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## Behavioral Treatment for Marijuana Dependence: Randomized Trial of Contingency Management and Self-Efficacy Enhancement

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### Abstract

**Objective**—The purpose of the present study was to develop a treatment for marijuana dependence specifically designed to enhance self-efficacy.

**Method**—The participants were 215 marijuana-dependent men and women randomized to one of three 9-week outpatient treatments: a condition intended to enhance self-efficacy through successful completion of treatment-related tasks (Motivational Enhancement plus Cognitive-Behavioral treatment plus Contingency Management reinforcing completion of treatment homework; MET+CBT+CM<sub>Homework</sub>); a condition that controlled for all elements except for reinforcement of homework (MET+CBT + Contingency Management reinforcing drug abstinence ; MET+CBT+CM<sub>Abstinence</sub>); or a Case Management control condition (CaseM). Participants in the two MET+CBT conditions were also asked to complete interactive voice recordings three times per week during treatment to confirm homework completion.

**Results**—All patients showed modest improvements over time through 14 months, with few between-treatment effects on outcomes. Latent Class Growth Models, however, indicated that a subsample of patients did extremely well over time. This subsample was more likely to have been treated in the CM<sub>Abstinence</sub> condition. In turn, this treatment effects appears to have been

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### Contributors

All authors designed the study and participated in the writing of the protocol. Author Kadden conducted literature searches and provided summaries of previous research studies. Author Litt conducted the statistical analyses, and wrote the first draft of the manuscript. All authors contributed to, and have approved, the final manuscript.

### Conflict of Interest

None of the authors have any financial or other relationships that might lead to a conflict of interest.

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accounted for by days of continuous abstinence accrued during treatment, and by pre-post increases in self-efficacy.

**Conclusions**—The most effective treatments may be those that elicit abstinence while increasing self-efficacy.

## Keywords

Marijuana treatment; contingency management; CBT; self-efficacy; coping

# 1. Introduction

## 1.1 Impact of Heavy Marijuana Use

Marijuana is the most commonly used illicit drug in the US. Both marijuana tolerance and a withdrawal syndrome have been documented as a result of chronic, heavy use (Budney, Hughes, Moore, & Novy, 2001; Budney, Novy, & Hughes, 1999; Compton, Dewey, & Martin, 1990; Haney, Ward, Comer, Foltin, & Fischman, 1999; Wiesbeck, et al., 1996). The multi-site Marijuana Treatment Project (MTP) found that participants reported multiple problems in living related to regular use (Stephens, Babor, Kadden, Miller, & The Marijuana Treatment Project Research Group, 2002). Similarly, Budney et al. (2007) reported that marijuana users seeking treatment had more than 6 prior quit attempts and perceived themselves as unable to stop.

Long-term heavy use of marijuana increases the likelihood of depression and anxiety (Troisi, Pasini, Saracco, & Spalletta, 1998), high risk sexual behavior (Bell, Wechsler, & Johnston, 1997), and aggressive behavior during withdrawal (Kouri, Pope, & Lukas, 1999). Heavy cannabis use also results in cognitive impairments characterized by diminished memory and impaired executive functioning (Bolla, Brown, Eldreth, Tate, & Cadet, 2002); reduced reasoning ability (Block & Ghoneim, 1993; Lundqvist, 1995); impaired ability to focus attention and filter out irrelevant information (Solowij, 1995); lower achievement motivation (Musty & Kaback, 1995); impairments in memory and learning (Solowij, Stephens, Roffman, & Babor, 2002); and declines in productivity and potential (e.g., Lehman & Simpson, 1992). There is thus considerable justification for the development of improved methods for achieving marijuana abstinence.

## 1.2 Treatment Record for Marijuana Dependence

Marijuana dependence has proven difficult to treat effectively. The largest controlled trial of treatment for marijuana dependent adults to date is MTP, which treated 450 dependent men and women in three sites. The highest abstinence rate achieved was 23% of participants at the 4-month follow-up in a Motivational Enhancement therapy + Cognitive-Behavioral treatment (MET+CBT) condition, declining to 15% at 9 months (Marijuana Treatment Project Research Group, 2004). Budney, Moore, Rocha and Higgins (2006) combined MET+CBT with contingency management: 37% of participants reported abstinence at a 12-month follow-up. Similar results were obtained in a comparable study by Kadden, Litt, Kabela-Cormier and Petry (2007); a combination of MET+CBT plus contingency management for abstinence yielded 14-month abstinence rates of 35%.

Similarly, the Cannabis Youth Treatment project (CYT; Dennis, et al., 2004) treated some 600 mostly white, male adolescents with a variety of cognitive-behavioral, motivational, and family-based methods. The overall percentage of adolescents in recovery (no use or abuse/dependence problems and living in the community) was about 25%, regardless of treatment condition. Thus, despite rather intense treatments that have included cognitive-behavioral

interventions and contingent reinforcement for abstinence, achieving and maintaining abstinence from marijuana has been difficult.

### 1.3 Mechanisms of Treatment for Marijuana Dependence

**1.3.1 Coping skills and self-efficacy**—The most effective treatments to date, CBT, MET, and contingency management, presumably employ different, though complementary, mechanisms to achieve treatment gains. The aim of CBT is to provide the skills necessary to gain abstinence and to cope with life stressors and high-risk situations in more adaptive ways (G.A. Marlatt & George, 1984; G.A. Marlatt & Gordon, 1985). According to social learning theory (Bandura, 1986) successful coping experiences should lead to increased self-efficacy for abstinence. In turn, increased self-efficacy is expected to result in greater use of, and persistence at, coping with further drug-related situations, all resulting in greater abstinence over time (Larimer, Palmer, & Marlatt, 1999; Marlatt, 1985).

Recent studies of mechanisms of change in the treatment of addictive behaviors have raised questions, however, about how CBT effects long-term change. Litt, Kadden and Stephens (2005), for example, explicitly examined the role of coping skills and cognitive constructs as mediators of treatment outcome in the MTP trial. Results indicated that marijuana outcomes out to 15 months were predicted by the use of coping skills, but that the coping skills-oriented MET-CBT treatment did not result in greater coping skills acquisition than did the MET comparison treatment in which no skills were explicitly taught.

A study conducted by Litt, Kadden, Kabela-Cormier, & Petry (2008) looked at mechanisms of treatment specifically for their power to predict changes in the short term and in the long term. The patients were 240 adult marijuana smokers assigned to one of four 9-week treatment conditions: a case management control condition, MET/CBT coping skills training, contingency management (ContM), or MET/CBT+ContM. Results indicated that, regardless of treatment condition, abstinence *in near-term follow-ups* was best predicted by abstinence during treatment, but *long-term abstinence* was predicted by posttreatment self-efficacy for abstinence, which in turn was predicted by increase in coping skills. Thus self-efficacy in particular appears to be important mechanisms of behavior change in marijuana treatment, particularly in the long term.

**1.3.2 Motivation and Commitment to Change**—MET is a non-confrontational approach that seeks to help patients resolve ambivalence about their drug use, and thereby develop motivation to change behavior (Miller & Rollnick, 2002). Here, too, actual mechanisms of action are not known. So far few studies have evaluated increases in motivation as a function of MET, and some investigators have suggested that, rather than motivation per se, MET succeeds by enhancing a cognitive shift toward *commitment* to behavior change (Amrhein et al., 2003; Miller et al., 2006; Walker et al., 2011). It may be this change in orientation toward drug use that leads the individual to reduce drug use and to seek out ways to stop using.

**1.3.3 Positive reinforcement**—Contingency management (CM) procedures treat abstinence behavior as an operant that is susceptible to reinforcement, such that the probability of abstinence increases with reinforcement for abstinent behavior. Short-term efficacy of CM procedures appears to be the result of two occurrences: increased retention in treatment, and enhanced periods of abstinence during treatment (see Petry, 2000; Petry & Simcic, 2002, for reviews). It is surmised that increasing exposure to the treatment environment, and achieving abstinence, increase the possibility of the patient gaining other benefits of treatment (e.g., coping skills; Moos, 2007). There is evidence that continuous abstinence during treatment is one of the best predictors of longer term outcomes (Carroll, et

al., 2006; S.T. Higgins, Badger, & Budney, 2000; Petry, Alessi, & Hanson, 2007). It is not clear, however, whether CM procedures alone result in long-term changes in outcomes.

#### 1.4 Self-Efficacy Enhancement in Treatment

According to Bandura (1977) there are four primary sources of self-efficacy: enactive mastery, verbal persuasion, vicarious experience (e.g., seeing others succeed), or physiological state (one's monitoring of one's own internal state in stressful situations). Of these, mastery experiences, i.e., experiencing success, are the most powerful determinants of self-efficacy for behavior change. According to this model, treatment is effective and durable to the extent that it increases expectations of personal efficacy, which occurs when patients have successful coping experiences (Annis & Davis, 1988b; Bandura, 1977; DiClemente, 2001). Therefore a promising strategy for enhancing self-efficacy is one in which behavioral homework assignments are used to practice skills for coping with high-risk situations (Annis & Davis, 1988a, 1989; Curry & Marlatt, 1987). As patients practice and master their skills, their self-efficacy should increase.

CBT generally includes homework exercises to practice skills learned in treatment, and to generalize these skills to the real world (e.g., Blagys & Hilsenroth, 2002; Burns & Spangler, 2000; Kazantzis, 2000). Recent research has indicated, however, that coping skills acquisition often does not occur as expected in CBT for addictions (e.g., Morgenstern & Longabaugh, 2000). Research across a variety of populations suggests that compliance with homework exercises is generally low (e.g., Woody & Adessky, 2002), perhaps explaining why CBT so often seems to fail to teach coping skills.

#### 1.5 Electronic Logs and Verification of Homework Adherence

The typical approach to verification of completion of treatment assignments (homework) has been to collect worksheets from patients each week. Because these sheets often are either not collected or not completed, a significant aspect of CBT is not engaged (Blagys & Hilsenroth, 2002). An additional type of nonadherence occurs when patients complete worksheets at some point in time removed from the actual event (e.g., just prior to the treatment session), resulting in inaccurate retrospective reports (e.g., Stone, Shiffman, Schwartz, Broderick, & Hufford, 2002).

The advent of Interactive Voice Response (IVR) systems has made it possible to more easily record daily information accurately and reliably. IVR is a telephone interviewing technique employing a recorded script to which the respondent provides answers by pressing the keys of a touch telephone, or records vocal responses to questions. IVR has numerous advantages over pencil-and-paper logs (Corkrey & Parkinson, 2002), and IVR reports are considered significantly more accurate than retrospective reports (e.g., Searles, Helzer, Rose, & Badger, 2002).

#### 1.5 The present study

In an effort to improve treatment outcomes for marijuana dependence, the current study was designed to enhance patients' coping self-efficacy, and treatment attendance and adherence. Based on social learning theory, it was anticipated that contingent reinforcement for homework completion, verified through IVR reports, would directly drive homework completion, leading to more success experiences, thereby enhancing confidence in one's ability to cope with high-risk situations (i.e., enhanced self-efficacy). Improved self-efficacy was expected to increase the likelihood of employing coping skills in high-risk situations, thereby increasing the probability of achieving abstinence and maintaining it over the long term. Alternatively, however, it was also considered plausible that contingent reinforcement

for abstinence per se might also result prompt development of coping skills, and thereby increase self-efficacy.

To test these assumptions marijuana-dependent patients were assigned randomly to one of three treatment conditions in a pre-post-follow-up design:

1. MET+CBT+CM<sub>Homework</sub>: A treatment combining motivational enhancement therapy (MET), cognitive-behavioral skills training (CBT), and contingent reinforcement for completing homework assignments designed to strengthen coping skills and self-efficacy
2. MET+CBT+CM<sub>Abstinence</sub>: A comparison treatment combining MET, CBT, and contingent reinforcement for marijuana-free urine specimens
3. Case Management (CaseM): A case-management control intervention in which patient problems are discussed, but in which no MET or substance abuse skills training occurs. In the two MET+CBT-based treatments, homework completion was monitored using daily IVR recordings. The MET+CBT+CM<sub>Abstinence</sub> condition was intended to control for delivery of MET and cognitive-behavioral treatment, plus the experience of contingency management. The Case Management condition was intended to control for time and attention.

Several hypotheses were explored: 1) It was expected that the MET+CBT+ CM<sub>Homework</sub> condition would lead to better outcomes than the other two conditions; 2) It was hypothesized that both of the MET+CBT+CM conditions would yield better outcomes than the CaseM condition; 3) It was expected that the effects of the CM<sub>Abstinence</sub> condition would be mediated by effects on treatment adherence and retention (i.e., abstinence during treatment, and treatment attendance), but that effects of CM<sub>Homework</sub> would be mediated by coping and self-efficacy. In our analyses we evaluated means over time, and employed latent class growth models to explore outcome trajectories and predictors of membership in trajectory-based patient subgroups.

## 2. Material and Methods

### 2.1 Participants

Participants were recruited through newspaper and radio advertisements announcing free treatment for marijuana dependence during the period March 2007 through April 2010, when recruitment was scheduled to end. To be eligible individuals had to be at least 18 years old, meet DSM-IV criteria for marijuana dependence or abuse, and be willing to accept random assignment to treatment. Individuals were excluded if they had acute medical or psychiatric problems requiring inpatient treatment (e.g., acute psychosis, or suicide risk), current dependence on drugs other than nicotine and marijuana, tested reading ability below the fifth grade level (Slosson Oral Reading Test; Slosson, 1963), or lack of reliable transportation to the treatment site. Individuals were also excluded if they were already engaged in substance abuse treatment elsewhere, or if they denied any marijuana use in the previous 60 days.

Of 464 men and women who responded to advertisements and were screened, 407 were initially eligible according to the criteria described. The most common reasons for exclusion (25 of 57) were lack of transportation and/or stable residence. The remainder (n=22) were excluded due to being currently engaged in some type of treatment, or dependence on other substances. Of the 407 eligible, 192 dropped out of the study prior to randomization, primarily due to lack of interest (184) or for time conflicts (8). The remaining 215 participants were assigned randomly to the three treatment conditions: MET+CBT+CM<sub>Homework</sub> (n= 71); MET+CBT+CM<sub>Abstinence</sub> (n= 73); CaseM (n= 71) (see Table 1 for

patient characteristics). Those randomized to treatment differed somewhat from those not randomized. Randomized persons tended to be older (32.7 years v 30.6;  $F=7.4$ ;  $p<.001$ ) and had slightly more education (13.0 years v 12.5;  $F=8.91$ ;  $p<.01$ ). Randomized persons also were somewhat more likely than those non-randomized to be white (60% v 47%;  $\chi^2=10.69$ ;  $p<.001$ ), employed (73% v 65%;  $\chi^2=4.62$ ;  $p<.05$ ), and married (40% v 32%;  $\chi^2=3.70$ ;  $p<.05$ ).

A sample size of 58 per cell was determined to be sufficient to test all hypotheses, based on effect sizes derived from our previous studies of marijuana treatment (Kadden, et al., 2007). Given the procedures used in each treatment, neither participants, therapists, nor research assistants could be blinded as to experimental condition. All patients met criteria for marijuana dependence (99%) or abuse (1%).

## 2.2 Measures and Instruments

**2.2.1 Telephone Screening and Diagnostic Interview**—Individuals seeking treatment contacted our research center by telephone, at which point they were interviewed using a 20-minute Quick Screen. The Quick Screen obtained information about demographics and inclusion/exclusion criteria. The Diagnostic Interview included the Structured Clinical Interview for DSM-IV Axis I Disorders, Patient edition, version 2.0 (SCID-I/P; First, Spitzer, Gibbon, & Williams, 1996), to determine whether subjects met inclusion/exclusion criteria for marijuana abuse or dependence, other drug dependence, and psychotic symptoms in the 90 days prior to the interview. Also included in the interview was the Slosson Oral Reading Test (SORT; Slosson, 1963). Those who could not read at the 5<sup>th</sup> grade level were excluded. A locator form was completed to identify individuals who could provide information regarding participants' whereabouts if we lost track of them.

**2.2.2 Marijuana use outcome data**—Marijuana use data at baseline and at follow-ups were collected using the Time-Line Follow-Back method (TLFB; Sobell & Sobell, 1992). The TLFB was used as described for the Marijuana Treatment Project (The Marijuana Treatment Project Research Group, 2004). Test-retest reliability for proportion days abstinent in a 90-day time period (PDA) is .74 (Kadden, et al., 2007). Marijuana use dependent variables were total abstinence (yes – no) for each follow-up interval, and proportion days abstinent (PDA) for each interval. Although other measures were considered (e.g., joints per smoking day), it has been our experience that these tend to follow the trajectories of PDA, and that PDA is a sensitive measure of outcome.

**2.2.3 Psychosocial Outcome**—The 20-item Marijuana Problems Scale (MPS; Stephens, Roffman, & Curtin, 2000) assesses marijuana-related problems (e.g., family, social, employment, memory/cognitive) and common complaints of heavy marijuana users (e.g., procrastination, feeling bad about using). In the current sample the MPS had an internal reliability alpha of .85.

**2.2.4 Treatment mechanism measures: Attendance, abstinence in treatment, self-efficacy, coping, readiness for change**—Attendance was simply the number of treatment sessions attended. Continuous abstinence in treatment was based on the longest period of abstinence recorded at the posttreatment TLFB. Self-efficacy was assessed at each follow-up point using the marijuana self-efficacy questionnaire (Stephens, Wertz, & Roffman, 1995). The questionnaire asks the participant to rate his/her level of confidence that he or she would not smoke in 20 different high-risk situations on a scale from 1 (*Not at all confident*) to 7 (*Very confident would not smoke*). The scale had an internal reliability of  $\alpha=.89$  in the present sample.



Coping skills were assessed at each follow-up point using the Coping Strategies Scale (CSS; Litt, Kadden, Cooney, & Kabela, 2003; Litt, Kadden, & Tennen, in press). Subjects rated the frequency from 0 (*never*) to 4 (*frequently*) of having used each of 48 specific strategies in the previous 3 months. Total coping is computed as the mean across all items (internal reliability  $\alpha = .95$  in the present sample), and has demonstrated validity (Litt, et al., in press).

Motivation/Readiness to change was measured using the Readiness to Change Questionnaire (RTCQ; Rollnick, Heather, Gold, & Hall, 1992). The RTCQ used here consisted of 12 items with each of three stages of change tapped by 4 items. Stages assessed are precontemplation, contemplation, and action. Internal reliability for the precontemplation and contemplation stage items was poor ( $\alpha < .50$ ). Internal reliability of the Action stage measure was  $\alpha = .69$  with one item (item 7) removed. This 3-item Action scale served as the measure of readiness in this study. The RTCQ was administered only at pre- and posttreatment.

## 2.3 Procedures

**2.3.1 Screening and assignment to treatment**—Prospective subjects were screened by phone, and either scheduled for an intake interview at our offices, or referred elsewhere for treatment. The final decision about eligibility was made at the intake interview, after completion of the SCID-I/P. Those who were eligible, and agreed to random assignment to treatment, completed the Informed Consent process and the intake assessments. Those who agreed to participate were assigned to treatment by a research assistant using an urn randomization procedure (Stout, Wirtz, Carbonari, & Del Boca, 1994) that balanced the three treatment conditions for gender, age, ethnicity, employment status, and number of marijuana problems.

**2.3.2 Data collection procedures**—Trained B.A.-level research assistants conducted the pretreatment and follow-up research assessments. Follow-up assessments occurred at posttreatment (Month 2) and at 90-day intervals thereafter for the next 12 months (i.e., to Month 14). In-person interviews were conducted at months 2 (posttreatment), 8, and 14. The intervening assessments at months 5 and 11 were conducted by telephone. Participants were compensated \$50 for each in-person follow-up assessment, and \$20 for each of the telephone follow-ups.

**2.3.3 Verification of marijuana use**—Urine tests were performed at intake, prior to each treatment session, and at the in-person follow-ups, using fast test cups (Varian, Inc., Onsite CupKit™). Because weekly urine screens are not adequate to assess marijuana use over an entire week, all participants were told that they might be called at random times to come to the clinic within 48 hours to submit a urine specimen. Participants in the MET+CBT+CM<sub>abstinence</sub> condition who failed to present to the clinic, or who submitted a positive urine in response to a random call, had the usual contingencies applied (see below). Everyone received a random call between weeks 3 – 5 of treatment, and were told that other calls were possible. In this trial 82% of participants in the CM conditions and 67% of those in the CaseM condition responded to these random calls.

## 2.4 Treatment

Treatment in all conditions consisted of 9 hour-long individual outpatient sessions. Treatment length of 9 weeks was patterned after MTP. All treatments were guided by manuals that provided specific guidelines to the therapists for each session.

**2.4.1 Condition 1: MET+CBT+CM<sub>Homework</sub>**—The MET+CBT treatment was based on that developed in MTP. It consisted of one session of motivational enhancement therapy,

followed by eight sessions of coping skills training. The motivational enhancement component was based on the Project MATCH MET manual (Miller, Zweben, DiClemente, & Rychtarik, 1992). Motivational strategies (e.g., development of discrepancies, supporting self-efficacy) were used in discussing the patient's reactions to a personalized feedback report of marijuana use, with the goal of moving the patient towards accepting the need for change and identifying specific changes to make. The single MET session was considered sufficient to enhance interest and increase initial motivation, while allowing the rest of the sessions to be devoted to skills training.

Coping skills training started in the second session. There were four core sessions: 1) identification of trigger situations, 2) coping with cravings, 3) managing thoughts about marijuana use, and 4) problem-solving. For the remaining four sessions, patients and therapists chose from among six elective topics, based on the patient's needs. The choice of topics for these sessions included marijuana refusal skills, coping with anger, managing negative moods, assertiveness training, coping with emergency situations and relapse, and decision-making.

The process of developing coping skills and increasing self-efficacy for abstinence was accomplished through the use of skills practice assignments (homework). Three related assignments per week were planned, each to be carried out on different days, and each to be recorded on work sheets to be reviewed in the next treatment session. Typical homework assignments might include recording high-risk situations, problem-solving ways to manage specific problems, and seeking out non-drug using social supports. Reinforcement was contingent upon verified completion of homework assignments between sessions. By reinforcing completion of homework, the treatment sought to increase the likelihood that patients would experience enactive mastery, thus providing the basis for increased coping self-efficacy.

The contingency management portion of this condition was adapted from Petry et al. (2000), using a fishbowl-drawing procedure for determining amount of reinforcement. Participants earned drawings from the fish bowl if they completed agreed-upon coping skills practice assignments. The drawing fish bowl contained 300 slips of paper. Half of these slips were "winning" slips, and the other half were non-winning slips that read, "Sorry, try again." Of the winning slips, 124 were for small prizes (e.g., \$1 coupons for local merchants), 25 specified large prizes (worth approximately \$20 in value, e.g., gift certificates), and one of the slips could be redeemed for a jumbo prize worth up to \$100 (e.g., a portable stereo CD player), or five large prizes. Participants were encouraged to make suggestions for prizes in all three categories.

Participants earned one drawing in Week 1 and two in Week 2 simply for attending those sessions. The first homework assignments were given in Week 2. Participants who completed all three assignments in a given week earned a drawing from the fishbowl. This was done to increase the likelihood that assignments would be completed throughout the week, rather than just at one or two isolated times in the week. There were three drawings in Week 3 if the client attended the first 2 sessions and completed the three activities for that week. The number of drawings escalated by one for each successive week in which all activities were completed, so patients could earn four drawings in Week 4, five in Week 5, etc. Those who attended all sessions and completed all activities could earn 45 drawings over the course of treatment.

We employed IVR technology to assess homework adherence. On each day that was agreed upon for doing homework, patients entered their homework via telephone by calling in to the automated IVR system. The IVR questions for each homework assignment inquired



about the day, time, and situation in which the assignment was attempted, details regarding execution of the assignment, the consequences, and the patient's reactions. If a patient failed to call in by the agreed upon deadline on a given day, the IVR system would call the person and prompt him/her to complete the assignment. Subjects had the option of delaying their response to a call for 5, 10 or 15 minutes. If the patient failed to respond, a second call was placed by the IVR system 15 minutes later. If there was still no response, that day's assignment was recorded as incomplete. If an IVR report showed incomplete adherence to assignments, reinforcement was withheld.

If a participant failed to attend a scheduled session, without calling at least 24 hrs in advance, or if he/she failed to complete any of the assignments, that person did not earn any drawings that week. The next time he/she completed all three assignments, one drawing was earned. After the person completed and verified all three assignments in two consecutive weeks, the number of drawings earned was restored to the highest level previously attained. In the case of missed sessions, only a verified emergency (e.g., subject became seriously ill, death in the family) prevented the resetting of the number of drawings. For participants in Condition 1, self-reports of marijuana use did not affect number of drawings. Patients were encouraged to provide honest reports of marijuana use, and their drawings continued to be earned as long as all three weekly assignments were recorded on the IVR system.

**2.4.2 Condition 2: MET+CBT+CM<sup>Abstinence</sup>**—Condition 2 was conducted in the same manner as in Condition 1, with the exception being that patients in Condition 2 were awarded fishbowl drawings contingent upon presentation of clean urines at each treatment session, instead of for verification of homework completion. Because of the long period (20 or more days) over which marijuana may be detected in the urine of chronic users (Hawks & Chiang, 1986; Verebey, Gold, & Mule, 1986), drawings for prizes in the first two weeks were based on attendance rather than negative urine samples. Drawings awarded upon presentation of negative urine samples began in Week 3. Starting in Week 3, drawings were earned by participants in Condition 2 contingent upon negative urine tests. They earned an extra draw for each consecutive week their urine was cannabis-free. If a urine test was positive, they were limited to a single draw for the next negative specimen, but could return to the prior level of drawings achieved after two consecutive weeks of negative tests. In this condition no contingencies were applied for completion or non-completion of assignments.

**2.4.3 Condition 3: Case management (CaseM)**—CaseM was included as an attention-control condition. CaseM was supportive in nature and did not directly target marijuana use. Rather, it helped participants identify and manage problems of daily living that might contribute to their marijuana use, but patients were not be given direct suggestions for changing their use. During the 9 CaseM sessions, the therapist and participant identified problems in daily living that might be of concern, and discussed community resources that might help in dealing with them (e.g., contacting a psychiatrist for depression, or finding a better place to live). Efforts were made to minimize overlap with MET+CBT+CM by not employing motivational interviewing techniques, skills training, or tangible reinforcement.

## 2.5 Therapists

Four therapists, each with graduate-level training and clinical experience with CBT and case management, provided treatment in this study. All therapists delivered all treatments. This was done to minimize therapist effects on outcomes. All were trained using treatment manuals, training seminars, and case examples. The Project Coordinator provided supervision weekly for three training cases, and biweekly thereafter, based on ratings of session tapes to assure adherence to the protocol for each intervention.

## 2.6 Treatment Integrity

Two methods were used to assess adherence to the treatment protocols and integrity of the treatments. First, therapist checklists for each session were used to provide an outline of material to be covered. Therapists were required to follow the outline and check off areas covered as the session proceeded. The requirement to adhere to the session outlines and record progress reduced the likelihood of extraneous or tangential discussions. Second, each treatment session was audio taped. The Project Coordinator (PC) listened to all session tapes for the therapist training cases and provided weekly supervision. Thereafter, 33% of sessions were evaluated, using tape-rating forms, and supervision was provided biweekly. The PC used the rating forms to assess treatment adherence and assure that elements unique to MET or CBT were not employed in the CaseM treatment. Therapist adherence to session guidelines, averaged over all sessions rated, ranged from 93% to 97%

## 3. Results

### 3.1 Homogeneity checks

Multiple chi-square tests and one-way analyses of variance were used to verify that the three treatment conditions were equivalent with respect to background characteristics. There were no significant between-groups differences on any background or balancing variable (see Table 1). Chi-square tests also indicated that dropouts were evenly distributed across treatment conditions. Of the 215 participants randomized to treatment, 19 (9%) dropped out of the study prior to completion of treatment and provided no posttreatment data. By the 14-month follow-up, another 14 had dropped out, and the remaining 182 participants were distributed among the treatment conditions as follows: MET+CBT+CM<sub>Homework</sub> ( $n = 61$ ), MET+CBT+CM<sub>Abstinence</sub> ( $n = 60$ ), and CaseM ( $n = 61$ ). Analyses indicated no differences in any patient characteristic by treatment condition among those who completed the 14-month follow-up and those who dropped out prior to the final follow-up.

### 3.2 Adherence to Treatment

We evaluated session attendance, adherence to treatment assignments, and days of continuous abstinence during treatment using one-way analysis of variance. Over all three conditions, participants attended a mean of 5.7 sessions out of 9 ( $SD = 3.6$ ). There were no significant differences in number of sessions attended as a function of treatment condition: MET+CBT+CM<sub>Homework</sub>, 5.7 sessions ( $SD = 3.5$ ); MET+CBT+CM<sub>Abstinence</sub>, 5.5 sessions ( $SD = 3.8$ ); CaseM, 6.0 sessions ( $SD = 3.5$ );  $F(2, 211) = 0.27, p > .75$ .

In the two MET+CBT+CM conditions, treatment assignments were recorded using the IVR system. Patients in the MET+CBT+CM<sub>Homework</sub> condition completed a significantly greater proportion of their assignments (50.2%) than did patients in MET+CBT+CM<sub>Abstinence</sub> (31.7%) ( $Z = 2.68; p < .01$ ). Patients in the MET+CBT+CM<sub>Homework</sub> condition earned on average \$106.00 worth of prizes, versus \$140.00 worth of prizes for MET+CBT+CM<sub>Abstinence</sub> patients [ $F(2, 142) = 2.00; p > .10$ ].

One measure of adherence to CM, and a presumed mechanism of action, is longest period of initial abstinence. Higgins, Alessi and Dantona (2002) have suggested that initial abstinence is the best predictor of longer term outcomes. In terms of days of initial continuous abstinence (starting from first treatment day), the MET+CBT+CM<sub>Homework</sub> condition elicited a mean of 18.65 days ( $SD = 23.74$ ), versus 27.95 ( $SD = 25.17$ ) for the MET+CBT+CM<sub>Abstinence</sub> condition, and 19.45 ( $SD = 24.13$ ) for CaseM. Although the omnibus  $F$  value for the ANOVA was non-significant [ $F(2, 193) = 2.88, p = .06$ ], the contrast of MET+CBT+CM<sub>Abstinence</sub> versus MET+CBT+CM<sub>Homework</sub> was significant [ $t(191) = 2.17; p < .03$ ].

### 3.3 Treatment Effects on Outcomes

The primary marijuana use outcome variables derived from the Form-90 were Continuous Abstinence and Proportion of Days Abstinent (PDA) for the time period prior to each follow-up. The Marijuana Problems Scale score was the primary psychosocial dependent variable.

Figure 1 shows the proportion of patients continuously abstinent during treatment and each 90-day follow-up period (panel A), and the mean values for PDA (panel B), and Marijuana Problem Scale score (panel C) by treatment condition over time. A generalized estimating equations (GEE) model (Proc GENMOD; SAS Institute, 1999) was used to analyze the effect of treatment condition on continuous abstinence prior to each of the follow-up points. Pretreatment PDA served as a covariate. Examination of the proportion abstinent data and the means values for PDA suggested that the Time effect might be showing a quadratic pattern, so quadratic time was also included as an effect in the models. The analysis yielded no significant main effect for Treatment condition, and there was no Treatment X Time interaction effect. Significant effects were seen for Time, Time<sup>2</sup>, and Treatment X Time<sup>2</sup> (see Table 2). A-priori contrasts were examined for CaseM versus the two MET+CBT+CM conditions, and for the contrast of MET+CBT+CM<sub>Homework</sub> versus MET+CBT+CM<sub>Abstinence</sub>. The first contrast was non-significant ( $\chi^2 = 0.07$ ), but the contrast between the two CM conditions indicated that the effect of quadratic time X treatment was significant ( $\chi^2 = 6.13$ ), indicating that abstinence in the early part of the follow-up (months 5 – 8) was higher for those in the MET+CBT+CM<sub>Abstinence</sub> condition.

Similar results were seen for PDA. Linear mixed modeling (Proc MIXED; SAS Institute, 1999) was used to analyze the main effects for Treatment and Time (from baseline to 15 months), as well as the two planned contrasts described above. Treatment condition was treated as a fixed effect. Both Time and intercept were included as random effects. An unstructured covariance structure was adopted on the basis of accepted fit criteria (–2 restricted log-likelihood, Akaike Information Criterion; Judge, Griffiths, Hill, Lutkepohl, & Lee, 1985).

As seen in Table 2, results for PDA showed significant effects for Time, Time<sup>2</sup>, and Treatment X Time<sup>2</sup>. As with abstinence, the contrast of CaseM versus the two MET+CBT+CM conditions was non-significant, but the contrast of MET+CBT+CM<sub>Homework</sub> versus MET+CBT+CM<sub>Abstinence</sub> indicated higher PDA for patients in the CM<sub>abstinence</sub> condition during the early part of the follow-up [ $F(1, 756) = 5.92; p < .05$ ]. In contrast to the drug use outcomes, Marijuana Problem Scale Scores declined through 5 months, and remained relatively low and stable through the end of the 14-month follow-up, regardless of treatment condition.

### 3.4 Treatment Effects on Mechanism Variables

It was expected that the MET+CBT+CM<sub>Homework</sub> condition would result in significantly greater increases in self-efficacy and use of coping skills than the other treatments. Means of these variables over time by condition are depicted in Figure 2. Linear mixed model analyses indicated that values for self-efficacy and for CSS increased significantly from pre- to posttreatment in all treatment conditions, and then remained stable through the end of the follow-up period. There were no differences attributable to treatment condition or to the interaction of treatment X time. Similarly, Readiness for change, measured as the RTC Action subscale, was seen to increase significantly from pre- to posttreatment in all treatments [ $F(1, 191) = 36.38, p < .001$ ], but there were no significant differences by treatment.

### 3.5 Analyses of Treatment Trajectories and Mechanisms

Given the ambiguous results found in the analyses of main effects of treatment on outcomes, we decided to determine whether we could detect a subset of “very successful” or “very unsuccessful” patients, and explore the predictors of membership in those subsets using Latent Class Growth Modeling (LCGM). LCGM is a technique used to identify distinct subgroups of individuals who follow a similar pattern of change over time on a given variable, that is, have similar trajectories (Nagin, 2005). Unlike standard latent growth modeling techniques in which individual differences in both the slope and intercept are estimated using random coefficients, LCGM fixes the slope and the intercept to equality across individuals within a trajectory. Such an approach is considered acceptable, given that individual differences are captured by the multiple trajectories included in the model (Andruff, Carraro, Thompson, & Gaudreau, 2009). In this study LCGM was carried out using Proc Traj (Jones & Nagin, 2007; Jones, Nagin, & Roeder, 2001), a program created for use in SAS (SAS Institute, 1999).

For these models Time was measured in months, and a logit distribution was used. Models comprising from 1 to 5 trajectory classes were evaluated. The decision regarding the number of classes to be retained was based in part on Bayesian Information Criteria (BIC), and in part on interpretability of the trajectories (Nagin, 2005). A model describing four abstinence trajectories best met these criteria. The basic model is shown in Figure 3.

Group 1 was labeled “Treatment Non-Responders.” These persons, making up 43.4% of the total sample, recorded almost no months of total abstinence from the beginning of treatment through 14 months of follow-up. The second group, labeled “Late Responders,” made up another 25.1% of the sample. Members of this group were initially unlikely to record abstinence, but improved somewhat as time went on. Group 3, labeled “Early Relapsers,” accounted for 12% of the sample, and was characterized by initially good response to treatment, followed by relapse to baseline levels of use. The fourth group, labeled “Long-Term Abstainers,” made up 19.5% of the sample, and represented almost total abstinence from month 4 through the end of the 14 months.

The LCGM method allows prediction of group membership with variables entered as risk factors, using multinomial logistic regression (Jones & Nagin, 2007). In order to test effects of treatment and potential treatment mechanisms, four risk models were evaluated: 1) Effect of Treatment; 2) Effects of treatment adherence (i.e., continuous abstinence in treatment, and attendance); 3) Effects of cognitive and behavioral change (i.e., pre-post changes in marijuana abstinence self-efficacy and in coping skills); and 4) a combined model of all variables to detect possible mediation. Effects of cognitive and behavioral change were limited to pre-posttreatment changes because it appears that neither coping nor self-efficacy increased after the posttreatment time period.

The results of the analyses of all models are summarized in Table 3. Based on results for 90-day abstinence and for PDA, the Treatment variable was treated as a contrast variable with MET+CBT+ CM<sub>Abstinence</sub> scored as +1, CaseM scored as 0, and MET+CBT+ CM<sub>Homework</sub> scored as -1. Pre- to posttreatment change in self-efficacy, in coping skills, and in Readiness were computed as residualized change scores (Cohen, 1983). For each model analyzed Group 1 (Treatment Non-responders) was used as a reference group.

As seen in Table 3, results for Model 1 shows that Treatment condition was a significant predictor of membership in Groups 3 and 4, relative to the reference group (Group 1). The relative distributions of trajectories based on treatment condition are shown in Figure 4. As seen in the Figure, relative to those in the other conditions, patients in the MET+CBT+ CM<sub>Abstinence</sub> condition were significantly more likely to be members of Groups 3 and 4. Of

the measures of adherence tested in Model 2, days of continuous abstinence during treatment was a significant predictor of membership in all groups 2 through 4, relative to Group 1, (Treatment Non-Responders). Cognitive and behavioral change variables, shown in the results for Model 3, were also significant predictors of membership in groups 2 through 4 (see Table 3).

The combined model, model 4, shows that abstinence during treatment and increase in self-efficacy were particularly important predictors of group membership, particularly in Group 4, the Long-Term Abstainers. The effect for Treatment drops out in this model, however, suggesting that the effects of the  $CM_{\text{Abstinence}}$  condition were mediated by its effects on both abstinence during treatment and on self-efficacy. Coping change continued to predict membership in Group 2, Late Responders, suggesting that members in this group benefited from their coping increases after treatment had ended.

### 3.6 Causal Chains: Effects of Mechanism Variables on Coping and Self-Efficacy

It was expected that the  $CM_{\text{Abstinence}}$  and  $CM_{\text{Homework}}$  treatments would have specific results. The  $CM_{\text{Abstinence}}$  treatment was expected to increase continuous abstinence during the treatment phase, and increase attendance.  $CM_{\text{Homework}}$  treatment was expected to result in increased homework compliance, and thus increased skills building. These expected changes in both treatments were hypothesized to result in increases in both coping and self-efficacy over time. The Table 4 shows the results of partial correlation analyses in which the presumed treatment mechanism variables are correlated with coping and self-efficacy measures over time. Analyses involving coping scores control for baseline coping total score. Analyses involving self-efficacy scores control for baseline marijuana abstinence self-efficacy score. All variables were strongly associated with pre-post changes in coping and self-efficacy (i.e., the Posttreatment values). Only continuous abstinence during treatment was reliably associated with self-efficacy scores at distal time points.

## 4. Discussion

Contrary to expectations, no treatment examined in this study yielded unequivocally better long-term results than any other. In terms of eliciting complete abstinence, decrease in use (increase in PDA) or decrease in marijuana-related problems, all of the treatments yielded moderately good effects that were maintained though 14 months. Except for the  $CM_{\text{Abstinence}}$  condition yielding somewhat better outcomes in the months immediately posttreatment, it is especially striking that neither of the MET+CBT+CM treatments was even demonstrably better than the CaseM treatment, which entailed no explicit skills building and no contingency management. In fact, it appeared that the weakest treatment offered in this study was the MET+CBT+ $CM_{\text{Homework}}$  treatment.

The LCGM analyses, however, revealed that, whereas overall results may appear homogeneous, this sample actually evidenced several identifiable trajectories of use/abstinence. Most problematic of course was the flat trajectory of the Treatment Non-Responders, who made up nearly half of the sample. These were people who recorded almost no single month of abstinence. These were contrasted sharply, however, by the Long-Term Abstainers (Group 4 patients), whose probability of recording monthly abstinence increased during treatment and was at nearly 100% throughout the 14 months of follow-up. The  $CM_{\text{Abstinence}}$  treatment was 1.8 times more likely to lead to membership in this group than to membership in the Non-Responder group.

The  $CM_{\text{Abstinence}}$  treatment was also more likely to yield membership in Group 3; patients who responded well during treatment, but relapsed quickly thereafter. This result is consistent with a number of other studies of treatments that reinforced presentation of



negative drug urines. Studies by Epstein, Hawkins, Covi, Umbricht, and Preston (2003), Budney, Moore, Rocha and Higgins (2006), and Kadden et al. (2007) all found that reinforcement for marijuana abstinence yielded good effects in the short-term but failed to show benefits over other treatments in extended follow-ups. Results from LCGM analyses here, however, indicated that reinforcement for abstinence was more likely than the other treatments to lead to a long-term abstinence trajectory, and that this occurred due to effects of treatment on both adherence to treatment, which was directly reinforced, and on self-efficacy, which was not directly reinforced.

The relatively poor showing for the MET+CBT+CM<sub>Homework</sub> treatment was surprising. As noted above, this treatment operated much as it was supposed to. Patients in this condition completed significantly more homework assignments than did patients in the CM<sub>Abstinence</sub> condition. Contrary to our hypotheses, however, the increase in homework did not translate into increases in coping and self-efficacy above those found in the other conditions. Indeed, significant increases in both self-efficacy and report of coping skills were seen in all conditions. It may be the case that merely participating in highly supportive treatment, while restricting one's drug use, may be sufficient to increase both efficacy expectancies and development of coping skills. Indeed, the initial abstinence elicited by the CM<sub>Abstinence</sub> condition may have resulted in increases in self-efficacy at least as effectively as did homework completion.

The results for the MET+CBT+CM<sub>Homework</sub> treatment, however, were somewhat worse than expected. Petry et al. (2006) reported in a study of substance abusing outpatients that reinforcement for abstinence was more effective than reinforcement for activity completion. This was also the case in this study, despite the fact that patients in both treatments earned nearly the same amount in reinforcements. The addition of reinforcement for activity completion to an MET+CBT treatment may, for some reason, have actually made treatment less effective. Certainly the results found here were less impressive than those in our earlier study of MET+CBT treatment (Kadden, et al., 2007). Likewise, in our Network-Support study of alcohol-dependent patients, the addition of reinforcement for activity completion appeared to result in less efficacy in the long-term when compared to Network Support without a contingency management component (Litt, Kadden, Kabela-Cormier, & Petry, 2009). It may be the case that engaging in treatment activities for material gain may somehow be distracting for patients, though we have no evidence for this. In any case, the results from this study, and others, suggest that simply increasing rates of homework completion are not sufficient to improve outcomes.

The present study was intended to explore and exploit hypothesized mechanisms of treatment in hopes of maximizing efficacy and promoting abstinence over the long-term. Given earlier results pointing to the importance of self-efficacy enhancement and use of coping skills in long-term improvements, we devised the MET+CBT+CM<sub>Homework</sub> treatment to directly address both self-efficacy and coping skills. Reinforcement for completing homework assignments was intended to enhance the development of skills, and success at skills building was expected to enhance self-efficacy. These expected changes did not occur. Increases in coping and self-efficacy from pre- to posttreatment did emerge, but not at levels greater than those seen in the other treatments.

Alternatively, the MET+CBT+CM<sub>Abstinence</sub> treatment was also intended to be effective, but to operate along somewhat different lines. Reinforcement for abstinence was expected to result in increased days of abstinence in treatment, and thereby lead to increases in self-efficacy. The inducement to present clean urines was expected to motivate patients to stay abstinent, and to make use of the skills taught in CBT to help them with that goal. To some extent these changes did occur as planned. As shown in Table 4, abstinence during treatment



did predict self-efficacy over time, but did not predict coping. Furthermore, abstinence during treatment was an independent predictor of membership in the Long-Term Abstainers group.

There are some limitations to this study as well. Many of those who contacted us chose to drop out before randomization for lack of interest. Given the integration of marijuana in the lifestyles of many of our patients this may be understandable. A comparison of those randomized to treatment to those not randomized, however, indicates that the patient sample in this study may have been higher functioning, and probably more motivated, than the population as a whole. That fact in itself may have served to restrict between-treatment differences.

Another limitation was that the therapists and research assistants were not blinded to study conditions, although this fact does not seem to have led to any biases discernible in the outcomes measured. Other issues include the fact that treatment attendance overall was modest, though in line with figures from other marijuana treatment studies, and it may be the case that a 9-week treatment is too short to thoroughly train complex coping skills.

## 5. Conclusions

As in past studies (e.g., Litt, et al., 2008), the effects of coping, and particularly self-efficacy, have emerged as important predictors of treatment success. In the present study, abstinence in treatment appeared to be effective in increasing self-efficacy, even over the long term, as well as having independent effects. Coping skills did emerge as a predictor, particularly among members of the group of Late Responders. We conclude from this that treatments that seek to enhance self-efficacy, coping and abstinence per se, using methods more effective than those used here, may represent the best chance for long-term abstinence for marijuana dependent patients.

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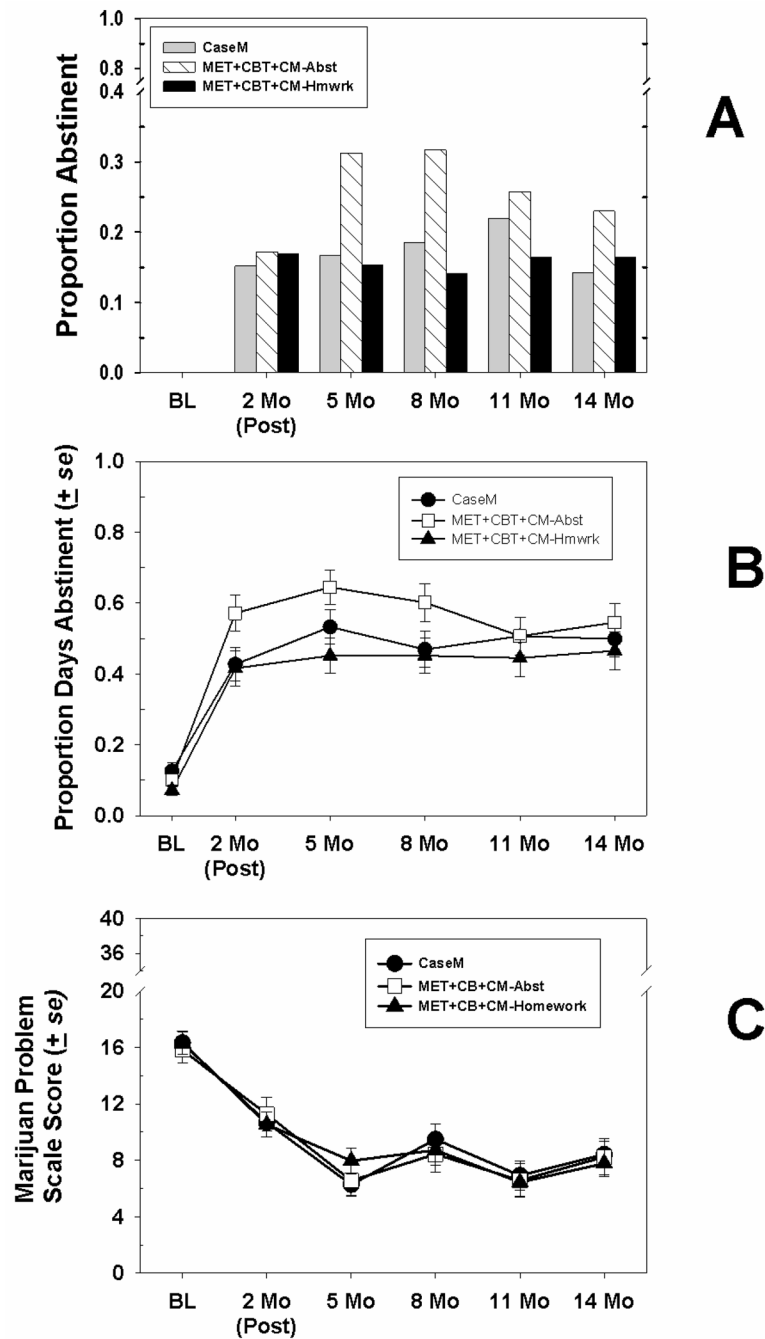
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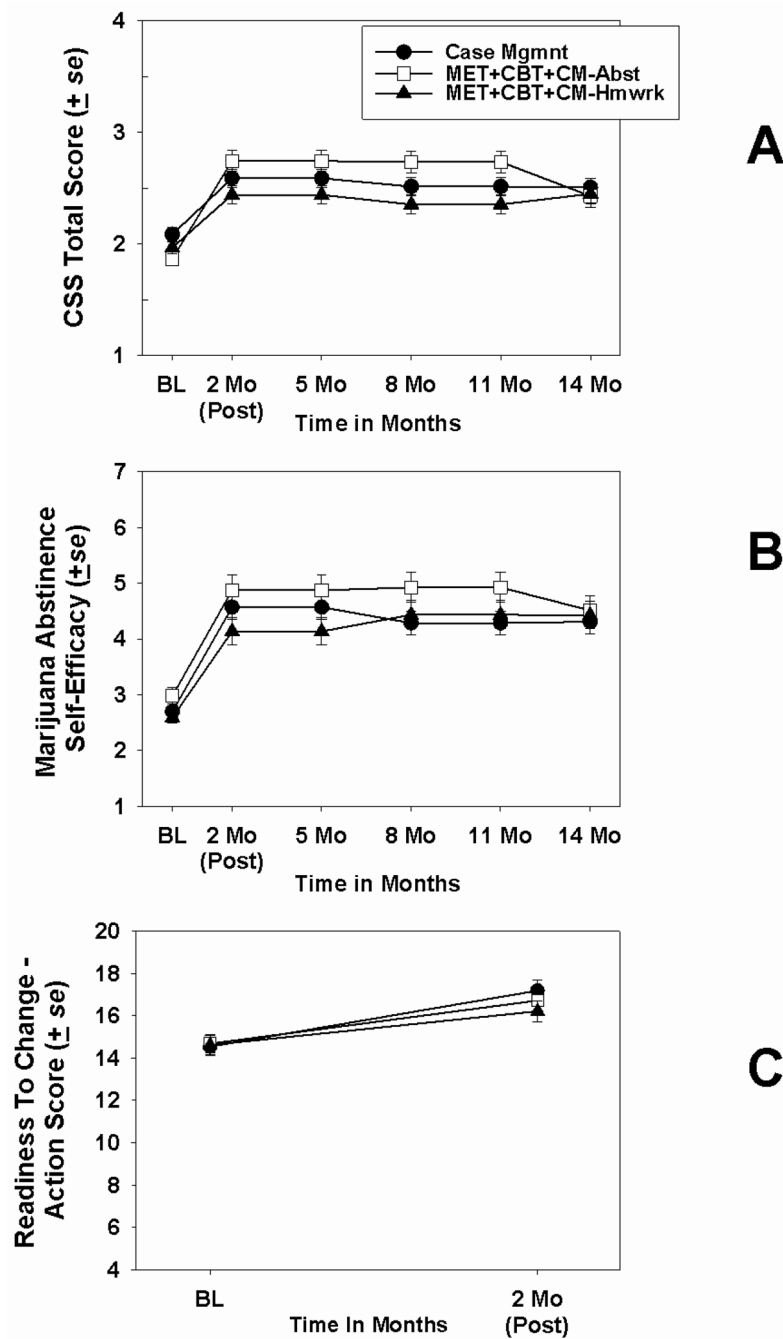
### Highlights

- Marijuana is the most commonly used illicit drug in the US, and achieving abstinence is difficult
- Treatments that include contingency management and increase self-efficacy have been effective
- The current study explored enhancing self-efficacy by reinforcing treatment assignments
- Results showed that a treatment that reinforced abstinence performed slightly better than others
- Latent class models indicated that initial abstinence and self-efficacy best predicted outcome

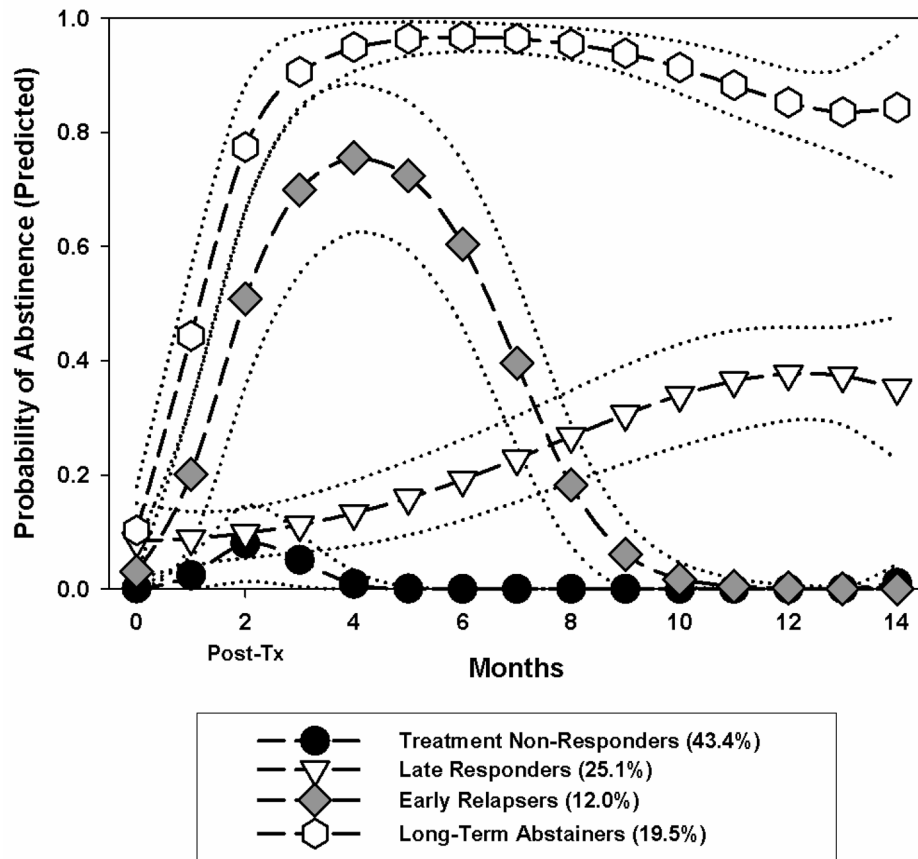




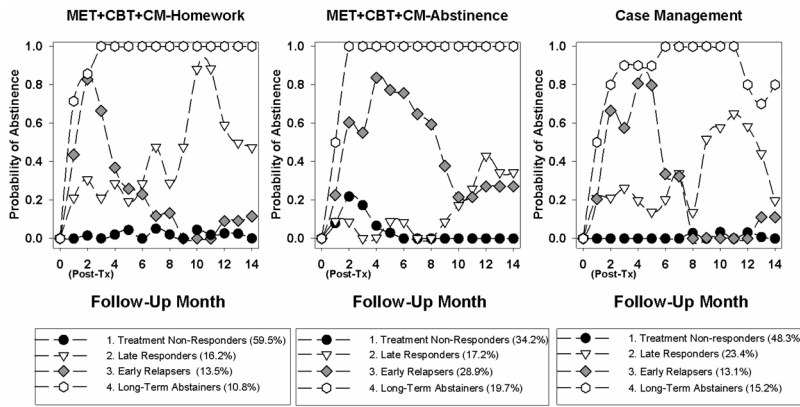
**Figure 1.** Main outcome measures over time by treatment condition. MET+CB+CM-Homework = Motivational Enhancement plus cognitive-behavioral treatment plus contingency management of homework completion. MET+CB+CM-Abst = Motivational Enhancement plus cognitive-behavioral treatment plus contingency management of abstinence. CaseM=Case Management.



**Figure 2.** Cognitive and behavioral mechanism variables over time by treatment condition. MET+CB+CM-Homework = Motivational Enhancement plus cognitive-behavioral treatment plus contingency management of homework completion. MET+CB+CM-Abst = Motivational Enhancement plus cognitive-behavioral treatment plus contingency management of abstinence. CaseM=Case Management.



**Figure 3.** Four-trajectory model extracted using Latent Class Growth modeling. Dotted lines indicated 95% confidence intervals around the estimated trajectories.



**Figure 4.** Four-trajectory Latent Class Growth model results by treatment condition. MET+CB+CM-Homework = Motivational Enhancement plus cognitive-behavioral treatment plus contingency management of homework completion. MET+CB+CM-Abst = Motivational Enhancement plus cognitive-behavioral treatment plus contingency management of abstinence. CaseM=Case Management.

Table 1

Background and Demographic Characteristics by Treatment Condition.

Background Variable	Treatment Condition							
	MET+CBT+CM Homework (n=71)		MET+CBT+CM Abstinence (n=73)		Case Management (n=71)		Total (N=215)	
	Mean or %	SD	Mean or %	SD	Mean or %	SD	Mean or %	SD
Age	32.3	10.2	32.1	9.1	33.6	10.8	32.7	10.0
Sex (% Male) [146 men 69 women]	73.0		70.0		62.0		68.0	
Ethnicity %								
White	72.9		68.5		62.9		68.1	
Black	8.6		11.0		17.1		12.2	
Hispanic	14.3		19.2		15.7		16.4	
Other	4.3		1.4		4.3		3.3	
Education (Years of School)	13.1	1.8	12.9	2.7	13.4	1.9	13.2	2.2
Employed Full or Part Time %	76.1		74.0		74.6		74.9	
Married or Cohabiting %	31.0		39.7		33.8		34.9	
Lifetime treatments for drug abuse	0.3	0.7	0.3	0.6	0.3	0.7	0.3	0.6
Estimated joints per day - Baseline	2.0	3.0	1.8	3.3	1.6	1.9	1.8	2.8
Marijuana Days in Period - Baseline	72.5	28.0	71.8	27.8	68.4	31.5	70.9	29.1

Note: *SD* = Standard Deviation

Table 2

Summary of Tests of Treatment Effects on Outcome Variables. Values Shown are Fs (for PDA and Marijuana Problem Scale Scores) or Wald  $\chi^2$  Values (for Continuous Abstinence). Maximum Likelihood Estimation Models Used. Effective N=215.

Dependent Variable	Effect Tested					
	Treatment (df = 2, 756)	Time (df=1, 192)	Treatment X Time (df=2,756)	Time <sup>2</sup> (df=1,192)	Treatment X Time <sup>2</sup> (df=2, 756)	Treatment X Time <sup>2</sup> (df=2, 756)
Continuous Abstinence <sup>a,b</sup>	0.97	33.15***	5.68	30.44***	6.01*	6.01*
PDA Marijuana	0.79	229.19***	3.00	159.72***	3.55*	3.55*
Problem Scale Score	0.02	212.79***	0.38	124.82***	0.60	0.60

<sup>a</sup>Baseline PDA used as a covariate in this model.

<sup>b</sup>Only numerator df apply in these analyses. Note:

\*  $p < .05$ ;

\*\*\*

$p < .001$ . df = degrees of freedom.



Summary of Analyses of Latent Class Growth Model Analyses with Four Trajectory-Based Groups. Estimates Indicate Probability of Membership in each Group as Compared to Group 1 (Treatment Non-Responders). Effective N=215.

**Table 3**

Model	Predictors	Group 2 (Late Responders)			Group 3 (Early Relapsers)			Group 4 (Long-Term Abstainers)		
		B	se	t	B	se	t	B	se	t
1	Treatment <sup>a</sup>	0.12	0.29	0.40	0.55	0.25	2.17*	.58	0.27	2.15*
2	Continuous Abstinence in Treatment	0.07	0.02	3.13**	0.13	0.02	5.42***	0.17	0.03	5.95***
	Attendance	0.01	0.07	0.11	0.16	0.11	1.46	0.15	0.11	1.29
3	Readiness Change	0.05	0.09	0.56	0.09	0.11	0.79	0.23	0.16	1.50
	Self-efficacy Change	0.48	0.35	1.39	0.78	0.43	1.80	2.61	0.60	4.30***
	Coping Change	0.86	0.44	1.94	0.92	0.48	1.88	0.91	0.40	2.37*
4	Treatment <sup>a</sup>	-0.05	0.45	-0.11	0.73	0.64	1.14	1.32	0.73	1.80
	Continuous Abstinence in Treatment	0.09	0.02	3.48***	0.14	0.03	4.85***	0.21	0.05	4.43***
	Attendance	-0.14	0.12	-1.20	0.09	0.16	0.53	0.14	0.21	0.68
	Readiness Change	0.10	0.12	0.81	0.24	0.19	1.26	0.46	0.24	1.94
	Self-efficacy Change	0.97	0.54	1.79	0.90	0.66	1.99*	2.22	0.42	3.75***
	Coping Change	0.55	0.54	1.98*	0.23	0.78	0.29	0.19	0.84	0.23

<sup>a</sup>Treatment contrast: MET+CBT+CMabstinence v. CaseM v MET+CBT+CMHmwrk

\*  $p < .05$ ;

\*\*  $p < .01$ ;

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

Partial Correlations of Presumed Mechanism Variables with Coping and Self-Efficacy Over Time. Correlations are Controlling for Baseline Values of Coping (or Self-Efficacy).

**Table 4**

Mechanism Variable	Coping Total Score		Marijuana Abstinence Self-Efficacy Score	
	Posttreatment	8 Months	14 Months	14 Months
Continuous Abstinence in Treatment <sup>a</sup>	.348***	.104	.024	.498***
Attendance <sup>a</sup>	.395***	.115	.006	.391***
Homework Adherence <sup>b</sup>	.256*	-.005	-.103	.404***
				.389***
				.417***
				.189*
				.142
				.263
				.187

<sup>a</sup>Degrees of Freedom = 175

<sup>b</sup>Degrees of Freedom = 105

\*\*\*  
\* $p < .001$ ;

\*\*  
\* $p < .01$ ;

\*  
\* $p < .05$