The Medical Cannabis Expectancy Questionnaire: Adult Medical Marijuana Users' Expectancies Associated with Combustible, Vaporized, and Edible Cannabis Use for Medical Purposes

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ABSTRACT

Measures of medical cannabis (MC) use are lacking. This study details the development and psychometric evaluation of The Medical Cannabis Expectancy Questionnaire (MCEQ), a novel measure of positive and negative expectations associated with using combustible, vaporizable, and edible MC. 333 adult MC users completed a 30-minute online survey in Spring 2017 (64.0% female, 82.3% White, mean age 32.77[±10.19] years). Participants reported on demographics, product preference, MCEs, frequency of MC use, quality of life, and negative cannabis use consequences. Psychometric analyses included evaluations of latent factor structure, measurement invariance, between-groups differences in MCEs, and test-criterion relationships with MC outcomes. The 27-item MCEQ evidenced a 2-factor structure (positive/negative). MCEs were scalar invariant by product type, sex, and reasons for MC use (medical only vs medical/recreational). Participants held more positive MCEs for combustibles than for vaporizables or edibles and more negative MCEs for combustibles and edibles than for vaporizables. MCEs did not differ by sex. Participants who also used cannabis recreationally reported stronger positive MCEs for all MC products. MCEs also differed by product preference. Additionally, preference for and more positive MCEs associated with using a specific product were associated with more frequent use of that product. Positive MCEs for all products also were associated with increased quality of life, but these relationships failed to reach statistical significance after accounting for covariates. Finally, negative MCEs for combustibles and edibles were associated with more negative consequences. The MCEQ is the first psychometrically promising measure of MC expectancies, and it uniquely distinguishes among expectations associated with using combustible, vaporizable, and edible MC. As MC use continues to proliferate, having measures dedicated to MC (versus recreational cannabis) may better inform research and clinical efforts. Further, differentiating between product types is important given established differences among them (e.g., duration of effect onset).

Key words: cannabis; marijuana; medical cannabis; medical marijuana; smoking; vaping

Rates of medical cannabis (MC) use are increasing, and MC currently is legal in 29 states and the District of Columbia (procon.org, 2017). Results of randomized clinical trials provide the strongest support for the efficacy of MC for treating symptoms of chronic pain, neuropathic pain, and muscle spasticity that occurs due to multiple sclerosis (e.g., Hill, 2015). However, state

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laws vary considerably with regard to the conditions that are approved for MC use, with some providing broad definitions and others listing specific medical conditions. For example, Maryland permits the use of MC for treating the symptoms of "any condition that is severe, for which other medical treatments have been ineffective, and if the symptoms 'reasonably can be expected to be relieved' by the medical use of Cannabis or if the patient has a chronic or debilitating disease or medical condition that causes severe loss of appetite, wasting, severe or chronic pain, severe nausea, seizures or severe or persistent muscle spasms, glaucoma, or Post Traumatic Stress Disorder (PTSD)" whereas California permits the use of MC for treating the symptoms of "AIDS, anorexia, arthritis, cachexia, cancer, chronic pain, glaucoma, migraine, persistent muscle spasms (including spasms associated with multiple sclerosis), seizures (including seizures associated with epilepsy), and severe nausea" (procon.org, 2017). Of note, a recent study suggests that MC patients use MC for a variety of conditions, the most common of which were anxiety, pain, stress, insomnia, and depression (HelloMD, 2016). Importantly, three of these conditions (i.e., stress, insomnia, depression) are not listed specifically as qualifying conditions in any state, suggesting that a subset of MC users is using MC to treat symptoms of conditions for which there is limited or no scientific evidence of the efficacy of MC.

Despite the increasing popularity of MC, measures of MC-relevant constructs are lacking. Further, many different MC products are available (e.g., combustible cannabis; vaporizable concentrates; edibles like baked goods containing cannabis; tinctures; salves/lotions; raw/juiced cannabis; Schauer et al., 2016). Notably, product potency can vary considerably. For example, relative to combustibles, concentrates can contain 4-20 times more tetrahydrocannabinol (THC), the cannabinoid that results in the characteristic cannabis "high" (Loflin & Earleywine, 2014; Mehmedic et al., 2010). Furthermore, the onset of drug effects differs by product type, with a delayed onset of effects characteristic of ingesting edibles (e.g., Barrus et al., 2016). Thus, in addition to developing psychometrically sound MC measures, it is important to differentiate between MC products used.

The current study focuses on one of the most well-researched constructs in the substance use literature: outcome expectancies. Broadly, expectancies, or the beliefs that individuals hold about the likely outcomes of using a substance, are powerful predictors of the initiation, maintenance, and cessation of a wide range of substances (e.g., Aarons et al., 2001; Brandon & Baker, 1991; Brown et al., 1987; Connor et al., 2011; Metrik, Farris, Aston, & Kahler, 2017; & Morean & L'Insalata, 2017). Using alcohol expectancies as an example (for which there is the largest body of research), research indicates that expectancies play a causal role in driving alcohol use. For example, expectancies develop during childhood before alcohol use onset occurs and predict the initiation of drinking (Dunn & Goldman, 1996; 1998; Jester et al., 2015); predict alcohol use, alcohol-related problems, the development of alcohol use disorder, and treatment outcomes (Jones, Corbin, & Fromme, 2001); mediate the relationship between other risk-factors and alcohol use including family history of alcoholism (Sher, et al., 1991), impulsivity (Barnow et al., 2004) and fun-seeking (Wardell, Read, Colder, & Merrill, 2012); and correspond to reductions in drinking in response to expectancy challenge (Darkes & Goldman, 1998; Wiers, Van De Luitgaarden, Van Den Wildenberg, & Smulders, 2005). Of note, there are numerous published expectancy measures (e.g., [alcohol] Brown et al., 1987; Morean, Corbin, & Treat 2012; [cigarettes] Brandon & Baker, 1991; [e-cigarettes] Harrell et al., 2017; Morean & L'Insalata, 2017); [stimulants] Aarons et al., 2001; Jaffee & Kilbey, 1994; Schafer & Brown, 1991; [cannabis] Connor et al., 2011; Schafer & Brown, 1991; Torrealday et al., 2008; [cannabis cessation] Metrik, Farris, Aston, & Kahler, 2017). Although these measures have been invaluable to their respective fields, no measure has undergone sufficient psychometric validation to assess MCEs. Further, prior research generally has not assessed expectancies associated with using different cannabis products; only one study of which we are aware has compared expectancies for different types of cannabis (synthetic/botanical; Lauritsen & Rosenberg, 2016).

The current study focuses on the development and psychometric evaluation of The Medical Cannabis Expectancy Questionnaire (MCEQ),

which assesses expectancies associated with three MC products: combustibles, vaporizables, and edibles. After reviewing the most commonly used recreational cannabis expectancy measures (MEEQ [Schafer & Brown, 1991]; CEQ [Connor et al., 2011]), we decided to develop a novel measure of MCEs rather than validate an existing measure for MC use. This decision was based on several factors. First, the MEEQ and CEQ focus nearly exclusively on smoking cannabis and/or make broad statements about cannabis use that do not account for product type. Second, each measure is lengthy (MEEQ [48-70 items]; CEQ [45-60 items]) and items are phrased as sentences. Third, although items should assess only one concept (Furr & Bacharach, 2014), both measures contain items assessing multiple concepts (e.g., CEQ [I am more aware of what I say and do when I am smoking cannabis]; MEEQ [Marijuana can cause me to become depressed and disappointed with myself]). Finally, we wanted to ensure that the MCEQ included effects that correspond to the symptoms for which individuals most often use MC (e.g., "pain relief" → treating chronic pain).

We largely based our item development on research about the subjective effects of cannabis (Lyons et al., 1997; Scherrer et al., 2009). These prior studies suggest that cannabis effects can be assessed using single-word items or short phrases without jeopardizing item integrity. For example, the MEEQ item "I get a sense of relaxation from smoking marijuana" could be shorted to "relaxed." This approach simultaneously reduces participant burden and removes any reference to product type from the items. Although many expectancy measures employ continuous response formats (e.g., The Anticipated Effects of Alcohol Scale [Morean et al., 2013; The Comprehensive Effects of Alcohol Scale [Fromme, Stroot, & Kaplan, 1993]; The Marijuana Effect Expectancy Questionnaire-Brief [Torrealday et al., 2008]), given that 30 expectancies were assessed for three products, we chose to employ a forced-choice response format (no/yes) that has been used in previous expectancy research (Brown et al., 1980; Schafer & Brown, 1991). Regarding psychometric evaluation, we evaluated the latent structure of the MCEQ using exploratory and confirmatory factor analysis; conducted measurement invariance analyses to determine whether MCEs could be compared meaningfully across product types, by sex, and by reasons for product use (medical only vs medical/recreational); examined differences in MCEs by product type (including examining the influence of product preference), sex, and reasons for use; and examined test-criterion relationships between MCEs for each product type and the frequency of using each product, quality of life since starting to use MC, and the experience of negative consequences of cannabis use.

We expected that the MCEQ would evidence one of two possible latent factor structures. First, it seemed plausible that a two-factor structure reflecting positive and negative expectancies would emerge, similar to the CEQ (Connor et al., 2011). Alternatively, the MCEQ items vary in terms of valence (negative/positive) and arousal (sedative/stimulant), so we also hypothesized that a four-factor latent structure may emerge, similar to the AEAS (Morean et al., 2013). We anticipated that the latent structure would be scalar invariant by product type, sex, and reasons for use, because, while mean-levels of endorsing expectancies may differ within these subgroups, the general latent structure was expected to remain stable. While we anticipated that MCEs may differ by product type, we did not outline specific hypotheses given the paucity of research on the topic. Globally, we expected that holding more positive expectancies and fewer negative expectancies for a given product would be associated with more frequent use of that product and with increased quality of life since starting to use MC. We also anticipated that holding more negative expectancies would be associated with experiencing more negative cannabis consequences. Of note, we expected that test-criterion relationships would be stronger for MC users' self-reported preferred product. Ultimately, to be considered a psychometrically promising measure, the MCEQ needed to demonstrate good psychometric properties across all domains assessed.

METHOD

Participants

354 adult MC users completed a 30-minute online survey in Spring 2017, 333 of whom completed all central study questions (64.0% female, 82.3% White, mean age 32.77[±10.19] years). Participants reported using MC primarily to treat pain conditions (55.9%), mental health

conditions (35.1%), and insomnia/sleep problems (9.0%).

Procedure

The Institutional Review Board of Blinded University approved the study. Participants were recruited via Qualtrics Online Sample, a secure, market research service. Qualtrics sent emails to participants who computer algorithms deemed to be most likely to be eligible for our study based on their responses to previous surveys. An embedded email link directed participants to six screener questions. Eligible individuals provided consent to participate. Qualtrics compensated participants based on the terms of pre-established agreements with panel members (up to $10).

Measures

Screening Questions. Participants completed six screening questions; four were used to determine study eligibility and two were used to disguise the study aims (i.e., cigarette/alcohol use). To be eligible, participants had to report 1) living in a state in which MC was legal (response options: all fifty states and Washington DC), 2) using cannabis in the past 30 days (no/yes), 3) using cannabis for medical reasons in the past 30 days (recreational, religious, medical), and 4) having "a valid 'medical marijuana card' that was authorized by a doctor and allows [them] to use medical marijuana legally" (no/yes).

Demographics. Participants reported on their sex, age, race, duration of MC use (years/months), and reasons for MC use (medical only vs. medical/recreational).

The Medical Cannabis Expectancies Questionnaire (MCEQ; see Appendix). After reading the instructions, participants indicated whether they expected to experience 30 effects as a result of smoking, vaping, or eating MC edibles. Twenty-five items were derived from extant subjective response measures (Lyons et al., 1997; Scherrer et al., 2009). The 9 positive effects obtained from previous measures were judged by our research team to map onto at least one common condition for which patients use MC. We developed 5 additional "positive" items that corresponded to reasons individuals commonly cite for MC use (i.e., "pain relief" [pain], "hungry" and "settled stomach" [appetite problems], "sleep better" [insomnia], "calm" [mental health conditions]). 16 items that were anticipated to be perceived as negative (e.g., paranoid, irritable) also were included.

Cannabis Product Use. Participants indicated all of the following products they had ever tried (even once or twice in their life) and which one they preferred to use to treat their primary medical condition: smoked/combustible marijuana (e.g., joints, blunts, pipes, bongs), vaporizable marijuana concentrates (e.g., hash oil, wax), vaporizable marijuana flower (e.g., "bud"), and edible marijuana (e.g., edibles like brownies or candies containing marijuana). Participants then reported how many days out of the past 30 days they used each product (0-30). In total, 90% of participants who endorsed vaping MC endorsed both vaping concentrates and vaporized flower. As such, vaping cannabis and vaping flower were combined into a single category (i.e., vaporizing cannabis). To further support combining these categories, we examined the mean positive and negative vaping expectancy scores for individuals who endorsed vaping flower and vaping concentrates, and the means and standard deviations were very similar [Positive Vaping Expectancies for Vaping Flower (M = 5.21, SD = 4.40) and Vaping Concentrates (M = 5.24, SD = 4.32); Negative Vaping Expectancies for Vaping Flower (M = 1.05, SD = 1.53) and Vaping Concentrates (M = 1.09, SD = 1.67)].

Quality of Life Since Starting to Use MC. Participants answered the following question: "Since I started using medical marijuana, my quality of life has…" (dramatically decreased, decreased, stayed the same, increased, dramatically increased).

Negative Consequences of Cannabis Use. Participants completed the 21-item Brief Marijuana Consequences Questionnaire (B-MACQ; Simons et al., 2012). Sample items include "I have lost motivation to do things because of my marijuana use" and "I haven't been as mentally sharp because of my marijuana use."

Data Analytic Plan

Descriptive Statistics. Descriptive statistics were run on the central study variables.

Latent Structure. Given that MC users were most experienced with combustibles, we first ran an exploratory factor analysis (EFA) on the

MCEQ items for combustibles (N = 354). We considered factor solutions ranging from 1-10 latent factors based on the rationale that a latent factor should comprise ≥ 3 items to be estimated reliably (Jöreskog and Sörbom, 1989). We identified plausible latent structures based on a combination of eigenvalues (>1)/scree plots, model fit, item loadings (i.e., primary factor loadings ≥ .45 with cross-loadings < .30), the number of items per factor, and factor interpretability (e.g., Tabachnick and Fidell, 2013). Plausible latent structure(s) identified via EFA were fit to the data for vaporizables and edibles using Confirmatory Factor Analysis (CFA). Because the data were binary, we specified a robust weighted least squares approach (WLSMV). Multiple fit indices were examined to evaluate acceptable model fit: Bentler's Comparative Fit Index (CFI) ≥ .95 (Hu and Bentler, 1999), Root Mean Square Error of Approximation (RMSEA) ≤ .05 (Ho, 20016), and Weighted Root Mean Square Residual (WRMR) ≤ 1.00 (Yu and Muthén, 2002).

Measurement Invariance. We used Mplus 7.0 to run CFA models using a WLSMV estimator to determine whether MCEs could be compared meaningfully for men and women, by product type, and by reasons for MC use. In each case, we evaluated three levels of MI: configural (invariance of the number of latent factors and items per factor), metric (invariance of the item factor loadings), and scalar (invariance of the item factor loadings and thresholds). Good fit was defined as CFI ≥ .95, RMSEA ≤ .05, and $0 \leq \chi^2 \leq 2*df$. Configural invariance was established if the model fit the data. Metric invariance was established if constraining the item factor loadings to equality did not result in significantly poorer model fit compared to the model testing configural invariance. Scalar invariance was established if constraining both the item factor loadings and thresholds did not result in significantly poorer model fit compared to the model testing metric invariance. Comparisons of the models evaluating configural, metric, and scalar MI were conducted using the WLSMV estimator and the DIFFTEST function in Mplus, which produces χ^2 difference tests between the models.

Comparisons of Expectancies by Product Type, Sex, and Reasons for MC Use. One-way, repeated measures ANOVAs were run to compare MCEs for combustibles, vaporizables, and edibles within the total sample and to examine the effect of product preference on MCEs (product preference was entered as a between-subjects variable). Independent-samples t-tests were run to examine differences in MCEs based on sex and reasons for MC use.

Test-Criterion Relationships. Bivariate correlations were run to examine unadjusted relationships between MCEs, product use frequency, quality of life since starting to use MC, and negative cannabis use consequences within the total sample and by product preference. To account for family-wise error, $p < .01$ was used to determine statistical significance.

Finally, univariate general linear models were run to assess if MCEs explained significant variance in the frequency of using each product, quality of life since starting to use MC, and/or the experience of negative cannabis use consequences above and beyond participant demographics and product preference. When predicting quality of life and negative consequences, the frequencies of using each product also were included as covariates. Again, $p < .01$ was used as the threshold for statistical significance.

RESULTS

Demographics

Most participants had tried each MC product (combustibles [91.6%]; vaporizables [74.2%]; edibles [86.2%]), and the majority preferred combustibles (combustibles [58.3%;], see Table 1 for information on all study variables). Within the total sample, product use frequencies ranged from 4.8 days (edibles) to 15.52 days per month (combustibles). Although several variables had non-normal distributions, using transformed data replicated the pattern of results observed using the non-transformed data. Thus, to facilitate interpretability, we present results using the non-transformed data.

Latent Structure

The EFA conducted on combustible MCEs indicated that a 2-factor solution was the only plausible latent structure; a single-factor solution did not fit the data, and models with > 2 factors had an insufficient number of items per subscale. However, the 2-factor model including all 30 items

Table 1. *Participant demographics*

	% or *M* (*SD*)
Sex (% female)	64.0%
Race (% White)	82.3%
Age	32.77 (10.19)
Duration of Medical Cannabis Use (yrs)	2.92 (3.32)
Use for Medical & Recreational Reasons (% yes)	55.6%
Ever Used Product (% yes)	
Combustible Cannabis	91.6%
Vaporizable Concentrates	67.9%
Vaporizable Flower	61.0%
Any Vaporizable Cannabis (Concentrates or Flower)	74.2%
Edible Cannabis	86.2%
Product Preference (% yes)	
Combustible Cannabis	58.3%
Any Vaporizable Cannabis	19.5%
Edible Cannabis	22.2%
Frequency of Use (# of days/past 30 days)	
Combustible Cannabis	15.52 (12.07)
Any Vaporizable Cannabis	5.14 (9.59)
Edible Cannabis	4.84 (8.34)
Positive Expectancies	
Combustible Cannabis	7.39 (3.83)
Any Vaporizable Cannabis	4.31 (4.31)
Edible Cannabis	4.33 (3.94)
Negative Expectancies	
Combustible Cannabis	1.46 (2.14)
Any Vaporizable Cannabis	1.02 (1.64)
Edible Cannabis	1.36 (1.90)
Quality of Life Since Using Medical Cannabis	4.19 (0.65)
Negative Consequences of Cannabis Use	4.00 (3.65)

did not adequately fit the data, sot items were removed to improve fit. In order to be retained, items had to have primary factor loadings ≥ .45 and cross loadings < .30. Using these cutoffs, 27 items were retained and the items lazy, drowsy, and keyed up were dropped. CFA indicated that this structure adequately fit the data for vaporizables and edibles (Table 2).

Measurement Invariance

All unconstrained models fit the data (Table 3), and imposing the constraints associated with the metric and scalar models did not produce significant decrements in model fit. As such, scalar invariance was established for sex, product type, and reasons for MC use.

Comparisons of Expectancies by Product Type, Sex, and Reasons for Use

Assumptions of sphericity were violated for all repeated measures ANOVAs, so Huynh-Feldt corrections were applied. Within the total sample, there were significant differences for positive MCEs (F[1.93, 641.04] = 118.83, η_p^2 = 0.26) and negative MCEs (F[1.84, 610.14] = 9.17, η_p^2 = 0.03, p-values < .001). Pair-wise comparisons indicated that participants held more positive MCEs for combustibles (*M*[*SD*]: 7.39[3.83]) than for vaporizables (4.31[4.21]) or edibles (4.33[3.94]) and more negative MCEs for combustibles (1.46[2.14]) and edibles (1.36[1.90]) than for vaporizables (1.02[1.64], all *p*-values < .001; Figure 1).

When examining the impact of product preference on MCEs, significant interactions

Table 2. *Exploratory and confirmatory factor analysis of the Medical Cannabis Expectancy Questionnaire items*

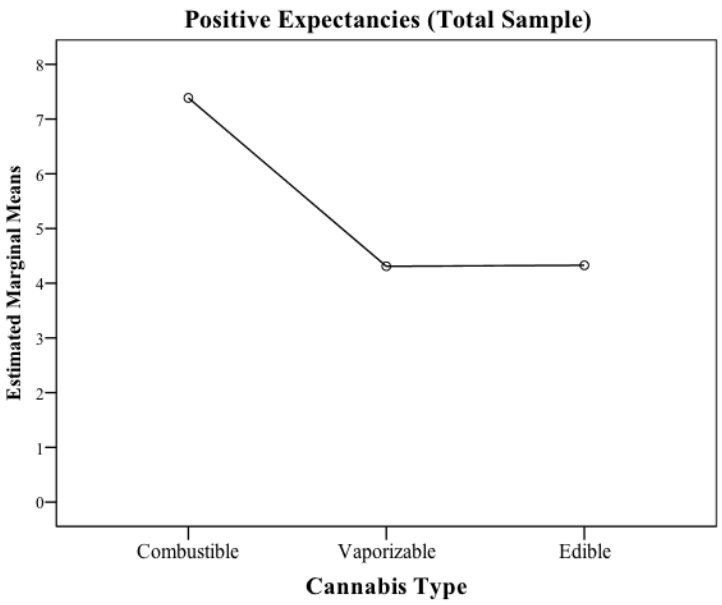
	Exploratory Factor Analysis		Confirmatory Factor Analysis			
	Combustible		Vaporizable		Edible	
	Negative	Positive	Negative	Positive	Negative	Positive
Confused	**.71**	-.13	.53		.57	
Unable to Concentrate	**.70**	.11	.80		.54	
Paranoid	**.78**	.16	.69		.76	
Jumpy	**.66**	.01	.61		.69	
Anxious	**.74**	.01	.54		.72	
Depressed	**.89**	-.18	.50		.58	
Out of Control	**.73**	-.27	.66		.73	
Lazy	.47	.43	--		--	
Dizzy	**.74**	.04	.63		.57	
Drowsy	.40	.44	--		--	
Keyed-up	.40	.19	--		--	
Nauseous	**.76**	-.17	.72		.67	
Guilty	**.75**	-.07	.68		.63	
Hear/See things that aren't really there	**.74**	.03	.76		.75	
Cry	**.71**	.10	.73		.77	
Irritable	**.72**	-.05	.73		.63	
Happy	.33	**.88**		.86		.74
Energetic	.23	**.49**		.64		.61
Creative	.15	**.70**		.87		.76
Euphoric	.20	**.76**		.82		.73
Mellow	-.21	**.88**		.92		.87
Sociable	-.12	**.84**		.84		.75
Confident	-.09	**.75**		.80		.78
Increased Sex Drive	.08	**.60**		.74		.68
Relaxed	-.12	**.95**		.95		.89
Pain Relief	-.08	**.88**		.92		.92
Hungry	.10	**.83**		.85		.75
Settled Stomach	-.03	**.75**		.78		.92
Calm	-.02	**.91**		.94		.92
Sleep Better	.29	**.78**		.82		.78
Fit Statistics						
RMSEA	.050		.028		.032	
CFI	.935		.991		.979	
WRMR	1.097		1.002		1.007	

Note. Bolded factor loadings indicate items that were retained based on the exploratory factor analysis. – denotes items that were not included in the confirmatory models. Note that cross-loadings are not provided for CFA.

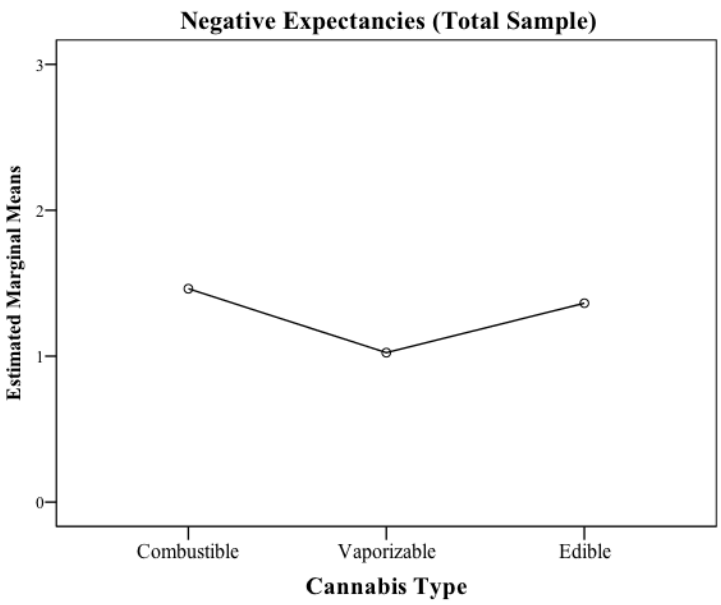
emerged between product preference and positive MCEs (F[3.93, 647.72] = 25.35., p < .001, η_p^2 = 0.13) and negative MCEs (F[3.71, 612.66] = 2.48, p = .047, η_p^2 = 0.02). Pair-wise comparisons indicated that, for combustibles, individuals who preferred smoking cannabis (7.91[3.43]) held more positive MCEs than individuals who preferred edibles (6.05[4.31], p < .001) and less negative MCEs (1.12[1.93]) than individuals who preferred vaporizables (1.72[2.09], p = .046) or edibles (2.14[2.52], p < .001). For vaporizables, individuals who preferred vaping reported more

Figure 1. *Positive and negative medical cannabis expectancies (by product type and product preference)*

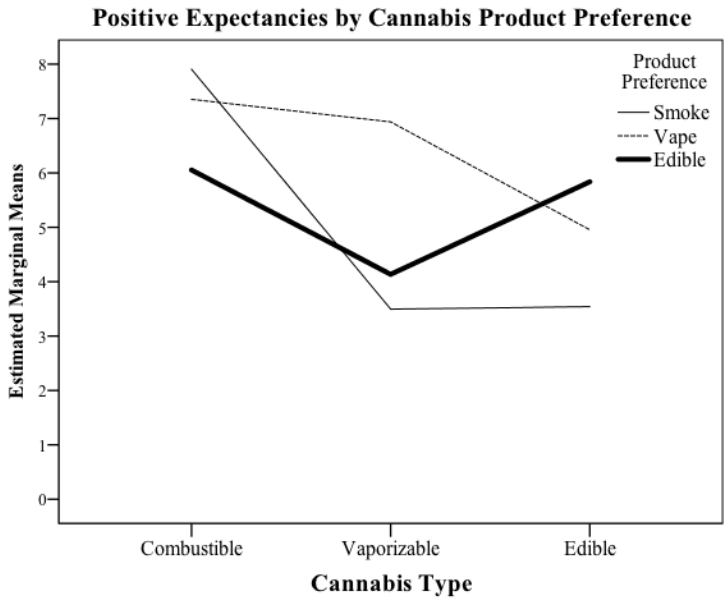
a



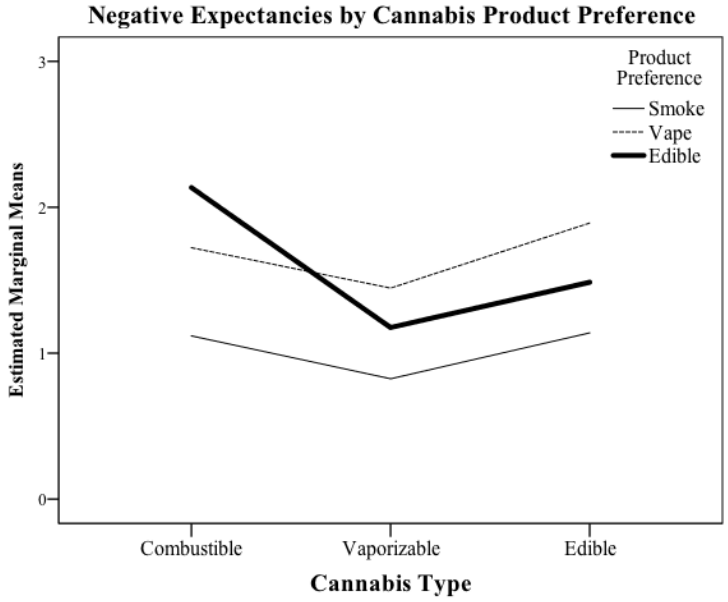
b



c



d



Note. Panel a: Positive expectancies in the total sample for each type of cannabis; Panel b: Negative expectancies in the total sample for each type of cannabis; Panel c: Positive expectancies for each type of cannabis by preferred product; Panel d: Negative expectancies for each type of cannabis by preferred product.

Table 3. *Medical cannabis expectancies are scalar measurement invariant by product type, sex, and reasons for use*

Product Type					
Model	*df*	χ^2	RMSEA	CFI	χ^2 Difference Test
Configural	753	1217.13	0.043	0.977	--
Metric	797	1241.70	0.041	0.978	$\chi^2(44) = 51.94$, $p = 0.19$
Scalar	793	1246.62	0.041	0.977	$\chi^2(40) = 52.61$, $p = 0.09$
Sex					
Model	*df*	χ^2	RMSEA	CFI	χ^2 Difference Test
Configural	502	1018.41	0.045	0.975	--
Metric	524	1021.29	0.044	0.976	$\chi^2(22) = 23.45$, $p = 0.38$
Scalar	522	1024.53	0.044	0.976	$\chi^2(20) = 24.02$, $p = 0.24$
Reasons for Use (Medical/Recreational vs. Medical Only)					
Model	*df*	χ^2	RMSEA	CFI	χ^2 Difference Test
Configural	502	995.49	0.044	0.975	--
Metric	524	1012.16	0.043	0.976	$\chi^2(22) = 32.15$, $p = 0.08$
Scalar	522	1008.19	0.043	0.976	$\chi^2(20) = 25.55$, $p = 0.18$

Note. Abbreviations are *df* (degrees of freedom); χ^2 (chi-square statistic); RMSEA (root mean square error of approximation); CFI (comparative fit index); χ^2 difference test (chi-square values associated with comparing model fit to that of the configural model).

positive MCEs (6.94[3.98]) than individuals who preferred either combustibles (4.17[3.49]) or edibles (4.14[4.07], p-values < .001). For edibles, individuals who preferred edibles reported more positive MCEs (5.84[3.76]) than individuals who preferred smoking cannabis (3.54[3.81], $p < .001$). For vaporizables and edibles, no significant differences in negative MCEs were observed.

Independent-samples t-tests indicated that there were no significant differences in MCEs based on sex (p-values > .50). However, individuals who used MC for medical and recreational reasons reported stronger positive MCEs for all products than individuals who used MC only for medical reasons (Positive Combustibles: Med/Rec 8.21 [3.56], Med only 6.36 [3.93], $t = 4.43$, $p < .001$; Positive Vaporizables: Med/Rec 4.94 [4.44], Med only 3.52 [4.01], $t = 3.04$, $p = .003$, Positive Edibles: Med/Rec 4.85 [4.05], Med only 3.68 [3.71], $t = 2.72$, $p = .007$). No significant differences in negative MCEs were observed.

Test-Criterion Relationships

Correlations run within the total sample and by product preference indicated that positive MCEs for a given product were associated with more frequent use of that product (p-values < .01; Table 4). Among individuals who preferred vaping, fewer negative vaping MCEs also were associated with more frequent vaping (p-values < .01). Within the total sample only, more positive MCEs for each product were associated with increased quality of life since starting to use MC (p-values < .01). Among individuals who preferred vaping, positive vaping MCEs were associated with an increased quality of life ($p = .001$). However, for individuals who preferred combustibles and edibles, correlations failed to reach the adjusted level for statistical significance ($p < .01$). Finally, within the total sample and among individuals who preferred combustibles, more negative MCEs for each product were associated with experiencing more negative cannabis use consequences (p-values < .001).

Initially, all GLM models included two-way interactions between MCEs and product preference. However, none of the interactions were statistically significant, so the models were rerun including only main effects (Table 5). The first GLM accounted for 29.9% of the variance in the frequency of combustible MC use. More frequent combustible MC use was associated with

Table 4. *Medical cannabis expectancies are associated with the frequency of cannabis product use and the experience of negative consequences of cannabis use*

	Cannabis Product Use Frequency (#days/Past 30 days)				
Expectancies	Combustible	Vaporizable	Edible	Improved Quality of Life	Negative Consequences of Cannabis Use
Total Sample					
Smoking Positive	.37***	.12	-.04	.20***	.05
Vaping Positive	.05	.39***	.11	.17**	.12
Edible Positive	.02	.12	.24***	.20***	.12
Smoking Negative	-.14	.04	.13	-.04	.25***
Vaping Negative	-.11	.03	.09	-.05	.24***
Edible Negative	-.15**	.10	.04	-.50	.32***
Prefer Smoke					
Smoking Positive	.27***	.03	.03	.17*	.02
Vaping Positive	.12	.33***	.06	.12	.17
Edible Positive	.15	.18	.13	.18*	.10
Smoking Negative	-.04	.10	.02	-.02	.32***
Vaping Negative	-.08	.14	.08	-.01	.31***
Edible Negative	-.19**	.10	.03	-.01	.39***
Prefer Vape					
Smoking Positive	.46***	.31	.05	.29*	.12
Vaping Positive	.14	.36**	.20	.40***	.01
Edible Positive	.15	.09	.15	.35**	.29
Smoking Negative	-.09	-.05	.07	-.09	.32**
Vaping Negative	-.04	-.31**	.11	-.16	.20
Edible Negative	-.04	-.01	-.13	-.14	.28
Prefer Edibles					
Smoking Positive	.38***	.07	.10	.07	.10
Vaping Positive	.26	.21	.18	.19	.04
Edible Positive	.12	-.02	.24**	.23*	-.03
Smoking Negative	-.08	-.05	.09	-.02	.06
Vaping Negative	-.02	.03	.02	-.06	.08
Edible Negative	.04	.02	.10	-.07	.18

Note. * $p < .05$ ** $p < .01$ *** $p < .001$

Table 5. *Medical cannabis expectancies predict the frequency of cannabis product use and the experience of negative consequences of cannabis use above and beyond participant demographics and product preference*

	Cannabis Product Use Frequency (#days/Past 30 days)						Improved Quality of Life		Negative Consequences of Cannabis Use	
	Combustible		Vaporizable		Edible					
	F	η_p^2	*F*	η_p^2	*F*	η_p^2	*F*	η_p^2	*F*	η_p^2
	Adj R^2 = .30		Adj R^2 = .32		Adj R^2 = .22		Adj R^2 = .06		Adj R^2 = .14	
Sex	1.03	0.00	0.04	0.00	0.06	0.00	0.84	0.00	4.84	0.02
Age	2.52	0.01	0.16	0.00	4.41	0.01	0.01	0.00	1.61	0.01
Race	0.07	0.00	0.19	0.00	0.15	0.00	0.02	0.00	0.01	0.00
Recreational Use	0.83	0.00	1.76	0.01	0.26	0.00	0.50	0.00	0.64	0.00
Duration of MC Use	8.02	0.03**	2.07	0.01	0.85	0.01	0.23	0.00	0.65	0.00
Product Preference	24.53	0.13***	35.12	0.18***	28.41	0.15***	1.26	0.01	0.06	0.00
Positive Expectancies										
Smoking	25.70	0.08***	0.09	0.00	0.24	0.10	0.71	0.00	1.10	0.00
Vaping	0.02	0.00	32.47	0.09***	0.26	0.00	0.12	0.00	0.87	0.00
Edible	0.00	0.00	4.39	0.01	5.44	0.02**	5.53	0.02*	0.02	0.00
Negative Expectancies										
Smoking	0.87	0.00	1.29	0.00	0.22	0.00	0.14	0.00	7.32	0.02**
Vaping	0.13	0.00	7.13	0.02**	0.35	0.00	0.30	0.00	0.02	0.00
Edible	3.67	0.01	1.16	0.00	0.21	0.01	0.38	0.00	11.98	0.04**
Frequency of Use										
Smoking	--		--		--		4.09	0.01	2.04	0.01
Vaping	--		--		--		0.01	0.00	0.50	0.00
Edible	--		--		--		0.37	0.00	0.03	0.00

Note. Sample size (N = 333) -- variables not included in the model * $p < .05$ ** $p < .01$ *** $p < .001$

preferring to smoke cannabis (*B*[Std. Error] = 8.18[1.58], t = 5.19, p < .001) and holding more positive combustible MCEs (*B*[Std. Error] = 0.89[0.18], t = 5.07, p < .001). The second GLM accounted for 32.4% of the variance in the frequency of vaporizable MC use. More frequent MC vaping was associated with preferring to vape cannabis (*B*[Std. Error] = 9.93[1.44], t = 6.89, p < .001), holding more positive vaping MCEs (*B*[Std. Error] = 0.81[0.14], t = 5.70, p < .001), and holding fewer negative vaping MCEs (*B*[Std. Error] = -0.95[0.35], t = -2.67, p = .008). The third GLM accounted for 21.6% of the variance in the frequency of edible MC use. More frequent edible use was associated with preferring to consume edibles (*B*[Std. Error] = 7.70[1.35], t = 5.70, p < .001) and holding more positive edible MCEs (*B*[Std. Error] = 0.33[0.14], t = 2.33, p = .010). The fourth GLM accounted for 5.7% of the variance in quality of life since starting to use MC. However, there were no statistically significant main effects at the adjusted p < .01 level. The final GLM accounted for 13.6% of the variance in the experience of negative cannabis use consequences. Experiencing more negative consequences was associated with holding more negative combustible (*B*[Std. Error] = 0.30[0.01], t = 2.71, p = .007) and edible MCEs (*B*[Std. Error] = 0.42[0.12], t = 3.46, p = .001).

DISCUSSION

The current study suggests that the MCEQ is a psychometrically promising measure for assessing expectancies associated with using combustible, vaporizable, and edible MC. Exploratory and confirmatory factor analyses supported a 27-item, 2-factor structure reflecting positive and negative MCEs for each product type. Although many of the expectancies included in the MCEQ also are included in recreational cannabis measures, the combination of MCEQ items is unique, and all five items that were developed to assess positive effects of using MC were retained. MCEs were scalar measurement invariant for product type, sex, and reasons for MC use. MC users generally held more positive MCEs for combustibles than for vaporizables or edibles and fewer negative MCEs for vaporizables compared to combustibles and edibles. The fact that MC users held different expectancies based on product type suggests that it is important to assess specific MC products rather than using inclusive terminology like "medical marijuana." Further, individuals who reported using MC for both medical and recreational reasons reported more positive MCEs for all products compared to individuals who used for medical purposes only, which is consistent with motivations for recreational use. No significant differences in MCEs were observed based on sex.

When MCEs were examined by product preference, individuals who preferred combustible cannabis held more positive and fewer negative combustible MCEs compared to users who preferred other products. These findings were consistent with the hypothesis that individuals who prefer a given product should be more likely to hold more positive and fewer negative expectancies for that product. However, the hypothesis was only partially supported for individuals who preferred vaporizables or edibles. These individuals reported stronger MCEs associated with their preferred product but no differences in negative MCEs were observed. These findings likely are linked to the fact that MC users generally reported few negative MCEs across products, which resulted in limited variability.

When considered in concert, the results of the unadjusted correlations and GLMs were partially consistent with our hypotheses. As predicted, preference for and more positive MCEs associated with using a given product were associated with more frequent use of that product compared to the other products. Although we anticipated that holding fewer negative MCEs for a given product also would be associated with more frequent use of that product, this relationship was observed only for vaping. These results suggest that product preference and positive MCEs are more informative for predicting the frequency of MC use than are negative MCEs or demographics. With regard to quality of life, unadjusted correlations showed that positive MCEs for all products were associated with an increased quality of life since starting to use MC within the total sample. However, MCEs generally were not associated significantly with quality of life when examined by product preference or after accounting for demographic covariates and product use frequency. These findings may be linked to the fact that multiple conditions were combined together to form the categories used in

the current study (e.g., Mental Health Conditions; Sleep Problems) and that some participants were using MC for conditions for which there is limited or no scientific evidence to support the use of MC. For example, although evidence on the efficacy of MC for treating symptoms of depression is mixed (e.g., Walsh et al., 2017), a recent study of psychiatric patients found that marijuana use exacerbated depression and anxiety symptoms and led to overall poorer physical health (Bahorik et al., 2017). Similarly, research findings on the utility of cannabinoids for treating insomnia have been inconsistent (e.g., Gates et al., 2011; Whiting et al., 2015).

Finally, the study findings generally were consistent with the hypothesis that holding more negative MCEs for each product would be associated with experiencing more negative cannabis consequences. However, only negative MCEs associated with combustibles and edibles were associated with experiencing more negative consequences above and beyond covariates. Of note, product preference was not significantly related to negative consequences, suggesting that product preference may be a more relevant construct for understanding the frequency of MC use.

The study findings should be considered in light of several limitations. Importantly, qualitative research (e.g., focus groups with MC users) was not conducted as part of the development of the MCEQ. Thus, the MCEQ may not assess the full range of positive and negative expectancies associated with using MC products, and some items may not be regarded as applicable to some MC users. Further, the current study relied on self-report data which may be limited by participants' willingness and ability to provide accurate responses. Given the online nature of the study, we could not confirm that participants were MC users who held a valid "medical marijuana card." Also, our sample comprised American, adult Qualtrics panel members, which may limit generalizability. However, relying on panel members also may be a strength because members are motivated to provide high quality data in order to remain panelists. To this end, there were very little missing data and no evidence that participants provided inaccurate responses. We also used a dichotomous scoring format for the MCEQ, which decreased participant burden but resulted in an inability to assess the strength of MCEs. Future research should investigate the psychometric properties of the MCEQ when a rating scale is used. Further, given that 90% of individuals who reported vaporizing MC had vaporized both concentrates and flower, we collapsed vaporizing concentrates and flower into a single category. Related to this issue, the MCEQ did not differentiate between vaping concentrates and flower when assessing vaping MCEs. Unfortunately, these limitations conflate mode of administration with product type, which may be problematic given that concentrates and flower can differ on a number of characteristics including THC content. As such, future research is needed to evaluate whether MCEs differ for vaporizing MC concentrates and flower. In addition, the restricted range of self-reported negative consequences, while consistent with prior research (e.g., HelloMD, 2016), may have reduced statistical power to detect effects. Further, the consequences measure we used did not differentiate between products. In addition, we did not assess positive subjective MC effects or positive consequences of MC use using a validated measure. Thus, future research is needed to evaluate whether the current findings extend to product-specific negative and positive MC use consequences. Finally, the study design did not permit an assessment of the full range of psychometric properties for the MCEQ. Longitudinal research is needed to evaluate the predictive validity of the MCEQ, and a repeated-measures design is needed to evaluate test-retest reliability.

Despite its limitations, we found preliminary psychometric support for using the MCEQ to assess adult MC users' expectancies associated with using combustible, vaporizable, and edible MC. In light of the continued growth of MC use in the United States and abroad, having measures that are dedicated specifically to assessing constructs related to MC use may have incremental utility for informing clinical and research efforts in this burgeoning area above and beyond measures of recreational cannabis use. Further, given the documented differences between MC products (e.g., delayed onset of effects associated with consuming edibles), the ability to differentiate between products may provide a more comprehensive understanding of MC use. That said, future research is needed to evaluate whether the MCEQ has utility for

assessing MCEs in other populations (e.g., adolescents; international MC users) and for other types of MC products (e.g., tinctures). Additional research also is needed to evaluate whether the MCEQ items can be used to assess subjective effects of MC use. In the meantime, researchers who are interested in MC are encouraged to consider using the MCEQ.

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Appendix. The Medical Cannabis Expectancy Questionnaire

Instructions. Please indicate whether you expect to experience each effect when smoking marijuana, vaping marijuana, and/or eating edibles. For example, if you expect to feel confused when you smoke marijuana or eat edibles but you do not expect to feel confused when you vape marijuana, you would only check off the boxes for 'smoking marijuana' and 'eating edibles.' If you have never used one or more of these products (e.g., you have never vaped marijuana), please indicate how you think you would feel if you were to use it.

	Smoking	Vaping	Edibles
Confused	☐	☐	☐
Unable to Concentrate	☐	☐	☐
Paranoid	☐	☐	☐
Jumpy	☐	☐	☐
Anxious	☐	☐	☐
Depressed	☐	☐	☐
Out of Control	☐	☐	☐
Dizzy	☐	☐	☐
Nauseous	☐	☐	☐
Guilty	☐	☐	☐
Hear/see things that aren't really there	☐	☐	☐
Cry	☐	☐	☐
Irritable	☐	☐	☐
Happy	☐	☐	☐
Energetic	☐	☐	☐
Creative	☐	☐	☐
Euphoric	☐	☐	☐
Mellow	☐	☐	☐
Sociable	☐	☐	☐
Confident	☐	☐	☐
Increased Sex Drive	☐	☐	☐
Relaxed	☐	☐	☐
Pain Relief	☐	☐	☐
Hungry	☐	☐	☐
Settled Stomach	☐	☐	☐
Calm	☐	☐	☐
Sleep Better	☐	☐	☐