Contributions of Ethnicity to Differential Item Functioning of Cannabis Abuse and Dependence Symptoms

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ABSTRACT. Objective: Cannabis is the most widely used illicit drug in the United States, and as a result, it is associated with significant public health costs. The present study sought to investigate whether item response theory (IRT) methods could be used to identify meaningful differences in how cannabis abuse and dependence symptoms (determined by criteria from the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*) function as indices of the severity of misuse across two ethnic groups: Native Americans and European Americans. **Method:** Participants were drawn from two previously collected samples, a population of Native Americans living on contiguous reservations (n = 406) and the University of California at San Francisco Family Alcoholism Study (n = 728). Cannabis use disorder symptoms were assessed using the Semi-Structured Assessment for the Genetics of Alcoholism. **Results:** Exploratory factor analysis demonstrated that the cannabis abuse and dependence symptoms indexed a single latent trait measuring severity of cannabis use. IRT and multiple indicators multiple causes (MIMIC) analyses suggested meaningful differences in the functioning of these symptoms across ethnic groups. Withdrawal represented a more prevalent and less severe symptom among Native Americans relative to European Americans, whereas each of the cannabis abuse symptoms and a symptom assessing psychological and health problems resulting from cannabis use were less prevalent but more severe in Native Americans. **Conclusions:** The findings suggest differences in how cannabis use disorders manifest in these populations and thus have implications for the assessment of these disorders as well as theories attempting to explain the increased rates of substance use diagnoses more generally among Native Americans living on reservations. (*J. Stud. Alcohol Drugs, 74,* 320–328, 2013)

CANNABIS IS THE MOST WIDELY USED illicit drug in the United States, with survey data indicating that more than 17 million individuals used cannabis in 2010 (Substance Abuse and Mental Health Services Administration, 2011), and lifetime rates of cannabis dependence are estimated to range from 1.3% to 4.2% (American Psychiatric Association, 1994; Anthony et al., 1994; Compton et al., 2004). Cannabis use is associated with psychiatric problems, including a pattern of apathy, loss of goal-directed behavior, and cognitive impairment referred to as the "amotivational syndrome" (Pope et al., 2001; Schuckit, 2006; Sharma, 1975; Solowij et al., 2002) as well as psychotic illness and depression (Degenhardt et al., 2003; Hall et al., 2004). Notably, early cannabis use is also associated with progression to other illicit drug use (the "gateway" drug hypothesis) (Fergusson and Horwood, 2000; Lynskey et al., 2003).

Previous studies have suggested that cannabis use among Native Americans living on reservations is particularly high, with prevalence rates of cannabis use disorders estimated to be two to three times higher than those observed in White samples (Beauvais, 1992; Plunkett and Mitchell, 2000). To explain this increased prevalence, researchers have proposed that social and economic conditions on reservations often lead to a disconnect between sobriety and access to employment, education, and housing (Spillane and Smith, 2007). If supported, this would suggest that the psychosocial consequences of heavy cannabis use may differ between Native Americans living on reservations and other ethnic groups. Potential cultural differences such as these are of particular interest, given efforts to explore cultural differences in the manifestation of psychopathological symptoms as evidenced by the formation of the Gender and Cross-Cultural Issues Study Group for the development of the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (DSM-5).

The application of analytic methods based on item response theory (IRT) to the study of substance use disorders has been particularly useful in exploring potential differences in symptom functioning across a number of social and ethnic groups. Briefly, IRT models assume that individual items or symptoms assess a continuous latent trait and estimate where on the latent trait dimension an item has a 50% probability of endorsement (Embretson and Reise, 2000). This provides

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a measure of item difficulty that is related to the rate of endorsement of the item, because low-frequency items will be considered more difficult. Further, how precisely the item can be located on the latent trait provides an index of item discrimination. When applied to psychiatric disorders, IRT analysis uses the diagnostic criteria as items and can be used to assess the severity of individual symptoms (Martin et al., 2006). Additionally, group differences in item severity, referred to as differential item functioning (DIF), can be assessed across stratifying variables of interest, such as gender or ethnic group.

In recent years, IRT methods have been used to demonstrate that substance abuse and dependence symptoms—rather than indexing distinct, hierarchically ordered disorders—measure a single construct and that the relative severities of individual symptoms of each disorder fail to conform to the abuse–dependence hierarchy (Helzer et al., 2007). These findings have proven extremely robust and have led the DSM-5 committee to combine these disorders into a single syndrome with severity measured by the number of symptoms endorsed (O'Brien, 2011).

In addition to examining the relative severity of substance abuse and dependence symptoms in the general population, IRT methods have been used to explore differences in how symptoms function between distinct subpopulations. For example, several studies have reported evidence of DIF across gender for alcohol (Harford et al., 2009) and cannabis use disorder symptoms (Agrawal and Lynskey, 2007; Martin et al., 2006; Srisurapanont et al., 2012), although there have been some exceptions (Compton et al., 2009; Piontek et al., 2011; Saha et al., 2006). In contrast, although rates of substance use disorders (Grant et al., 2004) including cannabis use disorders (Stinson et al., 2006) vary between ethnic groups, few studies have used IRT to examine potential differences in the severity of substance misuse symptoms in individuals of different ethnic backgrounds. A few studies have identified such differences across ethnic groups for alcohol use disorder symptoms (Harford et al., 2009; Saha et al., 2006; Wu et al., 2009), but, to our knowledge, no studies have examined differences in cannabis abuse and dependence symptom functioning across ethnic groups.

As part of a larger study examining the etiology of substance use disorders in a community sample of American Indians living on reservations (see Ehlers et al., 2001, 2004, 2007; Gilder et al., 2004, 2009), the present study applied IRT methods to accomplish two specific aims: (a) to evaluate whether cannabis misuse symptoms assess a continuous latent trait that indexes the severity of cannabis use in both Native Americans living on reservations and European Americans and (b) to evaluate whether individual cannabis misuse symptoms differentially index severity in these two populations. Because the Native American community under study has been shown to exhibit very high rates of substance use disorders (e.g., 70% alcohol dependent, 60% cannabis dependent), we chose to use an equally affected population of European Americans for the present report, the University of California, San Francisco (UCSF) Family Alcoholism Study population (70% alcohol dependent, 44% cannabis dependent), which is a nationwide population-based sample selected for the presence of alcohol dependence (Ehlers et al., 2010).

Method

Participants

Data for the present study were collected at two independent sites, the UCSF and The Scripps Research Institute (La Jolla, CA), and assessment procedures at each institution were approved by their respective institutional review boards. Participants at both sites were fully briefed on the nature of the study and provided written informed consent before study enrollment. Ongoing management and analysis of study data collected at the UCSF site were approved by the institutional review board at the University of North Carolina at Chapel Hill. Data collection at The Scripps Research Institute was also approved by the Indian Health Council, a tribal review group overseeing health issues for the reservations where recruitments took place.

UCSF Family Alcoholism Study sample. Participants in the present study represent a subset of the UCSF Family Alcoholism Study who reported European ancestry and prior exposure to cannabis as defined by smoking marijuana at least 21 times in a single year. This criterion was derived by the authors of the Semi-Structured Assessment for the Genetics of Alcoholism (SSAGA) to screen for cannabis use among interviewees and was included in the present study to ensure that participants in both study samples had similar degrees of cannabis exposure. The UCSF Family Alcoholism Study sample was recruited nationwide for inclusion in a study of the genetics of alcoholism and other substance dependence. Responding individuals were invited to participate if they met the screening criteria for alcohol dependence at some point in their lifetime and had at least one sibling or both parents available to participate. Permission was then obtained from the proband to invite relatives to participate by mail. Probands with serious drug dependencies other than cannabis (e.g., for stimulants, cocaine, or opiates) and those who reported any history of intravenous substance use were excluded. Also excluded were subjects reporting a current or past diagnosis involving psychotic symptoms (e.g., schizophrenia and bipolar disorder with psychotic symptoms), a life-threatening illness, or an inability to speak and read English. Of the 2,524 total participants in the UCSF Family Alcoholism Study, 728 reported prior cannabis exposure and were included in the present report. Participants were 56% female (n = 410), were an average age of 42.1 years (SD = 9.4), possessed an average of 14.3 (SD = 2.7) years of

education, included 70% who met the criteria for DSM-IV (American Psychiatric Association, 1994) alcohol dependence, and included 44% who met the criteria for DSM-IV cannabis dependence.

Native American sample. Participants from this Native American sample were recruited from eight geographically contiguous reservations with a total population of about 3,000 individuals. Briefly, individuals reporting at least 1/16th Native American heritage who were between ages 18 and 82 years were recruited to participate using a combination of a venue-based method for sampling hard-to-reach populations (Kalton and Anderson, 1986; Muhib et al., 2001) and a respondent-driven procedure (Heckathorn, 1997), as reported previously (Ehlers et al., 2004). Participants were included in the present study if they reported prior exposure to cannabis as defined by smoking marijuana at least 21 times in a single year during their lifetime. Of the 775 total participants in the Native American sample, 406 reported prior cannabis exposure and were included in the present report. Participants were 49% female (n = 199), were an average age of 29.31 years (SD = 10.84), possessed an average of 11.42 (SD = 1.50) years of education, included 70% who met the criteria for DSM-IV alcohol dependence, and included 60% who met the criteria for DSM-IV cannabis dependence.

Measures

Lifetime symptoms of DSM-IV diagnoses of cannabis abuse and dependence were obtained using a modified version of the SSAGA (Bucholz et al., 1994). In this modified version, legal problems resulting from cannabis use were not assessed. Additionally, minor differences in the versions of the SSAGA administered to the UCSF Family Alcoholism Study and Native American samples led to the alteration of the "continued use despite physical or psychological problems" symptom. Data were collected at both sites regarding whether participants experienced physical or psychological problems as a result of their cannabis use, but data were not collected from all UCSF sample participants regarding whether they continued to use cannabis despite experiencing these problems. Thus, assessment of this symptom from both samples was modified to reflect if participants experienced these problems regardless of whether they continued to use cannabis.

Data analysis

Preliminary analyses were conducted to assess the prevalence of the assessed DSM-IV cannabis abuse and dependence symptoms using SPSS Version 19 (SPSS Inc., Chicago, IL). Differences in prevalence rates between samples were assessed using a 2 × 2 contingency analysis and a Fisher's exact test to determine significance (see Table 1 for results). All subsequent analyses were conducted with MPlus Version 6 using the maximum likelihood estimator that is robust to nonnormality of the observed variables (MLR) (Muthén and Muthén, 2010).

To evaluate the unidimensionality of the cannabis symptoms, which is required for an IRT analysis, we conducted an exploratory factor analysis (EFA) of the three abuse and seven dependence symptoms assessed and then conducted a confirmatory factor analysis (CFA) to evaluate model fit using the sample size–adjusted Bayesian information criterion (SABIC), which is less biased toward parsimony than the unadjusted BIC (Sclove, 1987). This initial factor analysis was conducted as a single group analysis with all participants included. Potential sex and ethnic differences were then explored using a multiple-groups model in which item loadings and thresholds were estimated freely for each sex and ethnic group (e.g., Native American men, White women). A series of nested models to determine whether factor loadings and thresholds could be constrained across either the two sexes or two ethnic groups were then fit to the data and evaluated

Table 1. Prevalence of cannabis abuse and dependence symptoms in White and Native American samples

Cannabis abuse and dependence symptoms	Prevalence (%)			Test of significance	
	Full sample (n = 1,134)	Whites (n = 728)	Native Americans (n = 406)	χ^2	p
Tolerance	37.4	36.1	39.7	1.39	.2384
Withdrawal*	24.0	21.0	29.1	9.34	.0022
Larger/longer	27.8	26.7	29.8	1.21	.2713
Cut down/control	42.7	41.4	44.8	1.22	.2694
Time spent	44.7	43.7	46.6	0.87	.3510
Reduced activities	27.4	28.0	26.4	0.35	.5541
Caused problems*	47.3	52.6	37.9	22.53	<.0001
Role failure*	36.9	40.1	31.3	8.62	.0033
Hazardous use*	59.3	63.8	51.2	16.91	<.0001
Social problems*	27.5	31.0	21.2	12.55	.0004

*Indicates symptoms that showed significant differences in prevalence across ethnic groups (p < .05).

TABLE 2. Results of four-group item response theory analysis

Variable	No. of free parameters	Log-likelihood	$\Delta\chi^2$	*df*	*p*	Sample size–adjusted BIC
Base model	83	-7,639.51	–	–	–	15,599.03
Gender analysis						
Factor loadings and thresholds constrained	47	-7,669.52	58.10	36	.0112	15,520.25
Mean and variance constrained across gender	43	-7,673.01	6.97	4	.1376	15,511.83
Mean and variance constrained across all groups	**41**	**-7,673.67**	**1.17**	**2**	**.5563**	**15,505.42**
Ethnicity analysis						
Factor loadings and thresholds constrained	47	-7,711.63	138.58	36	<.0001	15,604.46
Mean and variance constrained	43	-7,716.60	9.85	4	.0430	15,598.98

Notes: **Bolded** text indicates best-fitting model. BIC = Bayesian information criterion.

using a scaled chi-square difference test of log-likelihood (LL) values (Satorra and Bentler, 2001) and a comparison of SABIC values. Because chi-square difference tests evaluating model fit become biased toward more complex models as sample sizes increase, a conservative *p* value of .01 was used to determine significance for these analyses.

After selecting the best-fitting model, the IRT analysis was run and followed up using multiple indicators multiple causes (MIMIC) models to test for evidence of DIF. MIMIC models can be used to test for DIF in an IRT framework as follows: First, a model is run in which the latent response factor is regressed on the variable of interest (e.g., sex or ethnicity) to measure the direct effect of this variable on the latent factor. Second, a path is added to the model in which an individual symptom is regressed on the variable of interest, providing a measure of the relation between that symptom and the variable of interest after accounting for its effect on the latent trait. Third, the fit between a model containing this path and a nested model in which this path was dropped were compared using the chi-square difference test and SABIC as described above.

Results

Symptom prevalence rates

As seen in Table 1, two of the cannabis-dependence symptoms and all three of the assessed abuse symptoms showed differences in prevalence across ethnic groups. Endorsement of the "withdrawal" symptom was more common among Native American than White participants, whereas the "caused problems" dependence symptom and the three abuse symptoms ("role failure," "hazardous use," and "social problems") were less common among Native American than White participants.

Factor analysis

Results of the single group EFA indicated that the two-factor solution yielded a better fit to the data (-2LL = -6164.89, BIC = 12441.66) than the single-factor solution (-2LL = -6234.37, BIC = 12545.90). Nonetheless, the two factors produced by this solution were highly correlated (r = .73), and a CFA specifying the two factors as orthogonal yielded a poor fit to the data (-2LL = -6243.41, BIC = 12594.85). Further, an examination of the loadings for the single-factor solution showed that all of the symptoms showed high loadings with the exception of the "hazardous use" and "cut down/control" symptoms (0.54 and 0.49, respectively). Similar results were obtained when the EFA and CFA were conducted separately for the White and Native American participants. Thus, we concluded that the symptom data displayed sufficient evidence of unidimensionality to proceed with the IRT analysis.

Multiple groups analysis

An initial one-factor model was fit to the data, allowing the item loadings and thresholds to be freely estimated for 9 of the 10 symptoms for each sex and ethnic group (Table 2). The factor loading and threshold for the remaining symptom were constrained across groups for model identification purposes. A nested model in which factor loadings and thresholds were constrained across sex did not result in a decline in model fit, $\Delta\chi^2(36) = 58.10$, $p = .0112$, SABIC = 15,520.25. A second model suggested that the mean and variance of the latent abuse/dependence trait could also be constrained across sex, $\Delta\chi^2(4) = 6.97$, $p = .1376$, and a third model, which was the best-fitting, suggested that the mean and variance of the latent trait could be constrained across all groups, $\Delta\chi^2(2) = 1.17$, $p = .5563$. Similar analy-

TABLE 3. Results of multiple indicators multiple causes (MIMIC) model analyses

Model	Log-likelihood	Sample size–adjusted BIC	β (*SE*)	$\Delta\chi^{2a}$	*p*
Base	-6,235.57	12,548.29	–	–	–
Ethnicity as covariate	-6,234.66	12,550.34	–	1.77	.1830
Tests of DIF					
Tolerance	-6,231.50	12,547.88	.40 (.16)	6.46	.0110
Withdrawal	**-6,222.60**	**12,530.07**	**.88 (.18)**	**24.15**	**<.0001**
Larger/longer	-6,231.12	12,547.13	.46 (.18)	5.60	.0180
Cut down/control	-6,232.61	12,550.09	.29 (.15)	3.94	.0471
Time spent	-6,232.09	12,549.05	.37 (.16)	5.15	.0232
Reduced activities	-6,234.16	12,553.19	.21 (.22)	0.95	.3297
Caused problems	**-6,222.43**	**12,529.75**	**-.77 (.16)**	**24.48**	**<.0001**
Role failure	**-6,230.84**	**12,546.57**	**-.52 (.19)**	**7.81**	**.0052**
Hazardous use	**-6,226.80**	**12,538.49**	**-.56 (.14)**	**15.73**	**<.0001**
Social problems	**-6,229.26**	**12,543.40**	**-.62 (.20)**	**10.36**	**.0013**

Notes: **Bolded** text indicates significant result at $p < .01$. BIC = Bayesian information criterion; DIF = differential item functioning. [a]All chi-square difference tests have 1 *df.*

ses conducted for ethnicity were significant, suggesting that the factor loadings and thresholds could not be constrained across ethnic groups. Thus, we proceeded to test for DIF as a function of ethnicity to identify those symptoms that showed differences across the White and Native American samples.

Differential item functioning

Analyses of ethnic background identified five symptoms that yielded significant evidence of DIF (Table 3). The withdrawal symptom was shown to be less prevalent among Whites than Native Americans, $\Delta\chi^2(1) = 24.15$, $p < .0001$, suggesting that this symptom indicates increased severity in Whites. To follow up this result, we compared the prevalence rates of the seven items that were used to assess for withdrawal (i.e., anxiety/restlessness, sleep problems, trembling, sweating, nausea, gastrointestinal distress, and appetite changes) across samples. The nausea, $\chi^2(1) = 21.32$, Fisher's Exact $p < .001$, and appetite changes, $\chi^2(1) = 14.98$, Fisher's Exact $p < .001$, items were more prevalent among Native Americans and were the only observed significant differences. The caused problems, role failure, hazardous use, and social problems symptoms were found to be less prevalent among Native Americans than Whites, $\Delta\chi^2(1) = 24.48$, $p < .0001$, $\Delta\chi^2(1) = 7.81$, $p = .0052$, $\Delta\chi^2(1) = 15.73$, $p < .0001$, and $\Delta\chi^2(1) = 10.36$, $p = .0013$, respectively, thus suggesting that these symptoms indicate increased severity among Native Americans.

Two-group IRT models were then run in which either the factor loading or threshold of a given symptom was constrained across ethnic groups to determine which parameter(s) contributed to the presence of DIF for that symptom. For all five symptoms, constraining the threshold parameter led to a significant decline in model fit (*p* values < .01) and increases in SABIC values (Table 4). In contrast, constraining the factor loadings did not lead to significant

TABLE 4. Results of two-group item response theory analysis

Symptom	Constrained parameter	No. of free parameters	Log-likelihood	$\Delta\chi^2$	*df*	*p*	Sample size–adjusted BIC
Base model	–	31	-6,922.92	–	–	–	13,965.44
Withdrawal	Loading	30	-6,923.69	1.60	1	.2060	13,962.13
	Threshold	30	-6,928.01	11.65	1	.0006*	13,968.13
Caused problems	Loading	30	-6,923.63	1.31	1	.2521	13,961.99
	Threshold	30	-6,938.48	24.05	1	<.0001*	13,997.66
Role failure	Loading	30	-6,923.04	0.20	1	.6578	13,963.86
	Threshold	30	-6,929.87	13.98	1	.0002*	13,979.96
Hazardous use	Loading	30	-6,926.58	5.65	1	.0174	13,965.06
	Threshold	30	-6,935.48	26.88	1	<.0001*	13,990.00
Social problems	Loading	30	-6,924.02	2.15	1	.1424	13,962.21
	Threshold	30	-6,925.89	7.56	1	.0059*	13,969.93
Final model–All factor loadings constrained		**26**	**-6,929.00**	**11.52**	**5**	**.0420**	**13,958.30**

Notes: BIC = Bayesian information criterion; **bolded** text indicates best-fitting model.
*Indicates significant result at $p < .01$.

Table 5. Item response theory parameters from two-group analysis with all factor loadings, means, and variances and selected thresholds constrained across ethnicity

Cannabis abuse and dependence symptoms	Discrimination (*SE*)	Difficulty (*SE*)	
		European Americans	Native Americans
Tolerance	0.86 (0.08)	0.49 (0.06)	0.49 (0.06)
Withdrawal[a]	0.95 (0.09)	0.82 (0.10)	1.18 (0.10)
Larger/longer	0.98 (0.09)	0.84 (0.07)	0.84 (0.07)
Cut down/control	0.64 (0.06)	0.34 (0.07)	0.34 (0.07)
Time spent	0.97 (0.08)	0.19 (0.05)	0.19 (0.05)
Reduced activities	1.48 (0.15)	0.74 (0.06)	0.74 (0.06)
Caused problems[a]	0.86 (0.08)	0.50 (0.09)	-0.13 (0.07)
Role failure[a]	1.32 (0.13)	0.64 (0.08)	0.30 (0.06)
Hazardous use[a]	0.56 (0.06)	-0.02 (0.12)	-0.72 (0.11)
Social problems[a]	1.11 (0.10)	1.09 (0.10)	0.66 (0.07)

[a]Indicates that threshold was allowed to vary across ethnic groups.

declines in model fit (p values > .01) and led to lower SABIC values. As a final step, a model was evaluated in which all factor loadings were constrained across ethnic groups but the thresholds were allowed to vary for the five symptoms showing evidence of DIF. This final model did not result in a decline in model fit, $\Delta\chi^2(5) = 11.52$, $p = .0420$, SABIC = 13,958.30, suggesting that the more parsimonious model was the best-fitting (see Table 5 for final parameter estimates).

Notably, all analyses were rerun to evaluate the impact of age, sex, and level of education on the study results. Inclusion of each variable as a covariate did not lead to any changes in the observed pattern of results, suggesting that the reported findings were independent of any differences between samples on these variables. To control for potential differences in the severity of use across samples, we also evaluated the length of time in years that participants reported using cannabis on a daily basis as a covariate. Although Native American participants reported greater daily use ($M = 4.06$ years, $SD = 5.89$, range: 0–40 years) than European American participants ($M = 3.71$ years, $SD = 6.29$, range: 0–30 years), this difference was not significant, $t(1128) = 0.914$, $p = .361$. Further, including this measure as a covariate in our analyses resulted in only one change in terms of statistical significance of the results. Specifically, in the two-group IRT models, the threshold for social problems could be constrained when years of daily use was included as a covariate, but this did not result in a change to the best-fitting model. Thus, for ease of presentation, study results were reported without the inclusion of the described covariates.

Discussion

The present study sought (a) to evaluate whether cannabis misuse symptoms assess a continuous latent trait that indexes the severity of cannabis use in both Native Americans living on reservations and European Americans and (b) to evaluate whether individual cannabis misuse symptoms differentially index severity in these two populations. Study findings supported previous reports suggesting that cannabis abuse and dependence symptoms describe a continuous, unidimensional latent trait indexing the severity of an individual's cannabis use and that these symptoms are interspersed along the severity continuum rather than organized into a set of mild and severe symptoms as suggested by DSM-IV (Agrawal and Lynskey, 2007; Compton et al., 2009; Martin et al., 2006). The presence of DIF of cannabis misuse symptoms across male and female participants was not directly evaluated, but the results of the present study suggested that such differences were likely to be limited in scope. This is consistent with a previous study that tested for DIF of DSM-III-R (American Psychiatric Association, 1987) cannabis abuse and dependence symptoms as a function of sex in the present Native American sample. This study reported significant evidence of DIF as a function of sex for only a single symptom (hazardous use) (Gilder et al., 2009), though other studies have reported more prominent sex differences (Harford et al., 2009; Srisurapanont et al., 2012).

The present study also demonstrated that cannabis misuse symptoms can show important differences in prevalence and severity across ethnic groups. Specifically, the cannabis withdrawal symptom was shown to be more prevalent and less severe among Native Americans relative to European Americans, whereas the caused problems symptom and the three assessed abuse symptoms (role failure, hazardous use, and social problems) were shown to be less prevalent and more severe among Native Americans relative to European Americans. Notably, withdrawal has typically been found to be one of the most severe cannabis misuse symptoms in previous studies (Agrawal and Lynskey, 2007; Gillespie et al., 2007; Harford et al., 2009; Piontek et al., 2011). Although withdrawal represented a relatively severe symptom among Native Americans in the present sample, the most severe symptom in this group was the social problems abuse symptom, which represents a psychosocial manifestation of the disorder rather than a physiological dependence. In addition, other psychosocial symptoms (e.g., role failure, hazardous use) were found to indicate increased severity relative to European Americans.

These findings have several important implications. First, these findings are relevant to theories attempting to explain the high rates of cannabis and other drug misuse among Native Americans living on reservations. Among these theories, some researchers have suggested that the increased rates of drug dependence within this population can be attributed to early exposure (Ehlers et al., 2007) and a lack of contingency between access to basic life reinforcers (e.g., employment, education, housing) and sobriety (Spillane and Smith, 2007). The reported result that the socially contingent abuse symptoms represent more severe symptoms among Native Americans than European Americans suggests that social contingencies are more frequently violated in the presence of

heavy cannabis use among European Americans and less so among Native Americans living on reservations. This would appear to support theories suggesting a lack of contingency between social and occupational obligations and sobriety. Prospective, longitudinal studies are needed to formally evaluate these conclusions, but the present study provides a preliminary examination of differences in the presentation of cannabis abuse dependence among Native Americans and European Americans.

Second, evidence of DIF for a specific symptom suggests limitations of that symptom in assessing the disorder of interest. For example, if the abuse symptoms are culturally influenced as indicated by the present study, this would suggest a limitation of those symptoms in assessing substance misuse across cultures. Similarly, if symptoms such as withdrawal show evidence of DIF, it could indicate a weakness in how that symptom is operationalized. A cannabis withdrawal syndrome has only recently been described in the literature, and thus items assessing this syndrome may require further refinement. Symptoms most frequently associated with cannabis withdrawal include anxiety, decreased appetite/weight loss, irritability, restlessness, sleep problems, and strange dreams, whereas physical symptoms such as nausea, sweating, vomiting, and diarrhea have not been consistently associated with cannabis withdrawal (Budney et al., 2004). The present study found that withdrawal symptoms of nausea and appetite changes were more prevalent among Native American participants and thus were likely responsible for the presence of DIF for the withdrawal symptom. It is possible that genetically influenced differences in the metabolism of the active substances found in cannabis led to the differences in prevalence rates, or there may be differences in how these items are interpreted across groups that give rise to the differences. Further studies will be needed to evaluate these possibilities, but in either case, these findings demonstrate the importance of studying substance use disorders across ethnic and cultural groups for the purpose of refining diagnostic assessment.

Third, these findings also have important implications for psychological research and practice regarding substance use disorders more generally. There is a growing emphasis on conducting large-scale, collaborative research, often across diverse cultural groups; thus, there is a need for data harmonization methods to ensure that the data collected can be equated across groups (Granda and Blasczyk, 2010; Hamilton et al., 2011; Khoury et al., 2004). The reported findings provide one method for investigating potential cultural differences in the process of data harmonization. In fact, the present report represents an initial step in harmonizing substance misuse data for use in genomic sequencing studies currently being conducted in the described populations. The reported findings also suggest that assessment, prevention, and treatment efforts for cannabis use disorders should consider cultural differences in symptom presentation. For example, if specific cannabis misuse symptoms manifest at different points in the course of the disorder among Native Americans and Whites, prevention efforts focusing on identifying early signs of problematic use or treatments designed to curtail use may need to be tailored to each population.

Although the findings described in the present report have the potential to further our understanding of the etiology of cannabis abuse and dependence, there are some limitations. Whereas the cannabis abuse and dependence symptoms assessed in the present study are largely consistent with those presented in the DSM-IV, the noted differences (i.e., "caused problems" rather than "continued use despite experiencing problems" and the absence of the legal problems abuse symptom) limit the extent to which we can apply these findings to the complete DSM-IV cannabis abuse and dependence symptoms. Nonetheless, the reported results provide important insights into differences in the development of these disorders between Native Americans and European Americans. It should also be noted that different ascertainment procedures were used to collect each sample, which raise potential questions about their comparability. A series of covariates including age, gender, level of education, and severity of use was used to evaluate this possibility, and study findings suggested that the reported differences between Native Americans and European Americans were robust to sample differences across these variables. Future studies using more uniform ascertainment procedures across ethnic groups would provide a strong test of the replicability of the reported findings. Finally, the Native Americans assessed in the present study represent individuals living on a set of contiguous reservations. Further studies are needed to determine whether these findings can be extended to other Native American populations.

In summary, the present report found that the prevalence and severity of cannabis abuse and dependence symptoms differ between Native Americans and European Americans. Specifically, withdrawal symptoms indicating a physiological dependence are less prevalent and indicate a more severe form of cannabis misuse in European Americans compared with Native Americans. In contrast, socially contingent symptoms indicating a failure to meet role obligations and social difficulties resulting from cannabis use are less prevalent and indicate a more severe form of cannabis misuse among Native Americans compared with European Americans. These findings describe potential cultural differences in the manifestation of cannabis misuse symptoms and have the potential to inform the research, assessment, and treatment of cannabis misuse disorders in these populations.

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