Item Response Theory Analysis of Lifetime Cannabis-Use Disorder Symptom Severity in an American Indian Community Sample*

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ABSTRACT. Objective: The aim of this study was to use Item Response Theory to assess Diagnostic and Statistical Manual of Mental Disorders, Third Edition, Revised (DSM-III-R), lifetime cannabis-use disorder (CUD) symptom severity and its relationship to first cannabis use before age 15 years, male gender, and childhood conduct disorder in an American Indian community sample. **Method:** The Semi-Structured Assessment for the Genetics of Alcoholism was used to determine demographic information, age at first use, and DSM-III-R childhood conduct disorder and lifetime CUD symptoms in a community sample of 349 American Indian participants who had used cannabis at least 21 times in a single year. Two-parameter Item Response Theory models generated marginal maximum likelihood estimates for discrimination (*a*) and threshold (*b*) parameters for nine DSM-III-R CUD symptoms along an underlying latent CUD severity continuum. Differential Item

Functioning (DIF) analysis was used to assess for differences in symptom severity in groups defined by presence versus absence of age at first use before 15 years, male gender, and childhood conduct disorder. **Results:** CUD symptoms of “use in larger amounts or over longer periods of time,” “activities given up,” and “role failure” were the most severe symptoms. All CUD symptoms fell on the moderate portion of the severity continuum. “Time spent” was more severe in individuals who first used cannabis after age 15 years, “hazardous use” was more severe in females, and “use in larger amounts or over longer periods of time” was more severe in individuals with co-morbid childhood conduct disorder. **Conclusions:** Specific risk factors for the development of lifetime CUD are associated with increased severity of several CUD symptoms in this high-risk group. (*J. Stud. Alcohol Drugs* **70**: 839-849, 2009)

EARLY AGE AT FIRST CANNABIS USE, male gender, and presence of co-morbid childhood conduct disorder are all associated with increased risk for developing cannabis-use disorders (CUDs; Clark et al., 1998; Compton et al., 2004, 2005; Ehlers et al., 2007; Goldstein et al., 2007; Marmorstein and Iacono, 2005; Nock et al., 2006; Stinson et al., 2006). Little is known, however, about whether symptoms of CUDs are more severe in regular cannabis users who began using at earlier ages, are male, or have co-morbid childhood conduct disorder, compared with those who began using at older ages, are female, or do not have childhood conduct disorder. In an American Indian community sample, first use before age 15 years, male gender, and childhood conduct disorder were found to be significantly associated

with the development of lifetime CUDs (Ehlers et al., 2007). This study uses Item Response Theory (IRT) in a sample of regular users from the same American Indian community to examine whether early age at first use, male gender, and co-morbid childhood conduct disorder were associated with increased severity of Diagnostic and Statistical Manual of Mental Disorders, Third Edition, Revised (DSM-III-R; American Psychiatric Association, 1987), CUD symptoms.

The study of American Indian populations is important because of the high burden of morbidity and mortality that substance use and use disorders pose to some American Indian communities. The limited data available on the relationship between early age at first use of cannabis, male gender, and presence of childhood conduct disorder and lifetime CUDs in American Indian groups suggests that, as in the general population, these are all associated with higher lifetime rates of cannabis and other substance dependence (Ehlers et al., 2007; Fickenscher et al., 2005; O’Connell et al., 2007). Moreover, there is evidence that the problem is particularly acute for Native Americans who, as a group, may be initiating marijuana use at an earlier mean age than other ethnicities (Beauvais et al., 2004; Gfroerer et al., 2002; Whitesell et al., 2007). A better knowledge of the relationship of early age at first use, gender, and childhood conduct

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disorder to subsequent lifetime CUD symptom severity has the potential to increase our understanding not only of the biological and psychosocial risk factors in that relationship but also to establish more effective diagnostic screening, intervention, and community prevention strategies for this and other high-risk groups.

In studies of non-Native American populations, earlier ages at first use of cannabis have been shown to be associated with increased risk not only for CUD but also for other psychiatric and substance-use disorders, risk behaviors, and psychosocial problems (Brook et al., 1999; Chen et al., 2002, 2005; Clark et al., 1998; DeWit et al., 2000; Ehlers et al., 2007; Fergusson et al., 1996; Hayatbakhsh et al., 2007; Jones et al., 2007; Kandel, 2003; Lynskey and Hall, 2001; Lynskey et al., 2003; Monshouwer et al., 2005; Patton et al., 2007; Perkonig et al., 2008; Robins and Przybeck, 1985). In the general population, first use of cannabis and the development of cannabis dependence during the teenage years appear to be the norm rather than the exception. In the general U.S. population, 16% of 8th graders, 35% of 10th graders, and 46% of 12th graders report ever having used marijuana (Johnston et al., 2005), and the lifetime cumulative probability of DSM-III-R cannabis dependence reaches 5.61% by age 18 years, more than half the lifetime cumulative probability of 10.02% at age 54 years (Wagner and Anthony, 2002).

IRT is a technique for evaluating the psychometric properties of assessment criteria or "items." IRT, like classical test theory, posits that a latent construct or trait can be measured by a group of items. However, IRT provides superior results to classical test theory in having more theoretically justifiable measurement principles, as well as advantages for understanding item behavior (Embretson and Reise, 2000; Martin et al., 2006). IRT analysis provides information regarding where on the latent trait dimension an item has a 50% probability of endorsement and how rapidly an item's probability of endorsement changes across the latent trait dimension. When applied to substance-use disorder diagnostic criteria, IRT analysis uses the diagnostic criteria as items and generates a latent trait dimension that is the underlying severity of the substance-use disorder. Differential item functioning analysis can be applied to diagnostic criteria to assess if individual criteria are more or less severe in groups defined by dichotomous variables. Applied in this context of this study, IRT is able to assess the severity of the symptom along the underlying latent trait continuum, and differential item functioning is able to assess if symptom severity is significantly different between groups defined by presence versus absence of early age at first use, male gender, and childhood conduct disorder.

In studies of substance-use disorder criteria, IRT has been used to study the construct validity of DSM-IV (American Psychiatric Association, 1994) abuse and dependence criteria for cannabis and other substances in several studies of both past-year and lifetime symptoms in adults and adolescents

(Hartman et al., 2008; Kirisci et al., 2004; Krueger et al., 2004; Lynskey and Agrawal, 2007; Langenbucher et al., 2004; Martin et al., 2006; Saha et al., 2006, 2007). In general, these studies have found evidence for unidimensionality of the underlying latent CUD trait; that cannabis abuse and cannabis dependence symptoms are intermixed in terms of severity; and that the CUD symptoms occupied the moderate and severe portions of the severity continuum, suggesting that current CUD diagnostic criteria may not adequately assess milder forms of CUD disorders. In a different approach, Gillespie and colleagues (2007) used IRT analysis to compare individual drug-use disorder symptoms across drug categories (cannabis, cocaine, stimulants, sedatives, opioids, and hallucinogens) in a sample of 4,234 adult male participants in the Virginia Twin Registry. In a symptom-by-symptom comparison, CUD symptoms occupied the moderate to severe portion of each symptom severity continuum. For some symptoms ("hazardous use," "use despite physical and psychological symptoms," "use longer than planned," "tolerance," and "withdrawal"), CUD symptoms were the most severe or close to the most severe of symptoms in any drug category.

Gender differences in CUD symptom severity have been previously found in both adolescent clinical (Martin et al., 2006) and adult epidemiological (Agrawal and Lynskey, 2007) samples. In the adolescent study, Martin and colleagues found gender differences in severity of three DSM-IV CUD symptoms: The cannabis abuse symptoms of (1) "hazardous use" and (2) "legal problems" were more severe in females than males and the cannabis dependence symptom of (3) "continued use despite psychological or physical problems" was less severe in females than males. In their factor analytic study of lifetime DSM-IV CUD symptoms from the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC) data set, Agrawal and Lynskey (2007) found both "hazardous use" and "legal problems" to be more severe in women, and "quit/cut down" and "psychological/physical problems" were more severe in men. To our knowledge, IRT and differential item functioning analysis have not been previously used to examine the relationship between early age at first use of a substance or childhood conduct disorder and the subsequent severity of substance-use disorder symptoms over the lifetime. This article examined these relationships in an American Indian community sample of regular users for nine DSM-III-R CUD symptoms using three aims. The first aim was to use Exploratory Factor Analysis (EFA) to examine the dimensional properties of the nine CUD symptoms. The second aim was to use IRT analysis to characterize the behavior of CUD symptoms along an underlying latent CUD severity continuum. The third aim was to use differential item functioning analysis to examine the relationship between early age at first use, male gender, and presence of childhood conduct disorder and the severity of CUD symptoms over the lifetime.

Method

Participants

American Indian participants were recruited from eight geographically contiguous reservations with a total population of about 3,000 individuals. Participants were recruited 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) that has been described elsewhere (Gilder et al., 2004). To be included in the study, participants had to be at least 1/16th Native American Heritage, between the ages of 18 and 70 years, and mobile enough to be transported from his or her home to the General Clinical Research Center of The Scripps Research Institute. The protocol for the study was approved by the Institutional Review Board of The Scripps Research Institute; the Scientific Advisory Committee of the General Clinical Research Center; and the Indian Health Council, a tribal review group overseeing health issues for the reservations where recruitment was undertaken. Written informed consent was obtained from each participant after the study was fully explained.

Measures

Each participant completed an interview with the Semi-Structured Assessment for the Genetics of Alcoholism (SSAGA) (Bucholz et al., 1994), which gathers demographic, cannabis use, and cannabis abuse and dependence symptom information. The SSAGA is a fully structured, polydiagnostic psychiatric interview that generates DSM-III-R diagnoses and has undergone both reliability and validity testing (Bucholz et al., 1994; Hesselbrock et al., 1999). SSAGA interviews were administered by trained research assistants. All interviews were reviewed, and all best final diagnoses were made by a research psychiatrist/addiction specialist (D.A.G.).

The SSAGA interview skips out of the section on cannabis use-related symptoms if a subject has used less than 21 times in a single year. Therefore, our data set included only those individuals who had used cannabis 21 or more times in a single year. Cannabis use-related symptoms were used to diagnose the presence or absence of each DSM-III-R symptoms for cannabis abuse (two symptoms) and cannabis dependence (nine symptoms). To render these criteria suitable for factor analysis, a symptom was eliminated or modified if it was fully embedded in any other symptom. One cannabis abuse symptom ("continued use despite social, occupational, psychological, or physical problem") and one cannabis dependence symptom ("used cannabis to avoid withdrawal") were removed because they were each embedded in two other cannabis dependence symptoms ("continued use despite social, psychological, or physical

problem" and "experienced withdrawal"), respectively. One cannabis dependence symptom ("frequent intoxication or withdrawal symptoms when expected to fulfill major role obligations at work, school, or home or when substance use is physically hazardous") was changed to measure only role failure because "hazardous use" was measured by a cannabis abuse symptom. As a result of these modifications, this study analyzed one DSM-III-R cannabis-abuse symptom and eight cannabis dependence symptoms.

Data analysis

Three sets of analyses were undertaken for all individuals who had used cannabis at least 21 times in a single year. First, the prevalence of each symptom in groups defined by early age at first use younger than 15 years, male gender, and presence of childhood conduct disorder and comparison of the prevalence of that symptom with the prevalence in its corresponding group (age at first use ≥ 15 years, female gender, and absence of childhood conduct disorder) was performed using contingency tables and calculating Fisher p values. Second, we performed EFA and IRT analyses following procedures used previously in other IRT analyses of substance-use disorder symptoms (Agrawal and Lynskey, 2007; Compton et al., 2009; Kirisci et al., 2006; Krueger et al., 2004; Langenbucher et al., 2004; Lynskey and Agrawal, 2007; Martin et al., 2006; Saha et al., 2006, 2007; Teesson et al., 2002). EFA was used to evaluate if the nine CUD symptoms were dominated by a single common factor. For this purpose, we used the Mplus statistical software program (Muthén and Muthén, 1998-2008) to investigate if the CUD symptoms fit a model consistent with a unidimensional underlying latent CUD severity trait. Subsequently, we used a two-parameter logistic IRT model to characterize the behavior of each CUD symptom on the underlying latent trait severity continuum using the 2003 BILOG-MG statistical program (Scientific Software International, Inc., Lincolnwood, IL). The BILOG-MG program generates marginal maximum likelihood estimates for two parameters that can be used to describe each criterion response curve: (1) a discrimination (a) parameter and (2) a threshold (b) parameter. The a parameter is the slope of the criterion response curve at its point of 50% probability of occurrence. The a parameter is a measure of how well the symptom discriminates between milder and more severe forms of the underlying trait at that point and how well the criterion loads onto the underlying factor structure of the CUD model. The b parameter is the point on the underlying CUD severity continuum where the symptom reaches a 50% probability of occurrence. The b parameter is a measure of the severity of the symptom. The criterion response curves of more severe symptoms occur on more severe portions of the underlying CUD severity continuum than those of less severe symptoms. Their b parameters have higher values than those of less severe crite-

rion response curves. Using the BILOG-MG software, each symptom can also be graphically represented as an S-shaped logistic criterion response curve showing the likelihood of the occurrence of the symptom along the underlying severity continuum.

In the third set of analyses, we used the BILOG-MG program to examine each CUD symptom for differential item functioning (Embretson and Reise, 2000) of the *b* parameter comparing subgroups defined by the following dichotomous variables: age at first use at younger than 15 years versus age 15 years or older, male versus female gender, and presence versus absence of childhood conduct disorder. In the context of the present analysis, differential item functioning occurs when a CUD symptom does not have the same severity value in the two subgroups, which indicates that that symptom measures a more severe level of the CUD latent severity trait in the subgroup with the higher *b* value. The age at first use of younger than 15 years versus age 15 years or older was selected for two reasons: (1) Multinomial logistic regression analyses of an earlier version of the same sample (Ehlers et al., 2007) indicated that first use at or before age 15 years was significantly associated with both lifetime DSM-III-R cannabis abuse ($B [SE] = 1.07 [0.32]$; odds ratio = 2.9, $p < .01$) and dependence ($B [SE] = 2.15 [0.25]$; odds ratio = 8.6, $p < .0001$); and (2) the sample was reasonably distributed between those who first used before age 15 years ($n = 214$, 61.3%) and at age 15 years or older ($n = 135$, 38.7%). Differential item functioning of the discrimination (*a*) parameter for each symptom was not undertaken as part of this analysis.

Results

Six hundred and twenty participants were assessed for lifetime cannabis use and cannabis-use symptoms. Three hundred and forty-nine participants had a history of using cannabis at least 21 times in a single year. Complete information was available on age at first cannabis use, gender, childhood conduct disorder, and DSM-III-R CUD symptoms for all 349 participants. Demographic characteristics and frequencies of age at first use before age 15 years versus after age 15 years and of presence versus absence of childhood conduct disorder for the entire sample are shown in Table 1. Demographic characteristics of the sample as a whole resemble those of U.S. census data (Bureau of the Census, 1994).

The first aim of the study was to use EFA to examine the dimensional properties of the nine CUD symptoms, and the second aim was to use IRT analysis to characterize the behavior of those CUD symptoms along an underlying latent CUD severity continuum. Table 2 shows the prevalence of each CUD symptom in the entire sample, EFA for one- and two-factor models, and IRT analysis of the nine CUD symptoms. The prevalence of lifetime DSM-III-R CUD

TABLE 1. Demographic characteristics and frequencies of early age at first cannabis use and childhood conduct disorder of American Indian adults ($n = 349$)

Variable	Mean	S.D.
Age (range: 18-61)	28.8	10.4
Years of education (range: 13-16)	11.4	1.51
	<i>n</i>	%
Gender ($n = 349$)		
Male	174	49.9
Female	175	50.1
Annual income ($n = 337$)		
<\$20,000	154	45.7
≥\$20,000	183	54.3
Any employment ($n = 335$)		
No	194	57.9
Yes	141	42.1
Married ($n = 348$)		
No	291	83.6
Yes	57	16.4
Native American heritage ($n = 298$)		
< 50%	141	47.3
≥ 50%	157	52.7
First cannabis use ($n = 349$)		
<15 years	214	61.3
≥15 years	135	38.7
Childhood conduct disorders ($n = 349$)		
Present	105	30.1
Absent	244	69.9

symptoms ranged from 27.8% for “activities given up” to 51.0% for “hazardous use.” In this sample of regular users, data were indicative of some multidimensionality with the two-factor model, showing a somewhat better fit to the data than the one-factor model. However, the second factor in the two-factor model was highly correlated (.596) with the first, the factor score determinancy was somewhat lower for one factor (.896) compared with the other factor (.935), and the ratio of first-to-second eigenvalues for the two-factor model was 3.2:1. The Comparative Fit Index (CFI), the Tucker-Lewis Index, and Root Mean Square Error of Approximation (RMSEA) for the two-factor model were .982, .967, and .053, compared with .948, .931, and .080, respectively, for the one-factor model. These index values are comparable to those found in other clinical symptom samples (Bolt et al., 2004; Cooke and Michie, 2001) in which IRT analysis has been usefully applied. Thus, despite the somewhat better fit of the two-factor model, the one-factor model was indicative of a first dimension strong enough to justify IRT analysis of the data.

In IRT analysis, CUD symptoms ranged in severity from “hazardous use” ($b [SE] = -0.07 [0.18]$) to “use in larger amounts or over longer periods of time” ($b [SE] = 0.82 [0.13]$). The CUD symptoms of “use in larger amounts or over longer periods of time,” “activities given up,” and “role failure” were the most severe symptoms. The *b* value for “role failure” ($b [SE] = 0.57 [0.10]$), which is a DSM-III-R symptom of dependence but a DSM-IV symptom of abuse, occupied the moderate portion of the severity continuum

TABLE 2. Prevalence, factor loadings, and item response parameters for nine lifetime DSM-III-R cannabis-use disorder symptoms ($n = 349$)

DSM-III-R symptoms	Prevalence ($n = 349$) %	EFA model ($n = 349$)		IRT model ($n = 349$)	
		One factor	Two factors	Discrimin. a (SE)	Severity b (SE)
Hazardous use	51.0	.349	-.156 .537	0.40 (0.08)	-0.07 (0.18)
Time spent	47.6	.696	.249 .526	0.95 (0.14)	0.09 (0.10)
Cut down/control	45.3	.434	.767 -.242	0.49 (0.00)	0.27 (0.16)
Larger/longer	29.8	.660	.656 .108	0.86 (0.13)	0.82 (0.13)
Tolerance	40.7	.712	.515 .291	0.97 (0.14)	0.35 (0.11)
Experienced withdrawal	45.8	.559	.645 .006	0.65 (0.10)	0.19 (0.13)
Role failure	33.5	.804	.071 .796	1.21 (0.19)	0.57 (0.10)
Continued use despite social/psychological/ physical problem	48.7	.597	.329 .341	0.73 (0.11)	0.06 (0.12)
Activities given up	27.8	.794	-.004 .861	1.18 (0.20)	0.79 (0.11)
Factor correlation			.596		
χ^2 test of model fit		87.298	39.421		
Degrees of freedom		27	19		
p		<.0001	.0039		
Eigenvalue		4.107	1.273		
Comparative fit index		.948	.982		
Tucker-Lewis index		.931	.967		
Root mean square error of approximation		.080	.053		
Factor score determinancies		.940	.896 .935		
Bayesian Information Criteria		3,854.415	3,861.105		

Notes: DSM-III-R = Diagnostic and Statistical Manual of Mental Disorders, Third Edition, Revised; EFA = exploratory factor analysis; IRT = Item Response Theory; Discrimin. = Discrimination.

and was more severe than all but two other symptoms: (1) “activities given up” (b [SE] = 0.79 [0.11]) and (2) “use in larger amounts or over longer periods of time.” All CUD symptoms fell on the moderate portion of the severity continuum. Figure 1 graphically portrays criterion response curves for the nine lifetime DSM-III-R CUD criteria.

The third aim of the study was to use differential item functioning analysis to examine the relationship between first use before age 15 years, male gender, and presence of childhood conduct disorder and severity of the nine CUD symptoms over the lifetime. Tables 3-5 show the results of the analyses for the third aim. Each table compares the prevalence and the severity (b) parameters of each of the nine CUD symptoms in groups defined by age at first use younger than age 15 years versus age 15 years or older (Table 3), male versus female gender (Table 4), and presence versus absence of childhood conduct disorder (Table 5). Results (difference of the b) of the differential item functioning analysis indicate that “time spent” (b [SE] = -0.36 [0.17], $p = .04$) was more severe in individuals who first used cannabis after age 15 years, “hazardous use” (b [SE] = 0.85 [0.31], $p = .006$) was more severe in females, and “use in larger amounts or over longer periods of time” (b [SE] = 0.61 [0.24], $p = .01$) was more severe in individuals with co-morbid childhood conduct disorder. Otherwise, first

use of cannabis before age 15 years, male gender, and childhood conduct disorder were not associated with a significant difference in severity of CUD symptoms in this sample of regular users.

Discussion

This study of CUD symptoms in a sample of regular cannabis users from an American Indian community found an admixture of cannabis abuse and cannabis dependence symptoms along an underlying latent trait severity continuum, a finding similar to IRT studies of CUD symptoms from samples of predominantly Euro-American ancestry (Agrawal and Lynskey, 2007; Compton et al., 2009; Hartman et al., 2008; Langenbucher et al., 2004; Lynskey and Agrawal, 2007; Martin et al., 2006). Although the order of severity of symptoms varies among these IRT studies, this study is consistent with several other studies (Compton et al., 2009; Langenbucher et al., 2004; Lynskey and Agrawal, 2007) in finding “hazardous use” among the least severe and “activities given up,” “role failure,” and “use in larger amounts or over longer periods of time” among the most severe CUD symptoms. These results suggest that, in this American Indian community sample, as in samples of other ethnicities, cannabis abuse is not a separate disorder from

FIGURE 1. Criterion response curves for nine lifetime Diagnostic and Statistical Manual of Mental Disorders, Third Edition, Revised, cannabis-use disorder symptoms. CA = cannabis abuse; CD = cannabis dependence.

cannabis dependence; and, in addition, cannabis abuse is not a milder disorder than cannabis dependence.

In this sample, all CUD symptoms occupied the moderate portion of the underlying latent trait continuum. In this respect, our study is most similar to the study by Längenbucher and colleagues (2004) of CUD in adults from treatment programs. IRT studies of CUD symptoms from

epidemiological samples (Compton et al., 2009; Lynskey and Agrawal, 2007) have found that CUD symptom severities spanned the moderate to very severe portions of the continuum. Differences in severity of symptoms along the underlying latent trait continuum between this and other IRT studies are likely the result of several factors, perhaps most importantly the quantity of cannabis use by individuals in

TABLE 3. Prevalence and differential item functioning of DSM-III-R cannabis-use disorder symptoms in groups defined by age at first use before 15 years versus after 15 years ($n = 349$)

DSM-III-R symptoms	Prevalence (%)			DIF	
	<15 years	≥15 years	<i>p</i>	Dif <i>b</i> (SE)	<i>p</i>
Hazardous use	51.9	49.6	.742	0.06 (0.28)	.826
Time spent	52.8	39.3	.016	-0.36 (0.17)	.036
Cut down/control	44.4	46.7	.741	0.35 (0.25)	.166
Larger/longer	28.5	31.9	.549	0.35 (0.21)	.089
Tolerance	43.9	35.6	.146	-0.15 (0.17)	.389
Experienced withdrawal	46.3	45.2	.912	0.16 (0.21)	.441
Role failure	37.4	27.4	.063	-0.22 (0.17)	.199
Continued use despite social/psychological/physical problem	50.5	45.9	.442	0.002 (0.18)	.991
Activities given up	31.3	22.2	.067	-0.21 (0.19)	.283

Notes: DSM-III-R = Diagnostic and Statistical Manual of Mental Disorders, Third Edition, Revised; DIF = Differential Item Functioning.

TABLE 4. Prevalence and differential item functioning of DSM-III-R cannabis-use disorder symptoms in groups defined by male versus female ($n = 349$)

DSM-III-R symptoms	Prevalence (%)			DIF	
	Male	Female	<i>p</i>	Dif <i>b</i> (SE)	<i>p</i>
Hazardous use	59.2	42.9	.003	0.85 (0.31)	.006
Time spent	50.6	44.6	.285	0.01 (0.16)	.950
Cut down/control	51.1	39.4	.032	0.45 (0.26)	.082
Larger/longer	29.9	29.7	1.000	-0.21 (0.21)	.322
Tolerance	41.4	40.0	.828	-0.16 (0.17)	.332
Experienced withdrawal	45.9	45.7	1.000	-0.23 (0.20)	.242
Role failure	32.8	34.3	.821	-0.25 (0.17)	.131
Continued use despite social/ psychological/physical problem	47.7	49.7	.748	-0.34 (0.18)	.053
Activities given up	28.7	26.9	.721	-0.11 (0.18)	.518

Notes: DSM-III-R = Diagnostic and Statistical Manual of Mental Disorders, Third Edition, Revised; DIF = Differential Item Functioning.

the sample. On one hand, samples that specify a history of regular use, as does the sample in this study, will have more frequently symptomatic participants whose symptom severities will appear on more moderate portions of the severity continuum. However, on the other hand, samples that specify lower levels of cannabis use, such as once or five times over the lifetime, will have less frequently symptomatic participants whose symptom severities will appear on more severe portions of the severity continuum. Other potential sources of differences in CUD symptom severity could include other differences in the samples themselves (e.g., treatment vs community vs epidemiological samples) and use of different diagnostic instruments (e.g., Composite International Diagnostic Interview vs SSAGA) and diagnostic criteria (DSM-III-R vs DSM-IV). IRT examination of CUD symptom severity differences in groups defined by ethnic differences is an important area for future study. Such differences, if they exist, might help define important phenotypes for genetic studies and/or subtypes of CUDs differentially responsive to treatment or prevention interventions in different ethnic groups.

Unlike several epidemiological studies (Agrawal and Lynskey, 2007; Compton et al., 2009; Lynskey and Agrawal,

2007; Teeson et al., 2002), we found evidence for some multidimensionality in our data of regular users. Also, in this respect, our results most closely resemble those of the analysis by Langenbucher and colleagues (2004) of CUD symptoms in adults in treatment programs. Interestingly, studies of factor structure in samples restricted to more heavily using and/or moderately symptomatic cannabis users tend to show superiority of a two-factor over a one-factor solution. Nelson and colleagues (1999), in their study of the factor structure of past-year CUD symptoms from the World Health Organization's reliability and validity of alcohol- and drug-use disorder instruments (which included sampling from drug and alcohol treatment programs), found that a one-factor solution for CUD symptoms was superior to a two-factor solution when the sample included all individuals who had used six or more times in their lives but that a two-factor solution was superior if the sample was restricted to individuals who had between two and nine CUD symptoms. The study by Beseler and colleagues (2006) of DSM-III-R CUD symptoms from a sample of male-male twin pairs who had used cannabis more than five times interviewed as part of the Vietnam Era Twin Registry found that a two-factor model fit their data better than a one-factor

TABLE 5. Prevalence and differential item functioning of DSM-III-R cannabis-use disorder symptoms in groups defined presence versus absence of childhood conduct disorder (CCD) ($n = 349$)

DSM-III-R symptoms	Prevalence (%)			DIF	
	+CCD	-CCD	<i>p</i>	Dif <i>b</i> (SE)	<i>p</i>
Hazardous use	60.0	47.1	.035	-0.67 (0.34)	.052
Time spent	50.4	46.3	.486	0.08 (0.17)	.657
Cut down/control	49.5	43.4	.348	-0.09 (0.26)	.723
Larger/longer	26.7	31.1	.445	0.61 (0.24)	.013
Tolerance	43.8	39.3	.477	0.08 (0.18)	.635
Experienced withdrawal	47.6	45.1	.726	0.16 (0.22)	.472
Role failure	39.0	31.1	.174	-0.04 (0.18)	.819
Continued use despite social/ psychological/physical problem	51.4	47.5	.560	0.08 (0.19)	.666
Activities given up	36.2	24.2	.027	-0.21 (0.20)	.288

Notes: DSM-III-R = Diagnostic and Statistical Manual of Mental Disorders, Third Edition, Revised; DIF = Differential Item Functioning.

model. In that study, the two factors did not correspond to an abuse-dependence dichotomy. Blanco and colleagues (2007), in their evaluation of cannabis symptoms in the epidemiologic National Longitudinal Alcohol Epidemiologic Survey data set, found a highly correlated two-factor solution. In that study, the two factors were similar to DSM-IV abuse and dependence. Fulkerson and colleagues (1999), in their analysis of substance-use disorder symptoms in 9th and 12th graders in traditional and alternative high schools with high-risk adolescents, also found that a correlated two-factor model, as well as a one-factor model, fit their data better than an uncorrelated two-factor model. In this study, the two symptoms that correspond to DSM-IV cannabis abuse, "hazardous use" and "role failure," loaded onto a second factor that included the cannabis dependence symptoms "time spent" and "activities given up." Thus, also in this respect, our analysis suggests that the diagnoses of cannabis abuse and cannabis dependence, as currently formulated, are not separate disorders in this American Indian sample. Taken together, the results of this and previous studies suggest that samples that include more heavily using and/or symptomatic individuals may show some multidimensionality to their CUD symptomatology and that the multidimensionality may reflect factors other than the traditional abuse-dependence dichotomy. Further research into the biological and psychosocial processes underlying those factors will likely be important in understanding the development and course of CUDs.

In this study of regular users, "time spent" was *less* severe in individuals who had first use before age 15 years than in those whose first use was after the age of 15 years. None of the other lifetime CUD symptoms showed severity differences by age at first use. This finding suggests that early age at first use of cannabis does not lead to more severe symptoms of subsequent CUD in regular users, at least in the population from which this sample was drawn. To our knowledge, early first use of cannabis or other substances has not been previously examined in IRT analyses of cannabis or other substance-use disorder symptom severity. Recently, Moss and colleagues (2007) reported that age at onset of drinking was not significantly different among five lifetime DSM-IV alcohol dependence subtypes identified in the NESARC data set. Although Moss and colleagues did not examine their sample for alcohol-use disorder symptom severity differences, the lack of significant difference between subgroups on the basis of age at first drink is consistent with the idea that earlier ages of first drink are not associated with variations in symptom severity in those who develop alcohol-use disorders. The findings of this study and the study by Moss and colleagues suggest that earlier age at first use of cannabis and alcohol, although associated with increased risk for development of CUD and alcohol-use disorder, is not associated with increased symptom severity in those who develop CUD.

Our finding that "hazardous use" occurred on a more severe portion of the severity continuum in females than in males is consistent with the analysis by Martin and colleagues (2006) of CUD symptoms from an adolescent clinical sample and with the analysis by Agrawal and Lynskey (2007) of the NESARC data. In both studies, "hazardous use" was found to be more severe in females than males. Grant and colleagues (2006) found that frequency of endorsing "hazardous use" was the most consistent and substantial gender difference in all four classes of CUD symptoms identified in the National Longitudinal Alcohol Epidemiologic Survey, a finding consistent with IRT analyses showing "hazardous use" is less frequent (and therefore more severe) in females than males. Lower frequencies of "hazardous use" in women in this and other IRT studies may have both biological (e.g., women have less neurobiologically based impulsivity than men) and social/cultural determinants (e.g., women are less likely to drive while intoxicated than men). In addition to "hazardous use," Martin and colleagues (2006) found "continued use despite psychological and physical problems" less severe in female adolescents as opposed to male adolescents, and Agrawal and Lynskey (2007) found "cut down/control" to be more severe in men than women. Both studies found "legal problems" to be more severe in females than males. In contrast, we found no other gender differences in CUD symptom severity, although we did not assess for "legal problems" in our sample and, therefore, cannot compare severity of that CUD symptom in our study with the previous studies. Thus, overall, CUD severity showed fewer gender differences in this sample than in previous IRT analyses of samples of non-Native American ancestry. Our finding of little gender difference in CUD symptom severity may be related to the specific CUD symptoms that we were not able to examine (e.g., "legal problems") or may have resulted from our sample being restricted to regular users (as opposed to including light or very infrequent users, as in other studies). It may also represent a true ethnic difference. In two studies of American Indian populations (Gilder et al., 2006; Mitchell et al., 2003), lifetime rates of CUDs have shown significantly greater frequencies in men than women, a phenomenon that mirrors gender frequency differences in the general U.S. population (Stinson et al., 2006). If these differences in gender-related CUD symptom severity do arise from a true ethnic difference, the results of this study suggest that higher CUD rates in males than females do not correlate with greater CUD symptom severity in this population as much as they do in non-Native American populations.

In this sample, "use in larger amounts or over longer periods of time than intended" indicated a more severe underlying CUD latent trait in those who had childhood conduct disorder than those who did not. This finding suggests that items related to loss of awareness of or control over amounts of cannabis used are less frequently endorsed in regular users with childhood conduct disorder than those without child-

hood conduct disorder. This suggests that regular users with a history of childhood conduct disorder may continue using at frequent intervals without consciously sensing a loss of control.

What is most striking about differences in CUD symptom severity in this sample of regular users is that there are few of them. With the three exceptions noted previously—(1) age at first use before age 15 years, (2) male gender, and (3) presence of childhood conduct disorder—factors associated with increased risk for CUD in the Native American population, from which this sample was drawn, were not associated differences in CUD symptom severity along the underlying latent trait severity continuum. The reason for this lack of severity difference in groups may reflect a diagnostic issue: Diagnostic symptoms as currently formulated may not differentiate moderately severe from very severe or mildly affected cases. For example, the cutoff for “recurrent” “hazardous use” is its occurrence three or more times. Perhaps a criterion cutoff at 10 or more times or a requirement for more than one kind of “hazardous use” would identify a more severe symptom. Alternatively, the results of this study may reflect a true physiological/psychosocial limit or ceiling effect in symptoms developing from repeated cannabis use, that is CUD severity as measured by symptom severity does not become greater with the addition of these risk factors. To date, differential item functioning analyses of CUD symptom severity in non-Native American samples of adult regular users has not been done; therefore, it is not possible to assess how much the results of this study are similar to or different from those non-Native American samples.

The results of this study should be interpreted in light of several limitations. First, our findings may not be representative of all Native Americans living in the communities from which the sample was drawn and may not generalize to other Native Americans or other ethnic groups. Second, we used cross-sectional and retrospective data. Our cross-sectional data may include regular cannabis users who will accrue additional CUD symptoms during their lives but have not yet done so. Retrospective data suffers from recall bias, which may include a reporting bias that results from having remitted or not remitted, advancing age, and other time-related variables not accounted for in the present analysis. Our analysis also excludes current users who have never been regular users (used at least 21 times in a single year). If low-level and infrequent cannabis users had been included in our sample, different discrimination and severity values for CUD symptoms would likely have been found. Additionally, our approach did not take possible cohort effects into account. Cohort effects could arise from variations in cannabis availability, strength of available preparations, and use patterns over time. These could influence discrimination, severity values, and group differences in CUD symptom severity in ways that were not taken into account in the present analysis. A prospective study of CUD symptom severity from initia-

tion of cannabis use to the development of regular use and continuing use over specific time periods would provide for a more powerful model of severity of CUD symptoms in this population. Third, comparisons with other populations of CUD individuals may be limited by differences in sampling techniques, as well as varying genetic and environmental variables in those populations. Fourth, the sample assessed in this study may be composed of important subgroups not considered in the current IRT approach that might have shown more significant symptom severity differences. Other data reduction approaches, such as latent factor mixture modeling, might have the potential to identify subgroups or mixtures within the sample. Despite these limitations, however, this paper represents an important additional step in characterizing the relationship of early age at first cannabis use, male gender, and childhood conduct disorder to CUD symptoms in this high-risk group.

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