Experimental and Clinical Psychopharmacology

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Online First Publication, July 22, 2021. http://dx.doi.org/10.1037/pha0000404

American Psychological Association

Experimental and Clinical Psychopharmacology

ISSN: 1064-1297

https://doi.org/10.1037/pha0000404

Verbal Behavior Related to Drug Reinforcement in Polysubstance Cannabis Users: Comparison Across Drugs

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Verbal reports of drug effects are often used in behavioral pharmacology. Two reports related to reinforcement are drug use (Harford, 1978; Liu et al., 2018) frequency and drug preference. Anecdotally, some individuals may specify a favorite/preferred drug (e.g., psilocybin) despite using another drug more frequently (e.g., tobacco). Research comparing these two measures has led to contradictory findings and included ratings from participants who may not have experience with the rated drugs. No comparisons have been made between use frequency and preference across multiple drugs in polysubstance users. To compare use frequency and preference for drug classes, and examine relations across drug classes, individuals reporting polysubstance use ($N = 428$) provided frequency and preference ratings for nine drug classes. Mean ratings showed smoked tobacco, alcohol, and cannabis were the most frequently used and most preferred drugs. Mean ratings showed 3,4-Methylenedioxymethamphetamine (MDMA) and classic hallucinogens were the least frequently used and least preferred drugs. However, more divergence between use frequency and preference was observed when these metrics were examined among individuals. Correlation coefficients between use frequency and preference were lower than previously published literature. The majority of polydrug comparisons were nonsignificant, and correlations between different drug classes differed depending on whether use frequency or preference was examined. Verbal reports about use frequency are likely not strongly predictive of verbal reports about the same drug preference. Clinicians and researchers should recognize that different verbal reports related to drug reinforcement might be proxies for distinct aspects of reinforcement and should consider these implications for assessment and research findings.

Public Health Significance

Verbal reports of drug use and drug preference are commonly used in drug use research. We found that different types of verbal reports are likely proxies for distinct aspects of drug reinforcement, and the relation between different types of verbal reports vary at the individual level.

Keywords: reinforcer value, polysubstance, preference, demand, choice

> "But if thought corrupts language, language can also corrupt thought."
> George Orwell (1946), Politics and the English Language

Drug reinforcement can be studied directly using rigorous laboratory methods and metrics, such as preference in discrete choice procedures, free operant response rate, and progressive ratio break point. Evidence from demand analysis shows that various traditional methods of studying drug reinforcement assess different aspects of reinforcement and are not expected to universally agree (Bickel et al., 2000; Bickel & Madden, 1999; Johnson & Bickel, 2006). Therefore, the outdated construct of "relative reinforcing efficacy," conveying the idea that commodities can be unidimensionally rank ordered in their ability to function as reinforcers (Griffiths et al., 1979), has failed to meet criteria as a valid intervening variable (MacCorquodale & Meehl, 1948).

Aside from rigorous laboratory measures, drug researchers also collect data on participant verbal behavior (e.g., via questionnaires) that are assumed to have some relationship to drug reinforcement. Although verbal reports lack the rigorous experimental control of laboratory procedures, such assessments are useful because participants can report from a much broader range of drug use behavior across broader swaths of time. Indeed, it would be impossible to bring the totality of past drug use behavior into the laboratory. Like laboratory measures of reinforcement, it is possible that various verbal behavior metrics related to reinforcement do not assess a singular valid construct.

Many verbal report metrics exist that broadly relate to drug abuse liability and are used to assess responses to laboratory drug administration (e.g., "liking," "high," and "good effects"). Two verbal report metrics that are more nominally related to the concept of reinforcement, and which have been used to characterize drug use behavior outside of

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This research was supported by NIDA Grants R01DA032363 and T32DA007209.

The authors report no conflict of interest or any circumstances that could be perceived as a potential conflict of interest.

These data have not been disseminated prior to this publication.

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the laboratory, are drug use frequency (i.e., the rate of consumption) and preference among drugs (i.e., drug choice). Like the aforementioned laboratory metrics related to reinforcement, it is possible these different verbal report metrics measure different things. For example, an individual might specify her/his favorite/preferred drug to be psilocybin, as it is not uncommon for users to claim that psilocybin-occasioned experiences are highly meaningful (Bogenschutz & Johnson, 2016). However, the typical rates of psilocybin consumption frequency are relatively low (Johnson et al., 2018). Therefore, the same person might report using another drug more frequently (e.g., nicotine).

Several studies have examined the relationship between verbal reports of drug frequency and drug preference. For example, Harford (1978) asked 130 persons seeking treatment for drug dependence to report what drug (heroin, marijuana, barbiturates, amphetamines, hallucinogens and psychedelics, other opiates) they consumed most frequently during the preceding 60 days. The same participants also completed a drug preference inventory where they chose which of two drugs they preferred across all pairwise comparisons of the same drugs. Harford (1978) reported that 46% of the participants more frequently consumed a drug other than the one they most preferred, suggesting that reported drug consumption and drug choice may be measuring different things.

Data from other studies suggest that reported drug consumption and drug choice may provide similar measures. Feldman et al. (2007, 2011) recruited 72 inmates who had a significant drug abuse history (Feldman et al., 2007) as well as 100 patients from drug and alcohol treatment facilities (Feldman et al., 2011). These researchers found that the rate of drug consumption and drug choice were correlated when group metrics were aggregated ($r = 0.92$, Feldman et al., 2007; $r = 0.68$, Feldman et al., 2011) which they interpreted as contrary to the results obtained by Harford (1978). However, it is unknown the extent to which reported drug consumption and drug choice were correlated in the study by Harford (1978). In addition, in the study by Feldman et al. (2007), it is unknown what proportion of the participants would have preferred a different drug than the drug they consumed most frequently and how drug consumption and drug choice were related at the individual level.

One limitation of previous research comparing reported drug frequency and drug choice is that all participants' ranking of drug choice was used for analysis even if they had never used a drug. Feldman et al. (2007, 2011) did note that a large proportion of the participants in both studies had a history of polysubstance use. However, it is unknown how many of those participants did not have experience with the drugs they were ranking in terms of drug choice. Similarly, information is absent from the study by Harford (1978) on participant experience with the different drugs under study and the proportion of participants who had a history of polysubstance use. It is possible a different relationship between reported drug consumption frequency and drug use preference would be obtained when data for each participant is used only for drugs they have experience with.

A second limitation of previous research comparing drug consumption and drug choice is the lack of cross-drug frequency and cross-drug choice analyses. To meaningfully compare drug frequency and drug choice, data should be obtained from participants who have or are currently consuming multiple drug classes. Polysubstance use is an established risk factor for overdose deaths (Jones et al., 2013; Warner et al., 2009) with an estimated 59% of heroin-related overdose deaths in the U.S. involving at least one other drug (Jones et al., 2015). In addition, over half of individuals who use cocaine report they concurrently use alcohol and/or cannabis (e.g., Liu et al., 2018) and over half of individuals with opioid use disorder have reported they use multiple drug classes (e.g., Hassan & Le Foll, 2019). Absent from past research comparing reports of drug frequency and drug choice are comparisons of cross-drug consumption and cross-drug choice in individuals who use multiple drug classes.

The purpose of this study was twofold. First, we sought to compare two types of verbal report measures regarding drug use in individuals who report polysubstance use. One measure was the reported frequency that participants consumed each of a variety of different drugs. The second measure was reported relative preference (i.e., choice) among the same set of different drugs. Importantly, we only used data from each participant for the drugs with which they had indicated experience. The second purpose was to examine the associations between frequency across drug classes, preference across drug classes, and the relative associations between frequency and preference across drug classes.

Method

Participants and Procedure

Participants ($N = 428$) were recruited from Amazon.com's Mechanical Turk (mTurk). mTurk is an online crowdsourcing platform that allows requesters to post work tasks (hits) for mTurk workers to complete in exchange for monetary compensation. mTurk workers responded to an ad described as a survey about purchase patterns and health behavior and with the opportunity to earn $2.00 for participation. Participants were required to: (a) have 95% or higher approval rating on all previously submitted mTurk tasks, (b) have greater than 100 approved tasks, (c) be 18 years of age or older, and (d) report current use of cannabis in conjunction with alcohol or tobacco products as this study was part of a larger study involving polysubstance use with cannabis. The study tasks were programmed using Qualtrics (Qualtrics Labs, Inc., 2009), were completed in a single sitting, and took between < 1 and 5 min to complete.

Participants first responded to a list of questions about their drug use history. Questions asked participants to report whether they have ever used the following drug classes: smoked tobacco products (e.g., cigarettes, cigars/cigarillos, or e-cigarettes), smokeless tobacco products (e.g., snuff, chewing tobacco, or dip), alcohol (e.g., liquor, wine, beer, or wine coolers), caffeine (e.g., coffee, tea, soda, energy drinks, No Doz, or Vivarin), cannabis (weed, pot, marijuana, bud, hash, wax, dabs, or oil), stimulants (cocaine, amphetamine, methamphetamine, Ritalin, Dexedrine, or Adderall), sedatives/hypnotics/tranquilizers (e.g., Valium, Xanax, Klonopin, Ativan, Librium, Daimane, Ambien, phenobarbital, or Quaaludes), opioids (e.g., heroin, morphine, oxycontin, Percocet, Percodan, oxycodone, Vicodin, hydrocodone, methadone, Tylenol 3, or codeine), 3,4-Methylenedioxymethamphetamine; MDMA (ecstasy, Molly, X, XTC, E), or classic hallucinogens (Lysergic acid diethylamide; LSD, acid, psilocybin, magic mushrooms, 2C-B, Foxy methoxy, N, N-Dimethyltryptamine; DMT, ayahuasca, mescaline, or peyote).

Next, we measured drug use frequency and drug preference for each participant. Drug use frequency was measured by having participants rank the above list of drug classes in order from the *drug class used most frequently* (1) to the *drug class used least frequently* (9). Drug use preference was measured by having participants rank the above list of

drug classes in order from the drug class they *most prefer to use* (1) to the drug class they *least prefer to use* (9).

Data Analysis

For each participant, the rankings used for the analyses were only for the drugs they had used within their lifetime (obtained from the drug use history questions). Pearson's product–moment correlation coefficients were used to quantify the relationship between rankings. We calculated three types of correlations. One set of calculations were the 81 correlations between drug preference rankings for each of the 9 drugs and drug use frequency rankings for each of the 9 drugs (i.e., how does preference for a drug relate to use of that drug or other drugs?). The second set of calculations were 36 correlations between drug use frequency rankings across each of all possible pairs of different drug classes (i.e., how does use frequency rankings of different drugs relate?). A final set of calculations were the 36 correlations between drug preference rankings across each of all possible pairs of different drug classes (i.e., how do preference rankings for different drugs relate?). Bonferroni corrections were applied within each set of calculations with family-wise α set to 0.05.

Study procedures were approved by the Johns Hopkins Medicine Institutional Review Board 3 (Office for Human Research Protections Registration 00001656). The study was conducted in accord with the principles expressed in the Declaration of Helsinki, and written informed consent was obtained from all participants.

Results

Table 1 shows the number of participants who endorsed having used each drug class and descriptive statistics for rankings of reported drug use frequency and drug use preference. Most participants reported using sedatives ($n = 416$) followed by cannabis ($n = 411$) and alcohol ($n = 406$). The fewest participants reported having used MDMA ($n = 171$) followed by classic hallucinogens ($n = 190$) and smokeless tobacco ($n = 200$). For each drug class except opioids, at least one participant reported using it most frequently (min of 1) and least frequently (max of 9). Similarly, for each drug class, at least one participant reported all drug classes were their most preferred (min of 1) or least preferred (max of 9). The mean most and least frequently used were the same as the mean least frequently used and preferred drugs. The most frequently used and preferred drugs were smoked tobacco, alcohol, and cannabis, and the least frequently used and preferred drugs were MDMA, classic hallucinogens, and opioids. Table 1 also includes the median ranks as the distribtutions of ranks for each drug were not always normal.

However, more divergence between use frequency and preference was observed when examining relations between these metrics among individuals. Table 2 shows the correlations between participant rankings of drug use frequency and drug use preference. Statistically significant positive correlations were observed between the ranking of drug use and ranking of drug preference within each individual drug class (i.e., the correlation between use frequency ranking and preference ranking for given drug) for all nine drug classes (mean $r = 0.52$; cells in the diagonal). The range of correlations between drug use frequency and the same drug use preference ranged from 0.33 (alcohol) to 0.64 (MDMA). More specifically, six of these nine correlations were moderate ($0.30 \leq r \leq 0.60$; smoked tobacco, alcohol, cannabis, stimulants, sedatives, and opioids), and three of the correlations were strong ($r > 0.60$; smokeless tobacco, MDMA, classic hallucinogens).

The strength and directions of the above correlations are not indicative of the actual use frequency rankings or preference rankings. It is possible to have a statistically significant positive correlation between use and preference, but actual use frequency rankings and preference rankings could be high or low. Figure 1 shows Everest plots that allow for examination of the relationship between drug preference ranking and actual drug use ranking at the group level. Specifically, Figure 1 shows the number of participants who reported each unique combination of drug class preference ranking (1–9) and drug use frequency ranking (1–9). Raised points that fall along the diagonal from the furthest corner back to the furthest corner forward indicate a positive correlation. Raised points that fall along the diagonal from the leftmost corner to the rightmost corner indicate a negative correlation.

As noted above, within each drug class, all nine drug classes showed a statistically significant positive correlation between the preference and use frequency rankings. Figure 1 shows that three drug classes were highly preferred and used frequently (cannabis, alcohol, and smoked tobacco), three drug classes were moderately preferred and used with modest frequency (sedatives, smokeless tobacco, and stimulants), and three drug classes were not generally preferred and not generally used frequently (MDMA, classic hallucinogens, and opioids). In addition, the landscape outside of the positive correlation diagonal was relatively

Table 1
Descriptive Statistics of Participant Rankings for Drug Class Use Frequency and Drug Class Preference

		Use frequency rankings					Use preference rankings				
Drug class	Number endorsed	Min	Median	Mean	*SD*	Max	Min	Median	Mean	*SD*	Max
Smoked tobacco	383	1	2	2.13	1.50	9	1	2	2.46	1.66	9
Smokeless tobacco	200	1	4	4.63	2.25	9	1	4	4.53	2.56	9
Alcohol	406	1	2	2.34	1.33	9	1	2	2.60	1.49	9
Cannabis	411	1	2	2.55	1.46	9	1	2	2.41	1.48	9
Stimulants	209	1	5	4.7	1.71	9	1	5	4.70	1.61	9
Sedatives	416	1	5	4.81	1.45	9	1	5	4.72	1.56	9
Opioids	204	2	6	5.86	1.70	9	1	6	5.78	1.95	9
MDMA	171	1	7	6.76	1.79	9	1	7	6.41	2.16	9
Classic hallucinogens	190	1	7	6.64	2.08	9	1	7	6.39	2.38	9

Note. 1 = most frequently used or most preferred; 9 = least frequently used or least preferred. MDMA = 3,4-Methylenedioxymethamphetamine.

Table 2
Correlations Between Ranked Drug Use Frequency and Preference

Drug Class	Preference								
	Smoked tobacco	Smokeless tobacco	Alcohol	Cannabis	Stimulants	Sedatives	Opioids	MDMA	Classic hallucinogens
Use frequency									
Smoked tobacco	***0.5567***	0.0082	0.0753	−0.0438	−0.1442	−0.1102	0.0412	***−0.1648***	−0.0018
Smokeless tobacco	0.1366	***0.6114***	−0.0308	−0.0059	***−0.1698***	−0.0254	***−0.1936***	−0.1075	***−0.2788***
Alcohol	−0.0719	***−0.1701***	***0.3273***	0.1575	0.0296	0.1244	−0.0165	0.0532	0.1320
Cannabis	−0.1290	***−0.1697***	0.1203	***0.4046***	−0.0429	***0.1697***	***0.2066***	***0.1880***	***0.2621***
Stimulants	−0.0225	0.0138	0.1554	−0.0834	***0.4560***	−0.0751	0.0178	−0.0944	***−0.2359***
Sedatives	0.0706	***−0.1947***	0.0985	0.1264	***0.3248***	***0.5101***	***0.1930***	−0.0895	−0.0882
Opioids	−0.0423	−0.0106	−0.1049	0.0846	−0.1605	***0.1920***	***0.5793***	0.0835	0.1036
MDMA	***−0.1879***	−0.1121	−0.1357	***0.2820***	−0.1236	−0.0142	−0.0543	***0.6396***	***0.3593***
Classic hallucinogens	−0.0873	−0.0857	−0.1016	0.1518	−0.1374	0.0296	−0.0740	***0.3060***	***0.6364***

Note. ***Bold and Italicized*** = $p < 0.05$ with Bonferroni correction. MDMA = 3,4-Methylenedioxymethamphetamine.

flat for some drug classes (e.g., alcohol or smoked tobacco) indicating low individual variability away from the positive correlation. And, the landscape outside of the positive correlation diagonal was relatively bumpy for some drug classes (e.g., smokeless tobacco, classic hallucinogens, or opioids) indicating greater individual variability away from the positive correlation.

The cells outside the diagonal in Table 2 show the correlations between drug preference ranking and different drug use frequency ranking. Fifty-three of the 72 (74%) correlations were not statistically significant, 16 of the 72 (22%) correlations were weak, and 3 of the 72 (4%) were moderate. Of the statistically significant correlations, 9 (47%) were negative (higher use frequency ranking associated with lower preference ranking) and 10 (53%) were positive (higher use frequency ranking associated with higher preference ranking). Preference ranking for classic hallucinogens had the greatest number of significant correlations with other drug use ranking (4 significant; 2 positive and 2 negative). The frequency of cannabis use ranking had the greatest number of significant correlations with other drug preference ranking (5 significant; 4 positive and 1 negative).

Table 3 shows the correlations between participant rankings of drug use frequency. Twenty-six of the 36 (72%) correlations were not significant, 8 of the 36 (22%) correlations were weak, and 2 of the 26 (6%) correlations were moderate. Of the statistically significant correlations, 7 of the 10 (70%) were negative and 3 (30%) were positive. The largest negative correlation was between stimulant use frequency and classic hallucinogen use frequency ($r = -0.30$). The largest positive correlation was between MDMA use frequency and classic hallucinogens use frequency ($r = 0.39$). The drug class with the greatest number of statistically significant correlations was stimulants, being significantly correlated with four of the eight other drug classes (sedatives $r = 0.18$; opioids $r = -0.25$; MDMA $r = -0.27$; and classic hallucinogens $r = -0.30$). The drug classes with the least number of statistically significant correlations (1) were sedatives ($r = 0.18$ with stimulants) and opioids ($r = -0.25$ with stimulants).

Table 4 shows the correlations between participant rankings of drug preference. Twenty-three of the 36 (64%) correlations were not significant, 10 (28%) were weak, and 3 (8%) were moderate. Of the statistically significant correlations, 11 of the 13 (85%) were negative and 2 (15%) were positive. The largest negative correlation was between MDMA use preference and smoked tobacco use preference ($r = -0.41$). The largest positive correlation was between MDMA use preference and classic hallucinogen use preference ($r = 0.44$). The drug class with the greatest number of statistically significant correlations was opioids, being significantly correlated with five of the eight other drug classes (smoked tobacco $r = -0.25$; smokeless tobacco $r = -0.27$; alcohol $r = -0.19$; stimulants $r = -0.19$; and classic hallucinogens $r = -0.30$). The drug classes with the least number of statistically significant correlations (1) were cannabis ($r = -0.28$ with smokeless tobacco) and sedatives ($r = -0.20$ with smokeless tobacco).

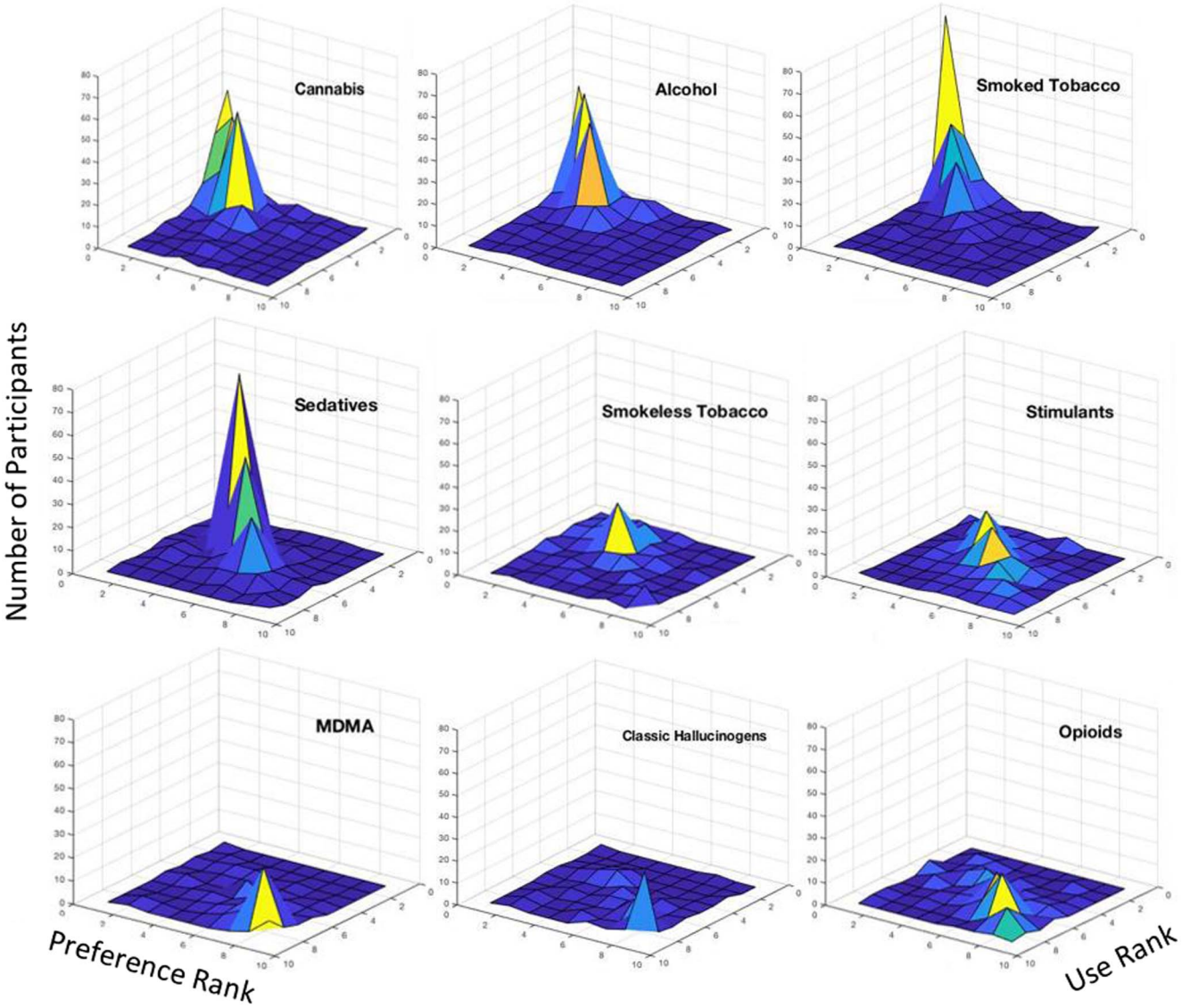
Discussion

Past research has led to mixed findings on the relationship between verbal reports of drug preference and drug use. However, these studies have included data about drug preference and use from participants who may not have had experience with the drug, and polysubstance associations were also not examined. The present study sought to compare the relationship between drug use frequency and preference rankings in people with experience using the drugs under consideration both within and between nine drug classes. We found moderate to strong correlations between preference rankings and use rankings within each of nine individual drug classes. However, few, and predominantly weak, correlations were observed between preference and use rankings between drug classes, use rankings between drug classes, and preference rankings between drug classes. Each of these findings will be discussed in turn.

Drug use frequency rankings and drug use preference rankings were significantly correlated for all nine drug classes. These data are in line with the results of Feldman et al. (2007, 2011) who also observed statistically significant correlations between individual drug consumption and drug preference. Though not directly comparable, the correlation coefficients using individual subject data in the present study were lower than the correlation coefficients observed by the correlations with aggregated group data reported by Feldman et al. ($r = 0.92$, 2007; $r = 0.68$, 2011) with an average (range) of $r = 0.52$ (0.33–0.64) in the present study. Together, the results from Feldman and colleagues and the present study suggest drug use frequency rankings and drug use preference rankings may be correlated, but neither is perfectly predictive of the other. This is most readily observed in the Everest plots shown in Figure 1 which visually show the individual variability across the different measures of drug rankings through the relative degree of elevation outside the

Figure 1

The Number of Participants (y-Axis) at Each Combination of Preference Rank (x-Axis) and Use Rank (z-Axis) for Each of the Different Drug Classes (Plot Labels)



Note. 1 = most preferred or most used; 9 = least preferred or least used. See the online article for the color version of this figure.

positive correlation diagonal (i.e., far back corner to furthest forward corner). Thus, at a practical and individual level, drug use frequency should not be automatically equated with drug preference.

The data from the present study also allowed for comparisons of use and frequency rankings across multiple drug classes for individuals who use multiple drug classes (i.e., polysubstance use). Polysubstance use has been associated with increased rates of psychiatric problems (Timko et al., 2017), poorer treatment outcomes (Jeffirs et al., 2019; Timko et al., 2017), and increased likelihood of overdose deaths (Barocas et al., 2019; Betts et al., 2015; Schneider et al., 2019). Among this sample of 428 individuals who use multiple drugs, the greater use frequency of one drug was not predictive of greater use frequency of most other drugs, greater preference for one drug was not predictive of greater preference for most other drugs, and the presence or absence of associations between drug classes differed depending on whether we used preference rankings or use rankings. Stated succinctly, the relationship between different drug classes for these participants was idiosyncratic and depended on whether we asked about preference or use frequency. Although the above may seem surprising in light of past research (e.g., Feldman et al., 2007, 2011), these data make sense from an operant perspective. Reinforcers are defined functionally at the individual level, rather than structurally at the group level. It makes sense that the reinforcing properties of each drug class would be determined

Table 3
Correlations Between Ranked Drug Use Frequency

Drug Class	Smoked tobacco	Smokeless tobacco	Alcohol	Cannabis	Stimulants	Sedatives	Opioids	MDMA	Classic hallucinogens
Smoked tobacco	—								
Smokeless tobacco	−0.0897	—							
Alcohol	***−0.1905***	***−0.2276***	—						
Cannabis	−0.0247	***−0.2592***	***0.1836***	—					
Stimulants	−0.0990	−0.1527	−0.1183	−0.0356	—				
Sedatives	−0.0402	−0.1249	−0.0168	−0.0350	***0.1758***	—			
Opioids	0.0343	−0.1066	−0.0948	0.0625	***−0.2456***	0.1151	—		
MDMA	***−0.2842***	−0.0465	−0.0310	−0.0624	***−0.2719***	−0.0437	0.1007	—	
Classic hallucinogens	−0.1170	−0.1341	−0.0339	0.0169	***−0.3024***	−0.1289	−0.0509	***0.3943***	—

Note. ***Bold and Italicized*** = $p < 0.05$ with Bonferroni correction. MDMA = 3,4-Methylenedioxymethamphetamine.

by each person's genetic makeup, each person's idiosyncratic learned history, and her or his individual experiences with each drug class. If a drug is reinforcing for an individual participant, the drug is a member of a unique reinforcer class (Catania, 2013, e.g., Steinman, 1968). Each reinforcer class may include one or more different drugs (or other stimuli) depending on the functional relations between responding and the drug-related consequences contacted by each individual (e.g., Thompson & Pickens, 1971).

One limitation of this study was the methods used to measure drug use frequency and drug preference. We asked participants to rank their use frequency and preference for all nine drug classes. This method is conceptually similar to the multiple-stimulus-without-replacement (MSWO) method of preference assessment (e.g., DeLeon & Iwata, 1996). This method of preference assessment has been shown to reliably predict reinforcers in nondrug clinical literature (e.g., Daly et al., 2009). Nevertheless, alternative types of preference assessments exist (e.g., Paired-Stimulus-Preference-Assessment, Fisher et al., 1992; Multiple-Stimulus-With-Replacement, DeLeon & Iwata, 1996; free-operant, Ortiz & Carr, 2000), explicit measures of reinforcer value exist (e.g., demand analysis, cross-price elasticity—Johnson et al., 2004; Reed et al., 2009; Smethells et al., 2018), and other types of self-report might be used as a proxy for the reinforcer efficacy of a drug (e.g., rating of willingness to take the drug again; Roache & Griffiths, 1984). The primary finding of this study is that different measures of drug-related behavior might be similar, but not identical. Understanding how drug-use frequency and drug preference relate to different measures of drug reinforcer value might aid the efficiency of assessment and effectiveness of interventions (e.g., Burrows et al., 2020).

An additional limitation of this study was the sample. We recruited individuals who self-reported polysubstance use of cannabis and alcohol, or cannabis and tobacco. It is possible that specifically recruiting individuals who self-reported polysubstance use focused on cannabis impacted the overall relations observed. A sample of individuals who self-reported polysubstance use focused on a different drug class (e.g., alcohol or opioids) may result in stronger correlations, correlations in opposite directions, or novel correlations not observed with cannabis polysubstance users. Nevertheless, if true, this would further support the primary conclusion of the present study: Drug use frequency and drug preference are not perfectly predictive and appear idiosyncratic to some degree.

In this study, different verbal reports of drug effects allowed us to study the relationship between drug consumption and the same drug preference, drug frequency and frequency of different drugs, drug preference and preference of different drugs, and drug consumption and preference of different drugs. The results of these analyses helped to highlight the importance of the method of measuring drug effects. Using a relative ranking of drug consumption and drug preference as measures of drug effects, all nine drug classes studied were significantly and positively correlated. However, the minimum, median, and highest correlation coefficients observed were $r = 0.33$, 0.56, and 0.64, respectively. Reported drug consumption and drug preference provide unique measurements of drug effects that are not perfectly predictive of each other for the same drug (Hursh & Silberberg, 2008). Verbal reports of drug effects also led to low overall associations between reported polysubstance consumption, polysubstance preference, and polysubstance consumption and preference in this sample. And, the majority of significant

Table 4
Correlations Between Ranked Drug Use Preference

Drug Class	Smoked tobacco	Smokeless tobacco	Alcohol	Cannabis	Stimulants	Sedatives	Opioids	MDMA	Classic hallucinogens
Smoked tobacco	—								
Smokeless tobacco	−0.0046	—							
Alcohol	0.1305	−0.0716	—						
Cannabis	−0.0011	***−0.2756***	0.0497	—					
Stimulants	−0.0310	−0.1396	0.0018	−0.0957	—				
Sedatives	−0.0854	***−0.1972***	−0.1440	0.0886	0.0147	—			
Opioids	***−0.2461***	***−0.2741***	***−0.1883***	−0.0204	***−0.1912***	0.1407	—		
MDMA	***−0.4149***	−0.1036	***−0.2650***	0.0713	−0.1096	−0.0792	0.1013	—	
Classic hallucinogens	***−0.3258***	−0.1461	***−0.2020***	0.0790	***−0.2959***	−0.0305	***0.2055***	***0.4403***	—

Note. ***Bold and Italicized*** = $p < 0.05$ with Bonferroni correction. MDMA = 3,4-Methylenedioxymethamphetamine.

correlations observed between multiple drugs using one measure of drug effects were not significant using the second measure of drug effects. Consumption or preference for one drug was generally not predictive of consumption or preference for other drugs. Together, the results of same and polydrug comparisons indicate that verbal reports of drug effects should be determined at the individual level, rather than at the group level.

That different verbal report metrics related to reinforcement result in different answers suggest they do not measure identical processes. This mirrors similar findings, mentioned in the Introduction, that show traditional laboratory measures of reinforcement assess different aspects of reinforcement (different aspects of demand curves) and are not expected to universally agree (Bickel & Madden, 1999; Bickel et al., 2000; Johnson & Bickel, 2006). Clinicians and future researchers should recognize that different verbal reports related to drug reinforcement might be proxies for distinct aspects of reinforcement, and should consider these implications for assessment and research findings.

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Received May 4, 2020
Revision received September 15, 2020
Accepted September 16, 2020 ■