in *Heavy Multidrug Intoxication* and *Heavy Opioid and Polysubstance Use*, and higher than the profiles characterized primarily by marijuana use.

#### 3.2.4. Maltreatment

Experiences of childhood maltreatment varied across the substance use profiles, with the profiles marked by heavy use reporting higher childhood maltreatment than the *Recreational Marijuana Use* profile. The *Heavy Multidrug Intoxication* and *Heavy Opioid and Polysubstance Use* profiles reported the highest levels and did not differ from each other on
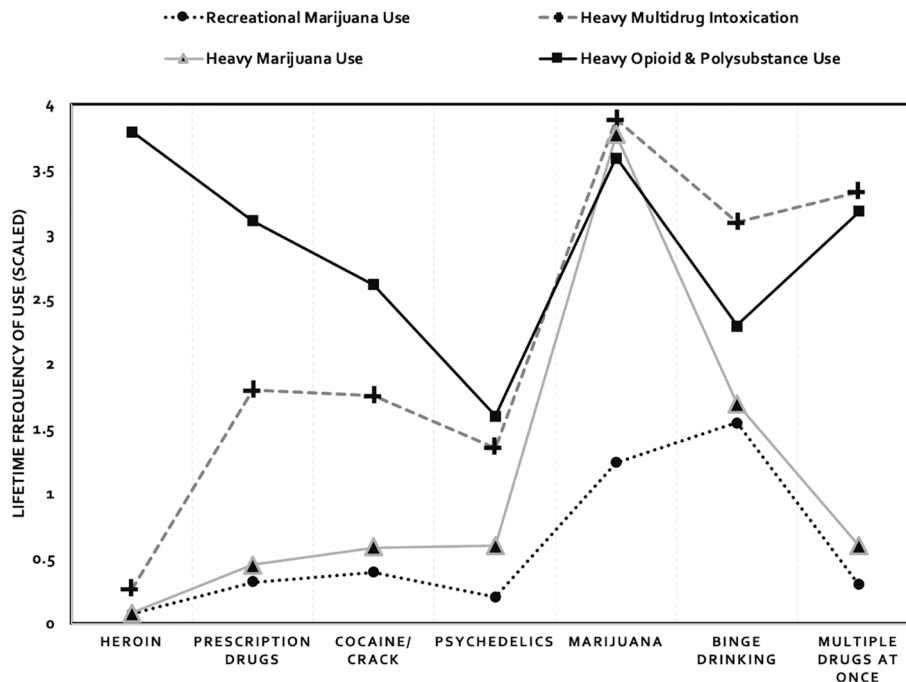
**Fig. 1.** Profiles of Lifetime Substance UseNote. Numbers on the y-axis represent the following frequency ranges: 1 = 2–10 times; 2 = 11–50 times; 3 = 51–100 times; 4 = 100 + times. Profile n's: Recreational Marijuana Use = 444, Heavy Multidrug Intoxication = 188, Heavy Marijuana Use = 354; Heavy Opioid and Polysubstance Use = 120.

**Table 2**
Substance Use Profiles Differ in Use Patterns, Childhood Trauma, and Demographics.

|  | Recreational Marijuana Use (Profile 1) | Heavy Multidrug Intoxication (Profile 2) | Heavy Marijuana Use (Profile 3) | Heavy Opioid & Polysubstance Use (Profile 4) | Statistic |
|---|---|---|---|---|---|
| Drugs Caused Problems in Living (M/SD) | [A] 0.36/0.85 | [B] 1.95/1.51 | [C] 0.74/1.02 | [D] 3.43/1.52 | $F = 285.58_{(3,1100)}$* |
| Drug Use Approach Motivations (M/SD) | [A] 2.27/1.41 | [B,D] 3.27/0.81 | [C] 2.83/1.14 | [D] 3.32/0.81 | $F = 46.74_{(3,1100)}$* |
| Drug Use Avoidance Motivations (M/SD) | [A] 1.41/1.47 | [B, C] 2.32/1.15 | [C] 2.18/1.34 | [D] 2.64/0.95 | $F = 44.16_{(3,1100)}$* |
| Childhood Maltreatment (M/SD) | [A] 46.31/ | [B] 57.75/ | [C] 53.37/17.35 | [B] 59.03/19.08 | $F = 26.24_{(3,977)}$* |
|  | 17.31 | 16.84 |  |  |  |
| Gender (%) |  |  |  |  | $X^2_{(6)} = 78.41$ * |
| Female | [A] 58.9% | [B] 29.1% | [B] 32.4% | [B] 35.1% |  |
| Male | [A] 39.5% | [B] 69.7% | [B] 66.1% | [B] 64.9% |  |
| Other | [A] 1.6% | [A] 1.2% | [A] 1.5% | [A] 0.0% |  |
| Education (%) |  |  |  |  | $X^2_{(9)} = 62.43$* |
| < High School | [A] 4.3% | [A,B] 5.0% | [A] 4.1% | [B] 11.0% |  |
| High School/GED | [A] 45.6% | [B] 65.2% | [B] 62.2% | [B] 72.5% |  |
| Some College | [A] 36.3% | [A, B, C] 24.8% | [C] 25.3% | [B] 12.8% |  |
| Graduate Degree | [A] 13.8% | [B] 5.0% | [A, B] 8.4% | [B] 3.7% |  |
| Race (%) |  |  |  |  | $X^2_{(9)} = 57.26$* |
| White | [A, B] 75.5% | [B, C] 71.3% | [C] 59.3% | [A] 86.5% |  |
| Black | [A, B] 15.8% | [B, C] 23.2% | [C] 33.3% | [A] 8.1% |  |
| Asian | [A] 4.7% | [A] 1.2% | [A] 2.1% | [A] 0.9% |  |

*Note.* Profile n's: Recreational Marijuana Use = 444, Heavy Multidrug Intoxication = 188, Heavy Marijuana Use = 354; Heavy Opioid and Polysubstance Use = 120. Superscript letter denotes significant differences across the classes for a given variable or category. Significant one-way ANOVAs were followed-up with post-hoc multiple comparisons calculated using a Games-Howell correction to evaluate pairwise comparisons. Significant chi-square analyses were assessed using z-tests to compare column proportions and adjusted using a Bonferroni correction. Drugs Caused Problems in Living reflects the average number of substance types that had caused problems in living (e.g., hospitalization, justice system involvement). Given that the incarcerated sample was composed entirely of men, we conducted supplemental analyses removing this sample to test whether the observed gender differences were due to the gender composition of the higher-risk sample. Results of this analysis showed that the gender differences remained significant, $X^2_{(6)} = 33.37$, p < .001, with the Recreational Marijuana Use profile consisting of more women than men and the heavy use profiles consisting of more men than women.
* p < .001.

childhood maltreatment.

### 3.2.5. Cognitive functioning

In the subset of participants from the offline sample who completed the neurocognitive battery, we examined differences among the heavy
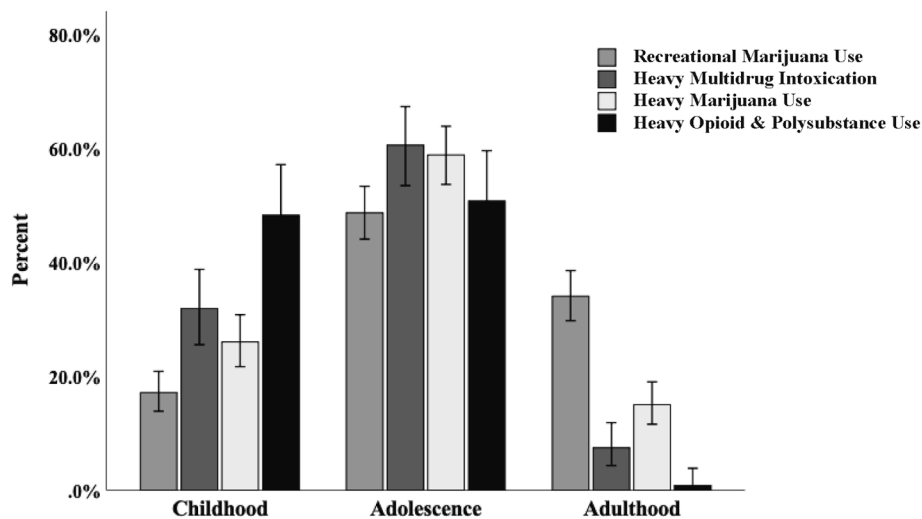
**Fig. 2.** Age of First Drug Use Varies as a Function of Substance Use Profile.Note. Percent of each substance use profile that first used illicit drugs (excludes alcohol) during each developmental period. Error bars: 95% CI. $X^2_{(6, N = 1104)} = 130.45$, p < .001.

use profiles on tests of working memory (Digit Span Backwards), inhibitory control (Color-Word Inhibition), and task switching (Color-Word Inhibition/Switching). We did not include the Recreational Marijuana Use profile in this analysis, because the proportion of participants who completed the tasks was substantially lower than the other profiles. No significant differences emerged across the profiles on the test of working memory, $F(2,244) = 0.77$, $p = 0.46$, inhibitory control, $F(2, 239) = 0.42$, $p = 0.66$, or task switching, $F(2, 237) = 0.54$, $p = 0.58$.

*3.2.6. Demographics*

Women were more likely to fall in *Recreational Marijuana Use*, whereas men evidenced greater representation in the heavy substance use profiles (see note in Table 2 about sex differences). Individuals in *Heavy Opioid and Polysubstance Use* obtained less education than those in the profiles marked primarily by marijuana. Black participants were overrepresented in *Heavy Marijuana Use*, and age did not vary across the substance use profiles, $F_{(3, 1026)} = 2.24$, $p = .08$.

*3.3. Discussion*

To inform personalized intervention efforts and improve outcomes, it will be necessary to identify heterogeneity in the risk and maintenance factors that distinguish typologies of substance use, as such knowledge can be translated into tailored interventions. Here, we tested whether lifetime patterns of substance use differentiated profiles of substance users in a diverse sample of adults. Latent profile analysis produced four profiles of lifetime substance use that diverged on two dimensions: severity of use (recreational vs. heavy consumption patterns) and degree of polysubstance use (exclusive marijuana use vs. multidrug intoxication). As well, the four profiles differed on affective motivations for drug use (e.g., using to avoid distress vs. seek pleasure), experiences of childhood maltreatment, age of first drug use, and drug-related problems in living. Notably, this study extends previous research by identifying data-driven profiles that distinguish adult users along a broad spectrum of severity, polysubstance use, and psychosocial functioning. Convergence of the profiles across diverse samples is a considerable contribution, as it suggests these four profiles are common typologies that may have important implications for understanding adult trajectories of substance use. Additionally, opioid users formed a unique typology among heavy polysubstance users with distinct clinical correlates, highlighting the need for further study of this profile in the context of the ongoing opioid epidemic.

The first and largest profile, *Recreational Marijuana Use* ($n = 444$),

endorsed occasional cannabis use and binge drinking across the lifespan. Overall, this profile reported less use across all of the drug categories compared to the other profiles, which is consistent with the more adult-onset pattern and fewer drug-related problems in living reported by these individuals. *Recreational Marijuana Use* also reported the lowest levels of childhood maltreatment and drug use motivated by emotional triggers or coping. Together, the psychosocial attributes of this profile suggest recreational use of marijuana, particularly when it starts in adulthood, may not be associated with functional impairment or addiction.

The second largest profile, *Heavy Marijuana Use* ($n = 354$), described participants who reported frequent marijuana use (over 100 times on average), but relatively infrequent use of other substances. Although both used marijuana almost exclusively, individuals in *Heavy Marijuana Use* reported more problems in living associated with their drug use, were more likely to start using marijuana in childhood and adolescence, and reported higher maltreatment in childhood than individuals in *Recreational Marijuana Use*. Heavy and recreational users of cannabis also diverged on the motivational processes related to their drug use, with the heavy users reporting a greater tendency to use substances to relieve distress or experience pleasure than the recreational users. This finding is consistent with research showing that adults with Cannabis Use Disorder are primarily motivated to use cannabis to cope with negative emotions (Moitra, Christopher, Anderson, & Stein, 2015), whereas adults who use marijuana recreationally tend to do so primarily to enhance leisure and social activities (Osborne & Fogel, 2008).

The next largest profile, *Heavy Multidrug Intoxication* ($n = 188$), was distinguished from the others by frequent use of multiple substances at once and low levels of opioid use. This profile reported greater childhood maltreatment and a higher likelihood of first using illicit substances in childhood than the profiles characterized primarily by marijuana use. A novel, and potentially clinically-relevant finding, was the higher endorsement of using substances to achieve pleasurable mood states in this profile compared to the exclusive marijuana use profiles. This finding suggests *Heavy Multidrug Intoxication* describes a group of substance users with a potentially distinct etiological pathway marked by an especially strong drive to use substances to achieve a thrill or feel excitement, which may motivate the frequent use of multiple substances simultaneously to get a high. This finding is consistent with emerging research showing that approach motivations for substance use are associated with increased severity of substance use disorders (Miglin et al., 2020).

The last profile to emerge, *Heavy Opioid and Polysubstance Use* ($n =$

120), was notable for the frequent opioid use reported, especially since the other profiles reported almost no opioid use, including the other two profiles characterized by heavy substance use. This profile also reported the highest levels of prescription drug and cocaine use, as well as elevated levels of using multiple drugs at once. This pattern of findings corroborates recent research showing that polysubstance use is the norm, not the exception, in Opioid Use Disorder (Cicero, Ellis, & Kasper, 2020), and extends it by indicating that opioid users form a unique typology of substance users. Consistent with growing awareness about the impairing nature of opioid addiction, individuals in this profile reported the most chronic and impairing history of substance use across the profiles. This corroborates past findings that the most chronic heroin users report early heroin use initiation (Grella & Lovinger, 2011), as well as early alcohol and marijuana use initiation (Nurco, Balter, & Kinlock, 1994). This profile reported high levels of childhood maltreatment and was uniquely characterized by the frequent use of substances to avoid unpleasant emotional states, bolstering research showing the most common motivations associated with nonmedical opioid use are to relieve pain and get high (McCabe, West, & Boyd, 2013). Very little work has compared typologies of substance users on the affective states motivating their use, and these results provide initial evidence that variation in affective motivations distinguishes opioid polysubstance users from non-opioid polysubstance users. Given the urgent opioid epidemic, understanding the role avoidance-based motivations play in initiating and maintaining opioid and heavy polysubstance use is a potentially innovative direction for future study.

The large sample, recruitment of clinically-relevant adults with elevated justice-system involvement, and examination of risk and maintenance factors with implications for mental health intervention are strengths of the study. Still, replication is needed to establish the reliability of the substance use profiles, as the sociodemographic composition of the sample was largely limited to White adults with low educational attainment. Men were also overrepresented, and no incarcerated women were sampled, which may hinder the generalizability of the findings. Moreover, our analyses focused on the convergence of profiles across diverse samples, and the possibility that there were subtypes of substance users specific to particular populations was not thoroughly investigated. Thus, an important caveat is that the identified profiles may not be exhaustive and research in larger, more homogenous samples is needed to explore potential population-specific profiles of use. Finally, the assessment of cognitive functioning was not available for the online sample, and investigation using a more thorough neurocognitive battery is needed to fully explore potential differences in cognitive functioning that may distinguish the substance use profiles.

*3.4. Conclusions*

Results provide strong evidence that dissociable profiles of adult substance users derived from lifetime frequency of use converge across samples with diverse characteristics and demonstrate unique risk and maintenance factors. Findings implicate childhood maltreatment and affective motivations for substance use (e.g., using to alleviate distress vs. chase a thrill) as factors that may initiate or maintain heavy substance use differentially across profiles of users, underscoring the importance of potentially targeting these factors in clinical interventions aimed at trauma-based work, distress tolerance, and emotion regulation. Further, although the recreational marijuana users evidenced few drug-related problems in living, the long-term outcomes for this group remain unknown. Growing access and social use of marijuana may lead this group to transition to heavier use over time (Alley, Kerr, & Bae, 2020), similar to what is seen with other legal drugs, like nicotine (Levy et al., 2019). Thus, researching the utility of these profiles for predicting substance-related trajectories and treatment outcomes is an important next step for understanding their clinical significance.

## 4. Contributors

All authors have approved the final article.

## 5. Role of funding sources

## CRediT authorship contribution statement

**Naomi Sadeh:** Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing - original draft, Writing - review & editing, Project administration, Resources, Funding acquisition, Supervision. **Rickie Miglin:** Investigation, Data curation, Writing - original draft, Writing - review & editing, Project administration. **Nadia Bounoua:** Investigation, Formal analysis, Data curation, Writing - original draft, Writing - review & editing, Project administration. **Emil Beckford:** Data curation, Writing - review & editing. **Suzanne Estrada:** Data curation, Writing - review & editing. **Arielle Baskin-Sommers:** Investigation, Data curation, Writing - review & editing, Resources.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.addbeh.2020.106710.

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