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Online personalized feedback intervention for cannabis-using college students reduces cannabis-related problems among women☆

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HIGHLIGHTS

- Tested a problem-focused online personalized feedback intervention (PFI).
- There was no main effect of condition on follow-up cannabis use.
- Gender moderated the relationship between condition and follow-up problems.
- Women in the PFI condition reported fewer problems than women in the control condition.
- Cannabis PFIs may reduce cannabis use-related problems among women (not men).

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ABSTRACT

There is growing evidence that college cannabis use is associated with use-related problems, yet efforts to reduce cannabis-related problems via online personalized feedback interventions (PFIs) have had limited success in significantly reducing risky cannabis use among college students. However, men and women may respond differently to such interventions and failure to examine effects of gender may obfuscate intervention effects. Thus, the current study tested intervention effects (moderated by gender) of an online, university-specific PFI for high-risk cannabis users (i.e., past-month cannabis users with at least one recent cannabis-related problem) who were randomly assigned to an online PFI (n = 102) or an online personalized normative feedback-only condition (PNF-only; n = 102). Gender moderated the relationship between condition and one-month follow-up problems, such that women in the PFI condition reported fewer cannabis-related problems at follow-up than women in the PNF-only condition. Men in the PFI condition did not significantly differ from men in the PNF-only condition on use-related problems at follow-up. Cannabis PFIs may be efficacious for reducing cannabis use-related problems among undergraduate women (but not men) and women may benefit from online interventions that include problem-focused components.

1. Introduction

Over one-third of college-aged students endorse past-year cannabis use (Schulenberg et al., 2017). Further, 90.8% of past-month cannabis users experiencing at least one cannabis-related problem (Pearson, Liese, & Dvorak, 2017) and one-fourth of past-month users meeting DSM-IV criteria for cannabis use disorder (CUD; Caldeira, Arria, O'Grady, Vincent, & Wish, 2008). College students are an at-risk population for cannabis-related problems; therefore, it is important to develop evidence-based interventions to target cannabis-related problems.

Online personalized feedback interventions (PFIs) may be one strategy to target cannabis problems among undergraduates, as online PFIs are brief, low-cost, and easily distributable. Alcohol-focused PFIs successfully reduced risky alcohol use among college populations (for review, see Miller et al., 2013) and typically include personalized normative feedback (PNF) on alcohol use norms and other alcohol-specific components. Cannabis PFIs for undergraduates have been modified from alcohol PFIs and typically contain PNF on cannabis use norms and information about risks/consequences associated with cannabis use (e.g., Elliott, Carey, & Vanable, 2014). Although interventions for risky cannabis use containing PNF have decreased descriptive

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Table 1
Demographic and baseline characteristics of sample by condition.

	Total (N = 204)	PNF-Only (n = 102)	PFI (n = 102)	F or χ^2	p	d or Cramer's V
Age	19.83 (1.43)	19.85 (1.53)	19.81 (1.31)	0.04	0.845	0.03
Gender (% female)	77.0%	74.5%	79.4%	0.69	0.406	0.06
Sexual orientation (% heterosexual)	84.8%	84.3%	85.3%	0.05	0.997	0.02
Gay or Lesbian (%)	2.9%	2.9%	2.9%			
Bisexual (%)	10.3%	10.8%	9.8%			
Other (%)	2.0%	2.0%	2.0%			
Race/Ethnicity (% White/Non-Hispanic)	71.1%	69.6%	72.5%	0.03	0.871	0.02
White/Hispanic (%)	5.4%	6.9%	3.9%			
African American/Non-Hispanic (%)	13.2%	13.7%	12.7%			
African American/Hispanic (%)	0.5%	0.0%	1.0%			
Asian (%)	2.9%	2.9%	2.9%			
Multiracial/Non-Hispanic (%)	4.4%	4.9%	3.9%			
Multiracial/Hispanic (%)	1.5%	1.0%	2.0%			
Other (%)	1.0%	1.0%	1.0%			
Class standing (% first year)	28.9%	28.4%	29.4%	7.58	0.104	0.19
Second year (%)	25.0%	24.5%	25.5%			
Third year (%)	29.4%	12.7%	33.3%			
Fourth year (%)	13.7%	15.7%	11.8%			
Fifth year (%)	2.9%	5.9%	0.0%			
% involved in Greek life	31.4%	27.5%	35.3%	1.46	0.227	0.09
% not receiving substance use treatment	99.5%	99.0%	100.0%	1.01	0.316	0.07
% with family substance use history	49.5%	48.0%	51.5%	0.18	0.674	0.03
Past-month cannabis use frequency	3.93 (2.97)	3.95 (2.94)	3.90 (3.02)	0.01	0.907	0.02
Number of past three-month cannabis use-related problems	7.99 (5.26)	7.89 (5.27)	8.09 (5.28)	0.07	0.791	0.04

norms, defined as an individual's perception of the frequency of others' cannabis use (e.g., Palfai et al., 2014), these interventions only reduced cannabis use frequency or cannabis-related problems among certain subgroups of college cannabis users, e.g., those with higher readiness to change at baseline (Palfai, Tahaney, Winter, & Saitz, 2016), family history of substance use (Lee, Neighbors, Kilmer, & Larimer, 2010), or heavy users (Riggs et al., 2018).

Given that PFIs for college samples do not seem to be as effective for decreasing cannabis use (e.g., Elliott et al., 2014) as they have been for decreasing alcohol use (for review, see Miller et al., 2013), it is important to consider cannabis-specific factors that could help improve the efficacy of cannabis-focused PFIs for undergraduates. As current (past-month) college cannabis users report experiencing an average of eight separate use-related problems in the past month (Pearson et al., 2017), it may be especially important to include PFI components that specifically target maladaptive beliefs related to risky cannabis use and use-related problems. Risk perception may be one problem-related target because risk perception is a leading indicator of cannabis use and changes in risk perception are related to changes in cannabis use (Bachman, Johnston, & O'Malley, 1998). Cannabis-related problem normative beliefs (an individual's perception of the quantity of cannabis-related problems experienced by others) may be another novel target for cannabis users. Cannabis-using students tend to overestimate others' use-related problems which is related to experiencing more problems themselves (Ecker, Richter, & Buckner, 2014). However, we know of no studies including problem norms as an intervention component.

Lack of impact of online cannabis-specific PFIs in the literature may also be due to failure to examine the impact of such interventions by gender. Although few studies on PFIs for cannabis use examine the role of gender, undergraduate women who completed e-TOKE, a commercially-available online cannabis-specific PFI, were more likely than men to make positive behavioral changes by increasing their use of protective behavioral strategies (PBS; Riggs et al., 2018) and undergraduate women who completed e-TOKE (compared to those in an assessment-only condition) reported fewer DSM-IV symptoms of cannabis abuse at follow-up whereas undergraduate men in the PFI condition reported more symptoms than those in the assessment-only condition (Elliott et al., 2014). However, there was no main effect of condition in either study – thus, failure to examine gender moderation effects would have obfuscated the impact of e-TOKE on women. Hence, in investigating the utility of a problem-focused online PFI for cannabis, it is important to test whether outcomes vary as a function of gender.

Online PFIs containing information on cannabis risks (e.g., driving under the influence, physical, cognitive, and mental health risks, academic risks) and PNF decreased descriptive norms (Elliott et al., 2014; Elliott & Carey, 2012; Palfai et al., 2014) but did not reduce cannabis use or cannabis-related problems. Thus, the current study sought to improve the efficacy of online cannabis PFIs by testing whether adding additional information on cannabis risks (e.g., legal consequences, low productivity/energy, procrastination, quality of life impairment) and two novel problem-focused components (i.e., PNF on cannabis problems and personalized risk for CUD) would impact cannabis use and problem outcomes among high-risk college cannabis users (i.e., current cannabis users with at least one cannabis-related problem). We tested our modified PFI against a PNF-only condition, given that PFIs containing PNF have not reduced cannabis use or related problems (Elliott et al., 2014; Elliott & Carey, 2012; Palfai et al., 2014). Given that online PFIs for cannabis may be more effective for college women than college men (Elliott et al., 2014; Riggs et al., 2018), we hypothesized that gender would moderate the relationship between condition and outcomes (i.e., cannabis use frequency, cannabis-related problems) such that among women, the PFI would be associated with better outcomes than the PNF-only condition.

2. Method

2.1. Participants and procedures

Participants were 204 current undergraduates who endorsed past-month cannabis use and experienced at least one recent (past three-month) cannabis use-related problem. See Table 1 for baseline sample descriptives. Most participants were recruited via the psychology department's online research pool (93.5%) and the remainder were recruited via flyers on campus. The study was advertised to all potential participants as a two-part study on marijuana use. To recruit participants at varying levels of readiness to change cannabis use, we did not advertise that it was an intervention study. Participants were informed that they would be randomized to one of two conditions: a PNF-only condition, which provided personalized feedback on cannabis use and

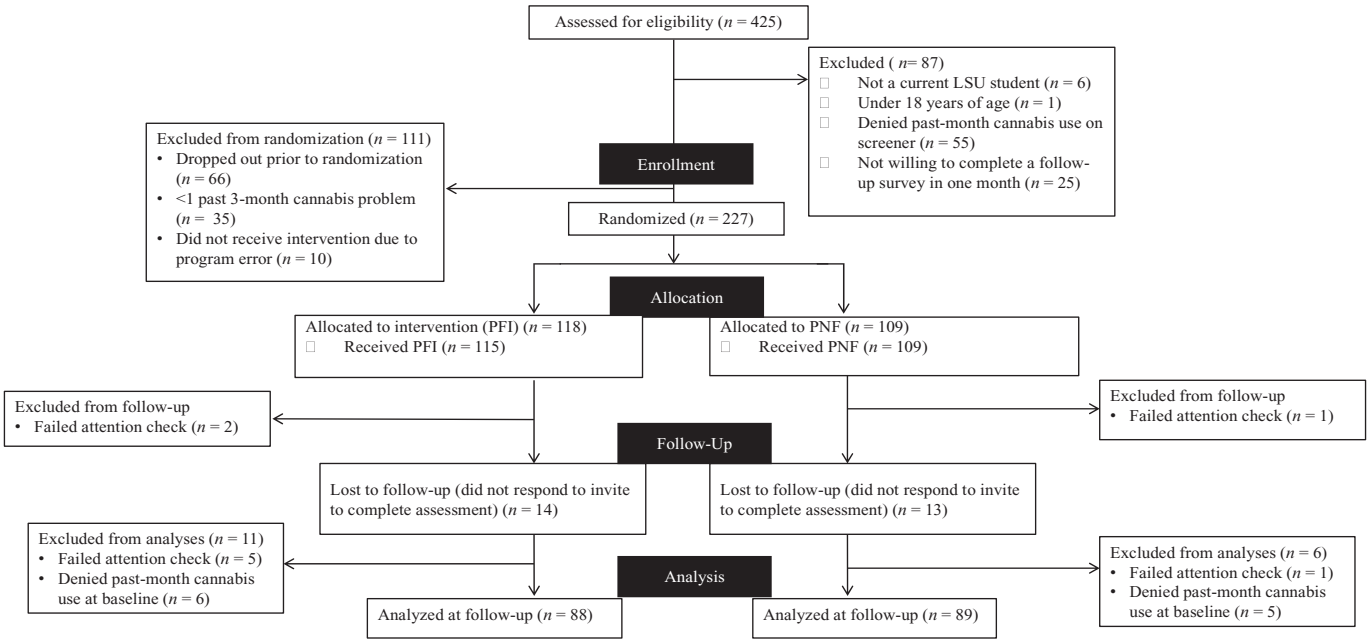

Fig. 1. Participant flowchart following Consolidated Standards of Reporting Trials guidelines.
Note. Results remained the same when we included the 11 individuals who did not report any past-month during baseline, despite endorsing past-month cannabis use on the screening survey.

use of other students at the university, or a PFI condition, which provided personalized feedback and information on cannabis use risk. The study was approved by the university's institutional review board and we obtained a Certificate of Confidentiality from the National Institute of Mental Health.

Participants first completed a brief screening survey to determine eligibility. Eligible participants were then directed to the baseline assessments after which they were randomized via Qualtrics to condition. The follow-up survey was completed approximately one month after baseline. Participants were compensated with research participation credits or $10 for baseline and $20 for follow-up. All participants who finished both surveys were entered into a drawing for a chance to win one of 3 cash prizes. Participant flow is depicted in a CONSORT flow diagram in Fig. 1. We excluded individuals who denied past-month use at baseline given that an inclusion criterion of the study was past-month cannabis use.

2.2. Intervention conditions

2.2.1. PNF-only condition

Per Lee et al. (2010), the PNF-only condition included PNF concerning: 1) participants' past-month cannabis use frequency; 2) perceived cannabis descriptive norms of other LSU students who use cannabis; and 3) information regarding actual norms for LSU students who use cannabis. Normative data were obtained from a sample of approximately 230 LSU undergraduate students who endorsed past-month cannabis use (Buckner, Lemke, & Walukevich, 2017).

2.2.2. Personalized feedback intervention (PFI)

The PFI included PNF and feedback pertaining to cannabis problem risk including: (1) risk related to cannabis use; (2) personalized feedback on cannabis-related problem norms obtained from a sample of approximately 230 LSU undergraduate students who endorsed past-month cannabis use (Buckner et al., 2017), and (3) risk for CUD. These components were randomized to control for order presentation effects.

2.3. Measures

Past-month cannabis use frequency was measured at baseline and follow-up using the Marijuana Use Form (MUF; Buckner, Bonn-Miller, Zvolensky, & Schmidt, 2007) using a 0–9 rating scale (0 = *once per month or less*, 5 = *5–6 times per month*, 9 = *21 times per week or more*). This measure demonstrated good convergent validity with ecological momentary assessment of cannabis use (Buckner, Crosby, Silgado, Wonderlich, & Schmidt, 2012).

Cannabis use-related problems were measured using a modified version of the *Marijuana Problems Scale* (MPS; Stephens, Roffman, & Curtin, 2000), a 19-item self-report questionnaire which asks participants to rate each item from 0 (*no problem*) to 2 (*serious problem*) to assess use-related problems (past 90-day problems at baseline, past-month problems at follow-up). The MPS was modified for the current study to contain an additional 13 items (e.g., problems with appetite/hunger) derived from a sample of 300 cannabis users who self-reported problems related to their use (Neighbors, 2014). Items scored 1 or 2 were counted to create a sum of cannabis-related problems, with higher MPS total scores indicating more cannabis-related problems (Lozano, Stephens, & Roffman, 2006). The original 19-item measure demonstrated convergent validity with DSM-IV symptoms of CUD (Farris, Metrik, Bonn-Miller, Kahler, & Zvolensky, 2016) and adequate consistency in prior work (Buckner, Ecker, & Cohen, 2010). The 30-item modified version[1] used in the current study demonstrated excellent internal consistency (baseline $\alpha = 0.96$, follow-up $\alpha = 0.98$).

To detect careless responding, 3 attention check questions were included in both baseline and follow-up surveys (e.g., “Please select ‘strongly agree’ as your answer to this question”). Participants were excluded from data analysis if they failed the attention check (i.e., answered 2 or more attention check questions incorrectly; Meade & Craig, 2012).

[1] The extended MPS is available from the first author by request.

2.4. Data analytic strategy

First, potential baseline differences between conditions and between study completers vs. non-completers conditions were tested (e.g., age, gender, race/ethnicity, baseline cannabis use frequency/use-related problems). Second, we tested whether conditions or genders differed on baseline and follow-up cannabis use frequency and use-related problems. Differences were tested using analysis of variance (ANOVA) for continuous dependent variables and chi-square analyses for categorical dependent variables.

Third, moderation analyses were conducted using the PROCESS macro for SPSS to test for main and interaction effects (Hayes, 2018). Separate models were constructed for follow-up cannabis use frequency and cannabis-related problems with condition as the predictor and gender (0 = *man* and 1 = *woman*) as the moderator. As cannabis use and cannabis-related problems at baseline are likely to be associated with their respective follow-up outcomes, baseline cannabis use frequency was included as a covariate in the follow-up cannabis use frequency model and baseline number of cannabis-related problems was included as a covariate in the follow-up number of cannabis-related problems model to provide a more unbiased estimate of the treatment effect. Covariates were centered to reduce multicollinearity.

3. Results

Inspection of the data revealed 27 participants were lost to follow-up.[2] One outlier was observed on baseline cannabis-related problems; we chose to retain this case without adjustment given that the case appeared to represent a genuine response (i.e., correctly answered all attention check items) and the results did not differ when the outlier was removed from analyses (Tabachnick & Fidell, 2013). No outliers were detected on follow-up use or problem variables. Conditions did not significantly differ on retention rates, χ^2 (1, N = 204) = 0.04, p = .836, φ = −0.01. Completers did not differ from non-completers on demographic variables or number of cannabis-related problems at baseline (ds = 0.09–0.41). Completers reported greater past-month cannabis use frequently than non-completers (M = 2.81, SD = 2.43), F (1,203) = 4.42, p = .037, d = 0.44. Conditions did not differ significantly on demographic variables, past-month cannabis use frequency, or use-related problems at baseline.

At baseline, women did not differ from men on cannabis use frequency, F(1,203) = 0.95, p = .330, d = 0.09, or number of cannabis-related problems, F(1,203) = 0.55, p = .460, d = 0.12. At baseline, men in the PFI condition did not differ from men in the PNF-only condition on cannabis use frequency or cannabis-related problems and women in the PFI condition did not differ from women in the PNF-only condition on cannabis use frequency or use-related problems. See Table 2 for baseline and follow-up variables stratified by gender and by condition.

The overall model including the main effects of condition and gender, the condition × gender interaction, and baseline cannabis use frequency as a covariate accounted for significant variance in follow-up cannabis use frequency, R^2 = 0.691, F(4, 172) = 96.194, p < .0001. Baseline cannabis use frequency was related to follow-up cannabis use frequency, (r = 0.83, n = 177, p < .0001). However, the main effects of condition, b = 0.389, SE = 0.548, t(172) = 0.710, p = .478, *95% CI* [−0.692, 1.470] and gender, b = 0.263, SE = 0.415, t(172) = 0.634, p = .527, *95% CI* [−0.556, 1.082] were non-significant, as was the condition × gender interaction, ΔR^2 = 0.000, F(1, 172) = 0.041, p = .839, b = −0.126, SE = 0.621, t(172) = −0.203, *95% CI* [−1.352, 1.100].

The overall model including the main effects of condition and gender, the condition × gender interaction, and baseline cannabis-related problems accounted for significant variance in follow-up cannabis-related problems, R^2 = 0.255, F(4, 172) = 14.750, p < .0001. Baseline problems were related to follow-up problems, (r = 0.47, n = 177, p < .0001. The non-significant main effects of condition, b = 1.748, SE = 1.450, t(172) = 1.206, p = .230, *95% CI* [−1.113, 4.610], and gender, b = 2.130, SE = 1.086, t(172) = 1.961, p = .051, *95% CI* [−0.014, 4.274], are qualified by a significant condition × gender interaction, ΔR^2 = 0.022, F(1, 172) = 5.033, p = .026, b = −3.690, SE = 1.645, t(172) = −2.243, *95% CI* [−6.936, −0.443]. Women in the PFI condition reported fewer cannabis-related problems at follow-up than women in PNF-only condition, b = −1.941, SE = 0.767, t(172) = −2.533, p = .012, *95% CI* [−3.454, −0.428]. Men in the PFI condition did not differ significantly from men in the PNF-only condition on number of cannabis-related problems, b = 1.748, SE = 1.607, t(173) = 2.029, p = .044, *95% CI* [0.089, 6.433].[3] The nature of the significant moderation is depicted in Fig. 2.

4. Discussion

The current study tested whether an online PFI designed to target cannabis use-related problems (compared to PNF-only) was related to less frequent cannabis use and fewer use related problems at follow-up. The significant moderation model indicated that the impact of the intervention varied as a function of gender. In our study, the effect of condition depends on whether participants were men or women. At follow-up, women in the PFI condition (compared to women in the PNF-only condition) reported fewer problems whereas men in the PFI condition did not significantly differ from men in the PNF-only condition.

Among women, cannabis-related problems, but not frequency of cannabis use, changed as a result of the problem-focused PFI, not the PNF-only condition. This adds to the growing literature that normative feedback about others' use does not appear to impact cannabis use frequency (Elliott et al., 2014; Elliott & Carey, 2012; Palfai et al., 2014). Findings extend prior suggesting that PFIs reduce DSM-IV symptoms of cannabis use among women (Elliott et al., 2014) by determining that a PFI that targets cannabis problems may be especially efficacious in reducing such problems among women. It may be that in response to the feedback concerning the severity of their cannabis-related problems, women may be engaging in more strategies to reduce or prevent risky cannabis use (i.e., PBS) in an attempt to manage problems related to cannabis use. In partial support of this hypothesis, women who were current cannabis users increased their use of PBS following an online, cannabis-specific PFI that contained information on cannabis-related PBS (Riggs et al., 2018), which may suggest women are more willing to make behavioral changes following a cannabis-related intervention.

Treatment-related differences between men and women may also explain these findings. Women endorse external reasons for change, such as experiencing cannabis-related problems (Sherman, Baker, & McRae-Clark, 2016), self-image/self-control, and health/social acceptability concerns (Chauchard, Levin, Copersino, Heishman, & Gorelick, 2013) whereas men seem to be motivated by internal reasons, such as self-efficacy (Sherman et al., 2016). Thus, women may more readily recognize a need to change cannabis use in response to a problem-focused PFI such as ours that targeted problems via personalized feedback about one's cannabis problems. Women in college may also be more likely than men to seek out cannabis use treatment online. Although help-seeking behaviors for cannabis use problems are rare among both undergraduate men and women (Caldeira et al., 2009), women endorse a greater likelihood of seeking out anonymous substance use resources,

[2] Results remained the same when baseline values were carried forward for the missing follow-up data.

[3] Without baseline number of use-related problems included as a covariate in the model, men in the PFI condition reported significantly greater cannabis-related problems at follow-up than men in the PNF-only condition.

Table 2
Baseline and follow-up characteristics of sample by gender.

Men						
	Total (N = 47)	PNF-only (n = 26)	PFI (n = 21)	F or χ^2	p	d or Cramer's V
Baseline past-month use frequency	4.30 (3.22)	4.08 (3.06)	4.57 (3.47)	0.27	0.606	0.15
Baseline number of past three-month cannabis use-related problems	8.49 (6.16)	7.19 (6.31)	10.10 (5.72)	2.67	0.109	0.48
	Total (N = 40)	PNF-only (n = 23)	PFI (n = 17)	F or χ^2	p	d or Cramer's V
Follow-up past-month use frequency	3.55 (3.00)	3.43 (3.04)	3.71 (3.02)	0.08	0.781	0.09
Follow-up number of past month cannabis use-related problems	5.13 (5.64)	3.74 (4.06)	7.00 (6.95)	3.48	0.070	0.57
Women						
	Total (N = 157)	PNF-only (n = 76)	PFI (n = 81)	F or χ^2	p	d or Cramer's V
Baseline past-month use frequency	3.82 (2.90)	3.91 (2.92)	3.73 (2.89)	0.15	0.699	0.06
Baseline number of past three-month cannabis use-related problems	7.84 (4.97)	8.31 (4.89)	7.57 (5.06)	0.50	0.480	0.15
	Total (N = 137)	PNF-only (n = 66)	PFI (n = 71)	F or χ^2	p	d or Cramer's V
Follow-up past-month use frequency	3.48 (3.07)	3.33 (2.90)	3.62 (3.24)	0.30	0.587	0.09
Follow-up number of past month cannabis use-related problems	5.16 (5.00)	6.29 (5.48)	4.11 (4.27)	6.76	0.010	0.44

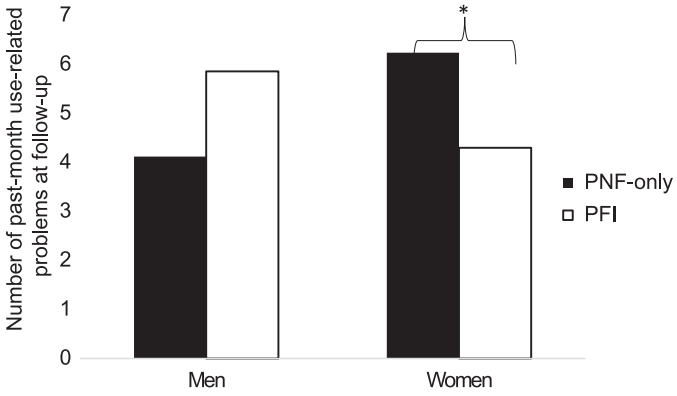

Fig. 2. Gender moderated the relationship between condition and number of cannabis use-related problems at follow-up. Men in the PFI condition did not differ significantly men in the PNF-only condition, whereas women in the PFI condition reported significantly fewer problems than women in the PNF-only condition at follow-up. *$p < .05$.

such as internet or computer-based treatment programs (Buscemi et al., 2010). The online intervention format of the current PFI may be one way to target women with cannabis-related problems who may not seek traditional in-person cannabis use treatment for cannabis problems.

Results should be interpreted in light of limitations. The majority of the sample was non-Hispanic White female undergraduates and future work may benefit from a more diverse sample of cannabis users. Future work would benefit from including other methodologies (e.g., ecological momentary assessment) and longer follow-up timeframes to test the longer-term impact of these interventions.

In sum, findings suggest that a PFI targeting cannabis problems reduced cannabis-use related problems among women but not men. These interventions may be useful for women whereas male cannabis users may benefit from alternative strategies to decrease risky cannabis use and related problems.

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Contributors

The data reported in this manuscript are from Katherine Walukevich-Dienst's Master's thesis completed under the supervision of Dr. Buckner. Ms. Walukevich-Dienst conducted the statistical analyses. All authors have agreed to authorship order and contributed to the final version of the manuscript.

Declaration of Competing Interests

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this paper.

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