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Are Changes in Negative Cannabis Expectancies, Peer Approval, and Perceptions of Dangerousness of Driving After Cannabis Use Associated with Changes in Instances of Driving After Cannabis Use Following a Mobile-Phone Based Intervention?

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ABSTRACT

Objective: Driving after cannabis use (DACU) has become an increasing public health concern nationwide. Although previous research has linked perceived peer approval, perceptions of dangerousness, and negative effect expectancies to DACU, no previous work has examined whether these constructs can be successfully targeted in an intervention or whether changes in these variables lead to changes in DACU. The present study is a secondary data analysis to investigate within-subject change and potential mechanisms of change in a pilot trial for a mobile phone-based intervention shown to significantly reduce DACU over time. **Method:** Participants were 66 emerging adults who completed the mobile-based intervention and provided 3-month follow-up data. Participants completed measures that assessed rates of DACU, negative cannabis expectancies, perceptions of dangerousness, and perceived peer-approval. **Results:** Results indicated that negative effect expectancies significantly increased from baseline to three-month follow-up, while perceived peer approval for DACU significantly decreased from baseline to three-month follow-up. Though significant within-subject change was found for all variables of interest, none of the variables of interest significantly mediated changes in instances of DACU over time. The results of the current study suggest that key variables associated with DACU-perceived peer approval and negative cannabis expectancies can be successfully targeted in a mobile-based brief intervention. **Conclusions:** Continued research investigating moderators and mediators of intervention outcomes is warranted.

Key words: = driving after cannabis use; interventions; cognitions

According to data from the National Institute on Drug Abuse, 43.6% of young adults (ages 19-30) reported past year cannabis use, which is the highest rate in the last 36 years (Patrick et al., 2023). In the past ten years, there has been an approximately 2% increase in past-year cannabis use among college students and a 9% increase in past-year cannabis use among same aged non-college peers. Daily use of cannabis has also been on the rise among both college and non-college young adults, with 14.5% of non-college students reporting daily use vs. 4.7% of college students

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(14.5% vs. 4.7%; Patrick et al., 2023). Given the rise in both lifetime and daily cannabis use among young adults, increased research on the consequences of cannabis use is vital. Of specific concern, more people are engaging in driving after cannabis use (DACU), such that in 2022, 4.7% of U.S. residents (11.7% aged 21-25; 6.3% aged 16-20) reported driving while impaired by cannabis (Center for Behavioral Health Statistics and Quality, 2023). Previously identified DACU-related cognitions that may impact the likelihood of DACU are perceptions of dangerousness of DACU, perceptions of peer approval of DACU, and cannabis effect expectancies (Arterberry et al., 2017; Beaulieu-Thibodeau et al., 2023; Sterzer et al., 2022; Wickens et al., 2019). This study aims to investigate the connection between perceptions of dangerousness, perceptions of peer approval, and cannabis effect expectancies and DACU among young adults. Specifically, the present study aims to examine whether a brief DACU intervention resulted in changes in perceived peer-approved and negative effect expectancies and whether changes in DACU-related cognitions mediated changes in instances of DACU over time.

Rates of DACU are especially high among young adult cannabis users (ages 19-22). Whitehill and colleagues (2014) found that undergraduate students who reported using cannabis had a higher prevalence of DACU (31.3%) compared to the reported frequency of alcohol using students driving after drinking (6.8%). Additionally, cannabis users were also more likely to ride with a cannabis impaired driver (45.3%) compared to alcohol users riding with a drinking driver (15.6%). Several other studies have shown a similar trend in rates of cannabis users engaging in DACU compared to alcohol users engaging in driving after drinking (Center for Behavioral Health Statistics and Quality, 2023; NIDA, 2018; O'Malley & Johnston, 2013). Given the high rates of DACU in this age group and the potential for fatal consequences, it is extremely important to identify risk factors for DACU that can be used as intervention targets.

McCarthy and colleagues (2007) reported several cognitive predictors of DACU. These include perceptions of dangerousness of DACU and peer norms surrounding cannabis use. They found that among cannabis using individuals, perceptions of dangerousness and peer norms were associated with DACU. Specifically, cannabis users were more likely to engage in DACU if they perceived their friends to be okay with it or if they perceived it as less dangerous. Additionally, cannabis effect expectancies also play an important role in the decision to engage in DACU. Cannabis expectancies include physiological and psychological effects one might expect to experience after using cannabis and can be both positive and negative. Positive cannabis effect expectancies often can create positive feelings and associations with cannabis use. Conversely, negative cannabis effect expectancies are effects that are associated with negative feelings or experiences (Schafer & Brown, 1991). Several previous studies have found links between negative cannabis expectancies and likelihood of DACU (Arterberry et al., 2013; King et al., 2020).

Many studies have utilized brief interventions (BIs) containing personalized feedback to reduce cannabis use and related problems by identifying and correcting faulty normative beliefs to increase motivation to change a problematic substance-related behavior (Halladay et al., 2019). Halladay and colleagues (2019) reviewed the literature on the effects of brief interventions for cannabis use among young adults and found that many brief interventions that included feedback specified for the individual (personalized feedback) were more successful than interventions that did not include this component. Studies included in their review utilized brief interventions that were aimed at reducing cannabis use and associated problems. One of the features that was consistent among different brief interventions reviewed was giving personalized feedback to the individuals about their substance use patterns and how their beliefs compared to their peers' beliefs. This personalized normative feedback is useful in helping the individual correct faulty normative beliefs. Personalized feedback also typically informs the individual about their problematic patterns of use and provides strategies for low-risk substance use. Although these types of brief interventions have shown some promise in reducing symptoms of cannabis use disorder, only one pilot study (using the present dataset) has examined whether a similar brief intervention approach could be used specifically to reduce DACU. Teeters and colleagues (2022) found that the mobile-based brief intervention described in the method section below resulted in 1) increased perceptions of

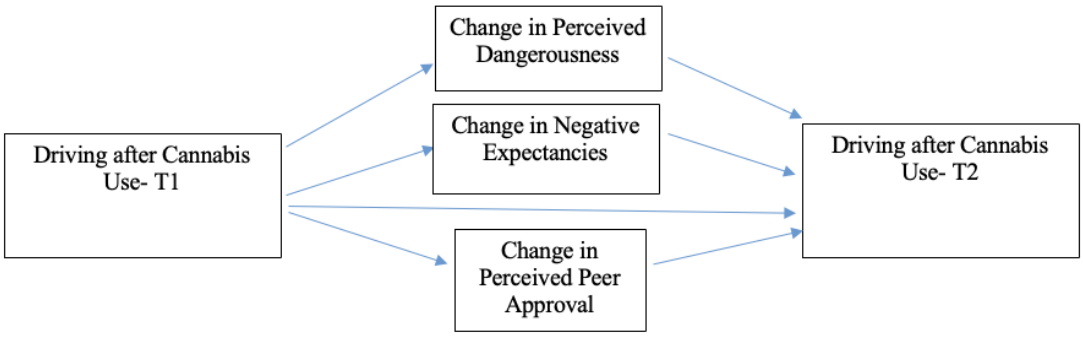
dangerousness of DACU (Teeters et al., 2021) and 2) decreases in DACU and riding with a cannabis-impaired driver (Teeters et al., 2022). Results from the pilot study suggest that the intervention could increase perceptions of dangerousness related to DACU and reduce instances of DACU over time. However, Teeters and colleagues (2021) did not examine whether changes in perceptions of dangerousness mediated changes in instances DACU over time. Additionally, it is important to measure changes in other intervention targets, such as perceived peer approval and negative effect expectancies, and test these as potential mediators of intervention outcomes. The present study uses previously published data from the personalized feedback intervention conditions of the pilot trial to attempt to examine whether changes in instances of DACU were mediated by changes in perceptions of dangerousness, perceived peer approval, and negative effect expectancies.

Identifying mechanisms underlying effects found in brief cannabis intervention studies represents a major gap in the literature. Many of the studies reviewed above include multiple components that target various mechanisms, and it is unclear which parts of the interventions led to behavior change. Given the research reviewed above, it is clear that perceptions of dangerousness, perceived peer approval, and negative cannabis expectancies influence decisions to use cannabis and to drive after use, but it remains unclear whether targeting and changing these DACU-related cognitions would lead to reductions in instances of DACU over time.

Rationale for the Current Study

Given the gap in current literature on mechanisms underlying change in brief cannabis interventions and the increase in individuals using cannabis and engaging in DACU, creating and deploying feasible and effective interventions targeting DACU is critical to ensure that fewer people engage in risky cannabis-related behaviors. Informing cannabis users about the impairing effects cannabis has on driving abilities is also an important step in changing the widespread belief that cannabis has little to no effect on driving ability. Interventions that create personalized feedback can help individuals become more aware of their beliefs about cannabis and their cannabis use behaviors and can lead to increased motivation to change. Research examining mechanisms of change in brief intervention studies is needed to ensure that individuals are receiving the most efficacious interventions and that resources are being used to fund the most effective interventions. Therefore, the current study aims to address this by investigating 1) if a mobile based brief intervention can increase negative cannabis effect expectancies and lower perceived peer approval of DACU and 2) whether changes in DACU-related cognitions (perceptions of dangerousness, perceived peer approval, and negative cannabis expectancies) mediate changes in instances of DACU over time. This hypothesized mediation model can be seen in Figure 1.

Figure 1. *Hypothesized Mediation Model of Change in Negative Expectancies/Perceptions of Dangerousness/Perceived Peer Norms Mediating Rates of Driving After Cannabis Use from Baseline to Three-Month Follow-Up.*



METHODS

Participants

The sample for this study comes from a randomized pilot trial examining efficacy of a mobile based brief intervention aimed at reducing DACU (clinicaltrials.gov NCT03496129). The primary specific aim of the pilot trial was to determine whether the intervention resulted in significantly greater reductions in instances of DACU compared to an educational control condition. For the present study, data comes from the personalized feedback + interactive text messaging condition (PF + MIT; the condition that received an intervention including personalized feedback and interactive Motivational Interviewing style text messages; described below), and the personalized feedback only condition (PF; the condition that received only personal feedback regarding their substance impaired driving responses from the survey; described below). Data from 66 participants were analyzed for this secondary data analysis. Participants were 65.2% women, 30.3% men, and 4.5% identified as "other." They were 78.8% Caucasian, 4.5% Black, 1.5% Hispanic or Latino, 1.5% Asian, 9.1% multi-ethnic, and the remainder identified as "other." The average age of participants was 21.80 (*SD* = 4.86). Regarding academic class, 15.2% were freshman, 15.2% sophomores, 30.3% juniors, 22.7% seniors, 12.1% were in graduate school, and 4.5% were not currently enrolled. Please see Teeters et al. (2022) for additional descriptions of study flow, including participant enrollment and participants lost to follow-up.

Measures

All measures were collected at baseline (prior to the intervention) and 3-month follow-up.

Demographics. Participants completed a brief questionnaire regarding age, race/ethnicity, gender, and class status.

Driving after cannabis use. Driving after cannabis use (DACU) was assessed at baseline and the 3-month follow up by asking, "In the past 3 months, how many times have you driven within 2 hrs. of using marijuana?"

Marijuana Effect Expectancy Questionnaire-Brief. The Marijuana Effect Expectancy Questionnaire-Brief (MEEQ-B; Torrealday et al., 2008) consists of a positive expectancy subscale that generalizes global positive effects of cannabis use (relaxation, social facilitation, and global positive effects), and a negative expectancy subscale that represents global negative effects of cannabis use (physical and psychological impairment). The MEEQ-B consists of 6-items that measure participants' level of agreement with assertions about marijuana's Positive Expectancies and Negative Expectancies (derived from the mean composite score of the 3 corresponding items). Participants rated items on a 5-point Likert Scale from 1 (disagree strongly) to 5 (agree strongly). An example of an item from the positive expectancy subscale is, "Marijuana helps a person relax and feel less tense (helps you unwind and feel calm)," and an example of an item from the negative expectancy subscale is, "Marijuana makes it harder to think and do things (harder to concentrate or understand; slows you down when you move)." Greater scores on the positive subscale of the MEEQ-B indicate that the individual endorses a stronger belief that using cannabis will have positive effects, while greater scores on the negative subscale of the MEEQ-B indicate that the individual endorses a stronger belief that using cannabis will have overall negative effects. In the present study, the MEEQ-B scales demonstrated low internal consistency at both baseline (positive: $\alpha = .56$; negative: $\alpha = .40$) and the three-month follow-up (positive: $\alpha = .66$; negative: $\alpha = .41$), which is consistent with previously published studies that have used the MEEQ-B (Aarons et al., 2001; Brackenbury et al., 2016).

Perceptions of dangerousness. Perceived dangerousness specific to DACU was measured using a 4-point Likert scale that ranges from 1 (not at all dangerous) to 4 (very dangerous) and was assessed by asking, ""How dangerous do you believe it is to drive after marijuana use?"

Perceived peer approval (friend and typical college student). Perceived peer approval was separated by perceived friend approval and perceived typical college student approval. Both perceived peer approval items were measured using a 7-point Likert scale that ranges from 1 (strongly disapprove) to 7 (strongly approve). Perceived friend approval was assessed by asking, "How much do you think your closest friends approve of driving a car after using marijuana?" To assess perceived typical college student

approval participants were asked, "How much do you think a typical student at your university approves of driving a car after using marijuana?"

Procedure

Prior to data collection, the pilot trial was reviewed and approved by the University Institutional Review Board. Participants were college students recruited at a mid-sized university in the southeastern United States. Participants in the pilot trial were recruited through a mass university-wide email, the university subject pool, and flyers posted on campus. Following an eligibility screener survey, eligible participants were contacted by phone by trained lab personnel and invited to participate. Eligible participants who wished to participate were then sent a 30-minute baseline questionnaire via text-message to be completed remotely on their mobile phone via a secure web server. After completing the battery of online measurements, participants were randomly assigned to one of three intervention conditions: personalized feedback + interactive text messaging intervention (PF + MIT), personalized feedback only (PF), and a substance use information intervention (IC), which served as the control group. Given that the present study focuses on the sample that received the personalized feedback, the personalized feedback only (PF) and personalized feedback with interactive text messaging (PF +MIT) conditions are described below. All data included in this manuscript come from the baseline assessment and 3-month follow-up assessments (collected between August 2018 and December 2019 and not impacted by the Covid-19 pandemic). Please see Teeters et al. (2022) for additional methodological details of the pilot trial.

Substance Impaired Driving Personalized Feedback Only (PF)

The participants that were randomized to the PF condition were sent a link to a secure site that contained feedback that was specific to their personal cannabis use, DACU frequency, and information regarding social norms surrounding DACU. Unlike the PF+MIT condition (described below), this condition did not receive the interactive text messaging component of the intervention.

Substance Impaired Driving Personalized Feedback + Interactive Text Messaging (PF + MIT)

The participants that were randomized to the PF +MIT condition were texted a link to a secure site containing feedback that was specified to their personal cannabis use, DACU frequency, as well as information regarding social norms surrounding DACU and cannabis use. Motivational Interviewing style interactive text messaging was included in this condition to help participants think more critically about their attitudes, expectancies, and perceptions of dangerousness surrounding DACU. Once the participants received the text message, they were instructed to respond back to the interventionist after they had completely read through their personalized feedback document. After receiving the confirmation text from the participant, the interventionist texted three open-ended questions that were (1) Of the information you just viewed, what was most interesting? (2) How would receiving a DUI impact your future career goals? (3) What is your plan for driving after substance use in the future? Once those were sent, based on the participant's response, the interventionist would engage in text messaging conversations with the participant to reflect and provide support and encouragement using Motivational Interviewing style. Often the conversations would consist of having participants come up with their own reasons for decreasing their engagement in DACU and included goal setting.

For both intervention conditions, negative effect expectancies, perceptions of dangerousness, and perceived peer approval surrounding DACU were targeted using the following feedback elements: feedback from the brief marijuana effect expectancies questionnaire that the participant endorsed during the survey (targeted negative expectancies), a percentile ranking of the individual's impaired driving rates compared to peers (targeted peer norms), a DUI information cost sheet, and a summary and infographic of research demonstrating driving related impairments associated with cannabis use (targeted perceptions of dangerousness).

Data Analysis Plan

Analyses were conducted using IBM SPSS Statistics (Version 28.0). These analyses represent a secondary data analysis of the previously published pilot trial (described above). Only data from participants assigned to Condition 1 & 2 (PF +MIT, PF) were analyzed, given that the aim is to investigate whether the personalized feedback interventions resulted in changes in DACU-related cognitions.

Paired samples *t*-tests were used to evaluate whether the intervention resulted in significant increases in negative expectancies and significant decreases in perceived friend and typical student approval of DACU. Mediation analyses using the MEMORE macro (Montoya, 2017) were conducted to examine whether changes in negative cannabis expectancies, perceptions of dangerousness, and perceived peer approval mediated intervention outcomes. MEMORE is a macro that estimates mediation models for two-instance repeated measures designs. The macro estimates the total, direct, and indirect effects of X on Y through the mediator M for mediation models. In order to determine if there is a mediation, the significance of the indirect effects is based on the confidence intervals (CI). MEMORE uses bootstrapping, Monte Carlo, or normal theory approaches in order to generate confidence intervals for inference about the indirect effect. There is a significant mediation when the CI values do not cross zero. If the values of the CI do cross or include zero, it is a nonsignificant mediation (Montoya, 2017).

RESULTS

Descriptive Statistics

On average, participants at baseline reported driving after cannabis use 24.7 times in the past three months (*SD* = 24.4). At the three-month follow-up, participants reported driving an average of 18.6 times in the past three-months (*SD* = 24.4). Means, standard deviations, and standard error means for the variables at baseline and three-month follow-up are shown below in Table 1.

Table 1. *Means, Standard Deviations, and Standard Error Means for Rates of Driving After Cannabis Use, Marijuana Effect Expectancy Questionnaire-Brief Negative Effect Expectancy Subscale, Perceptions of Dangerousness, and Perceived Peer Approval At Baseline And Three-Month Follow-Up*

Variable	Mean	*SD*	N	*SE*
T1 Driving after Cannabis Use	24.77	24.40	66	3.00
T2 Driving after Cannabis Use	18.59	24.40	66	3.00
T1 Negative Expectancies	9.06	2.08	66	.256
T2 Negative Expectancies	9.65	1.97	66	.243
T1 Dangerousness	1.59	.554	66	.068
T2 Dangerousness	1.77	.675	66	.083
T1 Friend Approval	4.89	1.28	66	.159
T2 Friend Approval	4.42	1.25	65	.155
T1 Student Approval	4.02	1.35	66	.167
T2 Student Approval	3.30	1.28	66	.157

Note. T1 = baseline, T2 = three-month follow-up

Paired samples t-test. Table 2 reports the results of the paired samples t-test. The results of the paired-samples *t*-test demonstrate that between baseline and the three-month follow-up, negative effect expectancies were significantly increased (t = -2.313, p = .012, Cohen's d = -.285). In regards to perceptions of peer approval, both friend and typical Western Kentucky University (WKU) student perceptions were significantly decreased from baseline to three-month follow-up (t = 3.237, p < .001, Cohen's d = .401 and t = 3.949, p < .001, Cohen's d = .486, respectively).

Table 2. *Paired samples t-test of Negative Effect Expectancies, Perceptions of Dangerousness, and Perceived Peer Approval from Baseline to Three-Month Follow-Up*

	Mean	*SD*	*SE*	Lower CI	Upper CI	*t*	df	One-sided *p*
T1 Negative Expectancies – T2 Negative Expectancies	-.591	2.08	.255	-1.10	-.081	-2.31	65	.012
T1 Dangerousness – T2 Dangerousness	-.182	.654	.081	-.343	-.021	-2.26	65	.014
T1 Friend Approval – T2 Friend Approval	.492	1.23	.152	.188	.796	3.24	64	<.001
T1 Student Approval – T2 Student Approval	.712	1.47	.180	.352	1.07	3.95	65	<.001

Note. CI = confidence interval, T1 = baseline, T2 = three-month follow-up

Mediation. The results of the indirect effect of the intervention on changes in times of DACU through changes in negative effect expectancies (standardized indirect effect = .22) had a confidence interval of [-2.06, 2.58]. The indirect effect of the intervention on changes of DACU frequency through changes in perceptions of dangerousness (standardized indirect effect = 1.22) had a confidence interval of [-.69, 4.43]. The results of the indirect effect of the intervention on changes in DACU through changes in perceived friend approval (standardized indirect effect = -.49) had a confidence interval of [-3.18, 3.99]. Lastly, the indirect effect of the intervention on rates of DACU through perceived typical WKU student approval (standardized indirect effect = -.24) had a confidence interval of [-3.10, 2.33]. All of these confidence intervals include zero, which indicates that negative effect expectancies, perceptions of dangerousness, and both perceived peer approval variables were not mediating this relationship. Please see Table 3 for the full mediation model.

Table 3. *The Indirect Association of Perceived Dangerousness, Negative Expectancies, Perceived Friend Approval and Perceived Typical Student Approval on Driving After Cannabis Use Over Time*

	B (*SE*)	*p*	95% C.I.: [LL, UL]
Outcome: Change in DACU Over Time (T1 DACU – T2 DACU)			
Intercept	4.30 (4.20)	.31	[-4.10, 12.69]
Negative Expectancies	-0.43 (1.92)	.83	[-4.28, 3.42]
Perceived Dangerousness	-7.90 (6.30)	.21	[-20.52, 4.71]
Perceived Peer Approval	0.99 (3.09)	.75	[-5.20, 7.19]
Perceived Typical College Student Approval	-0.35 (2.55)	.89	[-5.46, 4.75]

Direct effect of T1 DACU on T2 DACU	5.98 (3.39)	.31	[-4.10, 12.69]
Indirect effect of T1 DACU on T2 DACU via Changes in Negative Expectancies	.22 (1.10)		[-2.06, 2.58]
Indirect effect of T1 DACU on T2 DACU via Changes in Perceived Dangerousness	1.22 (1.33)		[-69, 4.43]
Indirect effect of T1 DACU on T2 DACU via Changes in Perceived Friend Approval	.49 (1.72)		[-3.18, 3.99]
Indirect effect of T1 DACU on T2 DACU via Changes in Perceived Peer Typical Student Approval	-.24 (2.65)		[-3.10, 2.33]
Total effect of the model	5.98 (3.39)	.08	[-.79, 12.76]

Note. B, Unstandardized regression coefficient; SE, Standard error; Confidence interval, 95%; LL, Lower limit; UL, Upper limit, DACU = Driving After Cannabis Use, T1 = baseline, T2 = three-month follow-up.

DISCUSSION

Driving after cannabis use is a significant public health concern, and with the increasing legalization of cannabis for medical and recreational purposes, research on DACU is needed now more than ever. The present study used data from a previously published pilot trial (see Teeters et al., 2022) of a mobile-phone based intervention with personalized feedback and interactive text-messages delivered in Motivational Interviewing style. Results have shown that the PF + MIT condition resulted in: 1) significant increases in perceptions of dangerousness of DACU (Teeters et al., 2021) and 2) significant decreases in DACU and riding with a cannabis-impaired driver compared to the substance information control condition (Teeters et al., 2022). Though the results from these studies have added to the literature on brief cannabis interventions, it remains unclear what led to the cognitive and behavioral changes. Said another way, it remains uncertain what components of the intervention contributed to successful intervention outcomes. The current study investigated negative effect expectancies, perceptions of dangerousness, and perceived peer approval as potential mediators given the previous literature showing a significant connection between these variables and DACU.

Our results showed that negative effect expectancies increased significantly following the personalized feedback interventions. Additionally, both perceived peer approval variables (perceived friend approval and perceived typical college student approval) decreased in both conditions. These findings are encouraging because it demonstrates that the intervention was effective at changing these cognitive perceptions of DACU, and while they may not have mediated the changes in DACU over time, the significant changes are noteworthy. Research is mixed on whether cognitive changes lead to behavior change (Dijkstra & Vries, 2001), but changing attitudes and cognitions represent a step in the right direction.

The hypothesis that the changes in negative effect expectancies, perceptions of dangerousness, and perceived peer approval would mediate a DACU intervention outcome was not supported, as shown by the results from the MEMORE mediation analysis. Although negative effect expectancies and perceptions of dangerousness significantly increased, and perceived peer approval significantly decreased from baseline to the three-month follow-up, none of these variables independently mediated the intervention outcomes. The nonsignificant mediation results may be the result of the intervention and feedback including several different components geared towards several cognitive mediators, which might have come together to lead to the change in times driving after cannabis use. It may be that components of the intervention are not working in

isolation to influence the reduction in DACU. The intervention targeted a combination of mechanisms that are interlinked. Therefore, it may be the combination of elements that led to changes in DACU, rather than specific mechanisms in isolation. Relatedly, different intervention components may have appealed to different individuals. While it is important to try to disentangle specific mechanisms underlying the effects in brief interventions, a paper conducted by O'Donnell (2022) argues that brief interventions themselves are actually complex, and the combination of the multiple components may lead to successful intervention outcomes. The complexity of the brief interventions and feedback could be contributing to the effects in the current study because of the multiple cognitive and behavioral targets that are within the intervention. For the current study, it could have been that small changes in negative expectancies combined with small changes in perceptions of dangerousness and perceptions of norms that mediated the intervention outcomes. Future research should examine the impact of the entire brief intervention targeting several cognitive mediators of DACU in comparison to interventions targeting only one cognitive mediator in order to isolate effective intervention components.

Limitations of the current study include that cannabis use, effect expectancies, perceptions of dangerousness, perceived peer approval, and rates of DACU were collected via retrospective self-report. The data may have been skewed due to biases from reporting sensitive substance use information. This could have negatively influenced accurate data reporting; however, the participants were reminded several times that their information was anonymous and that they could have refused to answer any questions they did not feel comfortable answering. Nonetheless, future studies should use either daily diary report of substance use or Ecological Momentary Assessment (EMA) to track substance use in a way that is more frequent and does not require participants to report substance use from months ago that they may not accurately remember. These methods reduce bias and reporting error due to the increased frequency of having participants complete assessments and can be done via apps or text messaging for efficiency and accessibility. Notably, the present study measured instances of driving after cannabis use in the past 3 months rather than driving impairment due to cannabis use. The measures used did not account for how much cannabis was used before driving, timeframe of use, type of product, potency of product used, or participant cannabis-use history (tolerance). It is extremely important that efforts are made in future research to include additional details related to cannabis use impairment in order to gain a more nuanced assessment of possible cognitive and behavioral changes that could impact driving behaviors.

Additionally, due to the COVID-19 pandemic, six-month follow-up data were not collected as planned in the original pilot study (Teeters et al., 2022). Having data six-months after the intervention would have provided more informative data regarding the change in expectancies, perceptions of dangerousness, perceived peer approval as well as change in DACU. This would have also shown the impact and duration of the effects from the intervention outcome to examine if this trend lasts beyond the three-month follow-up. Future studies would benefit greatly from collecting data at six months and a year post-intervention to examine the durability of the intervention effects.

Another potential explanation for the null mediation results in the present study is the sample size. Although the original pilot study was adequately powered to detect medium effects, mediation analyses were not planned as part of the original data analysis plan and were undertaken as secondary data analyses in the present manuscript. This is important, as the mediation models tested in the present study were likely not adequately powered to detect mediation effects. In the future, power analyses including suspected mediating variables should be conducted during intervention planning in order to make sure the sample size is large enough to detect these effects. Also, because the data were collected from a small sample of young adults in southwestern Kentucky, it cannot be fully representative of all young adults in Kentucky or other states, specifically where medical and recreational cannabis use is legal. Future studies should replicate the current study from a population in a state where cannabis is legal to examine any differences in perceptions, attitudes, and behaviors surrounding DACU. Additionally, this sample was not diverse in terms of racial and

ethnic diversity, and future interventions should aim to include a more diverse sample to get a better generalization of all cannabis users. On a related note, future adequately powered studies should consider including other relevant variables that may influence results such as state of residence (legal to purchase recreational and medical cannabis versus not legal, legal driving limit set versus no legal limit) and location of residence (living on campus versus off, living with roommates versus alone, living in a rural area versus an urban area with rideshare resources).

Despite these limitations, this study has significant relevance, as it is one of the first to examine the mediating role of negative cannabis effect expectancies, perceptions of dangerousness, and perceived peer approval on a brief intervention targeting DACU. The current study fills a gap in the literature by longitudinally examining a potential mechanism of change. Few studies have longitudinally assessed cannabis use and DACU, and none have assessed negative effect expectancies, perceptions of dangerousness, and perceived peer approval as mediators of this relationship. Several pieces of information from this study can be used to inform improvement of this text-based intervention prior to future trials. Because the intervention resulted in significant changes in DACU-related cognitions, it is clear that the intervention should be replicated in a larger, more diverse sample. Based on our findings, it appears that including information related to negative effect expectancies, perceptions of dangerousness, and perceived peer approval was helpful in altering DACU-related cognitions over time. This is especially important given past research showing that many emerging adults and other members of the public do not view DACU as dangerous or believe that they can compensate for impairment if they are indeed driving while high, leading to a permissive attitude toward DACU (Colonna et al., 2021). Concerningly, some individuals report that they believe using cannabis improves their driving abilities (Donnan et al., 2022). Due to the potentially damaging consequences that can occur when an individual drives after using an impairing level of cannabis, it is extremely important to identify factors that can changes beliefs and attitudes related to DACU, such as those identified in the present study.

Additionally, many participants in this intervention also reported driving after using other substances, mainly alcohol. Future studies should examine the effect of an intervention that targets polysubstance impaired driving and the role driving-related cognitions play in that especially risky behavior. Future research addressing polysubstance impaired driving is becoming increasingly needed as more individuals engage in the decision to drive after using multiple impairing substances. Increased understanding of the risky behaviors young adults are engaging in may help with creating better intervention and prevention techniques to keep more people on the road safe.

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