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## The Protective Behavioral Strategies for Marijuana Scale: Further Examination Using Item Response Theory

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### Abstract

Given recent state legislation legalizing marijuana for recreational purposes and majority popular opinion favoring these laws, we developed the Protective Behavioral Strategies for Marijuana scale (PBSM) to identify strategies that may mitigate the harms related to marijuana use among those young people who choose to use the drug. In the current study, we expand on the initial exploratory study of the PBSM to further validate the measure with a large and geographically diverse sample ( $N = 2,117$ ; 60% women, 30% non-White) of college students from 11 different universities across the United States. We sought to develop a psychometrically sound item bank for the PBSM and to create a short assessment form that minimizes respondent burden and time. Quantitative item analyses, including exploratory and confirmatory factor analyses with item response theory (IRT) and evaluation of differential item functioning (DIF), revealed an item bank of 36 items that was examined for unidimensionality and good content coverage, as well as a short form of 17 items that is free of bias in terms of gender (men versus women), race (White versus non-White), ethnicity (Hispanic versus non-Hispanic), and recreational marijuana use legal status (state recreational marijuana was legal for 25.5% of participants). We also provide a scoring table for easy transformation from sum scores to IRT scale scores. The PBSM item bank and short form associated strongly and negatively with past month marijuana use and consequences. The measure may be useful to researchers and clinicians conducting intervention and prevention programs with young adults.

### Keywords

marijuana; protective strategies; negative consequences; young adult; short form

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Marijuana use peaks in young adulthood. According to the most recent Monitoring the Future study report, over one-third of young adults aged 19–29 have used marijuana in the

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past year, with 21% of full-time college students and 25% of their non-college peers reporting past 30 day use (Johnston, O'Malley, Bachman, Schulenberg, & Miech, 2016). About 5% of college students and nearly 12% of non-college youth report daily use of marijuana (Johnston et al., 2016). Examining data from 596,500 adults aged 18 and older from the National Survey on Drug Use and Health (NSDUH), researchers found that annual prevalence of marijuana use increased from 10.4% of the United States (U.S.) population in 2002 to 13.3% in 2014 (Compton, Han, Jones, Blanco, & Hughes, 2016). For those who used marijuana, number of days using marijuana, as well as daily or near daily use, increased over that time period. These two national datasets (Monitoring the Future, NSDUH) also demonstrate that the percentage of young adults believing that marijuana use poses great risk has decreased substantially over the past 20 years (Johnston et al., 2016; Lipari, 2016). Marijuana is perceived by young adults as less harmful than cigarettes, other tobacco products, other drugs such as cocaine and heroin, and binge drinking (Berg et al., 2015; Lipari, 2016) and users are more likely to report limited perceived harms than those who do not use the drug (Kilmer, Hunt, Lee, & Neighbors, 2007).

In addition to widespread use and limited perceived harms of the drug, most people in the U.S support legalization of marijuana for recreational purposes. The latest national survey conducted by the Pew Research Center found that the majority of Americans (53%) favor legalization of marijuana, with the highest level of support (68% in favor) from young adults aged 18–34 (Pew Research Center, 2015). As of November 2016, 28 states have legalized marijuana for medical purposes and eight (as well as Washington, DC) have expanded marijuana laws that allow for legalized recreational marijuana possession among adults aged 21 and older. All eight states (not Washington, DC) have legalized production and for-profit sales. With the recent passing of legislation in California, it has been speculated that many other states will follow suit and perhaps pave the way for federal recreational legalization.

The research on the harms and benefits of marijuana use is far from conclusive. There has been much research linking frequent marijuana use to both short- and long-term consequences, including physical injuries, health complications, psychological problems, academic difficulties, cognitive deficits, and participation in other risky behaviors (Buckner, Ecker, & Cohen, 2010; Hall & Degenhardt, 2009; Kalant, 2004; Looby & Earleywine, 2007; Simons, Dvorak, Merrill, & Read, 2012; Taylor, Poulton, Moffitt, Ramankutty, & Sears, 2000). However, recent longitudinal studies have found that even long-term use of marijuana in young adulthood and adolescence has minimal lasting negative consequences on health factors traditionally believed to be negatively affected by use, such as asthma and poor lung functioning, complications related to cardiovascular health, and mental health problems like anxiety and depression (Bechtold, Simpson, White, & Pardini, 2015; Meier et al., 2016). Emerging research is also finding benefits to use of medical marijuana, such as in reducing nausea and vomiting, promoting weight gain, limiting intraocular pressure from glaucoma, decreasing frequency of epileptic seizures, and relieving symptoms of chronic neuropathic pain in conditions such as multiple sclerosis (Fischer, Murphy, Kurdyak, Goldner, & Rehm, 2015; Grant, Atkinson, Gouaux, & Wilsey, 2012; Koppel et al., 2014; Volkow, Baler, Compton, & Weiss, 2014; Whiting et al., 2015).

## The Protective Behavioral Strategies for Marijuana Scale

In reaction to recent public policies around both medical and recreational marijuana use, majority popular opinion favoring these laws, decreasing perceptions about harms of the drug among young people, and the emerging research documenting potential limited harms of use and medicinal benefits of the drug, we designed the Protective Behavioral Strategies for Marijuana scale (PBSM), which began as a 50-item pool and was reduced to a single-factor 39-item measure in initial exploratory work (Pedersen, Hummer, Rinker, Traylor, & Neighbors, 2016). The measure is intended for researchers and clinicians to assess the strategies that young adults use prior to, during, after, and instead of using marijuana and is based on principles of harm reduction, which indicate that any step toward reduced or limited use is a step toward minimizing harms from a substance. In the initial exploratory study with 210 college student marijuana users, an iterative principal component analysis revealed that 39 of the initial 50 PBSM items represented a single factor with strong psychometric properties, including excellent internal consistency and convergent validity with a measure of alcohol protective strategies. Composite mean scores on the PBSM negatively associated with marijuana use and consequences, with the strongest correlations evident for more recent users. Other work has also confirmed that more frequent use of the PBSM strategies associates with less frequent marijuana use and fewer marijuana-related consequences (Bravo, Prince, Pearson, & Marijuana Outcomes Study Team, in press).

Despite the promise of the initial exploratory PBSM study, there is a need for further validation of the PBSM. First, regarding the analytic methods used, the initial study sought to summarize and to explore patterns in the data obtained from the college student sample. As such, principle component analysis was used as a first attempt to explore and reduce the items to a manageable number. More advanced factor analytic techniques (i.e., exploratory factor analysis, confirmatory factor analysis) and advanced item response theory (IRT) techniques would be beneficial to strengthen the understanding and utility of the PBSM. The IRT technique is particularly important given the promise of a shorter form of the PBSM, which would make it more accessible to researchers and clinicians who have limited time with patients and research participants. Such a short form would reduce patient and participant burden. Second, the sample in the initial validation study was composed of 210 college students from a single institution. These students were primarily women (78%) and gender was not factored into the analyses, which is a potentially important omission considering men are more likely than women to have cannabis use disorders (Haberstick et al., 2014). In addition, the institution where data were collected was located in a state that at the time had no form of legalized marijuana use and it is unknown if the PBSM items are applicable to young people in states that have legalized use. Thus, further work with the PBSM using more advanced statistical techniques on a larger, more diverse sample is needed.

## The Present Study

Two primary aims guided the design of the current study. First, we sought to expand on the initial exploratory PBSM validation study by building a psychometrically sound item bank for the PBSM using a large sample of marijuana users (including a greater proportion of

male students than the initial study) enrolled in universities across the U.S.. Universities were included that were located in states that both had and had not legalized recreational marijuana use. Second, we sought to create a short assessment form that would reduce respondent burden and completion time. We used quantitative methods to conduct item analyses to achieve our goal of building the item bank and short form assessments of the PBSM. To produce a short form that is free from bias on identified factors, we selected four demographic factors to test for differential item functioning in the IRT analyses: gender (men versus women), race (White versus non-White), ethnicity (Hispanic versus non-Hispanic), and recreational marijuana use legal status (recreational marijuana legal in the participant's state for those at least 21 years of old or not). In addition to this aim, we reported the extent to which the protective strategies were associated with frequency of marijuana use and experience of marijuana-related consequences. We hypothesized that more frequent use of protective strategies as indicated by higher scores on both the bank item measure and the short form measure would be associated with less frequent marijuana use and fewer negative consequences.

## Methods

### Participants and Procedures

Data for the current study were drawn from Project MOST, a collaboration of researchers from 11 different universities in the U.S. that make up the Marijuana Outcomes Study Team (MOST) (Pearson, Liese, Dvorak, & Marijuana Outcomes Study Team, 2017). The schools were geographically diverse, with sites located in Alabama, California, Colorado, Kansas, New Mexico, New York, North Dakota, Texas, Virginia, Washington, and Wyoming. Data were collected from 8,141 students at these 11 sites over two sequential semesters (or three sequential quarters) during the 2015–2016 academic year. Of these students, 4,339 (53.3%) reported lifetime marijuana use. Of the lifetime users, 2,129 (49%) reported past month use. Only past month users were given the full 50-item PBSM to fill out, as those who used infrequently did not have a chance to engage more regularly in the targeted strategies the measure assessed. Given our focus on gender bias in the IRT analyses, we removed 12 participants who identified as transgender from the sample, as we did not have a large enough N of these individuals to conduct meaningful analyses that included transgender as a separate gender category. Demographics of the final analytic sample of  $N = 2,117$  can be found in Table 1. As of the time of data collection, two universities were located within states that had legalized recreational marijuana use for those over the age of 21 (i.e., Colorado, Washington). See Pearson et al. (2017) for a detailed description of marijuana involvement across the 11 universities as well as a breakdown of demographics by site.

All participants completed measures online for participation credit as part of psychology classes at their respective universities. The study was advertised as a study to look at risky behaviors among college students, but no eligibility criteria was specified beyond being a college student involved in the psychology subject pool at one of the 11 institutions. IRB approval was obtained at each of the 11 institutions separately prior to data collection.

## Measures

**Demographics**—Participants reported their age, ethnicity (Hispanic or not), race, class level, affiliation with the Greek system on campus (i.e., currently in a social fraternity or sorority, currently pledging), and student athlete affiliation.

**Marijuana Use and Consequences**—Participants were asked if they had ever used marijuana in any form (e.g., smoking, consuming edibles) in their lifetime. Lifetime users were asked to indicate on how many days in the past month (30 days) they used marijuana. Past month users were then asked on how many days during the past month they used marijuana to the point of being high, as well as how many days in the past month they passed out or got sick from using marijuana. They were also asked to indicate how old they were the first time they used marijuana. Past month users also completed the 50-item Marijuana Consequences Questionnaire (MACQ; Simons et al., 2012), which has been used in prior work with young adults (e.g., Dvorak & Day, 2014). This measure had adequate reliability in the current sample ( $\alpha = 0.92$ ). Example items include “When using marijuana I have done impulsive things that I regretted later” and “I have lost motivation to do things because of my marijuana use.”

**Protective Behaviors for Marijuana Use**—As discussed, the PBSM was developed in prior work (Pedersen et al., 2016), following a mixed-method approach commonly used for developing item banks (Cella et al., 2007; DeWalt, Rothrock, Yount, & Stone, 2007). We used qualitative methods to compile a preliminary item pool for field testing, which included a broad literature review to identify all relevant measures, building a conceptual framework through seeking feedback from marijuana users, and reducing the item pool by item sorting and revision with input from experts. We then used quantitative methods to conduct initial exploratory item analyses. In the present study, past month users filled out the full 50-item PBSM (see Table 2 for the 50 items). Participants were asked to “Please indicate the degree to which you engage in the following behaviors when using marijuana/cannabis” using response options of 1 = never, 2 = rarely, 3 = occasionally, 4 = sometimes, 5 = usually, and 6 = always. These instructions and response options mirror those from a similar protective strategies scale for alcohol use (Martens et al., 2005; Martens, Pedersen, LaBrie, Ferrier, & Cimini, 2007). PBSM items encompass behaviors one engages in prior to, during, after, and instead of using marijuana. For example, items related to avoiding use entirely, only using when it seemed like doing so would not get in the way of important things, avoiding use where one could get in trouble, not putting oneself in risky situations, taking breaks from use during important periods, and strategies used during use, such as passing on a shared joint after a certain number of hits.

## Analytic Strategy

**Exploratory and confirmatory factor analysis to develop the item bank**—Using the initial pool of 50 PBSM items, we conducted item analyses with data collected from the college student sample. We started with exploratory factor analysis (EFA) to confirm if these 50 items were again best represented by a single factor, as in our original validation paper, or if it was appropriate to construct multiple factors. We then conducted a confirmatory factor analysis (CFA) to verify the factor structure given the EFA results. These analyses were

utilized to identify problematic items for deletion (e.g., items that load poorly on all dimensions and/or items that load consistently on more than one dimension). These problematic items were then removed from the initial 50-item pool.

A second CFA model was then fit to the data with the reduced set of items. Model fit was evaluated using root mean squared error of approximation (RMSEA) 0.08 (Browne & Cudeck, 1993; Hu & Bentler, 1999). We also examined model modification indices from this CFA to identify and remove items affecting unidimensionality. For example, a cluster of two items with very similar wording may have a residual relationship that is not accounted for by the unidimensional model. These problematic item clusters were identified using model modification indices and items were removed to minimize the excess dependence and ensure unidimensionality.

**Calibrating the item bank**—We used IRT to conduct the final item bank calibration with a Graded Response Model (Samejima, 1997) due to ordered categorical responses on the PBSM. Unidimensionality was evaluated with model fit statistics such as RMSEA, AIC, and BIC computed from the software IRTPRO (Cai, Thissen, & du Toit, 2011). Item parameters were obtained for later IRT scoring purposes. We used a two-parameter logistic model (2PL) that includes the discrimination parameter (the  $a$  parameter) and the location parameters (the  $b$  parameters). These item parameters carry useful information such as the strength of each item's relationship to the measured construct (i.e., item discrimination) and where along the construct score continuum the item provides the most reliable responses (i.e. item location or item difficulty, representing the location of an item on the latent scale where the respondent has a 50% chance of endorsing the item.). Since the PBSM has six response options, there were 5  $b$  parameters estimated. Note that each location parameter utilizes all responses in the estimation of that location (e.g.,  $b_{1i} = 1$  vs. 2, 3, 4, 5, or 6;  $b_{2i} = 1$  or 2 vs. 3, 4, 5, or 6... etc). To examine reliability of the calibrated bank, we calculated marginal reliability, an important IRT-based measure of overall scale reliability (Thissen & Wainer, 2001) instead of the traditional Cronbach's alpha ( $\alpha$ ).

**Differential item functioning (DIF) to creating a short form**—DIF occurs when two respondents who differ on a specified grouping variable (e.g., gender) have equal levels of the construct being measured but do not have the same probability of endorsing the item. For example, a response indicating frequent crying may indicate a more severe depression level if the respondent is a man relative to if the respondent is a woman, based on the assumption that women may cry more frequently than men (Nyklicek, Temoshok, & Vingerhoets, 2004). Thus men and women with equal levels of depression are likely to have unequal probabilities of endorsing the crying symptom. Such difference in probability of endorsing each response category of that item can be statistically modeled by having different estimated item parameters for different groups. Ignoring DIF can lead to misleading group differences and inaccurate scoring (Holland & Wainer, 1993). Thus, we should remove items with problematic DIF to ensure that the items yield comparable unbiased scores across subgroups.

We assessed DIF through a two-step procedure to test the magnitude of DIF (Langer, 2008; Woods, Cai, & Wang, 2013). In the first step, we fit a two-group IRT model for each

grouping variable with freely estimated item parameters for all the items in each group. We retained the items that showed statistically significant DIF from the Wald  $\chi^2$  test, however, in order to control the overall (familywise) error rate, we adjusted the critical  $p$  values for the test statistics using the Benjamini–Hochberg procedure (Benjamini & Hochberg, 1995; David Thissen, Steinberg, & Kuang, 2002) with an overall alpha level of 0.05. In the second step, we used items that were free of significant DIF, in the first step, as anchors. We constrained parameters to be equal across groups, and freely estimated item parameters for items that were found to have significant DIF in step one. We used the Wald  $\chi^2$  for the second time (with Benjamini–Hochberg adjustment of critical values) to test the equality of the item parameters across groups. Items found to exhibit significant DIF at this second step were considered having problematic DIF for the particular grouping variable.

We examined DIF on four factors appropriate for our young adult college sample: gender (men versus women), race (white or not), ethnicity (Hispanic or not) and legal status of use (recreational use legal in the participant’s state for users at least 21 years of old or not). This led to a total of four pair-wise comparisons. We counted how many significant DIF tests as a summary across each of the pair-wise comparisons reflecting combined performance of each item.

**Scoring, validity and reliability of bank and short form scores**—Item parameters from the item bank calibration were used for IRT scoring. We calculated expected a posteriori (EAP) scores for both the item bank and the short form using the original response data in the full sample ( $N = 2,117$ ). These scores were placed on a T-score metric (mean = 50, standard deviation = 10). We evaluated the psychometric properties of the short form by comparing reduction in score reliability when going from the complete item banks to the short forms. We also plotted the test information curves to illustrate score precision across the distribution of respondents. Lastly, we provide sum score to IRT scale score translation table to enable straightforward scoring of the short form on the T-score metric (see Table 4). By using the translation table, researchers and clinicians may quickly convert an observed sum into an IRT-scaled score without having to conduct IRT analysis based on full response data to obtain an IRT scale score (Thissen, Nelson, Rosa, & McLeod, 2001).

## Results

### Exploratory and confirmatory factor analysis to develop the item bank

We started with exploratory factor analysis (EFA). Although eigenvalues from EFA suggested 5 factors to be extracted using the eigenvalue  $>1$  criterion, we noticed that the biggest drop in eigenvalues was from one factor (30.74) to two factors (2.65). This indicated the presence of an overwhelming major factor. The 1-factor CFA result confirmed the factor loading pattern of the 1-factor EFA solution. Eight items were dropped from the initial item pool of 50 because of low loadings ( $< 0.5$ ). With the remaining 42 items, we again used a 1-factor CFA model to further investigate whether there were clusters of items that might affect the unidimensional nature of the scale. We examined model modification indices from this set of CFA result to identify problematic items. Six items were removed due to excess dependence reflected by modification indices and overlapping content wording. This

resulted in a bank of 36 items. Table 2 contains the bank items and deleted items along with corresponding reasons for the removal of items at each stage.

### Calibrating the item bank

We calibrated the item bank with the 36 items and we used response pattern scoring to calculate the bank scores. Our results showed very good calibration of the PBSM scale and good model fit (RMSEA = 0.06). We examined typical item properties such as the item parameter estimates. See Table 3 for the calibrations of the 36-item bank. These results showed that the items in the bank tended to be strongly related to the underlying latent construct that defines protective behavioral strategies for marijuana (*a* parameters for items ranged from 1.06 to 2.78) and covered a wide range the latent continuum (*b* parameters ranged from -3.9 to 1.35). We used IRTPRO to calculate marginal reliability given the existing item parameters and found marginal reliability was high (0.97) for the bank.

### Differential item functioning (DIF) and short form scoring

Results from the four pairwise comparisons in the DIF analyses showed that 19 items exhibited at least one kind of DIF. One item exhibited three kinds of DIF and two items showed both legal and race DIF. These 19 items were removed from the candidate list and the remaining 17 items formed the short form. Table 2 contains the 17 short-form items and the additional 19 bank items indicating the kind of DIF detected.

The short form was scored using the item parameter estimates from the bank calibration. Marginal reliability for the short form was high (0.93) and the model fit the data very well (RMSEA = 0.04). Correlation between the short form score and bank score was high:  $r = 0.98$ ,  $p < .001$ . The summed score to IRT scale score translation table is provided in Table 4.

### Validity of the item bank and the short form

To examine the validity of the item bank and the short form, we calculated the correlation between the bank and short form scores with the existing scales for measuring marijuana use and consequences. Table 5 contains the correlations between both PBSM scores and days used in the past month, days used to the point of feeling high in the past month, days passed out or felt sick after using marijuana in the past month, age at first marijuana use, and the sum score of the MACQ. Nearly identical moderate to strong negative correlations were evident for marijuana use and consequences across both PBSM scores, suggesting that greater frequency of protective strategies as measured by both the 36-item PBSM and the 17-item short form PBSM is associated with lower use rates and fewer marijuana-related consequences. There was a positive correlation between age at first use and the PBSM scores, suggesting that those who first used marijuana at a later age reported more frequent use of protective strategies.

## Discussion

Using quantitative analytic techniques with a sample of 2,117 college students from 11 universities across the country, the current study provides further validation of the PBSM, a measure to assess the protective strategies young adults use prior to, during, after, and



instead of using marijuana. Our analyses yielded an item bank of 36 items, with a PBSM short form of 17 items that are free from bias on gender (men versus women), race (white versus non-White), ethnicity (Hispanic versus non-Hispanic), and state recreational legal status. The 36-item bank and the 17-item short form were strongly correlated with each other and scores from both were moderately correlated with less frequent marijuana use and less frequent experience of marijuana consequences. Moreover, individuals who initiated marijuana use at a later age were more likely to engage in protective strategies.

The EFA and CFA analyses that led to the 36 bank items generally confirmed what we found in the original validation study using principle components analysis (Pedersen et al., 2016). Eight of the 11 items dropped in our prior work were also dropped through the present analyses. Three items (“only purchase marijuana from a trusted source;” “if attending a party or going out to a social event [e.g., bar], decide in advance whether you want to use marijuana or not;” and “use marijuana only among trusted peers”) were dropped in the prior study but were retained in the present study. Six items that were retained in the prior study were dropped due to excess dependence reflected by modification indices and overlapping content wording. We encourage researchers and clinicians to use one of the two versions validated in the present study (the “PBSM-36” or the “PBSM-17”) as opposed to 39-item version from the preliminary study (Pedersen et al., 2016) due to the more advanced statistical techniques and larger, more gender and geographically diverse sample in the present study.

### **Clinical and Research Utility of the PBSM**

There is much promise for the PBSM in research settings, as it can be used in future work to examine how use, consequences, and other marijuana-related beliefs (e.g., perceptions of peer use, self-efficacy, marijuana expectancies) among young adults associate with the PBSM. Researchers can also look at how use of the PBSM strategies change over time in longitudinal work and if use of protective strategies are universal for an individual across situations or if they are context specific. There is also promise for the scale to assist with the development of interventions targeting protective strategies, based on successful preliminary intervention studies targeting alcohol protective strategies with students (Kenney et al., 2014). Given that there have been critiques of the alcohol protective behaviors literature, primarily due to limited methodological rigor and the availability of too many scales to assess the construct (Pearson, 2013; Prince, Carey, & Maisto, 2013), we provided a strong methodological base upon which to build future studies with the PBSM. The PBSM was designed to comprehensively include a variety of protective behavioral strategies, encompassing strategies young adults use not only during use of marijuana, but also before, after, and instead of use. It is noted that this measure was developed and validated with current *users* of the drug, as it intended to assess strategies among those who actually used the drug and had an opportunity to engage in protective behaviors. The PBSM has not been validated with less recent users (e.g., those who used once or twice a year ago), though it is possible this scale may not be appropriate for assessment among these individuals.

The PBSM also has much potential for practical and clinical use with young adults. For example, the scale could be used by a provider to determine which behaviors a patient

engages in to protect him- or herself and help to reinforce those in discussions with the patient. The provider can also learn which strategies the youth engages in less often and work with him/her in a harm-reduction manner to use these strategies when in potentially risky situations. Beyond individual discussions, most group- and online-based interventions for college student marijuana use include a discussion of strategies to limit use (Elliott et al., 2014; Lee et al., 2013), and the PBSM could be incorporated into these established marijuana intervention approaches. The short form can be very useful in reducing a respondent's burden; however, its validity as an important clinical and research tool still needs to be further explored within clinical settings (e.g., marijuana users in treatment).

Given there are two versions of the scale of varying lengths, at present, researchers and clinicians are free to use either format for their purposes. The 36-item item bank contains a breadth of items that may be of interest particularly in a clinical setting, but some of these items are removed in the short form. For example, clinicians may wish to highlight certain behavioral practices that may be helpful to try if one is desiring to cut down use (e.g., "keep track of your costs to get an accurate picture of how much you spend on marijuana;" "avoid situations that you anticipate being pressured to use marijuana") or may wish to use the scale to assess the degree to which a patient may have difficulty cutting down due to use of marijuana to alleviate negative affect (e.g., infrequent endorsement of items such as "avoid using when feeling anxious [e.g., using to calm you down or stop worrying]" and "avoid using marijuana out of boredom"). Researchers interested in ecological momentary assessment or intervention (EMA; EMI) may desire to know if participants use strategies centered around certain times of the day (e.g., "only use at night [that is, not during the day];" "avoid using marijuana early in the day"). These items are removed from the 17-item version. If the item bank format is used, researchers and clinicians should be aware of the potential biases with this longer format, but should weigh whether they desire breadth of items with potential for bias in their sample versus exclusion of items of interest with assurance of no known bias at least in the four areas we examined here.

## Limitations

The PBSM to date has only been validated with college students, and more specifically, college students from psychology subject pools (see also Pedersen et al., 2016). However, in the present study we examined the PBSM among a large and geographically diverse sample of college students across multiple institutions in the U.S., whom as a whole reported lifetime marijuana prevalence rates comparable to other representative samples of college students (Pearson et al., 2017). Non-college young adults (e.g., those in the workforce or involved in military service) may differ substantially in their marijuana use and in the use of these strategies, as may older adults or populations younger than college students (e.g., high school students, middle school adolescents). We encourage researchers to use the PBSM with non-college groups to determine its utility. In the present study, participants were primarily freshmen and sophomore students and were mostly under the age of 21 (79% were aged 18–20). Future research is needed to examine how age may impact responses on the PBSM, especially in states with recreational marijuana laws that allow possession and growth of marijuana among those 21 and older. We also did not assess location of residence (e.g., on campus residency, off campus with friends or with parents) and this is an area for

future exploration with the PBSM. Despite our examination of whether the PBSM was biased based on race and ethnicity, it will be important for researchers to determine if the PBSM is a culturally competent assessment tool by exploring how individuals from varying cultural backgrounds within and outside the United States respond to certain items. In addition, participants were asked to endorse the frequency of a pre-defined list of strategies. It is possible that participants may have used strategies not on the list, which would not have been captured. Future work could utilize an open-ended item at the end of the item list to determine if individual participants or patients use particular strategies not indicated on the measure. Finally, while the quantity and frequency of protective behavioral strategies use has been shown to be robustly related to outcomes both for alcohol and marijuana, future studies should examine the perceived helpfulness of individual strategies to help develop effective individualized treatment plans.

## Conclusions

In conclusion, the PBSM is a promising measure that can be used to assess behavioral strategies among young people who choose to use marijuana. The short form of the PBSM reduces participant and patient burden and has the advantage of being free from any known bias across four indices germane to this population: gender (men versus women), race (White versus non-White), ethnicity (Hispanic versus non-Hispanic), and recreational marijuana use legal status. Given the moderate negative associations with a range of marijuana related outcomes, this measure has the potential to be used in studies testing protective behavioral strategies use as a mechanism of behavior change for marijuana users, both naturalistically or following treatment.

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## References

- Bechtold J, Simpson T, White HR, Pardini D. Chronic adolescent marijuana use as a risk factor for physical and mental health problems in young adult men. *Psychology of Addictive Behaviors*. 2015; 29(3):552–563. [PubMed: 26237286]
- Benjamini Y, Hochberg Y. Controlling the False Discovery Rate: A Practical and Powerful Approach to Multiple Testing. *Journal of the Royal Statistical Society Series B (Methodological)*. 1995; 57(1): 289–300.
- Berg CJ, Stratton E, Schauer GL, Lewis M, Wang Y, Windle M, Kegler M. Perceived harm, addictiveness, and social acceptability of tobacco products and marijuana among young adults: Marijuana, hookah, and electronic cigarettes win. *Substance use & misuse*. 2015; 50(1):79–89. [PubMed: 25268294]
- Browne, MW., Cudeck, R. Alternative ways of assessing model fit. In: Bollen, K., Long, J., editors. *Testing structural equation models*. Newbury Park, CA: Sage; 1993. p. 136-162.

- Buckner JD, Ecker AH, Cohen AS. Mental health problems and interest in marijuana treatment among marijuana-using college students. *Addictive Behaviors*. 2010; 35(9):826–833. [PubMed: 20483200]
- Bravo AJ, Prince MA, Pearson MR. Marijuana Outcomes Study Team. Can I use marijuana safely? An examination of distal antecedents, marijuana protective behavioral strategies, and marijuana outcomes. *Journal of Studies on Alcohol and Drugs*. 78(2):203–212.
- Cai, L., Thissen, D., du Toit, SHC. IRTPRO for Windows. [Computer software]. Lincolnwood, IL: Scientific Software International; 2011.
- Cella D, Yount S, Rothrock N, Gershon R, Cook K, et al. The Patient-Reported Outcomes Measurement Information System (PROMIS): progress of an NIH Roadmap cooperative group during its first two years. *Medical Care*. 2007; 45(5 Suppl 1):S3–s11.
- Compton WM, Han B, Jones CM, Blanco C, Hughes A. Marijuana use and use disorders in adults in the USA, 2002–2014: Analysis of annual cross-sectional surveys. *The Lancet Psychiatry*. 2016; 3:954–964. [PubMed: 27592339]
- DeWalt DA, Rothrock N, Yount S, Stone AA. Evaluation of item candidates: the PROMIS qualitative item review. *Medical Care*. 2007; 45(5 Suppl 1):S12. [PubMed: 17443114]
- Dvorak RD, Day AM. Marijuana and self-regulation: Examining likelihood and intensity of use and problems. *Addictive behaviors*. 2014; 39(3):709–712. [PubMed: 24315407]
- Elliott JC, Carey KB, Vanable PA. A preliminary evaluation of a web-based intervention for college marijuana use. *Psychology of Addictive Behaviors*. 2014; 28(1):288. [PubMed: 24731118]
- Fischer B, Murphy Y, Kurdyak P, Goldner E, Rehm J. Medical marijuana programs — Why might they matter for public health and why should we better understand their impacts? *Preventive Medicine Reports*. 2015; 2:53–56. [PubMed: 26844050]
- Grant I, Atkinson JH, Gouaux B, Wilsey B. Medical Marijuana: Clearing Away the Smoke. *The Open Neurology Journal*. 2012; 6:18–25. [PubMed: 22629287]
- Haberstick BC, Young SE, Zeiger JS, Lessem JM, Hewitt JK, Hopfer CJ. Prevalence and correlates of alcohol and cannabis use disorders in the United States: Results from the national longitudinal study of adolescent health. *Drug and Alcohol Dependence*. 2014; 136:158–161. [PubMed: 24440049]
- Hall W, Degenhardt L. Adverse health effects of non-medical cannabis use. *Lancet*. 2009; 374(9698):1383–1391. [PubMed: 19837255]
- Holland, PW., Wainer, H. *Differential item functioning*. Hillsdale, NJ: LEA; 1993.
- Hu, Lt, Bentler, PM. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*. 1999; 6(1):1–55. DOI: 10.1080/10705519909540118
- Johnston, LD., O'Malley, PM., Bachman, JG., Schulenberg, JE., Miech, RA. *Monitoring the Future national survey results on drug use, 1975–2015: Volume II, college students and adults ages 19–55*. Ann Arbor: Institute for Social Research: University of Michigan; 2016.
- Kalant H. Adverse effects of cannabis on health: an update of the literature since 1996. *Progress in Neuropsychopharmacology and Biological Psychiatry*. 2004; 28(5):849–863.
- Kenney SR, Napper LE, LaBrie JW, Martens MP. Examining the efficacy of a brief group protective behavioral strategies skills training alcohol intervention with college women. *Psychology of Addictive Behaviors*. 2014; 28:1041–1051. [PubMed: 25347024]
- Kilmer JR, Hunt SB, Lee CM, Neighbors C. Marijuana use, risk perception, and consequences: Is perceived risk congruent with reality? *Addictive Behaviors*. 2007; 32(12):3026–3033. [PubMed: 17822856]
- Koppel BS, Brust JC, Fife T, Bronstein J, Youssof S, Gronseth G, Gloss D. Systematic review: Efficacy and safety of medical marijuana in selected neurologic disorders: report of the Guideline Development Subcommittee of the American Academy of Neurology. *Neurology*. 2014; 82(17):1556–1563. [PubMed: 24778283]
- Langer, MM. *A reexamination of Lord's Wald test for differential item functioning using item response theory and modern error estimation*. The University of North Carolina; Chapel Hill: 2008.

- Lee CM, Kilmer JR, Neighbors C, Atkins DC, Zheng C, Walker DD, Larimer ME. Indicated prevention for college student marijuana use: a randomized controlled trial. *Journal of Consulting and Clinical Psychology*. 2013; 81(4):702. [PubMed: 23750464]
- Lipari, R., Jean-Francois, B. Trends in perception of risk and availability of substance use among full-time college students. Rockville, MD: Center for Behavioral Health Statistics and Quality, Substance Abuse and Mental Health Services Administration; 2016.
- Looby A, Earleywine M. Negative consequences associated with dependence in daily cannabis users. *Substance Abuse Treatment and Prevention Policy*. 2007; 2:3.
- Martens MP, Ferrier AG, Sheehy MJ, Corbett K, Anderson DA, Simmons A. Development of the Protective Behavioral Strategies Survey. *Journal of Studies on Alcohol*. 2005; 66(5):698–705. [PubMed: 16329461]
- Martens MP, Pedersen ER, LaBrie JW, Ferrier AG, Cimini MD. Measuring alcohol-related protective behavioral strategies among college students: further examination of the Protective Behavioral Strategies Scale. *Psychology of Addictive Behaviors*. 2007; 21(3):307–315. [PubMed: 17874881]
- Meier MH, Caspi A, Cerdá M, et al. Associations between cannabis use and physical health problems in early midlife: A longitudinal comparison of persistent cannabis vs tobacco users. *JAMA Psychiatry*. 2016
- Nyklicek, I., Temoshok, L., Vingerhoets, A. Emotional Expression and Health: Advances in Theory, Assessment and Clinical Applications. 2. Routledge; New York, NY: 2004.
- Pearson M, Liese B, Dvorak R. Marijuana Outcomes Study Team. College student marijuana involvement: Perceptions, use, and consequences across 11 college campuses. *Addictive Behaviors*. 2017; 66:83–89. [PubMed: 27894029]
- Pearson MR. Use of alcohol protective behavioral strategies among college students: A critical review. *Clinical Psychology Review*. 2013; 33(8):1025–1040. [PubMed: 24036089]
- Pedersen ER, Hummer JF, Rinker DV, Traylor ZK, Neighbors C. Measuring protective behavioral strategies for marijuana use among young adults. *Journal of Studies on Alcohol and Drugs*. 2016; 77(3):441–450. [PubMed: 27172576]
- Pew Research Center. In *Debate Over Legalizing Marijuana, Disagreement Over Drug's Dangers*. Washington, DC: Author; 2015.
- Prince MA, Carey KB, Maisto SA. Protective behavioral strategies for reducing alcohol involvement: A review of the methodological issues. *Addictive Behaviors*. 2013; 38(7):2343–2351. [PubMed: 23584196]
- Samejima, F. Graded response model. In: Van der Linden, WJ., Hambleton, RK., editors. *Handbook of modern item response theory*. New York: Springer; 1997.
- Simons JS, Dvorak RD, Merrill JE, Read JP. Dimensions and severity of marijuana consequences: Development and validation of the Marijuana Consequences Questionnaire (MACQ). *Addictive Behaviors*. 2012; 37(5):613–621. [PubMed: 22305645]
- Taylor DR, Poulton R, Moffitt TE, Ramankutty P, Sears MR. The respiratory effects of cannabis dependence in young adults. *Addiction*. 2000; 95(11):1669–1677. [PubMed: 11219370]
- Thissen, D., Nelson, L., Rosa, K., McLeod, LD. Item response theory for items scored in more than two categories. In: Thissen, D., Wainer, H., editors. *Test scoring*. Mahwah, NJ: Lawrence Erlbaum & Associates; 2001. p. 141–186.
- Thissen D, Steinberg L, Kuang D. Quick and Easy Implementation of the Benjamini-Hochberg Procedure for Controlling the False Positive Rate in Multiple Comparisons. *Journal of Educational and Behavioral Statistics*. 2002; 27(1):77–83.
- Thissen, D., Wainer, H., editors. *Test Scoring*. Hillsdale, NJ: Lawrence Erlbaum Associate; 2001.
- Volkow ND, Baler RD, Compton WM, Weiss SR. Adverse health effects of marijuana use. *N Engl J Med*. 2014; 370(23):2219–2227. [PubMed: 24897085]
- Whiting PF, Wolff RF, Deshpande S, Di Nisio M, Duffy S, et al. Cannabinoids for medical use: A systematic review and meta-analysis. *JAMA*. 2015; 313(24):2456–2473.
- Woods CM, Cai L, Wang M. The Langer-Improved Wald Test for DIF Testing with multiple groups: Evaluation and comparison to two-group IRT. *Educational and Psychological Measurement*. 2013; 73(3):532–547.

## Appendix I: 36-item version of the PBSM (PBSM-36)

Please indicate the degree to which you engage in the following behaviors when using marijuana/cannabis.

1 = never, 2 = rarely, 3 = occasionally, 4 = sometimes, 5 = usually, 6 = always

1	Use marijuana only among trusted peers
2	Avoid use while spending time with family
3	Avoid using marijuana before work or school
4	Avoid using marijuana to cope with emotions such as sadness or depression
5	Do not keep marijuana in the car, whether as a driver or passenger
6	Avoid bringing marijuana into events or venues where you are likely to be searched
7	Limit use to weekends
8	Avoid driving a car after using
9	Only purchase marijuana from a trusted source
10	Avoid using marijuana habitually (that is, every day or multiple times a week)
11	Avoid using marijuana early in the day
12	Keep track of your costs to get an accurate picture of how much you spend on marijuana
13	Avoid using marijuana for several days in advance of a big test, interview, performance, or other engagement for which you need to be crisp and are being evaluated
14	Use a little and then wait to see how you feel before using more
15	Avoid buying marijuana
16	Avoid mixing marijuana with other drugs
17	Only use at night (that is, not during the day)
18	Stop using marijuana if you become anxious or paranoid
19	Avoid using marijuana in public places
20	Take periodic breaks if it feels like you are using marijuana too frequently
21	Buy less marijuana at a time so you smoke less
22	Avoid situations that you anticipate being pressured to use marijuana
23	Only use when you know you have nothing important to do for the rest of the day/night
24	Have a set amount of "times" you take a hit (e.g., passing on a shared joint if you have already hit that limit)
25	Avoid using marijuana out of boredom
26	Avoid methods of using marijuana that can make you more intoxicated than you would like (e.g., using large bongs, volcano, 'edibles,' etc.)
27	Pass on shared joints, bongs, etc. if already feeling high
28	Only use one time during a day/night
29	Avoid using marijuana in large gatherings or crowds
30	Limit the amount of marijuana you smoke in one sitting
31	If attending a party or going out to a social event (e.g., bar), decide in advance whether you want to use marijuana or not
32	Avoid using when feeling anxious (e.g., using to calm you down or stop worrying)

33	Avoid using marijuana in concentrated forms (e.g., hashish, hashish/honey oil, kief, marijuana butter/oil, etc.) to avoid getting too high
34	To decrease tolerance, take a break for a week or two, or take longer breaks than usual between use
35	Use enough only to achieve a slight buzz or to avoid getting “too high”
36	Avoid using marijuana before engaging in physical activity (i.e., exercise, hiking)

## Appendix II: 17-item short-form version of the PBSM (PBSM-17)

Please indicate the degree to which you engage in the following behaviors when using marijuana/cannabis.

1 = never, 2 = rarely, 3 = occasionally, 4 = sometimes, 5 = usually, 6 = always

1	Use marijuana only among trusted peers
2	Avoid use while spending time with family
3	Avoid using marijuana before work or school
4	Avoid using marijuana to cope with emotions such as sadness or depression
5	Limit use to weekends
6	Only purchase marijuana from a trusted source
7	Avoid using marijuana habitually (that is, every day or multiple times a week)
8	Use a little and then wait to see how you feel before using more
9	Avoid mixing marijuana with other drugs
10	Avoid using marijuana in public places
11	Take periodic breaks if it feels like you are using marijuana too frequently
12	Buy less marijuana at a time so you smoke less
13	Have a set amount of “times” you take a hit (e.g., passing on a shared joint if you have already hit that limit)
14	Avoid methods of using marijuana that can make you more intoxicated than you would like (e.g., using large bongs, volcano, ‘edibles,’ etc.)
15	Only use one time during a day/night
16	Limit the amount of marijuana you smoke in one sitting
17	Avoid using marijuana before engaging in physical activity (i.e., exercise, hiking)

**Table 1**

## Sample Description

<b>MOST<sup>1</sup> past month marijuana users (N = 2,117)</b>	
<i>Mean (SD) or Percentage</i>	
Age	19.95 (3.66)
Gender	
Men	39.8%
Women	60.2%
Hispanic ethnicity	18.3%
Race <sup>2</sup>	
White	70.1%
Black or African American	12.9%
Asian	9.5%
American Indian or Alaska Native	3.9%
Native Hawaiian/Other Pacific Islander	1.5%
Other	10.2%
Residence in state with legal recreational marijuana <sup>3</sup>	25.5%
Education	
Freshman	51.0%
Sophomore	22.3%
Junior	16.2%
Senior	10.0%
Graduate Student	0.5%
Greek affiliation	
In a fraternity/sorority	19.8%
Currently pledging	3.1%
Student athlete	5.4%

<sup>1</sup>MOST = Marijuana Outcomes Study Team

<sup>2</sup>Participants could endorse more than one racial category

<sup>3</sup>At the time of data collection, two institutions were located in states that had legalized recreational use of marijuana (Colorado, Washington State). Both states had been legally selling marijuana for recreational purposes to those 21 and over for at least one year at the time of data collection.



**Table 2**

Initial item pool with decisions that lead to final item bank with 36 items and 17 short form items

Item	Item status	Item wording
1	Factor loading 0.47	Only use marijuana after completing all of the day's responsibilities
2	Bank/SF	Use marijuana only among trusted peers
3	Factor loading 0.49	Avoid mixing marijuana with alcohol
*4	Bank/SF	Avoid use while spending time with family
*5	Bank/SF	Avoid using marijuana before work or school
*6	Bank/SF	Avoid using marijuana to cope with emotions such as sadness or depression
*7	MI	Use a designated driver (i.e., someone who has not used) after using marijuana
*8	Bank (legal <sup>e</sup> )	Do not keep marijuana in the car, whether as a driver or passenger
*9	Bank (legal <sup>e</sup> )	Avoid bringing marijuana into events or venues where you are likely to be searched
*10	Bank/SF	Limit use to weekends
*11	Bank (legal <sup>f</sup> ; race <sup>d</sup> )	Avoid driving a car after using
12	Bank/SF	Only purchase marijuana from a trusted source
*13	Bank/SF	Avoid using marijuana habitually (that is, every day or multiple times a week)
*14	Bank (legal <sup>f</sup> ; race <sup>d</sup> )	Avoid using marijuana early in the day
*15	Bank (gender <sup>a</sup> )	Keep track of your costs to get an accurate picture of how much you spend on marijuana
*16	Bank (gender <sup>b</sup> )	Avoid using marijuana for several days in advance of a big test, interview, performance, or other engagement for which you need to be crisp and are being evaluated
*17	Bank/SF	Use a little and then wait to see how you feel before using more
*18	Bank (gender <sup>a</sup> )	Avoid buying marijuana
*19	MI	Avoid using marijuana if currently taking any kind of prescription drug that might intensify the effects (e.g., make you feel more tired)
*20	Bank/SF	Avoid mixing marijuana with other drugs
*21	Bank (gender <sup>b</sup> ; legal <sup>f</sup> ; race <sup>d</sup> )	Only use at night (that is, not during the day)
*22	Bank (gender <sup>a</sup> )	Stop using marijuana if you become anxious or paranoid
*23	Bank/SF	Avoid using marijuana in public places
*24	Bank/SF	Take periodic breaks if it feels like you are using marijuana too frequently
*25	Bank/SF	Buy less marijuana at a time so you smoke less
*26	MI	Excuse yourself from the room if people are smoking marijuana and you feel uncomfortable or do not wish to be offered marijuana.
*27	Bank (race <sup>c</sup> )	Avoid situations that you anticipate being pressured to use marijuana
28	Factor loading 0.32	Use only at home
*29	MI	Avoid possibilities of legal repercussions (e.g., smoke in a safe place like home, avoid having marijuana with you where you might get searched, etc.)
30	Factor loading 0.21	Use a vaporizer or other smokeless method to avoid carcinogens

Item	Item status	Item wording
*31	MI	Take a break from using if feeling a loss of motivation
*32	Bank (legal <sup>f</sup> )	Only use when you know you have nothing important to do for the rest of the day/night
*33	Bank/SF	Have a set amount of “times” you take a hit (e.g., passing on a shared joint if you have already hit that limit)
*34	Bank (gender <sup>b</sup> )	Avoid using marijuana out of boredom
*35	Bank/SF	Avoid methods of using marijuana that can make you more intoxicated than you would like (e.g., using large bong, volcano, ‘edibles,’ etc.)
*36	MI	Only use marijuana on private property
*37	Bank (gender <sup>a</sup> )	Pass on shared joints, bong, etc. if already feeling high
38	Factor loading 0.19	Use eye drops so others do not know you have used
*39	Bank/SF	Only use one time during a day/night
*40	Bank (gender <sup>b</sup> )	Avoid using marijuana in large gatherings or crowds
*41	Bank/SF	Limit the amount of marijuana you smoke in one sitting
42	Bank (gender <sup>b</sup> )	If attending a party or going out to a social event (e.g., bar), decide in advance whether you want to use marijuana or not
*43	Bank (gender <sup>b</sup> )	Avoid using when feeling anxious (e.g., using to calm you down or stop worrying)
44	Factor loading 0.43	Only use before special events (e.g., movies, concerts) or on special occasions
*45	Bank (gender <sup>a</sup> )	Avoid using marijuana in concentrated forms (e.g., hashish, hashish/honey oil, kief, marijuana butter/oil, etc.) to avoid getting too high
46	Factor loading 0.31	Use higher potency marijuana so you can take less hits and avoid lung damage
*47	Bank (gender <sup>b</sup> )	To decrease tolerance, take a break for a week or two, or take longer breaks than usual between use
*48	Bank (gender <sup>a</sup> )	Use enough only to achieve a slight buzz or to avoid getting “too high”
49	Factor loading 0.44	Use your own marijuana (if alone or sharing with friends) so you know what you are using
*50	Bank/SF	Avoid using marijuana before engaging in physical activity (i.e., exercise, hiking)

Note: “Item” corresponds to items in the original PBSM scale published in Pedersen et al., 2016. There was no DIF based on ethnicity.

\* in the first column indicate the item was retained in the original 39-item version of the scale. In column 2, the numeric numbers represent estimated factor loadings that are considered low (<0.5) from the 1-factor CFA model. There are 8 items dropped from the initial 50 item pool due to low loadings. MI (modification indices) in the same column represents the items that were dropped due the excess dependence reflected by MI and overlapping content wording. The rest of the 36 items indicated with “Bank” are the final bank items. Nineteen of the bank items are indicated in the parenthesis the kind of DIF detected, hence not included in building the short form. Among the 36 bank items, the 17 short form items that are free of DIF are indicated as “Bank/SF,” where SF indicates short form.

The directions of DIF are indicated using the following superscripts:

<sup>a</sup> = significantly higher level of this item for males,

<sup>b</sup> = significantly higher level of this item for females,

<sup>c</sup> = significantly higher level of this item for whites,

<sup>d</sup> = significantly higher level of this item for non-whites,

<sup>e</sup> = significantly higher level of this item for those in states with legal recreational marijuana laws,

<sup>f</sup> = significantly higher level of this item for those in states without legal recreational marijuana laws.

**Table 3**

Item bank calibration for the PBSM scale with 36 items

	a	SE	b <sub>1</sub>	SE	b <sub>2</sub>	SE	b <sub>3</sub>	SE	b <sub>4</sub>	SE	b <sub>5</sub>	SE
1	1.18	0.06	-3.90	0.21	-3.07	0.15	-2.14	0.10	-1.61	0.08	-0.02	0.04
2	1.48	0.07	-2.63	0.12	-2.00	0.09	-1.50	0.06	-1.08	0.05	-0.32	0.04
3	2.18	0.09	-2.17	0.08	-1.67	0.06	-1.21	0.04	-0.90	0.03	-0.26	0.03
4	1.41	0.06	-2.09	0.09	-1.24	0.06	-0.60	0.04	-0.06	0.04	0.66	0.05
5	1.62	0.07	-2.32	0.09	-1.43	0.06	-0.89	0.04	-0.55	0.04	0.16	0.04
6	1.49	0.07	-2.75	0.13	-1.99	0.09	-1.46	0.06	-1.10	0.05	-0.54	0.04
7	1.96	0.07	-1.54	0.05	-0.90	0.04	-0.45	0.03	0.03	0.03	1.00	0.05
8	1.99	0.08	-1.86	0.07	-1.07	0.04	-0.63	0.03	-0.25	0.03	0.40	0.04
9	1.06	0.06	-3.76	0.21	-3.09	0.16	-2.28	0.12	-1.70	0.09	-0.41	0.05
10	2.62	0.10	-1.36	0.04	-0.82	0.03	-0.50	0.03	-0.22	0.03	0.34	0.03
11	2.67	0.10	-1.77	0.06	-1.26	0.04	-0.83	0.03	-0.55	0.03	0.29	0.03
12	1.06	0.05	-2.02	0.10	-1.20	0.07	-0.70	0.05	-0.23	0.05	0.64	0.06
13	2.56	0.09	-1.62	0.05	-1.07	0.04	-0.65	0.03	-0.29	0.03	0.34	0.03
14	1.69	0.06	-1.90	0.07	-1.04	0.04	-0.56	0.04	0.02	0.03	1.12	0.05
15	1.75	0.07	-1.48	0.06	-0.71	0.04	-0.11	0.03	0.38	0.04	1.12	0.05
16	1.96	0.08	-1.91	0.07	-1.32	0.05	-0.84	0.04	-0.44	0.03	0.18	0.03
17	2.47	0.09	-1.76	0.06	-1.23	0.04	-0.73	0.03	-0.28	0.03	0.75	0.04
18	2.26	0.08	-1.75	0.06	-1.19	0.04	-0.75	0.03	-0.36	0.03	0.42	0.03
19	1.93	0.07	-2.43	0.09	-1.61	0.06	-0.94	0.04	-0.44	0.03	0.41	0.04
20	2.78	0.10	-1.70	0.05	-1.22	0.04	-0.80	0.03	-0.34	0.03	0.35	0.03
21	1.66	0.07	-1.58	0.06	-0.99	0.04	-0.47	0.03	0.12	0.03	0.88	0.05
22	1.72	0.07	-0.91	0.04	-0.26	0.03	0.15	0.03	0.59	0.04	1.21	0.06
23	2.27	0.09	-2.13	0.07	-1.55	0.05	-1.06	0.04	-0.63	0.03	0.31	0.03
24	1.58	0.06	-1.45	0.06	-0.73	0.04	-0.28	0.03	0.24	0.04	1.14	0.06
25	2.08	0.07	-1.52	0.05	-0.70	0.03	-0.17	0.03	0.39	0.03	1.08	0.05
26	1.89	0.07	-1.26	0.05	-0.52	0.03	-0.02	0.03	0.50	0.04	1.22	0.05

	a	SE	b <sub>1</sub>	SE	b <sub>2</sub>	SE	b <sub>3</sub>	SE	b <sub>4</sub>	SE	b <sub>5</sub>	SE
27	1.54	0.06	-2.18	0.09	-1.44	0.06	-0.82	0.04	-0.19	0.04	0.87	0.05
28	2.23	0.08	-1.82	0.06	-1.09	0.04	-0.57	0.03	-0.06	0.03	0.93	0.04
29	1.74	0.07	-2.22	0.08	-1.11	0.04	-0.45	0.03	0.09	0.03	1.05	0.05
30	2.65	0.09	-1.76	0.05	-1.03	0.03	-0.54	0.03	-0.01	0.03	0.90	0.04
31	1.46	0.06	-2.31	0.09	-1.37	0.06	-0.79	0.04	-0.21	0.04	0.96	0.05
32	2.11	0.08	-1.58	0.05	-0.80	0.03	-0.30	0.03	0.20	0.03	0.95	0.05
33	1.94	0.07	-1.37	0.05	-0.71	0.03	-0.25	0.03	0.17	0.03	0.89	0.05
34	1.48	0.06	-1.80	0.07	-0.99	0.05	-0.35	0.04	0.41	0.04	1.29	0.06
35	1.93	0.07	-1.75	0.06	-0.92	0.04	-0.30	0.03	0.35	0.03	1.35	0.06
36	1.95	0.07	-1.93	0.07	-1.21	0.04	-0.66	0.03	-0.19	0.03	0.51	0.04

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**Table 4**

Summed score to scale score conversion table for the 17-item short form (PBSM-17)

Summed score	Scaled score ( <i>T</i> )	<i>SE</i>
17	15	5
18	18	4
19	19	4
20	21	4
21	22	4
22	23	4
23	23	4
24	24	4
25	25	3
26	26	3
27	27	3
28	27	3
29	28	3
30	29	3
31	29	3
32	30	3
33	31	3
34	31	3
35	32	3
36	32	3
37	33	3
38	33	3
39	34	3
40	34	3
41	35	3
42	35	3
43	36	2
44	36	2
45	37	2
46	37	2
47	37	2
48	38	2
49	38	2
50	39	2
51	39	2
52	40	2
53	40	2
54	40	2
55	41	2

Summed score	Scaled score ( <i>T</i> )	<i>SE</i>
56	41	2
57	42	2
58	42	2
59	42	2
60	43	2
61	43	2
62	44	2
63	44	2
64	44	2
65	45	2
66	45	2
67	46	2
68	46	2
69	46	2
70	47	2
71	47	2
72	48	2
73	48	2
74	48	2
75	49	2
76	49	2
77	50	3
78	50	3
79	51	3
80	51	3
81	52	3
82	52	3
83	53	3
84	53	3
85	54	3
86	54	3
87	55	3
88	56	3
89	56	3
90	57	3
91	58	3
92	58	3
93	59	3
94	60	3
95	61	3
96	62	3
97	63	4

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Summed score	Scaled score ( <i>T</i> )	<i>SE</i>
98	64	4
99	65	4
100	67	4
101	69	4
102	73	5

Note. The T-score transformation is directly from a latent trait (factor) normal distribution with mean of 0 and variance of 1, which itself has the range from negative infinity to infinity. The probability at the tails is so small that the minimum or the maximum summed score is not going to be exactly at the negative infinity or infinity. Instead, they are estimated at the values of 15 and 73 (after a T transformation) with a rather large SE of 5.

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Means and correlations of the PBSM bank item scores and short form scores with marijuana use and consequences

Table 5

	Mean (SD), Range	Past month users	
		Correlation with PBSM bank score (36 items)	Correlation with PBSM short form (17 items)
Days used in past month	9.56 (9.91), 1–30	–0.49	–0.50
Days use to point of being high in past month	8.90 (9.67), 0–30	–0.51	–0.51
Days passed out or getting sick due to marijuana use in past month	0.22 (1.29), 0–24	–0.11	–0.11
Age at first use of marijuana	16.34 (2.15), 10–39	0.25	0.25
Marijuana Consequences Questionnaire (sum score) past month	8.10 (7.83), 0–50	–0.40	–0.40
PBSM bank score (36 items)	50.0 (10)	--	0.98
PBSM short form score (17 items)	50.0 (10)	0.98	--

Note. All correlations significant at  $p < .001$