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

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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 3-month (95.0%) and 6-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

Use of personalized feedback, often in the context of motivational 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, 2005) and is a growing public health concern (Hall & Babor, 2000). In addition to health issues (Solowij, 1998; Taylor, Poulton, Moffitt, Ramankutty, & Sears, 2000), marijuana use is associated with academic consequences (Lynskey & Hall, 2000; Roebuck, French, & Dennis, 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).

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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). In addition, 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 motivational enhancement interventions utilizing personalized feedback have been shown to be efficacious in an indicated prevention context with college student drinking up to 4 years after 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 et al., 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). Although 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 (Muñoz et al., 2006; Strecher, Shiffman, & West, 2005). 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 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

In addition, research is beginning to explore factors that influence the efficacy of college student alcohol interventions (Carey, Henson, 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) suggested 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, Roffman, Copeland, and Swift (2006) suggested that motivational enhancement approaches were 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 brief motivational interventions has been mixed, with some studies suggesting higher RTC is associated with reductions in alcohol use whereas other studies have found no evidence of moderation when other individual and situational factors were controlled (Carey et al., 2007; Fromme & Corbin, 2004; Mun et al., 2009). Given that motivational 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 FH 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 postintervention, although no significant difference was found between FH– and control participants (Labrie et al., 2009). The authors suggested 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 FH 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-ups. 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 4,000 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 of age 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 = 2,123 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

Table 1
Demographics of Initial Invited Screening Sample, Completers, and Nonresponders

Demographics	% of total invited sample (N = 4,050)	% of completed screen (n = 2,123)	% of nonresponders to screen (n = 1,927)
Gender			
Female	53.25	58.97	46.94
Male	46.75	41.03	53.06
Ethnicity			
Asian	25.50	25.44	25.57
White	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

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 1 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 3-months and 6-months after baseline (December and March, respectively). Follow-up data were provided by 324 participants (95.01%) at 3 months and 322 participants (94.42%) at 6 months, with 315 (92.38%) providing both. Small differences in numbers in Tables 2 and 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 3- and 6-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% White, 15.54% Asian, 1.47% African American, 6.16% Hispanic, 0.88% Native American, 0.59% Hawaiian/Pacific Islander, and 7.04% other or not indicated.

Intervention Procedures

Randomization. Students were randomly assigned to a personalized feedback intervention (PFI) 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.

Table 2
Descriptive Information by Intervention Group

	Control		Feedback		Total	
Variables	*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
	M	*SD*	*M*	*SD*	*M*	*SD*
Contemplation[a]	−0.94	0.87	−1.05	0.94	−0.99	0.91
Baseline days used[b]	9.84	16.17	9.89	15.84	9.86	15.99
Baseline days used[a]	11.01	16.73	11.03	16.40	11.07	16.54
Baseline consequences[b]	1.86	2.23	2.11	2.69	1.98	2.47
Baseline consequences[a]	2.09	2.26	2.38	2.75	2.24	2.51
3-month days used[c]	9.06	15.78	9.14	14.07	9.10	14.92
3-month consequences[c]	1.99	2.76	2.47	3.77	2.23	3.31
6-month days used[d]	11.94	19.31	11.05	18.71	11.50	18.99
6-month consequences[d]	2.19	2.95	2.59	3.96	2.39	3.49

[a] n = 302. Participants who used in the last 90 days and had contemplation scores. [b] n = 341. [c] n = 323 to 324. [d] n = 320.

Table 3
Correlation Among Baseline Measures

Variables	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).
* $p < .05$. ** $p < .01$. *** $p < .001$.

Intervention. Students in the intervention group received individual personalized feedback based on baseline information. On 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 3 months. All analyses are based on intent-to-treat, regardless of whether participants viewed their feedback.

The individual PFI is based on the Motivational Interviewing (MI) approach described by Miller and Rollnick (1991) and the brief PFI approach pioneered by Marlatt and colleagues for alcohol prevention (Brief Alcohol Screening and Intervention for College Students; Dimeff, Baer, Kivlahan, & Marlatt, 1999; Marlatt et al., 1998; see Larimer & Cronce, 2002, for review). The approach was also informed by recent work by Walker, Roffman, Stephens, Wakana, and Berghuis (2006) regarding PFI for adolescent marijuana smokers and studies of computerized normative feedback for alcohol prevention (Lewis & Neighbors, 2007; Neighbors, Larimer, & Lewis, 2004; Neighbors, Lewis, Bergstrom & Larimer, 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., 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 3 months. 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 four 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 3 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. Nonresponders 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, $t(276.77) = 2.16$, $p < .05$, 3-month follow-up, $t(240.58) = 3.27$, $p < .01$, and 6-month follow-up, $t(246.79) = 3.37$, $p < .01$. However, intervention effects did not vary by gender at 3- or 6-month follow-up. Nor did gender interact with intervention effects and contemplation or family history in predicting changes in use at 3-month follow-up or 6-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 3- and 6-month follow-ups. Sex was included as a covariate in all analyses. A repeated-measures analysis of variance (ANOVA) evaluating changes in past 90-day use from baseline to 3-month follow-up indicated no main effect of time, nor was the intervention associated with reduced use among participants as a whole (Fs < 1). Results were similar in evaluating main effects of time and intervention at 6-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 3-month follow-up or change from baseline to 6-month follow-up. Thus there were no overall intervention effects at 3- or 6-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 3-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 formulas $d = 2t/\sqrt{df}$ and $t = \sqrt{F}$ (Rosenthal & 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 3-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 and 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 3-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 6-month follow-up. Contemplation did not interact with treatment condition in predicting changes in marijuana-related problems at 3-month or 6-month follow-up.

FH. 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 3-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 6-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) in which 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 6-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 6-month follow-up except among FH+ intervention participants.

FH did not interact with treatment condition in predicting changes in marijuana problems at 3-month follow-up but did at 6-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 in which 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 FH 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

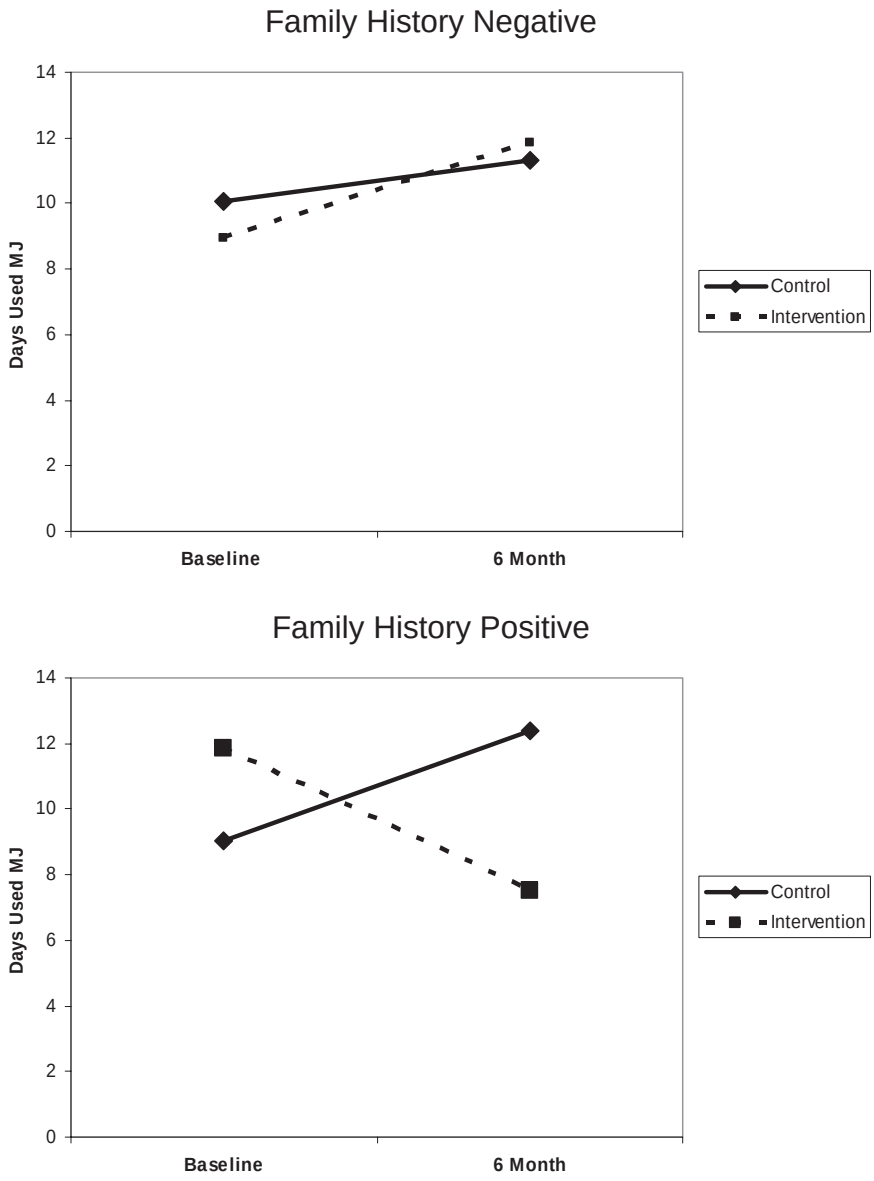

Figure 1. Three-way interaction between time, intervention group, and family history status on marijuana (MJ) use.

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, 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. Although 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.

Although prior research regarding development of motivational feedback interventions for college alcohol and drug use has been promising (Larimer & Cronce, 2007; Marlatt et al., 1998; McCambidge & Strang, 2004; 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 that 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. Although 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, although 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, Steinberg, Anton, & Del Boca, 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, Dennis, Tims, & Diamond, 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 3 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.

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