Dimensions and severity of marijuana consequences: Development and validation of the Marijuana Consequences Questionnaire (MACQ)

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ABSTRACT

The Marijuana Consequences Questionnaire (MACQ) is a 50-item self-report measure modeled after the Young Adult Alcohol Consequences Questionnaire (YAACQ). College students ($n = 315$) completed questionnaires online. A confirmatory factor analysis supported the hypothesized 8-factor structure. The results indicate good convergent and discriminant validity of the MACQ. A brief, unidimensional, 21-item version (B-MACQ) was developed by a Rasch model. Comparison of item severity estimates of the B-MACQ items and the corresponding items from the YAACQ indicates that the severity of alcohol- and marijuana-problems is defined by a relatively unique pattern of consequences. The MACQ and B-MACQ provide promising new alternatives to assessing marijuana-related problems.

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1. Introduction

Marijuana is the most common illicit drug used in the U.S. Results of several national surveys indicate that approximately half of young adults 18–25 have used marijuana in their lifetime (CORE Institute, 2010; Johnston, O' Malley, Bachman, & Schulenberg, 2010a; Substance Abuse and Mental Health Service Administration, 2010). Lifetime prevalence rates among adolescents indicate a steady progression of initiation through high school and into young adulthood and college years with approximately 16% of 8th graders, 32% of 10th graders and 42% of 12th graders reporting using marijuana in their lifetime (Johnston, O'Malley, Bachman, & Schulenberg, 2010b). The prevalence of marijuana use is high, in part, because the perceived risk of marijuana use is low (CORE Institute, 2010; Johnston et al., 2010a; Substance Abuse and Mental Health Service Administration, 2010). For example, results from the 2009 NHSDUH indicate that 18–23% of 19–26 year olds consider occasional marijuana use to be of "great risk" and for regular use, roughly 43–46% reported great risk.

Though the risk of marijuana may be relatively low compared to other drugs such as alcohol, nicotine, or cocaine; marijuana use is not without its consequences. Marijuana use is associated with respiratory problems including lung cancer (Aldington et al., 2007; Aldington et al., 2008; Earleywine & Barnwell, 2007; Hall & Degenhardt, 2009; Looby & Earleywine, 2007), deficits in cognitive functioning (Hanson et al., 2010; Lane, Cherek, Tcheremissine, Steinberg, & Sharon, 2007), mental health-related problems (Buckner, Ecker, & Cohen, 2010; Looby & Earleywine, 2007), and impaired impulse control and error monitoring (Hester, Nestor, & Garavan, 2009; Lane, Cherek, Tcheremissine, Lieving, & Pietras, 2005; McDonald, Schleifer, Richards, & de Wit, 2003). Other deleterious outcomes associated with marijuana use are sexual risk behavior (Griffin, Botvin, & Nichols, 2006; Simons, Maisto, & Wray, 2010), traffic accidents (Hall & Degenhardt, 2009), poor academic performance (Buckner et al., 2010), and a broad range psychosocial problems (Copeland, Gilmour, Gates, & Swift, 2005; Simons & Carey, 2006b). Among young adult college students 18–22, 6.2% met criteria for a past year marijuana use disorder in 2009 (Substance Abuse and Mental Health Service Administration, 2010). There has been increased recognition of problems with marijuana dependence and an emphasis on the development and evaluation of empirically supported treatments in recent years (Buckner & Carroll, 2010; Stephens, Babor, Kadden, & Miller, 2002).

The alcohol literature benefits from a wide array of relatively brief screening instruments (AUDIT; Saunders, Aasland, Babor, De La Fuente, & Grant, 1993; SMAST; Selzer, Vinokur, & van Rooijen, 1975), measures of dependence symptoms (ADS; Skinner & Horn, 1984), broad measures of psychosocial consequences (YAAPST; Hurlbut & Sher, 1992; RAPI; White & Labouvie, 1989), and multifactor scales that assess impairment in multiple domains (DrInC; Miller, Tonigan, & Longabaugh, 1995; YAACQ; Read, Kahler, Strong, & Colder, 2006). Although marijuana use and associated consequences are common among young adults, there has been relatively limited research on the development of assessment instruments for marijuana consequences.

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Commonly used instruments for young adults include the Marijuana Problem Index (a variant of the RAPI; Johnson & White, 1989; White & Labouvie, 1989) and the Marijuana Problem Scale (Stephens, Roffman, & Curtin, 2000). Recently, Stein et al. (2010) developed the Risk and Consequences Questionnaire for use with incarcerated adolescents, which assesses consequences associated with both alcohol and marijuana. Each of these provides a broad assessment of the extent of consequences stemming from marijuana use. In addition, there are a number of brief screening instruments for marijuana-related problems including the Cannabis Use Disorders Identification Test, Cannabis Abuse Screening Test, and Problematic Use of Marijuana (For a review, see Piontek, Kraus, & Klempova, 2008). Finally, Copeland et al. (2005) developed a 3-factor scale that assesses physical, psychological, and social problems stemming from marijuana use. None of the available marijuana problem scales provides as comprehensive assessment of problems in multiple domains as the Young Adult Alcohol Consequences Questionnaire does for alcohol (discussed below).

In recent years, there has been increased emphasis on utilizing item-response methods to refine instruments and clarify the severity of individual consequences (Hagman et al., 2009; Kahler, Strong, Read, Palfai, & Wood, 2004; Kahler, Strong, & Read, 2005; Neal, Corbin, & Fromme, 2006). Item response methods evaluate the extent of coverage of problem severity over a range. These methods can be used to ensure that a scale can adequately differentiate substance use impairment at low, moderate, and severe levels. In addition, they provide information regarding discrete symptoms as indicators of relative severity of the disorder. Information regarding the type of problems that individuals experience across the continuum of severity of a disorder can inform understanding of the disorder and the meaning of presenting problems. There has been some research applying these methods to marijuana related problems, however this has been limited primarily to brief screening instruments and indicators of DSM cannabis abuse and dependence indicators (Annaheim, Scotto, & Gmel, 2010; Compton, Saha, Conway, & Grant, 2009; Martin, Chung, Kirisci, & Langenbucher, 2006; Wu et al., 2009).

Negative consequences associated with marijuana and alcohol use overlap. For example, each drug may be associated with impairment in socio-occupational functioning, risk-taking behaviors, and affect interpersonal functioning. In contrast, symptoms of heavy use (e.g., blackouts, vomiting, paranoia) and withdrawal symptoms may be unique to alcohol or marijuana. Similarly, chronic marijuana users may exhibit some unique features such as apathy that is often considered a feature of marijuana use in the popular media, though empirical evidence for this is limited (Barnwell, Earleywine, & Wilcox, 2006; Zimmer & Morgan, 1997). Despite similarities of consequences across alcohol and marijuana, endorsement of a symptom may indicate a different level of severity for each drug. For this reason, it is important, to systematically evaluate marijuana consequences utilizing item-response analysis. Understanding of both alcohol and marijuana consequences can be enhanced by having comparable scales for each. There are enough similarities in the type of consequences that establishing alternate forms of instruments to evaluate alcohol and marijuana consequences can be informative. For example, this would facilitate identifying unique patterns of consequences for each drug.

The Young Adult Alcohol Consequences Questionnaire (YAACQ) is a 48-item questionnaire assessing alcohol problems among young adults (Read et al., 2006). The scale has 8 factors; Social-Interpersonal Consequences, Impaired Control, Self-Perception, Self-Care, Risky Behaviors, Academic/Occupational Consequences, Physical Dependence, and Blackout Drinking. In addition, a brief 24-item unidimensional version exists that was developed using item-response analysis and orders items along a single continuum of severity (Kahler et al., 2005). These scales have excellent psychometric properties and benefit from being able to be used to examine either problem severity across a continuum or to assess functioning in

discrete domains (Devos-Comby & Lange, 2008; Kahler et al., 2005; Read et al., 2006; Read, Merrill, Kahler, & Strong, 2007).

The present study modified the YAACQ to assess marijuana consequences (the Marijuana Consequences Questionnaire, MACQ). The revised scale maximizes comparability across the measures, yet incorporates necessary modifications reflecting unique features of marijuana consequences. We fit a confirmatory factor analysis model to test whether the scale exhibits a factor structure comparable to the YAACQ. Subsequently, we utilize item response modeling to develop a brief measure (the B-MACQ) and to evaluate the items as indicators of problem severity. To our knowledge, this has not been done with as extensive a measure of marijuana-related consequences. We compare the functioning of the items as indicators of alcohol versus marijuana use problem severity. Finally, we present evidence of criterion validity of the scales and test–retest reliability.

2. Methods

2.1. Participants

The total sample consisted of 2151 college students from two universities in the Midwestern and Northeastern parts of the U.S. The analysis sample ($n = 315$ (14.6%)) was composed of participants who reported using marijuana at least once per month over the last six months. The analysis sample consisted of 51.10% women and ranged in age from 18 to 29 ($M = 20.52$, $SD = 1.62$). The racial composition was 88.64% Caucasian, 2.21% Asian, 2.21% African American, 0.95% Alaskan Native/Native American, 0.32% Native Hawaiian or Pacific Islander, 5.05% multiracial. Four individuals reported "other" or "do not wish to respond." Twelve participants (4.53%) reported they were of Hispanic or Latino/Latina origin.

2.2. Measures

2.2.1. Marijuana use

Marijuana use frequency in the last 6 months was assessed by a 9 point rating scale (0 = none at all to 8 = more than once a day). Marijuana use intensity was assessed by a 1-week grid with 4, 6-hour, periods per day. Participants indicated the number of time periods that they consumed marijuana in a typical week in the past 6 months. These measures of marijuana use have demonstrated good criterion validity and stability over 6-month intervals in previous research (Simons & Carey, 2006a; Simons, Gaher, Correia, Hansen, & Christopher, 2005; Williams, Adams, Stephens, & Roffman, 2000).

2.2.2. Marijuana problems

The present study modified the YAACQ to assess marijuana consequences (the Marijuana Consequences Questionnaire, MACQ). The majority of items were left unchanged aside from referring to marijuana rather than alcohol to enhance comparability across the scales. Items related to withdrawal symptoms were modified to reflect symptoms of marijuana withdrawal (Hasin et al., 2008) and descriptions of "hangover" were modified to better reflect effects of marijuana. In addition, we added two items to reflect deficits in motivation and paranoia. The MACQ is a 50-item scale assessing marijuana problems over the past 6 months. A 6-month time frame was chosen to adequately capture potential infrequent consequences among marijuana users. Each item is rated dichotomously (yes/no) to indicate whether the marijuana-related problem occurred in the last 6 months. The problems were hypothesized to load onto the 8 factors established for the YAACQ (Social-interpersonal Consequences, Impaired Control, Self-Perception, Self-Care, Risk Behaviors, Academic/Occupational Consequences, Physical Dependence, and Blackouts). In addition, the Marijuana Problems Index was included to assess criterion validity of the new scale (Johnson & White, 1989). The MPI is a 23-item scale similar to the RAPI (White & Labouvie, 1989) and has

good criterion validity and stability over 6-month intervals in young adult samples (Simons & Carey, 2006a; Simons et al., 2005).

2.2.3. Alcohol consumption

Alcohol consumption in the past 6 months was measured with the Modified Daily Drinking Questionnaire (DDQ-M; Dimeff, Baer, Kivlahan, & Marlatt, 1999). Participants indicate the typical number of standard alcoholic drinks consumed and number of hours of drinking for each day of the week on a grid. Previous research has shown adequate test–retest reliability over a seven day period ($r = 0.93$; Miller et al., 1998).

2.2.4. Alcohol problems

Alcohol problems in the past 6 months were assessed with the Young Adult Alcohol Consequences Questionnaire (YAACQ; Read et al., 2006). The YAACQ provides a measure of alcohol problems across 8 domains as well as a total score. The YAACQ has shown excellent test–retest reliability and convergent validity with alcohol use and other measures of alcohol problems (Read et al., 2006; Read et al., 2007).

2.3. Procedure

Participants from two state universities completed all questionnaires online. All participants provided informed consent and were recruited through an online university research pool. Participants were told that all responses would be anonymous and that participation would include answering questions regarding substance use and problems. Participants received either course credit (Midwest U.S. site) or a gift card up to $35 (Northeastern U.S. site) for participation. The reliability and validity of online assessments of substance use are well supported (Miller et al., 2002; Simons, Carey, & Wills, 2009). All participants were treated in accordance with APA ethical guidelines for research and the studies were approved by the respective Institutional Review Boards (Sales & Folkman, 2000). Thirty-seven of the participants at the Midwest site were taking part in another study (Simons, Dvorak, Batien, & Wray, 2010) and their data were used to examine test–retest reliability. Participants at the Northeastern site were part of an ongoing study of associations between traumatic stress and substance use among college students (Read, Ouimette, White, Colder, & Farrow, 2011; Read et al., under review).

3. Results

3.1. Descriptive statistics

Marijuana use frequency in the analysis sample (scale $M = 4.24$, $SD = 1.85$) ranged from 2 (*once a month*) to 8 (*more than once a day*), with the mode ($n = 100$; 31.75% of sample) using *2–3 times a month*. Fifty-two percent of the analysis sample reported using marijuana at least once a week, 25% nearly every day or more, and 14% at least once a day. Typical weekly marijuana use intensity ranged from 0 to 28 times per week ($M = 6.92$, $SD = 6.53$). The total number of marijuana problems endorsed on the MACQ ranged from 0 to 44 ($M = 8.36$, $SD = 8.59$). Marijuana use frequency and intensity did not differ by gender or university ($ps = 0.08$–0.59). Number of marijuana related problems endorsed on the MACQ did not differ by gender ($t(313) = -1.18$, $p = 0.24$). There was a small difference in number of problems across university ($t(313) = -2.09$, $p = 0.037$, Cohen's $d = 0.25$).

3.2. Confirmatory factor analysis

All responses for marijuana problems were binary, thus we utilized the mean- and variance-adjusted weighted least squares estimator (WLSMV) in MPlus 6.1 (Muthén & Muthén, 2010). A CFI greater than or equal to 0.96, and a weighted root-mean-square residual (WRMR) of approximately 1.0 indicate good fit with categorical data (Yu,

2002). Chi-square difference testing was performed using the DIFFTEST function of Mplus 6.1 (Muthén & Muthén, 2010).

We first specified an 8-factor model of marijuana problems modeled after the 8-factor YAACQ. This model was an excellent fit to the data, $\chi^2(1147) = 1347.44$, $p < 0.001$, CFI = 0.97, TLI = 0.97, RMSEA = 0.024 (90% CI = 0.018–0.029), WRMR = 0.98. Examination of the model indicated high correlations between some of the latent variables ($rs = 0.57$ (Physical Dependence with Self-Perception) to 0.91 (Risk Behaviors with Social-Interpersonal Consequences)). Thus, we specified an alternative single factor unidimensional model. This model showed reasonable fit to the data, $\chi^2(1175) = 1553.53$, $p < 0.001$, CFI = 0.94, TLI = 0.94, RMSEA = 0.032 (90% CI = 0.028–0.036), WRMR = 1.17. However, a chi-square difference test indicated the initial 8-factor model was a better fit to the data than the 1-factor model, $\Delta\chi^2(28) = 220.03$, $p < 0.001$.

Next, we tested an alternative model in which the 8-latent marijuana problems loaded on a higher-order marijuana problems factor. This model also showed good fit to the data, $\chi^2(1167) = 1417.66$, $p < 0.001$, CFI = 0.96, TLI = 0.96, RMSEA = 0.026 (90% CI = 0.021–0.031), WRMR = 1.05. Standardized factor loadings ranged from 0.78 (Self-Perception) to 0.92 (Risk Behaviors) and the R^2 for the lower-order factors ranged from 0.61 (Self-Perception) to 0.85 (Risk Behaviors). However, a chi-square difference test indicated the initial 8-factor model was a better fit to the data than the higher-order factor model, $\Delta\chi^2(20) = 85.79$, $p < 0.001$. Thus, we retained the original 8-factor model (see Table 1). Table 2 presents means, internal consistency, and correlations for the manifest MACQ scales.

3.3. Rasch model

In the CFA analysis, both a unidimensional and a higher-order factor structure fit the data well. Thus, we sought to derive a brief measure of marijuana problems that would assess the severity of problems along a unidimensional continuum. To do this, we utilized Rasch modeling to identify items of progressive problem severity. The Rasch analysis was conducted using Winsteps® 3.71.0 (Linacre, 2011). We proceeded by initially examining all items and iteratively removing items with poor model fit as indicated by infit and outfit statistics, and/or multidimensionality assessed by high residual loadings on extraneous factors (Bond & Fox, 2007; Linacre, 2002). Criteria for item elimination by infit/outfit were items falling outside the range of 0.5–1.5 (Bond & Fox, 2007). We then examined differential item functioning (DIF) across items by gender and university. Next we conducted a principal components analysis of the residual variance of each item to examine multidimensionality. Finally, we tested the fit of the Rasch model in Mplus 6.1.

No items had infit statistics outside the 0.5 to 1.5 range. However, 29 items had outfit statistics outside this range, and were thus removed. Next, we examined differential item functioning (DIF) by gender and university. None of the remaining 21 items showed DIF by gender; however, two items (MACQ items #15 and #25) showed DIF by university, and were removed. Finally, we examined multidimensionality of items via the loadings of residual variances on additional factors in a principal components analysis of item residuals. The first principal component (i.e., first contrast) had an eigenvalue of 1.8. Examination of the indicators with the highest loadings on this component did not reveal any meaningful conceptual theme. Thus, no additional items were eliminated. This process resulted in the retention of 19 items.

Examination of these 19 items revealed a lack of measurement at low levels of problems, resulting in reduced reliability. Thus, we added two additional items that had been previously removed due to high outfit statistics (MACQ items #4 and #5). Previous research has shown that some fit indices in Rasch (e.g., infit/outfit) may be biased in skewed samples (Hidalgo & López-Pina, 2011). Considering our sample was not normally distributed, we let overall model fit dictate the retention of these two items. Despite outfit statistics >1.50,

Table 1
Factor loadings and endorsement for MACQ items.

Items ordered by factor	Factor loading	% Endorsed
Social-Interpersonal Consequences		
1. While using marijuana I have said or done embarrassing things.	0.67	37.26
11. My marijuana use has created problems between myself and my boyfriend/girlfriend/spouse/parents, or other near relatives.	0.93	7.99
17. I have become very rude, obnoxious, or insulting after using marijuana.	0.80	6.03
23. My boyfriend/girlfriend/spouse/parents have complained to me about my marijuana use.	0.75	11.86
33. While using marijuana I have said harsh or cruel things to someone.	0.91	8.89
36. I have said things while using marijuana that I later regretted.	0.92	11.43
Impaired Control		
10. I often used more marijuana than I originally had planned.	0.59	32.15
14. I have spent too much time using marijuana.	0.85	22.68
28. I often have ended up using marijuana on nights when I had planned not to use marijuana.	0.57	37.50
30. I often have found it difficult to limit how much marijuana I use.	0.97	15.02
41. I have tried to quit using marijuana because I thought I was using too much.	0.86	16.29
45. I often have thought about needing to cut down or to stop using marijuana.	0.80	25.00
Self-Perception		
3. I have felt badly about myself because of my marijuana use.	0.80	19.29
12. I have been unhappy because of my marijuana use.	0.90	11.18
18. I have felt guilty about my marijuana use.	0.68	24.04
48. Using marijuana has made me feel depressed or sad.	0.86	11.54
49. I have felt panicked or paranoid after using marijuana.	0.64	38.22
Self-Care		
20. Because of my marijuana use, I have not eaten properly.	0.63	27.16
21. I have been less physically active because of my marijuana use.	0.80	29.71
34. Because of my marijuana use, I have not slept properly.	0.83	9.90
35. My physical appearance has been harmed by my marijuana use.	0.83	7.99
38. I have been overweight because of my marijuana use.	0.68	7.94
39. I haven't been as sharp mentally because of my marijuana use.	0.74	21.15
43. I have not had as much time to pursue activities or recreation because of my marijuana use.	0.85	9.97
46. I have had less energy or felt tired because of my marijuana use.	0.80	36.31
50. I have lost motivation to do things because of my marijuana use.	0.80	26.37
Risk Behaviors		
4. I have driven a car when I was high.	0.59	58.15
7. I have taken foolish risks when I have been high.	0.83	15.87
13. I have gotten into physical fights because of my marijuana use.	0.79	2.88
19. I have damaged property or done something disruptive like setting off a fire alarm, or other things like that after using marijuana.	0.84	4.15
26. As a result of marijuana use, I neglected to protect myself or partner from an STD or unwanted pregnancy.	0.93	4.17
29. When using marijuana I have done impulsive things that I regretted later.	0.82	12.10
31. My marijuana use has gotten me into sexual situations I have later regretted.	0.80	5.71
44. I have injured someone else while using marijuana or high.	0.90	3.19
Academic/Occupational Consequences		
2. The quality of my work or schoolwork has suffered because of my marijuana use.	0.86	9.35
9. I have gotten into trouble at work or school because of marijuana use.	0.76	3.53
15. I have not gone to work, or have missed classes or school because of using marijuana, being high, or after effects (feeling hung-over).	0.90	11.11
27. I have neglected obligations to family, work, or school because of my marijuana use.	0.90	12.50
40. I have received a lower grade on an exam or paper than I ordinarily could have because of marijuana use.	0.91	9.94
Physical Dependence		
16. I have felt like I needed a hit of marijuana after I'd gotten up (that is, before breakfast).	0.84	16.61
22. I have had trouble sleeping after stopping or cutting down on marijuana use.	0.83	14.74
25. I have found that I needed larger amounts of marijuana to feel any effect, or that I could no longer get high on the same amount that used to get me high.	0.84	27.80
42. I have felt anxious, irritable, lost my appetite or had stomach pains after stopping or cutting down on marijuana use.	0.87	12.46
Blackout Use		
5. I have felt in a fog, sluggish, tired, or dazed the morning after using marijuana.	0.60	39.17
6. I have passed out from marijuana use.	0.53	20.06
8. I have felt very sick to my stomach or thrown up after using marijuana.	0.41	11.11
24. I have woken up in an unexpected place after using marijuana.	0.88	4.14
32. I have not been able to remember large stretches of time while using marijuana.	0.95	9.24
37. I have awakened the day after using marijuana and found I could not remember a part of the evening before.	0.73	14.38
47. I have had a blackout after using marijuana heavily (i.e. could not remember hours at a time).	0.78	5.71

Note. Italicized variables are latent constructs. All factor loadings significant at $p<0.001$.
Items are administered in numeric order.

these items increased the overall person reliability (PR) of the scale (19-item PR = 0.51; 21-item PR = 0.67), increased person separation (19-item = 1.57; 21-item = 1.72), increased the overall variance accounted for by the measure (19-item = 33.1%; 21-item = 38.8%), and reduced the variance accounted for in the 1st principal component (19-item = 6.4%; 21 item = 5.3%). Although these individual items did not offer ideal statistical fit to the Rasch framework, they improved overall performance of the brief measure. Table 3 presents

the model statistics for the 21-item brief measure with items ordered in terms of severity. In addition, we added the relative severity of comparative alcohol problems from the YAACQ to examine differences in indicators of problem severity by substance. Severity estimates are in reference to the latent continuum of substance use problem severity. A higher severity estimate indicates that the item is endorsed by individuals with greater problems, but does not necessarily indicate that the specific consequence is a more significant or

Table 2
Means, internal consistency, and correlations of MACQ scales.

	α	M(SD)	Range	1	2	3	4	5	6	7	8	9
1. Soc.-Interper.	0.88	0.83(1.21)	0–6	–								
2. Impaired Con.	0.89	1.47(1.71)	0–6	0.55	–							
3. Self-Per.	0.86	1.03(1.30)	0–5	0.54	0.54	–						
4. Self-Care	0.90	1.75(2.10)	0–8	0.57	0.66	0.55	–					
5. Risk Beh.	0.93	1.06(1.32)	0–8	0.71	0.54	0.43	0.52	–				
6. Ac.–Occ.	0.92	0.46(1.04)	0–5	0.54	0.48	0.41	0.60	0.61	–			
7. Phys. Dep.	0.90	0.71(1.13)	0–4	0.47	0.61	0.37	0.59	0.53	0.53	–		
8. Blackout	0.84	1.03(1.31)	0–6	0.63	0.46	0.41	0.50	0.55	0.43	0.40	–	
9. MACQ — Total	0.98	8.36(8.59)	0–44	0.80	0.81	0.70	0.85	0.78	0.73	0.73	0.71	–
10. B-MACQ	0.95	4.02(4.23)	0–19	0.68	0.78	0.61	0.87	0.70	0.71	0.77	0.63	0.95

Note. $N = 315$. Variables are observed scores. All correlations significant at $p < 0.0001$. Alpha was calculated based on the tetrachoric correlations. Soc.-Interper. = Social-Interpersonal Consequences, Impaired Con. = Impaired Control, Self-Per. = Self-Perception, Risk-Beh. = Risk Behaviors, Ac.–Occ. = Academic–Occupational Consequences, Phys. Dep. = Physical Dependence. B-MACQ = Brief Marijuana Consequences Questionnaire.

severe behavioral risk relative to an item with a lower severity estimate (Kahler et al., 2005). Thus, whereas, impaired academic performance or interpersonal conflict may be equally problematic regardless of whether they stem from drinking or using marijuana, the presence of such consequences may convey different information regarding level of substance use disorder.

The final Rasch model contained several non-variable cases (i.e., cases with no problems). This presents a difficulty as the exact location on the theta ruler for these people cannot be accurately identified. Consequently, the reliability of the scale, which includes non-variable cases, is bound to be reduced. A further complication is the fairly low base rate of problems in this population. Thus, we present data on the reliability of the scale for all those that could be located on theta, as well as the reliability for the entire sample. For the entire sample ($n = 315$) person reliability was 0.67 and person separation was 1.42, this included 65 individuals with no variability in scores. The lack of variability among these individuals was due to all zero scores (i.e., they did not acknowledge any of the 21 B-MACQ items). There were no individuals acknowledging all 21 items. Among individuals with variable scores ($n = 250$) the scale performed much better. The scale was more reliable ($PR = 0.75$) and had adequate power to accurately categorize high and low problem users (person separation $= 1.72$). Cronbach's alpha

calculated from tetrachoric correlations also indicated good internal consistency ($\alpha = 0.95$). The final 21-item scale accounted for 38.8% of the variance, indicating a moderately strong measurement dimension (Linacre, 2006). We fit the 21-item Rasch model in Mplus 6.1 using Theta parameterization with the WLSMV estimator. The model showed good fit to the data: $\chi^2(209) = 321.33$, $p < 0.01$, RMSEA $= 0.04$ (90% CI $= 0.03$–0.05), CFI $= 0.96$, TLI $= 0.96$, WRMR $= 1.32$.

The raw score distribution is presented in Table 4. The B-MACQ score is the total number of items endorsed. The B-MACQ can range from 0 (no consequences endorsed, least severe) to 21 (every consequence endorsed, most severe). Appendix 1 includes the B-MACQ and scoring instructions. Each score may be expressed in equal interval logit units along a latent continuum of marijuana problem severity. Comparison of the score severity estimates to the item severity estimates in Table 3 indicates the type of problems individuals along the severity continuum are likely to have. For example, a score of 7 on the B-MACQ reflects a severity score of -0.85. This indicates that the individual would have approximately a 50% probability of endorsing item 21 on the B-MACQ, which has an item severity of -0.86. The probability of endorsing items with severity estimates less than -0.85 (i.e., items 2, 3, 9, and 20) would be greater than 50% with the probability increasing as the item severity decreases. Similarly,

Table 3
B-MACQ item severity and comparison with alcohol items.

B-MACQ items	Item severity	SE	Infit	Outfit	Alcohol severity[*]
2. I have driven a car when I was high.	−3.27	0.16	1.25	1.67	−0.55
3. I have felt in a fog, sluggish, tired, or dazed the morning after using marijuana.[d5]	−1.83	0.15	1.39	1.83	−4.76
20. I have had less energy or felt tired because of my marijuana use.	−1.61	0.15	0.90	0.96	−0.30
9. I have been less physically active because of my marijuana use.	−1.12	0.16	0.99	0.92	0.31
21. I have lost motivation to do things because of my marijuana use.	−0.86	0.16	0.91	0.82	n/a
19. I often have thought about needing to cut down or to stop using marijuana.	−0.72	0.17	0.98	0.99	0.46
6. I have spent too much time using marijuana.	−0.54	0.17	0.86	0.70	−0.09
15. I haven't been as sharp mentally because of my marijuana use.	−0.39	0.17	1.00	0.96	0.59
7. I have felt like I needed a hit of marijuana after I'd gotten up (that is, before breakfast).	0.07	0.19	0.95	0.92	1.58
17. I have tried to quit using marijuana because I thought I was using too much.	0.10	0.19	0.93	0.80	1.19
10. I have had trouble sleeping after stopping or cutting down on marijuana use.[d22]	0.27	0.19	0.92	0.83	1.83
13. I have awakened the day after using marijuana and found I could not remember a part of the evening before.	0.28	0.19	1.19	1.03	−2.42
18. I have felt anxious, irritable, lost my appetite or had stomach pains after stopping or cutting down on marijuana use.[d45]	0.52	0.20	0.86	0.55	1.83
11. I have neglected obligations to family, work, or school because of my marijuana use.	0.52	0.20	0.94	0.67	0.28
12. When using marijuana I have done impulsive things that I regretted later.	0.59	0.21	0.96	1.27	−1.48
4. I have been unhappy because of my marijuana use.	0.70	0.21	1.03	0.71	0.61
16. I have received a lower grade on an exam or paper than I ordinarily would have because of marijuana use.	0.89	0.22	0.85	0.64	0.30
1. The quality of my work or schoolwork has suffered because of my marijuana use.	0.99	0.23	0.94	0.78	−0.16
14. I have been overweight because of my marijuana use.	1.23	0.24	1.14	0.73	1.29
8. I have become very rude, obnoxious, or insulting after using marijuana.	1.62	0.27	0.96	0.96	−1.05
5. I have gotten into physical fights because of my marijuana use.	2.56	0.36	0.99	1.26	0.53

Note. [*]Alcohol severity refers to the severity of the comparable item from the YAACQ computed by Rasch analysis on this group of items. The YAACQ was only given in one site ($N = 206$) and thus the sample for the B-MACQ items and YAACQ items differ. However, the severity estimates for the B-MACQ were consistent across site. Except where noted, the items are identical aside from alcohol or marijuana being the referent drug. [d]Items marked with a superscript were changed to better reflect specific marijuana consequences, and hence are not strictly comparable. [d5]YAACQ — *I have had a hangover (headache, sick stomach) the morning after drinking.* [d22]YAACQ — *I have had "the shakes" after stopping or cutting down on drinking.* [d45]YAACQ — *I have felt anxious, agitated, or restless after stopping or cutting down on drinking.* n/a — New item added to the MACQ, no equivalent on the YAACQ.

Table 4
B-MACQ raw score totals.

Total score	Severity	SE	Frequency	% of sample	Cumulative frequency
0	−5.14	1.89	64	20.3	64
1	−3.77	1.11	54	17.1	118
2	−2.87	0.83	35	11.1	153
3	−2.29	0.71	28	8.9	181
4	−1.84	0.63	27	8.6	208
5	−1.47	0.59	22	7.0	230
6	−1.14	0.55	16	5.1	246
7	−0.85	0.53	9	2.9	255
8	−0.58	0.51	6	1.9	261
9	−0.32	0.50	14	4.4	275
10	−0.07	0.50	8	2.5	283
11	0.17	0.49	6	1.9	289
12	0.42	0.50	6	1.9	295
13	0.67	0.50	6	1.9	301
14	0.93	0.52	3	1.0	304
15	1.20	0.53	5	1.6	309
16	1.50	0.56	1	0.3	310
17	1.84	0.61	3	1.0	313
18	2.25	0.67	1	0.3	314
19	2.77	0.79	1	0.3	315
20	3.59	1.06	0	0	315
21	4.89	1.86	0	0	315

an individual with a score of 7 on the B-MACQ would be relatively unlikely to endorse items 1, 8, 5, or 14, which have severity estimates of ≥0.99. Thus, the total score not only quantifies the severity of marijuana problems, but also provides information regarding the type of problems individuals along the continuum are likely to experience. A comparison of the mean person level severity estimates to the mean item severity estimates (standardized to 0), indicated the current sample of marijuana users had considerably lower mean severity levels (mean person severity = −2.49 logits; $SD = 1.50$). Thus, the B-MACQ items are targeting a level of problem severity that is higher than the severity of problems experienced by users in this sample.

3.4. Validity and test–retest reliability

Table 5 presents correlations between the MACQ scales and other measures of marijuana and alcohol use and problems. The significant positive correlations between the MACQ scales and marijuana frequency, use intensity, and the Marijuana Problems Index support the convergent validity of the scales. Correlations between the marijuana use indicators and the subscales ranged from non-significant associations with Self-Perception to strong positive associations with the Physical Dependence scale. The MACQ total score and the B-MACQ demonstrate substantially higher correlations with the marijuana

use indices than with drinks per week, providing evidence of discriminant validity. Similarly, the MACQ and B-MACQ exhibited substantially stronger associations with the Marijuana Problems Index than with the YAACQ. Thirty-seven participants took the MACQ a second time (test–retest interval range 1–19 days, $M = 6.24$, $SD = 4.31$). Scores on the MACQ were comparable to the full sample ($M = 8.57$, $SD = 10.28$). Test–retest intra-class correlations were 0.75 for the MACQ total score and 0.80 for the B-MACQ, thus demonstrating good test–retest reliability over a brief interval.

4. Discussion

Marijuana and alcohol are the most common drugs of abuse among young adults (Substance Abuse and Mental Health Service Administration, 2010). There has been less research on measurement of marijuana-related consequences relative to alcohol consequences. Though specific health risks may vary across drugs of abuse, problematic use may be defined by a common set of indicators reflecting symptoms of dependence and impairment in intrapersonal, behavioral, social, and occupational functioning (American Psychiatric Association, 2000). Comparable versions of measurement instruments that assess problems stemming from alcohol and marijuana use can help advance research on the etiology and treatment of substance related problems as well as contribute to refining understanding of the constructs and associated taxons. We developed the MACQ to provide a marijuana version of the YAACQ.

4.1. MACQ

The hypothesized 8-factor structure of the MACQ was a good fit to the data, yielding 8 subscales: Social-Interpersonal Consequences, Self-perception, Self-care, Academic–Occupational Consequences, Blackout Use, Impaired Control, and Physical Dependence. Although factors were moderately-to-strongly correlated, the hypothesized 8-factor structure was a better fit to the data than a unidimensional structure. The Physical Dependence scale exhibited the strongest associations with marijuana use. Similar to findings with the YAACQ, feelings of guilt and other internalizing symptoms assessed by the Self-Perception scale were not associated with marijuana use. Intermediate between these extremes were subscales assessing involvement in risk behaviors, self-control, and impaired functioning in social and occupational domains.

The pattern of associations between the subscales and marijuana use is consistent with research indicating the role of situational and dispositional factors contributing to substance-related problems (Simons et al., 2009; Simons, Dvorak, Batien, & Wray, 2010a; Wills, Ainette, Stoolmiller, Gibbons, & Shinar, 2008). Whereas physical

Table 5
Correlations between the MACQ scales and marijuana and alcohol use and problems.

Scale	MJ use frequency	MJ use intensity	MPI	DDQ	YAACQ
B-MACQ	0.41	0.39	0.59	0.14	0.30
MACQ — Total	0.31	0.30	0.58	0.18	0.39
MACQ — Subscales					
Soc.-Interpersonal	0.17	0.17	0.51	0.12[ns]	0.31
Impaired Control	0.31	0.24	0.51	0.17	0.29
Self-Perception	−0.00[ns]	0.05[ns]	0.39	−0.00[ns]	0.29
Self-Care	0.28	0.25	0.51	0.10[ns]	0.30
Risk Behaviors	0.26	0.24	0.33	0.21	0.34
Ac.–Occupational	0.23	0.26	0.48	0.23	0.31
Phys. Dependence	0.51	0.48	0.45	0.09[ns]	0.21
Blackout	0.12	0.18	0.34	0.18	0.32

Note. MJ = Marijuana, Soc. = Social, Ac. = Academic, Phys. = Physical, MPI = Marijuana Problem Index, DDQ = Daily Drinking Questionnaire, YAACQ = Young Adult Alcohol Consequences Questionnaire. $N = 315$ for correlations with marijuana use frequency and intensity. The MPI ($N = 206$, $M = 5.16$, $SD = 5.04$), DDQ ($N = 209$, $M = 18.51$, $SD = 15.22$), and YAACQ ($N = 206$, $M = 15.21$, $SD = 11.97$) were only administered at one university. Thus, the correlations with the MPI, DDQ, and YAACQ are based on a subset of the full sample used to calculate correlations with MJ use frequency and intensity. However, the pattern in respect to convergent and discriminant validity is comparable, thus the correlations from the full sample for marijuana use frequency and intensity are presented. All correlations significant at $p < 0.05$ unless otherwise noted, ns = non-significant.

dependence is strongly associated with drug intake, the extent to which individuals engage in risk behaviors, experience interpersonal problems, or have difficulty meeting social obligations may be influenced by factors extrinsic to the drug. The Blackout scale includes items assessing acute consequences of over-consumption. Although some of these items seem more relevant to alcohol consumption than marijuana (e.g., vomiting), the scale mean indicates these were as commonly endorsed as some of the other scales (e.g., Social-Interpersonal Consequences). The relatively low association with marijuana use may reflect the fact that the use indicators do not provide a good assessment of quantity used or level of intoxication. Alternatively, if individuals are using heavy amounts of both alcohol and marijuana simultaneously, it may be difficult to attribute the consequence to one drug.

As discussed above, there are both statistical and theoretical justifications for utilizing the subscales. In addition, the subscales may be useful in clinical applications to provide specific feedback regarding problem areas. However, both a unidimensional structure and a model with a higher-order general consequences factor were an adequate fit to the data. Thus, there is also justification for utilizing the MACQ total score, and this may be determined by the goals of the assessment.

4.2. B-MACQ

Given that substance use problems may be described by a continuum defined by items of increasing severity (Kahler et al., 2004; Kahler et al., 2005), we utilized a Rasch model analysis to develop the B-MACQ. The B-MACQ provides two advantages. On a practical level, the 21-item scale provides a more efficient assessment of marijuana problem severity relative to the 50-item MACQ. This is accomplished with no loss of criterion validity. It correlated at 0.95 with the full scale, exhibited slightly stronger associations with marijuana use and the MPI, and had better discriminant validity in respect to associations with alcohol measures. On a theoretical level, the Rasch model provides an index of item severity, which can provide insight into the nature of marijuana problems and allows evaluation of the extent to which the instrument can adequately differentiate individuals at varying levels of problematic marijuana involvement. In addition, the B-MACQ minimizes gender bias. In the current sample, the B-MACQ provides good coverage along the continuum of severity, indicating that it can adequately differentiate individuals at all points of the continuum. The model indicates that problems such as lack of energy and being less physically active are relatively common and reflect minor levels of marijuana-related problems. In contrast, interpersonal conflicts (e.g., reports of physical fights or being rude and obnoxious) are relatively rare and may reflect more severe problems associated with marijuana use. Difficulty with sleeping after cutting down marijuana use and memory loss for the previous evening lie along the middle of the continuum, reflecting moderate problems.

4.3. Marijuana and alcohol consequences: relative severity

Though marijuana and alcohol use share similar types of negative consequences, a given consequence related to one's marijuana vs. alcohol use may indicate a different level of problem severity. This may occur due to differences in pharmacological properties of the drugs, the meaning of the consequence in the socio-cultural context, and/or differences in psychological–behavioral response profiles associated with the drug. For example, reports of being "rude or obnoxious" when under the influence were commonly endorsed for alcohol and reflected low severity whereas this consequence was relatively rare for marijuana use and indicated more severe use related problems. Similarly, memory loss for the previous evening and impulsive behavior were among the least severe of the items in respect to

alcohol problem severity, whereas for marijuana these items reflected moderate severity.

Needing to use marijuana in the morning, one of the Physical Dependence indicators, was a moderate marijuana-related consequence, whereas this was among the most severe alcohol items. Similarly, indicators of withdrawal were among the most severe alcohol items, yet seemed to indicate more moderate marijuana problems. Both of these items were changed to reflect a withdrawal symptom that was more appropriate for marijuana. For example, item 22 of the MACQ refers to sleeping problems associated with withdrawal whereas item 22 on the YAACQ, refers to having "the shakes." Thus, the alcohol symptoms assessed appear to be more severe withdrawal symptoms, reflecting a higher degree of alcohol use disorder. Concern about use and efforts to cut down or stop appear to reflect a lower level of problems for marijuana relative to alcohol in this sample. This may reflect differences in the social acceptance of these drugs.

The severity ranking of some items was fairly comparable across drugs. For example, feeling unhappy about use and reporting weight gain were among the upper 1/3 of items and hangovers were among the least severe. Driving while high was the least severe marijuana item, endorsed by 58% of the sample. The comparable item assessing drinking and driving on the YAACQ indicated somewhat higher severity. However, the wording of the two items is slightly different, assessing driving when "high" vs. "had too much to drink to drive safely." This does not indicate that driving under the influence of marijuana is a less serious risk behavior, but that, relative to alcohol, individuals with fewer substance-related problems tend to engage in the behavior.

Differences in the meaning of negative consequences across drugs in respect to severity of drug use disorder suggest that drug use disorder is a complex psychosocial phenomenon embedded within a cultural context whereby the likelihood and severity of individual consequences varies as a function of both pharmacological properties of the drugs as well as psychosocial context. Such differences have important implications for interpreting assessment results. That is, despite being similar behaviors, some items reflect potential different degrees of use disorder.

4.4. Limitations and future directions

The results should be interpreted in light of limitations of the research. Sample characteristics are a notable limitation. The sample provided a wide range of marijuana use and associated problems. However, mean use level and associated problems were relatively low. Further research validating the findings in a heavier using sample is needed. It is possible that the distribution of participants' level of consequences impacted decisions to drop items that may be informative in a heavier use sample. For example, a sample with more severe problems (e.g., an inpatient sample in a substance use treatment facility) may reduce the outfit of items with extremely low response rates in the current sample, ultimately leading to retention of items we have removed here. Thus, the B-MACQ may not fully capture the range of severity among those with higher rates of problems. Similarly, validating the scale in populations with different age, education, and ethnic/racial characteristics would be beneficial. The two measures of marijuana use assess frequency and intensity of use. However, they do not provide a clear measure of quantity, level of intoxication, or peak consumption. These variables are likely important indicators of problematic use. Understanding of marijuana related consequences may be advanced by examining associations between the MACQ scales and measures that better capture level of intoxication. Research that incorporated more detailed assessment of marijuana use via interview or other valid assessment among young adults not enrolled in college would be useful to provide additional validation evidence for the B-MACQ.

Although drinks per week and marijuana use frequency were not significantly correlated in this sample of marijuana users, alcohol and marijuana are commonly used simultaneously (Midanik, Tam, & Weisner, 2007). Individuals may have difficulty determining whether some target consequences were the result of alcohol or marijuana use. The pattern of correlations supports the discriminant validity of the scales, however individual use patterns will limit the ability to accurately discriminate consequences stemming from individual drugs. Similarly, the ability to discriminate sources of problems may vary depending on the target consequence. For example, the Physical Dependence scale is moderately to strongly associated with marijuana use and not significantly associated with drinks per week. In contrast, other subscales such as Academic–Occupational consequences and Risk Behaviors exhibit more comparable correlations with both marijuana and alcohol use. This may be because consequences such as failure to fulfill social role responsibilities are determined in part by dispositional factors or alternatively, that individuals have difficulty determining if these consequences stem from their marijuana or alcohol use.

Finally, the YAACQ items were used as the basis for the MACQ and few items were modified or added to be unique to marijuana related problems. It is thus possible that there exist problems that are particularly unique to marijuana use (e.g., respiratory problems) that the MACQ does not capture. We modified or added some key items (e.g., paranoia, descriptions of hangover, withdrawal, lack of motivation) and believe there is sufficient commonality in the types of problems associated with the two drugs that the benefits of having comparable alcohol and marijuana scales outweigh the limitations. For example, due to our approach we were able to compare item severity across the drugs. This provides new information regarding the pattern of consequences that individuals experience and provides some insight into the meaning of the consequences vis-à-vis indicators of severity of use disorder.

4.5. Summary

In summary, the MACQ is an 8-factor scale assessing problems associated with marijuana consumption. The scale covers a broad range of associated problems including risk behaviors, problems with intra- and inter- personal functioning, acute adverse effects, social role functioning, and indicators of difficulty controlling use and signs of physical dependence. The results support the criterion validity of the MACQ, providing evidence of convergent and discriminant validity. The MACQ subscales may be useful in clinical or research applications where assessment of discrete problem areas is desired. The B-MACQ is recommended as an efficient unidimensional measure of marijuana problem severity that minimizes gender bias. Examination of indices of item severity indicates variation in the meaning of individual marijuana and alcohol consequences in respect to the problem severity continuum. For alcohol and marijuana, not all consequences are created equal.

Contributors

All authors contributed the collection of the data. Dr. Simons designed the study and prepared the first draft of the manuscript. Mr. Dvorak conducted the majority of the data analyses and prepared results. All authors contributed to and approved the final manuscript.

Conflict of interest

The authors have no conflicts of interest.

Appendix 1

The Brief Marijuana Consequences Questionnaire - B-MACQ

INSTRUCTIONS: The following is a list of things that sometimes happen to people either during, or after they have been using marijuana. Select either **YES** or **NO** to indicate whether that item describes something that has happened to you **IN THE PAST 6 MONTHS**.

	Yes	No
1. The quality of my work or schoolwork has suffered because of my marijuana use.		
2. I have driven a car when I was high.		
3. I have felt in a fog, sluggish, tired, or dazed the morning after using marijuana.		
4. I have been unhappy because of my marijuana use.		
5. I have gotten into physical fights because of my marijuana use.		
6. I have spent too much time using marijuana.		
7. I have felt like I needed a hit of marijuana after I'd gotten up.		
8. I have become very rude, obnoxious, or insulting after using marijuana.		
9. I have been less physically active because of my marijuana use.		
10. I have had trouble sleeping after stopping or cutting down on marijuana use.		
11. I have neglected obligations to family, work, or school because of my marijuana use.		
12. When using marijuana I have done impulsive things that I regretted later.		
13. I have awakened the day after using marijuana and found I could not remember a part of the evening before.		
14. I have been overweight because of my marijuana use.		
15. I haven't been as sharp mentally because of my marijuana use.		
16. I have received a lower grade on an exam or paper than I ordinarily could have because of marijuana use.		
17. I have tried to quit using marijuana because I thought I was using too much.		
18. I have felt anxious, irritable, lost my appetite or had stomach pains after stopping or cutting down on marijuana use.		
19. I often have thought about needing to cut down or to stop using marijuana.		
20. I have had less energy or felt tired because of my marijuana use.		
21. I have lost motivation to do things because of my marijuana use.		

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