



Published in final edited form as:

*Psychol Addict Behav.* 2010 June ; 24(2): 265–273. doi:10.1037/a0018859.

## A Brief, Web-based Personalized Feedback Selective Intervention for College Student Marijuana Use: A Randomized Clinical Trial

Christine M. Lee, Ph.D., Clayton Neighbors, Ph.D., Jason R. Kilmer, Ph.D., and Mary E. Larimer, Ph.D.

Department of Psychiatry and Behavioral Sciences, University of Washington

### Abstract

Despite clear need, brief web-based interventions for marijuana using college students have not been evaluated in the literature. The current study was designed to evaluate a brief, web-based personalized feedback intervention for at-risk marijuana users transitioning to college. All entering first-year students were invited to complete a brief questionnaire. Participants meeting criteria completed a baseline assessment ( $N = 341$ ) and were randomly assigned to web-based personalized feedback or assessment-only control conditions. Participants completed three-month (95.0%) and six-month (94.4%) follow-up assessments. Results indicated that although there was no overall intervention effect, moderator analyses found promising effects for those with a family history of drug problems and, to a smaller extent, students who were higher in contemplation of changing marijuana use at baseline. Implications of these findings for selective intervention of college marijuana use and web-based interventions in general are discussed.

### Keywords

marijuana; personalized feedback intervention; college; emerging adult

## A Brief, Web-based Personalized Feedback Selective Intervention for College Student Marijuana Use: A Randomized Clinical Trial

Use of personalized feedback, often in the context of motivation enhancement interventions, has been successful in reducing a number of high-risk behaviors, including alcohol use among college students and marijuana use in adolescent and adult treatment populations. Surprisingly, similar interventions for college student marijuana use have not been widely developed or evaluated (Larimer, Kilmer, & Lee, 2005). The purpose of this research was to evaluate preliminary efficacy of a brief, web-based personalized feedback intervention for marijuana using students transitioning to college and to examine contemplation for change and family history of drug problems as potential moderators of intervention efficacy.

Marijuana is the most widely used illicit substance in the United States (Johnston, O'Malley, Bachman, & Schulenberg, 2008; Substance Abuse and Mental Health Services Administration,

---

Please direct all correspondence regarding this manuscript to Christine Lee, Department of Psychiatry & Behavioral Sciences, University of Washington, Box 354944, Seattle, WA 98195. Phone: (206) 543-6574, Fax (206) 616-1705, leecm@u.washington.edu.

**Publisher's Disclaimer:** The following manuscript is the final accepted manuscript. It has not been subjected to the final copyediting, fact-checking, and proofreading required for formal publication. It is not the definitive, publisher-authenticated version. The American Psychological Association and its Council of Editors disclaim any responsibility or liabilities for errors or omissions of this manuscript version, any version derived from this manuscript by NIH, or other third parties. The published version is available at [www.apa.org/journals/adb](http://www.apa.org/journals/adb)

2005) and is a growing public health concern (Hall & Babor, 2000). In addition to health issues (Solowij, 1998; Taylor et al., 2000), marijuana use is associated with academic consequences (Lynskey & Hall, 2000; Roebuck et al., 2004) and impaired driving and accidents (Kalant, 2004). Further, chronic use among emerging adults is associated with lower likelihood of graduating college, getting married, and maintaining employment (Schulenberg et al., 2005).

### **Marijuana Use and College: A Time of Risk**

College students appear to be at particular risk for marijuana use and related harm (Bachman, Wadsworth, O'Malley, & Johnston, 1997), with approximately one-third of college students reporting past year use (Gledhill-Hoyt, Lee, Strote, & Wechsler, 2000; Johnston et al., 2008). Additionally, first-year students have the highest prevalence of past-month marijuana use (Gledhill-Hoyt et al., 2000). Risk for marijuana initiation peaks around 18 years of age (Chen & Kandel, 1995; Wagner & Anthony, 2002), and highest use occurs between the ages of 19 to 22 (Chen & Kandel, 1995). Few studies have examined the impact of intervention efforts during this high-risk period, and those that do place alcohol as the primary focus (Larimer et al., 2005).

### **Motivational Interventions for Alcohol and Other Substance Use**

Most well-researched substance-use interventions with college students have targeted alcohol use, and involve motivational enhancement approaches (Miller & Rollnick, 2002), which can be used to explore and resolve ambivalence about change and often involve the provision of personalized feedback about the impact of use. Brief motivation enhancement interventions utilizing personalized feedback have been shown to be efficacious in an indicated prevention context with college student drinking up to four years post-intervention (e.g., Baer, Kivlahan, Blume, McKnight, & Marlatt, 2001; Borsari & Carey, 2000; Larimer et al., 2001; Marlatt et al., 1998, National Institute on Alcohol Abuse and Alcoholism, 2002).

Few published studies have tested the efficacy of brief, research-based prevention programs for marijuana on college campuses. Encouraging results from selective and indicated approaches targeting general college student drug use have been found (e.g., McCambridge & Strang, 2004; Miller, Toscova, Miller, & Sanchez 2001; White, Morgan, Pugh, Celinska, Labouvie, & Pandina, 2006), including effects on marijuana specifically. White and colleagues (2006) found an overall reduction in substance use and related problems (including marijuana frequency) in a group that received in-person brief interventions for drug, cigarette, and alcohol use and in a group that received written feedback with no in-person component (effects did not differ by group). While each of these studies focused on multiple drugs and/or had individual study limitations, together findings suggest motivational strategies may offer a promising approach for substance use prevention on college campuses, though more research is needed.

### **Web-Based Personalized Feedback Interventions**

Even without in-person contact, personalized feedback can be associated with reductions in problem behaviors (Agostinelli, Brown, & Miller, 1995; Borsari & Carey, 2000, Walters, Bennett, & Noto, 2000). The Internet is increasingly used to deliver health and risk behavior information due to cost-effectiveness, ability to personalize information, and accessibility (Strecher, Shiffman, & West, 2005; Muñoz, Lenert, Delucchi, et al., 2006). Tailored prevention or intervention materials (with or without personalized feedback) delivered through the Internet have included alcohol use (Chiauzzi, Green, Lord, Thum, & Goldstein, 2005; Neighbors, Lee, Lewis, Fossos, & Walter, 2009; Walters, Vader, & Harris, 2007), tobacco use (McDaniel & Stratton, 2006; Muñoz, Lenert, Delucchi et al., 2006; Strecher, Shiffman, & West, 2006), and alcohol use by smokers (Cunningham, Selby, & van Mierlo, 2006). More research is needed to evaluate the impact of such an approach and delivery format for marijuana.

## Factors Potentially Influencing Intervention Efficacy

Additionally, research is beginning to explore factors that influence the efficacy of college student alcohol interventions (Carey, Hanson, Carey, & Maisto, 2007; Fromme & Corbin, 2004; Mun, White, Morgan, 2009) to identify for whom interventions may be more or less efficacious. The current study extended this line of research to evaluate contemplation of change and family history of drug problems as moderators of marijuana prevention efficacy.

**Contemplation about changing behavior**—Prochaska and DiClemente (1986) suggest readiness to change (RTC) can vary both across individuals and within individuals over time, with stages of RTC including precontemplation (not considering change), contemplation (noticing reasons for concern or considering change), and action (actively making changes). Stephens and colleagues (2006) suggest that motivational enhancement approaches are well suited for working with individuals ambivalent about change (i.e., contemplating change) or those who would benefit from formalizing commitment to change. Research examining RTC as a moderator of BMIs has been mixed, with some studies suggesting higher RTC is associated with reductions in alcohol use (Carey et al., 2007; Fromme & Corbin, 2004; Mun et al., 2009) while other studies have found no evidence of moderation when other individual and situational factors were controlled (Carey et al., 2007; Mun et al., 2009). Given that MI interventions are theoretically appropriate for individuals contemplating change, we specifically evaluated baseline contemplation as a moderator of intervention efficacy.

**Family history of drug problems**—The role of family history (FH) of drug problems, a risk factor for substance use, abuse, and dependence (e.g., Merikangas et al., 1998), on intervention outcome has been virtually unexplored. Research suggests disorder severity may be greater for family history positive (FH+) individuals (Boyd, Plemons, Schwartz, Johnson, & Pickens, 1999). Studies of college student alcohol use show FH+ students cannot be differentiated from students with no family history of alcohol problems (FH-) but are at increased risk for alcohol use disorders later (Baer, Kivlahan, & Marlatt, 1995; Jackson, Sher, Gotham, & Wood, 2001).

A recent study found that family history moderated the efficacy of a group motivational alcohol intervention for college student women (Labrie, Feres, Kenney, & Lac, 2009, with FH+ participants reducing their alcohol use post-intervention, while no significant difference was found between FH- and control participants (Labrie et al., 2009). The authors suggest that FH+ women may have unique perspectives and self-awareness, through direct and indirect modeling, possibly making them more receptive of interventions. Given these findings, we were interested in whether family history was associated with differential marijuana intervention outcomes.

## Present Study

The current study builds on existing literature in support of motivational and personalized feedback approaches through evaluating efficacy of a web-based approach for selective prevention of marijuana during the transition from high school to college. We further evaluated potential moderators of efficacy including contemplation of change and family history. We hypothesized students randomized to the web-based intervention would evidence less marijuana use and fewer marijuana-related consequences relative to the control group at 3- and 6-month follow-up. We further hypothesized the effect of the intervention would be greater for participants more contemplative at baseline and for those who were FH+ for drug problems.

## Method

### Participants and Procedures

Approximately 4000 incoming students at a large public university in the northwest United States between the ages of 17 and 19 were recruited to participate in an online screening survey the summer prior to beginning college. In June of 2005, participants received a mailed letter and an email inviting their participation, describing the project, and detailing incentives, confidentiality protection, and rights as a participant in human subjects' research. Participants who were 17-years-old were eligible to participate with written parental consent. Participants logged onto the study website and read an online information statement detailing requirements of the study. Students who actively agreed to participate were invited to complete the screening survey, which consisted of measures about marijuana use, consequences of use, and other demographic and psychosocial measures ( $N = 2123$  students, response rate = 52.4%). The response rate for this survey is similar to other large scale surveys conducted on large public college campuses (e.g., Marlatt et al., 1998). Table 1 presents demographic characteristics of the initial invited sample, as well as those completing and not completing the survey. All study procedures were approved by the university IRB and a federal Certificate of Confidentiality was obtained from the National Institutes of Health. There were no adverse events reported.

Eligibility for the current longitudinal trial was any use of marijuana in the 3 months prior to screening. Approximately one month prior to the start of the academic year (August / September 2005), all students meeting criteria were invited to participate in the randomized trial. Of the 370 eligible students (17.43%), 341 (92.16%) completed the baseline survey. Students randomized to the intervention condition received their personalized feedback immediately after completing the baseline survey (see intervention procedures for further details). All baseline survey participants were invited to complete follow-up assessments three and six months post-baseline (December and March, respectively). Follow-up data was provided by 324 participants (95.01%) at three months and 322 participants (94.42%) at six months, with 315 (92.38%) providing both. Small differences in numbers in Table 2 and Table 3 are due to missing data on select items. All data were collected online over a secure website. Participants were paid \$10 for completing screening, \$25 for baseline, and \$30 for three and six-month follow-ups.

The 341 baseline participants were, on average, 18.03 years old ( $SD = 0.31$ ). Participants included 54.55% women. Ethnic representation consisted of 68.33% Caucasian, 15.54% Asian, 1.47% African American, 6.16% Hispanic, .88% Native American, .59% Hawaiian/Pacific Islander, and 7.04% other or not indicated.

### Intervention Procedures

**Randomization**—Students were randomly assigned to feedback or control condition based on their screening responses (prior to baseline), using a stratified randomization procedure to produce groups with equivalent use rates at randomization. Eligible participants were stratified into quartiles based on frequency of marijuana use in the past 3 months; within each quartile, students were then randomly assigned to condition using a random number generator. Of the 341 baseline participants, 171 were in the intervention and 170 were in the control groups.

**Intervention**—Students in the intervention group received individual personalized feedback (PFI) based on baseline information. Upon completion of the baseline survey, PFI participants could immediately view feedback online and could choose to print feedback to their own printer. Participants could return to view feedback on the web for three months. All analyses are based on intent-to-treat, regardless of whether participants viewed their feedback.

The individual PFI intervention is based on the MI approach described by Miller and Rollnick (1991) and the brief PFI approach pioneered by Marlatt and colleagues for alcohol prevention (BASICS; Dimeff et al., 1999; Marlatt et al., 1998; See Larimer & Cronce, 2002 for review). The approach was also informed by recent work by Walker and colleagues (2006) regarding PFI for adolescent marijuana smokers and studies of computerized normative feedback for alcohol prevention (Lewis & Neighbors, 2007; Neighbors et al., 2004, 2006). The feedback was primarily text based, but incorporated pictures to enhance interest and appeal as well as figures/graphs representing normative information and comparisons. Participants were presented with feedback about their marijuana use (e.g., frequency and quantity of use), perceived and actual descriptive norms for marijuana use (e.g., how frequently they believe the typical student uses marijuana), and perceived pros and cons of using marijuana. Self-reported negative consequences were included in the feedback, as well as ways in which reducing or eliminating marijuana use might be associated with reduced social and academic harm and participants own cost-benefit scale for use. Finally, skills training tips for avoiding marijuana and making changes in one's use were provided, as well as limited alcohol feedback. Perceived high-risk contexts and alternative activities around campus and in the community were provided.

**Assessment-only control condition**—Students randomized to the control condition did not receive any feedback or information. Students were asked to complete web-based assessments.

## Measures

*Marijuana use* was utilized as the primary outcome measure and was assessed by asking participants “On how many days did you use any kind of marijuana or hashish?” in the last 90 days. Items were adapted from the Global Appraisal of Individual Needs-I (Dennis et al., 2000; Dennis et al., 2002).

*Consequences of marijuana use* were assessed using the Rutgers Marijuana Problem Index (RMPI; White et al., 2005). Respondents indicate how many times, from 0 (never) to 4 (more than 10 times), they experienced each of 18 negative consequences due to marijuana use in the past three months (Simons et al., 2000; White et al., 2005). Items include: “Not able to do your homework or study for a test” and “Missed out on other things because you spent too much money on marijuana.” Items were summed to assess number of different problems experienced.

*Contemplation to change marijuana use* was assessed with 4 items ( $\alpha = .79$ ) adapted from the Readiness to Change Questionnaire (RTCQ; Heather, Gold, & Rollnick, 1991). Students rated how strongly they agreed or disagreed with four items including “Sometimes I think I should cut down on my marijuana use” or “I enjoy marijuana, but sometimes I use too much.” A single continuous contemplation score was created averaging the four items (higher scores indicated more contemplation). Because questions refer to current marijuana use, only students who reported using in the last three months at each assessment received these questions.

*Family history of drug problems* was assessed using a modified scale from the Brief Drinker Profile (BDP; Miller & Marlatt, 1984). Students answered whether any biological family members might have (or had) a drug problem that did or should have led to treatment. Family history was coded as 0 (no history of problems) or 1 (one or more biological family member with history of problems). This subscale has shown good construct validity when compared to other self-report measures of family history (Larimer et al., 2001; Turner, Larimer, & Sarason, 2000).



## Results

### Preliminary analyses

Descriptive information for all primary study variables by intervention group are in Table 2. Preliminary analyses were conducted to evaluate baseline comparability between the control and intervention groups, using Pearson's Chi-square for categorical data and independent *t*-tests for continuous data. There were no statistically significant differences found between feedback and control groups on ethnicity, gender, family history, baseline marijuana use, consequences, or contemplation scores. We also conducted analyses using a dichotomous variable indicating "missingness" to determine if loss to follow-up differed based on baseline characteristics or intervention condition. Non-responders at either or both follow-ups did not differ according to condition, ethnicity, gender, family history, marijuana use, consequences, or contemplation.

Analyses evaluating gender differences revealed men used marijuana significantly more often than women at baseline,  $t(276.77) = 2.16, p < .05$ , three-month follow-up,  $t(240.58) = 3.27, p < .01$ , and six-month follow-up  $t(246.79) = 3.37, p < .01$ . However, intervention effects did not vary by gender at three- or six-month follow-up. Nor did gender interact with intervention effects and contemplation or family history in predicting changes in use at three-month follow-up or six month follow-up. Gender was included as a covariate in all analyses.

For primary analyses missing data were imputed using expectation maximization, which has been described as the best single imputation procedure (Shafer & Graham, 2002). Contemplation was not assessed (and we did not impute values) for participants who did not report use in the past 90 days at baseline (20 students in intervention and 19 students in control conditions) because of the focus on reducing current use (which was not relevant for these students). Exclusion of participants was equivalent in both conditions,  $\chi^2(1, 341) = .02, p = ns$ . Table 2 presents the means and standard deviations for baseline marijuana use and consequences by intervention group for the entire sample and limited to those with contemplation scores.

### Correlations among baseline measures

Correlations among baseline measures are presented in Table 3. As noted above, men reported using significantly more marijuana at baseline but did not report significantly more problems compared to women. Men were higher in contemplation than women. Contemplation was significantly associated with both use and problems, whereas family history was unrelated to contemplation, use, or problems. Finally, use was significantly associated with problems.

### Efficacy of the Personalized Feedback Intervention

Primary analyses focused on evaluating intervention efficacy among marijuana users and evaluated family history of drug use and contemplation as moderators of intervention efficacy at three and six-month follow-ups. Sex was included as a covariate in all analyses. A repeated measures ANOVA evaluating changes in past 90 day use from baseline to three-month follow-up indicated no main effect of time, nor was the intervention associated with reduced use among participants as a whole ( $F$ 's  $< 1$ ). Results were similar in evaluating main effects of time and intervention at six-month follow-up. Similarly, there were no significant time or time by treatment condition interactions in evaluating change in marijuana related problems from baseline to three-month follow-up or change from baseline to six-month follow-up. Thus there were no overall intervention effects at three or six month follow-up. Remaining analyses focused on contemplation and family history as potential moderators of the intervention. Denominator degrees of freedom for each analysis were based on within subjects tests. The number of degrees of freedom were equal to the total within degrees of freedom (302 for

analyses including contemplation and 341 for all other analyses) minus the number of within subjects effects.

**Contemplation**—Participants indicating past three month marijuana use at baseline were asked about their contemplation of change (recall 39 participants did not receive these questions, resulting in a sample of 302 for the following analyses). There were no differences at baseline between students asked these questions and those who were not. Effect size (Cohen's  $d$ ) was calculated using the formula  $d=2t/\sqrt{df}$  and  $t=\sqrt{F}$  (Rosenthal and Rosnow, 1991). Cohen's  $d$  was selected as a common measure of effect size that many researchers are familiar with.

Analysis evaluating contemplation as a moderator revealed a marginally significant interaction suggesting the intervention's impact on three month marijuana use depended somewhat on participants' baseline level of contemplation,  $F(1, 297) = 3.42, p < .07, d = .21$ . Interactions were interpreted following guidelines suggested by Aiken & West (1991) (i.e., high and low values of contemplation were specified as one standard deviation above and below the mean respectively). Results indicated that among control participants, changes in use did not differ as a function of contemplation,  $F < 1$ . In contrast, among intervention participants, changes varied significantly as a function of contemplation scores,  $F(1, 297) = 7.65, p < .01, d = .32$ . Marijuana use was significantly reduced from baseline to three-month follow-up among intervention participants who were higher in contemplation,  $F(1, 297) = 5.55, p < .05, d = .27$ , but not among intervention participants who were lower in contemplation,  $F < 1$ . Additional results did not indicate an interaction between contemplation and treatment condition at six-month follow-up. Contemplation did not interact with treatment condition in predicting changes in marijuana-related problems at three-month or six-month follow-up.

**Family history**—Following the same approach, examining FH as a moderator revealed a marginally significant interaction between FH and treatment condition in predicting changes in use from baseline to three-month follow-up,  $F(1, 336) = 3.58, p = .06, d = .21$ , and a significant interaction between FH and treatment condition in predicting changes in use from baseline to six-month follow-up,  $F(1, 336) = 6.06, p < .05, d = .27$ . Further evaluation of these interactions were examined using tests of simple slopes (Aiken & West, 1991) where associations between FH and changes in marijuana use were evaluated with intervention condition specified as present versus absent. Results indicated that the association between FH and changes in marijuana use was somewhat stronger in the intervention group than in the control group. Moreover, from baseline to six-month follow-up, the association between FH and changes in use was significant for intervention participants,  $F(1, 336) = 6.60, p = .01, d = .28$ , but not for control participants,  $F(1, 336) = .82, p = ns, d = .10$ . Marginal means for FH by treatment condition are presented in Figure 1, and revealed that use tended to increase from baseline to six-month follow-up *except* among FH+ intervention participants.

FH did not interact with treatment condition in predicting changes in marijuana problems at three-month follow-up but did at six-month follow-up,  $F(1, 336) = 6.38, p = .01, d = .28$ . The pattern of marginal means was comparable to the raw means presented in Table 2 and suggested that the interaction was likely due to increases in problems for control participants who were FH+ relative to all other participants. This was directly assessed by a simple effects test examining changes in problems comparing these participants versus all others. Results of this test confirmed the presence of a significant time  $\times$  contrast effect where FH+ control participants were contrasted with all others,  $F(1, 338) = 3.79, p = .05, d = .21$ .

## Discussion

The current study is one of the first to examine a web-based preventive intervention for incoming college students who have recently reported using or trying marijuana. Contrary to hypotheses, we did not find that our web-based intervention produced overall reductions in marijuana use or marijuana-related consequences among students receiving the feedback compared to a control group, however we did find that family history of drug problems moderated the relationship between intervention and marijuana use. As seen in Figure 1, the pattern of results suggests that for the most part students increased use during the transition to college, with the exception of FH+ intervention participants. It may be that students with this FH perceived the preventive information to have greater relevance, thus leading to more active processing of the information (LaBrie et al., 2009; Petty & Cacioppo, 1979; Petty & Cacioppo, 1986). To some extent this pattern was also evident for students who were more contemplative about their baseline marijuana use. Students who report being more contemplative of their use at baseline may be better candidates for brief web-based PFIs; future studies could examine this possibility in addition to further exploring assessment of contemplation within this population.

### Implications for Future Interventions and College Campuses

The current study assessed and intervened with students during the summer prior to their matriculation into college. Early intervention can be important for altering trajectories of substance use during college (Schulenberg & Maggs, 2001) but interventions rarely target this transitional period. While the present study focused only on students prior to matriculation, other interventions have been implemented with students already in (or shortly after entering) the college setting (Marlatt et al., 1998; White et al., 2006). Future research should examine the role of intervention timing on outcomes. It may be that the expectations of college and the context of marijuana use are very influential during the first few months of college, such that more targeted and in-depth motivational programming is needed compared to a brief web-based program.

The current study also evaluated hypothesized moderators of intervention efficacy. Results suggest that contemplation about marijuana use and FH of drug problems may be important individual characteristics influencing response to prevention and intervention efforts. Given these preliminary results, intervention approaches may be tailored to specific individual characteristics to maximize efficacy. The present research suggests the web-based intervention in its current form may not be ideal for targeting general incoming first year college students who are possibly experimenting with marijuana for the first time and/or are light or infrequent users. Instead, students with a more extensive history with marijuana use and problems, both direct and indirect, may be more receptive to or interested in receiving personalized feedback (findings related to typical use provide some support for this possibility). Students not ready to contemplate changes in their use may be less impacted due to perceived lower relevance of the information, and/or it may be that a longer follow-up period and a larger sample is needed to detect preventive effects for those who use relatively infrequently at baseline.

While prior research regarding development of motivational feedback interventions for college alcohol and drug use has been promising (Marlatt et al. 1998; McCambridge & Strang, 2004; Larimer & Crouse, 2007; White et al., 2006), the web-based mode of delivery of this feedback was quite different than in the majority of prior studies, suggesting that interventions that do not actively include in-person motivational interviewing strategies, and instead rely solely on feedback reports, may not work well with marijuana-involved emerging adults. In-person motivational interventions allow for the exploration of goals, reactions, and consideration of behavior change and can be much more tailored to students' interests and concerns in a way which was not possible in the web-based intervention. Future studies could test the efficacy of



in-person PFIs with college students, and could explore ways to make web-based interventions more interactive with students (e.g., ways to more effectively prompt contemplation of change, consider reactions to feedback components, and evaluate future goals around substance use).

### Limitations and Other Future Directions

Results of this research should be viewed in the context of its limitations. First, randomization did not include baseline contemplation or FH of drug problems in the stratification procedure. While there were no differences based on intervention condition on these variables, a stronger randomization procedure would include hypothesized moderators. Second, our measure of contemplation for changing marijuana use has not been validated in college samples, and additional work could further validate this measure. Moreover, while FH and contemplation were proposed as a priori moderators of intervention efficacy, we did not adjust the alpha level for multiple tests, and results should be interpreted cautiously. Further, only students who reported using in the last 90 days at baseline were asked about their contemplation of changing their marijuana use. Future research should examine contemplation among very light or infrequent users and how this may influence intervention efficacy.

An additional limitation includes the validity of self-report for marijuana use as assessed on the internet. Although research supports the validity of self-report in confidential research contexts when measures with established reliability and validity are utilized (Babor et al., 2000), self-report is nonetheless unquestionably subject to some error. Research suggests self-report is both over- and underreported depending on several factors, including recency of use, reporting period, and dose (e.g., Buchan et al., 2002). Other studies suggest that self-report rates and those found with urinalysis are fairly consistent (e.g., Marijuana Treatment Project Research Group, 2004). Future research could evaluate validity of self-reported marijuana use via the internet.

Due to programming limitations there was no measure of exposure to the intervention (including duration of viewing, components reviewed, and times feedback was viewed). However, most students randomized to the intervention reported receiving emails about the feedback (92.5%) and reported linking to and viewing feedback (75.2%), though a smaller percentage reported actually printing the feedback (5.6%). Further, there was no measure of the salience or relevance of feedback components, so it is not clear if there were any essential (or less useful) sections of the brief intervention. Future web-based interventions should include measures of exposure and salience to assess whether these may moderate intervention efficacy.

Only incoming first-year students participating in the study, thus it is not clear how the study would generalize to other students. With inclusion criteria defining a current user as anyone reporting use at least once in the past three months, the current study included students who may have been using so infrequently that it was difficult to detect any change. Future studies should examine issues around intervening with light- and heavy-using students. Further, future studies should evaluate appropriate timing of the interventions (e.g., before or after matriculation). It is also important to consider whether more intensive prevention/early intervention efforts might be needed to reduce risks related to marijuana use in college populations, at least for those who are unresponsive to web-based approaches. In particular, there remains a strong need for research comparing in-person motivational feedback to web-based feedback.

Overall, the current results support the potential promise of brief, feedback-based interventions for marijuana use, and serve to increase awareness of the need to carefully evaluate moderators of efficacy. As future research addresses the issues described above, intervention efforts to

reduce substance-related harm on campuses will be able to more effectively respond to students' use of a substance that could have health, mental health, social, and academic impacts.

## Acknowledgments

This research was supported by National Institute on Drug Abuse Grant DA019257.

## References

- Agostinelli G, Brown JM, Miller WR. Effects of normative feedback on consumption among heavy drinking college students. *Journal of Drug Education* 1995;25:31–40. [PubMed: 7776148]
- Aiken, LS.; West, SG. Multiple regression: Testing and interpreting interactions. Thousand Oaks, CA: US: Sage Publications, Inc; 1991.
- Babor TF, Steinberg K, Anton R, Del Boca F. Talk is cheap: measuring drinking outcomes in clinical trials. *Journal of Studies on Alcohol* 2000;61:55–63. [PubMed: 10627097]
- Bachman, JG.; Wadsworth, KN.; O'Malley, PM.; Johnston, LD. Smoking, drinking, and drug use in young adulthood: The impacts of new freedoms and new responsibilities. Hillsdale, NJ., editor. England: Lawrence Erlbaum Associates, Inc.; 1997.
- Baer JS, Kivlahan DR, Blume AW, McKnight P, Marlatt GA. Brief intervention for heavy-drinking college students: 4-year follow-up and natural history. *American Journal of Public Health* 2001;91:1310–1316. [PubMed: 11499124]
- Baer JS, Kivlahan DR, Marlatt GA. High-risk drinking across the transition from high school to college. *Alcoholism: Clinical and Experimental Research* 1995;19:54–61.
- Borsari B, Carey KB. Effects of a brief motivational intervention with college student drinkers. *Journal of Consulting and Clinical Psychology* 2000;68:728–733. [PubMed: 10965648]
- Boyd SJ, Plemons BW, Schwartz RP, Johnson JL, Pickens RW. The relationship between parental history and substance use severity in drug treatment patients. *The American Journal on Addictions* 1999;8:15–23. [PubMed: 10189511]
- Buchan BJ, Dennis ML, Tims FM, Diamond GS. Cannabis use: Consistency and validity of self-report, on-site urine testing and laboratory testing. *Addiction* 2002;97:98–108. [PubMed: 12460132]
- Carey KB, Henson JM, Carey MP, Maisto SA. Which heavy drinking college students benefit from a brief motivational intervention? *Journal of Consulting and Clinical Psychology* 2007;75:663–669. [PubMed: 17663621]
- Chen K, Kandel DB. The natural history of drug use from adolescence to the mid-thirties in a general population sample. *American Journal of Public Health* 1995;85:41–47. [PubMed: 7832260]
- Chiauzzi E, Green TC, Lord S, Thum C, Goldstein M. My Student Body: A high-risk drinking prevention web site for college students. *Journal of American College Health* 2005;53:263–274. [PubMed: 15900990]
- Cunningham JA, Selby PL, Kypri K, Humphreys KN. Access to the Internet among drinkers, smokers, and illicit drug users: Is it a barrier to the provision of interventions on the World Wide Web? *Medical Informatics and the Internet in Medicine* 2005;31:53–58. [PubMed: 16754367]
- Cunningham JA, Selby P, van Mierlo T. Integrated online services for smokers and drinkers? Use of the Check Your Drinking assessment screener by participants of the Stop Smoking Center. *Nicotine & Tobacco Research* 2006;8 Suppl. 1:S21–S25. [PubMed: 17491167]
- Dennis M, Titus JC, Diamond G, Donaldson J, Godley SH, Tims FM, et al. The Cannabis Youth Treatment (CYT) experiment: Rationale, study design and analysis plans. *Addiction* 2002;97:16–34. [PubMed: 12460126]
- Dimeff, LA.; Baer, JS.; Kivlahan, DR.; Marlatt, GA. Brief Alcohol Screening and Intervention for College Students (BASICS): A harm reduction approach. New York, NY: Guilford Press; 1999.
- Fromme K, Corbin W. Prevention of heavy drinking and associated negative consequences among mandated and voluntary students. *Journal of Consulting and Clinical Psychology* 2004;72:1038–1049. [PubMed: 15612850]

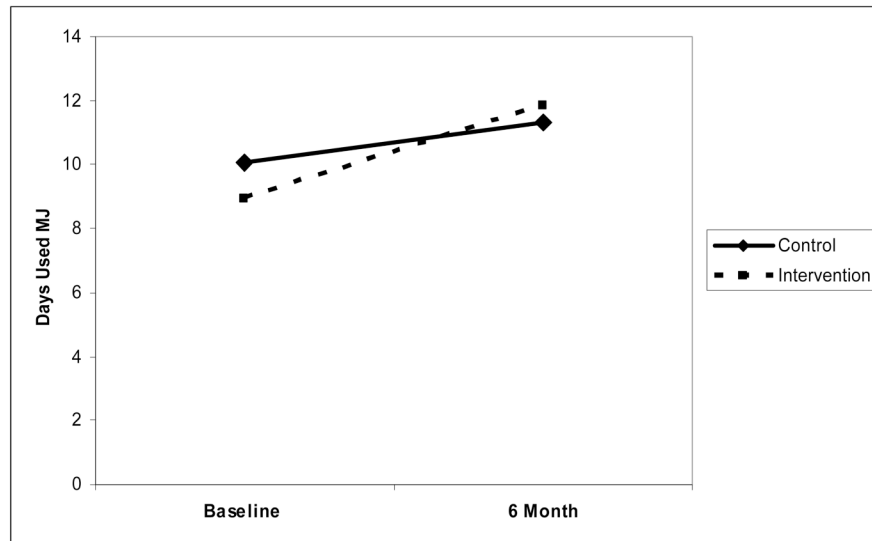
- Gledhill-Hoyt J, Lee H, Strote J, Wechsler H. Increased use of marijuana and other illicit drugs at US colleges in the 1990s: Results of three national surveys. *Addiction* 2000;95:1655–1667. [PubMed: 11219369]
- Hall W, Babor TF. Cannabis use and public health: Assessing the burden. *Addiction* 2000;95:485–490. [PubMed: 10829325]
- Heather, N.; Gold, R.; Rollnick, S. Technical Report 15. Kensington, Australia: National Drug and Alcohol Research Center, University of New South Wales; 1991. Readiness to change questionnaire: User's manual.
- Jackson KM, Sher KJ, Gotham HJ, Wood PW. Transitioning into and out of large-effect drinking in young adulthood. *Journal of Abnormal Psychology* 2001;110:378–391. [PubMed: 11502081]
- Johnston, LD.; O'Malley, PM.; Bachman, JG.; Schulenberg, JE. Monitoring the Future national survey results on drug use, 1975–2007. Volume II: College students and adults ages 19–45. Bethesda, MD: National Institute on Drug Abuse, 2008; NIH Publication No. 08-6418B
- Kalant H. Adverse effects of cannabis on health: An update of the literature since 1996. *Progress in Neuro-Psychopharmacology & Biological Psychiatry* 2004;28:849–863. [PubMed: 15363608]
- LaBrie JW, Feres N, Kenney SR, Lac A. Family history of alcohol abuse moderates effectiveness of a group motivational enhancement intervention in college women. *Addictive Behaviors* 2009;34:415–420. [PubMed: 19162406]
- Larimer ME, Cronce JM. Identification, prevention, and treatment: A review of individual-focused strategies to reduce problematic alcohol consumption by college students. *Journal of Studies on Alcohol* 2002 Suppl14:148–163.
- Larimer ME, Cronce JM. Identification, prevention, and treatment revisited: individual-focused college drinking prevention strategies 1999–2006. *Addictive Behaviors* 2007;32:2439–2468. [PubMed: 17604915]
- Larimer ME, Kilmer JR, Lee CM. College Student Drug Prevention: A Review of Individually-Oriented Prevention Strategies. *Journal of Drug Issues* 2005;35:431–456.
- Larimer ME, Turner AP, Anderson BK, Fader JS, Kilmer JR, Palmer RS, et al. Evaluating a brief alcohol intervention with fraternities. *Journal of Studies on Alcohol* 2001;62:370–380. [PubMed: 11414347]
- Lewis MA, Neighbors C. Optimizing personalized normative feedback: The use of gender-specific referents. *Journal of Studies on Alcohol and Drugs* 2007;68:228–237. [PubMed: 17286341]
- Lynskey M, Hall W. The effects of adolescent cannabis use on educational attainment: A review. *Addiction* 2000;95:1621–1630. [PubMed: 11219366]
- The Marijuana Treatment Project Research Group [MTPRG]. Brief treatments for cannabis dependence: Findings from a randomized multisite trial. *Journal of Consulting and Clinical Psychology* 2004:455–456. [PubMed: 15279529]
- Marlatt GA, Baer JS, Kivlahan DR, Dimeff LA, Larimer ME, Quigley LA, et al. Screening and brief intervention for high-risk college student drinkers: Results from a 2-year follow-up assessment. *Journal of Consulting and Clinical Psychology* 1998;66:604–615. [PubMed: 9735576]
- McCambridge J, Strang J. The efficacy of single-session motivational interviewing in reducing drug consumption and perceptions of drug-related risk and harm among young people: Results from a multi-site cluster randomized trial. *Addiction* 2004;99:39–52. [PubMed: 14678061]
- McDaniel A, Stratton RM. Internet-based smoking cessation initiatives: Availability, varieties, and likely effects on outcomes. *Disease Management & Health Outcomes* 2006;14:275–285.
- Merikangas KR, Stolar M, Stevens DE, Goulet J, Preisig MA, Fenton B, et al. Familial transmission of substance use disorders. *Archives of General Psychiatry* 1998;973–979. [PubMed: 9819065]
- Miller WR, Toscova RT, Miller JH, Sanchez V. A theory-based motivational approach for reducing alcohol/drug problems in college. *Health Education & Behavior* 2001;27:744–759. [PubMed: 11104373]
- Miller, WR.; Marlatt, GA. Brief drinking profile. Odessa, FL: Psychological Assessment Resources; 1984.
- Miller, WR.; Rollnick, S. Motivational interviewing: Preparing people to change addictive behavior. New York, NY: Guilford Press; 1991.
- Miller, WR.; Rollnick, S. Motivational interviewing: Preparing people for change. 2nd ed.. New York, NY: Guilford Press; 2002.

- Mun EY, White HR, Morgan TJ. Individual and situational factors that influence the efficacy of personalized feedback substance use interventions for mandated college students. *Journal of Consulting and Clinical Psychology* 2009;77:88–102. [PubMed: 19170456]
- Muñoz RF, Lenert LL, Delucchi K, Stoddard J, Perez JE, Penilla C, Pérez-Stable EJ. Toward evidence-based Internet interventions: A Spanish/English Web site for international smoking cessation trials. *Nicotine & Tobacco Research* 2006;8:77–87. [PubMed: 16497602]
- The National Center on Addiction and Substance Abuse at Columbia University (CASA). Depression, Substance Abuse and College Student Engagement: A Review of the Literature. Report to The Charles Engelhard Foundation and the Bringing Theory to Practice Planning Group. 2003
- National Institute of Alcohol Abuse and Alcoholism. A call to action: Changing the culture of drinking at U.S. colleges. Bethesda, MD: National Institute of Health; 2002.
- Neighbors C, Larimer ME, Lewis MA. Targeting Misperceptions of Descriptive Drinking Norms: Efficacy of a Computer-Delivered Personalized Normative Feedback Intervention. *Journal of Consulting and Clinical Psychology* 2004;72:434–447. [PubMed: 15279527]
- Neighbors C, Lee CM, Lewis MA, Fossos N, Walter T. Internet-based personalized feedback to reduce 21<sup>st</sup>-birthday drinking: A randomized controlled trial of an event-specific prevention intervention. *Journal of Consulting and Clinical Psychology* 2009;77:51–63. [PubMed: 19170453]
- Neighbors C, Lewis MA, Bergstrom RL, Larimer ME. Being controlled by normative Influences: Self-determination as a moderator of a normative feedback alcohol intervention. *Health Psychology* 2006;25:571–579. [PubMed: 17014274]
- Petty RE, Cacioppo JT. Issue involvement can increase or decrease persuasion by enhancing message-relevant cognitive responses. *Journal of Personality and Social Psychology* 1979;37:1915–1926.
- Petty, RE.; Cacioppo, JT. *Communication and persuasion: Central and peripheral routes to attitude change*. New York: Springer-Verlag; 1986.
- Prochaska, JO.; DiClemente, CC. Toward a comprehensive model of change. In: Miller, WR.; Heather, N., editors. *Treating addictive behaviors: Processes of change*. New York: Plenum Press; 1986. p. 3-27.
- Roebuck MC, French MT, Dennis ML. Adolescent marijuana use and school attendance. *Economics of Education Review* 2004;23:133–141.
- Rosenthal, R.; Rosnow, RL. *Essentials of behavioral research: Methods and data analysis*. New York: McGraw-Hill; 1991.
- Schulenberg J, Maggs JL. Moving targets: Modeling developmental trajectories of adolescent alcohol misuse, individual and peer risk factors, and intervention effects. *Applied Developmental Science* 2001;5:237–253.
- Schulenberg JE, Merline AC, Johnston LD, O'Malley PM, Bachman JG, Laetz VB. Trajectories of marijuana use during the transition to adulthood: The big picture based on national panel data. *Journal of Drug Issues* 2005;35:255–280. [PubMed: 16534532]
- Solowij, N. *Cannabis and Cognitive Functioning*. Cambridge, England: Cambridge University Press; 1998.
- Shafer JL, Graham JW. Missing data: Our view of the state of the art. *Psychological Methods* 2002;7:147–177. [PubMed: 12090408]
- Stephens, RS.; Roffman, RA.; Copeland, J.; Swift, W. Cognitive-behavioral and motivational enhancement treatments for cannabis dependence. In: Roffman, RA.; Stephens, RS., editors. *Cannabis Dependence*. New York: Cambridge University Press; 2006. p. 131-153.
- Strecher VJ, Shiffman S, West R. Randomized controlled trial of a web-based computer-tailored smoking cessation program as a supplement to nicotine patch therapy. *Addiction* 2005;100:682–688. [PubMed: 15847626]
- Strecher VJ, Shiffman S, West R. Moderators and mediators of a Web-based computer-tailored smoking cessation program among nicotine patch users. *Nicotine & Tobacco Research* 2006;8 Suppl. 1:S95–S101. [PubMed: 17491176]
- Substance Abuse and Mental Health Services Administration. Results from the 2004 national survey on drug use and health: National findings. Rockville, MD: 2005. Office of Applied Studies, NSDUH series H-28, DHHS Publication No.SMA 05-4062

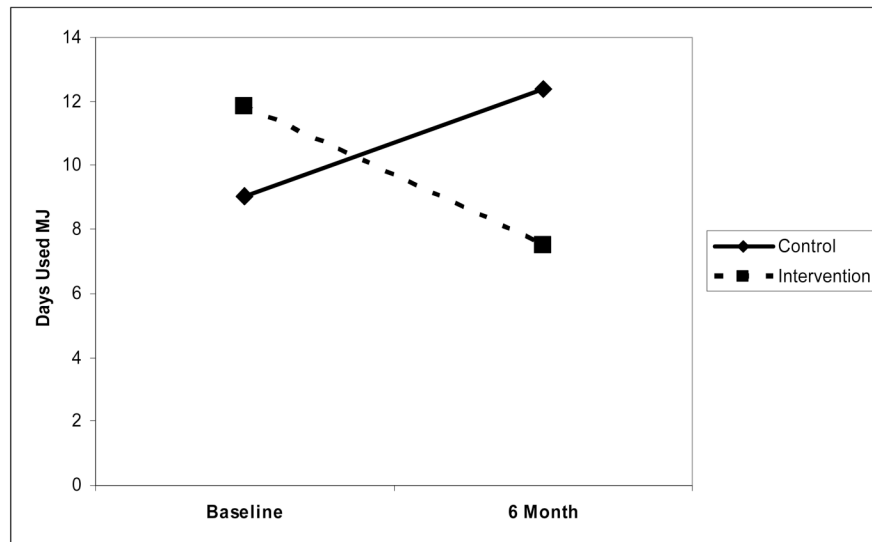
- Taylor RD, Poulton R, Moffitt ET, Ramankutty P, Sears RM. The respiratory effects of cannabis dependence in young adults. *Addiction* 2000;95:1669–1677. [PubMed: 11219370]
- Turner AP, Larimer ME, Sarason IG. Family risk factors for alcohol-related consequences and poor adjustment in fraternity and sorority members: Exploring the role of parent-child conflict. *Journal of Studies on Alcohol* 2000;61:818–826. [PubMed: 11188487]
- Wagner FA, Anthony JC. From first drug use to drug dependence: Developmental periods of risk for dependence upon marijuana, cocaine, and alcohol. *Neuropsychopharmacology* 2002;26:479–488. [PubMed: 11927172]
- Walker DD, Roffman RA, Stephens RS, Wakana K, Berghuis J. Motivational Enhancement Therapy for Adolescent Marijuana Users: A Preliminary Randomized Controlled Trial. *Journal of Consulting and Clinical Psychology* 2006;74:628–632. [PubMed: 16822119]
- Walters ST, Bennett ME, Noto JV. Drinking on campus: What do we know about reducing alcohol use among college students? *Journal of Substance Abuse Treatment* 2000;19:223–228. [PubMed: 11027891]
- Walters ST, Vader AM, Harris TR. A controlled trial of web-based feedback for heavy drinking college students. *Prevention Science* 2007;8:83–88. [PubMed: 17136461]
- White HR, Morgan TJ, Pugh LA, Celinska K, Labouvie EW, Pandina RJ. Evaluating Two Brief Substance-Use Interventions for Mandated College Students. *Journal of Studies on Alcohol* 2006;67:309–317. [PubMed: 16562414]
- White HR, Labouvie EW, Papadaratsakis V. Changes in substance use during the transition to adulthood: A comparison of college students and their noncollege age peers. *Journal of Drug Issues* 2005;35:281–306.



### Family History Negative



### Family History Positive



**Figure 1.** Three-way interaction between Time, Intervention Group, and Family History Status on Marijuana Use.

**Table 1**

Demographics of Initial Invited Screening Sample, Completers, and Non-responders

	Total Invited Sample (N = 4050) %	Completed Screen (N = 2123) %	Non-responders to Screen (N = 1927) %
Gender			
Female	53.25	58.97	46.94
Male	46.75	41.03	53.06
Ethnicity			
Asian	25.50	25.44	25.57
Caucasian	56.60	59.63	53.27
Hispanic	4.84	4.43	5.29
Native American	1.21	1.22	1.19
Hawaiian/Pacific Islander	0.39	0.33	0.47
African American	2.12	1.27	3.06
Other/Not Identified	9.33	7.68	11.13

Table 2

## Descriptive Information by Intervention Group

Variable	Control		Feedback		Total	
	N	%	N	%	N	%
Gender: Female	88	51.76	98	57.31	186	54.55
Ethnicity: % White	123	72.35	133	79.17	256	75.74
Family History Positive	48	28.24	52	30.41	100	29.33
	Mean	SD	Mean	SD	Mean	SD
Contemplation <sup>a</sup>	-0.94	0.87	-1.05	0.94	-0.99	0.91
Baseline Days Used <sup>b</sup>	9.84	16.17	9.89	15.84	9.86	15.99
Baseline Days Used <sup>a</sup>	11.01	16.73	11.03	16.40	11.07	16.54
Baseline Consequences <sup>b</sup>	1.86	2.23	2.11	2.69	1.98	2.47
Baseline Consequences <sup>a</sup>	2.09	2.26	2.38	2.75	2.24	2.51
3-Month Days Used <sup>c</sup>	9.06	15.78	9.14	14.07	9.10	14.92
3-Month Consequences <sup>c</sup>	1.99	2.76	2.47	3.77	2.23	3.31
6-Month Days Used <sup>d</sup>	11.94	19.31	11.05	18.71	11.50	18.99
6-Month Consequences <sup>d</sup>	2.19	2.95	2.59	3.96	2.39	3.49

Note.

<sup>a</sup>N = 302. Participants who used in the last 90 days and had contemplation scores.

<sup>b</sup>N = 341.

<sup>c</sup>N = 323-324.

<sup>d</sup>N = 320.

Table 3

Correlation among baseline measures

Variable	1.	2.	3.	4.	5.
1. Sex	--				
2. Contemplation	-.15**	--			
3. Family history	.08	.04	--		
4. Baseline days used	-.12*	.42***	.03	--	
5. Marijuana Problems	-.05	.49***	.02	.43***	--

Note. Correlations with contemplation were based on an *N* of 302. All other correlations were based on an *N* of 341. Sex was dummy coded (women = 1; men = 0).

\*\*\*  
*p* < .001.

\*\*  
*p* < .01.

\*  
*p* < .05.