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Follow-Up Treatment Effects of Contingency Management and Motivational Interviewing on Substance Use: A Meta-Analysis

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Motivation is an integral factor in substance use treatment and long-term recovery. However, it is unclear what role intrinsic and extrinsic motivation play across different treatment modalities. A meta-analysis ($N = 84$) was performed to estimate the pooled effect size of Motivational Interviewing (MI; primarily targeting intrinsic motivation) and contingency management (CM; primarily targeting extrinsic motivation) at different follow-up periods. Collapsed across all substance types, CM had a significant effect at 3-month follow-up, only. In contrast, MI had a significant effect at 6-month follow-up, only. CM had small and medium effects on multiple substances at 3-month follow-up (i.e., tobacco, marijuana, stimulants, polysubstances), but not at 6-month follow-up. MI had 1 significant medium effect at 3-month follow-up (i.e., marijuana), but several significant small effects at 6-month follow-up (i.e., alcohol, tobacco, polysubstances). This meta-analysis suggests that both CM and MI promote reductions in a range of substances, even several months after the intervention concludes. Further, these results provide some evidence that extrinsically focused CM may produce medium follow-up effects in the short run, but intrinsically focused MI may produce small but durable follow-up effects. However, this interpretation is complicated by the differences between the MI and CM studies that preclude statistical tests comparing effect sizes, and few studies assessed motivation itself. Future researchers should investigate how motivational dynamics impact lasting outcomes in substance use treatment.

Keywords: contingency management, efficacy, meta-analysis, motivational interviewing, substance use disorders

Substance abuse is a pernicious public health concern, contributing to more than 7 million years of life lost globally (Whiteford et al., 2013). A growing body of research suggests that substance use disorder should be conceptualized as a chronic illness, characterized by high risk of relapse even after initially successful treatment (Arria & McLellan, 2012). Therefore, it is important for substance use intervention researchers to examine whether effects endure after termination to develop treatment approaches that adequately address complex needs.

Motivation is recognized to be an important factor in lasting recovery from substance use disorders (DiClemente, 1999). Self-Determination Theory (Deci & Ryan, 1985) describes two broad categories of motivation. Intrinsic motivation is evident when a person engages in a behavior because of the inherent satisfaction or enjoyment the action entails. Extrinsic motivation is present when a person performs a behavior because of external factors, such as the promise of reward or the fear of punishment. The role of intrinsic and extrinsic motivation in substance use treatment is not yet clear, especially considering potentially different impacts on different target substances. For example, interventions focusing on intrinsic rather than extrinsic motivation appear to lead to more sustained tobacco abstinence (e.g., Curry, Wagner, & Grothaus, 1991; Williams, Gagné, Ryan, & Deci, 2002). However, motivation related to legal concerns and social acceptability (i.e., relatively extrinsic reasons) significantly reduce the risk of cannabis relapse (Chauchard, Levin, Copersino, Heishman, & Gorelick, 2013).

To better understand the roles of intrinsic and extrinsic motivation in sustained substance use recovery, it is important to examine the long-term outcomes associated with interventions that target each type of motivation. Motivational Interviewing (MI) is a psychosocial intervention that aims to enhance intrinsic motivation by eliciting and strengthening an individual's internal commitment to change (Miller & Rollnick, 2012). Several meta-analyses suggest that MI has significant, but small effects on substance use (e.g., Burke, Arkowitz, & Menchola, 2003; Lundahl, Kunz, Brownell, Tollefson, & Burke, 2010). However, the evidence for lasting reductions in substance use is unclear. Burke et al. (2003) and Lundahl et al. (2010) found effects to be stable for many months after treatment ends, whereas Vasilaki et al. (2006) showed significant effects at 3-month, but not 6-month follow-up assessments.

In contrast, contingency management (CM) is a substance use intervention which monitors and rewards evidence of substance abstinence, or rarely, reduced use, with tangible reinforcers (e.g.,

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These results have not been presented in any other format, including conference presentations.

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Petry & Simcic, 2002). For example, an individual using cocaine might earn money or prizes for producing urine that screens negative for cocaine. CM is rooted in operant theory (Skinner, 1953) and is based on the notion that extrinsic rewards can motivate behavior change (Higgins et al., 1994). Numerous studies support CM's efficacy during treatment (e.g., Higgins, Heil, & Jennifer, 2004; Prendergast, Podus, Finney, Greenwell, & Roll, 2006), even when compared with alternative substance use treatments such as cognitive–behavioral interventions and relapse prevention (Dutra et al., 2008). However, the durability of CM's effect on substance use is less certain (e.g., Benishek et al., 2014), with some reviews indicating that CM's effects may disappear several months after treatment is terminated (e.g., Cahill & Perera, 2008; Prendergast et al., 2006).

Rationale for the Meta-Analysis

Considering the complex and chronic nature of substance use disorders, it is important to determine which interventions can achieve lasting, clinically significant effects (e.g., Donovan et al., 2012; Marsden et al., 2011). This meta-analysis sought to examine the size and durability of follow-up effects of MI and CM, substance use interventions that target intrinsic versus extrinsic motivation, respectively. We selected MI and CM because each intervention is designed to increase a specific type of motivation. Further, this meta-analysis aimed to clarify how interventions targeting intrinsic or extrinsic motivation impact lasting reductions in varying substances, such as alcohol, marijuana, stimulants, tobacco, and opiates.

Method

Literature Search

We used two strategies to identify trials of MI and CM for the treatment of substance use. First, we searched the PsycINFO, ERIC, NCJRS, Sociological Abstracts, and PubMed databases using search terms for CM and MI ("motivational interview*" or "motivational enhancement" or "motivation* intervention" or "contingency management" or "voucher*" or "behavioral contracting" or "token economy"), and drug use ("substance*" or "drug*" or "alcohol*" or "cigarette*" or "nicotine" or "tobacco" or "cocaine" or "stimulant" or "amphetamine*" or "heroin*" or "opiate*" or "marijuana" or "cannabis"). Second, we searched an online bibliography of MI literature (http://www.motivationalinterview.net/library/biblio.html), and the reference sections of MI and CM meta-analyses and review papers that were identified through the terms described above. The publication date was limited to articles published before January 1, 2016 by specifying an end date (e.g.,

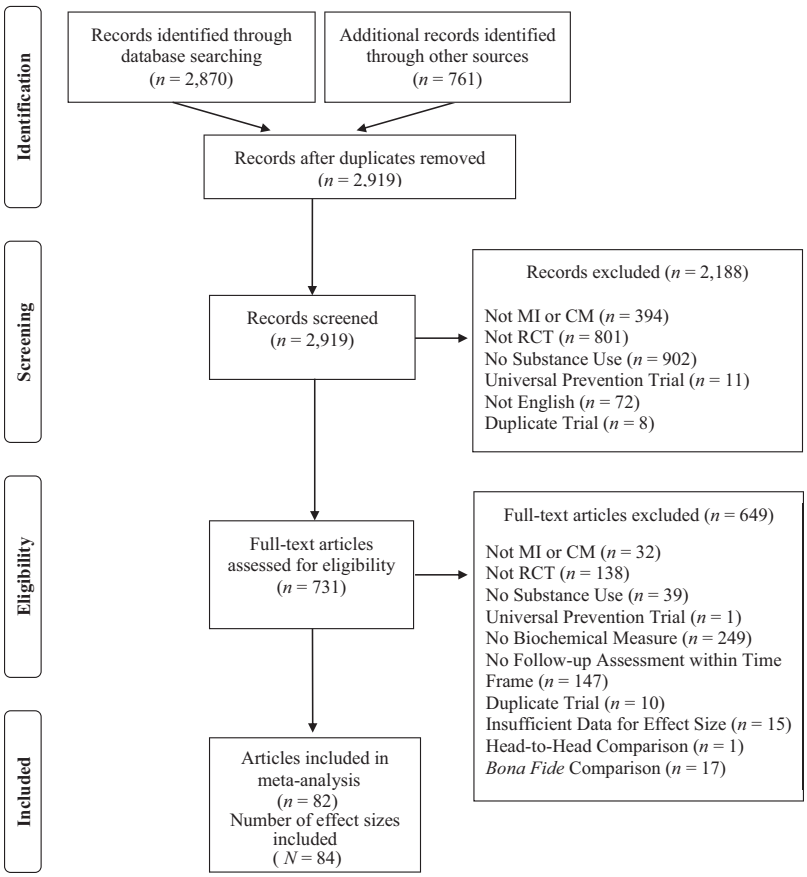

Figure 1. Preferred reporting items for systematic reviews and meta-analyses (PRISMA) flow diagram.

"2015" or "January 1, 2016") depending on the structure of the database search terms. There were 3,631 potential articles identified. After removing duplicates, 2,919 articles were eligible for inclusion.

We included all randomized controlled trials testing either (a) an intervention described as following the tenets of MI, or (b) an intervention rewarding biochemical measures of substance use abstinence or reduction with tangible reinforcers (CM). Trials were included only if individual participants (not groups) were randomized to conditions, the trial was not a universal prevention or analogue study, substance use was the target behavior for change, and outcomes were measured at least once following the termination of the intervention. This did not include assessments conducted on the same day as the last day of the intervention. Only studies that reported biochemical or biochemically validated substance use outcomes were included, as these measures are more valid than self-report measures alone (Connor Gorber, Schofield-Hurwitz, Hardt, Levasseur, & Tremblay, 2009; Delaney-Black et al., 2010; Grekin et al., 2010; McPherson, Packer, Cameron, Howell, & Roll, 2014). Trials that used *bona fide* comparison groups were excluded to facilitate the interpretation of effect sizes, unless the intervention group also received the *bona fide* treatment combined with CM or MI. *Bona fide* treatments were defined as "those that were delivered by trained therapists and were based on psychological principles, were offered to the psychotherapy community as viable treatments (e.g., through professional books or manuals), or contained specified components" (Wampold et al., 1997, p. 205). Lastly, articles that did not include sufficient data to calculate effect sizes were excluded, unless authors provided additional information after being contacted by e-mail.

Following these criteria, 2,188 articles were excluded based on information found in abstracts, and 649 were excluded based on information found in the full text (see Figure 1 for details). Dissertations and theses were examined as well; however, all trials found in dissertations or theses that met inclusion criteria were already included in the meta-analysis from articles in peer-reviewed journals. There were 82 articles that met inclusion criteria for the present meta-analysis. This research was not reviewed by the University of Southern California institutional review board because it did not involve human subjects.

Data Coding

The mean sample age, proportion male, and proportion White were determined when possible. The targeted substance was categorized as alcohol, tobacco, marijuana, stimulant, opiate, or poly-substance. Each sample was also categorized as treatment-seeking or non-treatment-seeking, following the coding scheme developed by Vasilaki et al. (2006). When possible, the average baseline self-reported motivation to change was coded and adjusted to a 10-point scale. The average maximum daily financial reward a participant could earn per day in CM conditions was also coded (i.e., total amount of rewards divided by number of intervention days). Study quality was assessed using the Cochrane Consumers and Communication Review Group's method (CCCRG; Higgins & Green, 2011). This tool includes a list of biases with the potential to be high risk, unclear, or low risk. To assess whether MI and CM were delivered consistently with their treatment models, coders also examined whether a manual was used and whether fidelity was evaluated. All variables were coded by two independent coders. Based on Cicchetti's (1994) guidelines, reliability was good-to-excellent, with kappas ranging from .64–1.00 and intraclass correlation coefficients (ICCs) ranging from .96–1.00.

Effect sizes were calculated using biochemical or biochemically verified substance use outcomes measured for two different follow-up periods, between >0 months and ≤3 months (F1), or between >3 months and ≤6 months (F2) after treatment was terminated. If outcomes were assessed multiple times within one period, the latest measurements were used to best estimate 3-month or 6-month outcomes. Outcome data included proportions of each condition biochemically confirmed as abstinent, continuous measures of biochemical markers of substance use, and bio-

Table 1
Characteristics of Motivational Interviewing Trials

Trials	Age	%Male	%White	Treatment-seeking	Baseline motivation
Ahluwalia et al. (2006)	45.10	33.11	.00	Yes	9.05
Baer et al. (2007)	17.90	56.00	58.00	No	—
Bager and Vilstrup (2010)	51.00	76.00	—	No	—
Bernstein et al. (2005)	37.95	70.59	14.20	No	—
Bernstein et al. (2011)	40.25	47.93	9.80	No	—
Bock et al. (2008)	47.70	52.90	69.10	No	—
Bolger et al. (2010)	19.20	70.00	—	Yes	2.16
Borrelli et al. (2010)	36.80	27.10	.00	No	6.45
Brown et al. (2010)	46.10	89.70	—	Yes	—
Carroll et al. (2006a)	32.80	56.80	71.60	Yes	—
Colby et al. (1998)	16.15	42.50	65.00	No	—
Colby et al. (2005)	16.30	29.00	55.00	No	—
Colby et al. (2012)	16.20	52.47	72.22	No	8.30
Curry et al. (2003)	33.91	.00	32.51	Yes	6.35
Davis et al. (2011)	37.60	55.05	76.15	—	—
Dieperink et al. (2014)	55.50	95.65	67.39	Yes	—
Emmen et al. (2005)	48.94	75.61	—	No	—
Gariti et al. (2002)	44.00	100.00	—	Yes	—
Haug et al. (2004)	29.70	.00	—	Yes	—
Helstrom et al. (2007)	15.98	58.02	78.98	No	—
Ingersoll et al. (2009)	42.00	55.00	5.00	No	—
Ingersoll et al. (2011)	44.70	46.30	12.96	Yes	—
Joya et al. (2016)	31.09	.00	—	No	—
Jungerman et al. (2007)	32.32	80.00	89.40	Yes	—
Manuel et al. (2013)	49.00	.00	30.00	Yes	7.85
Marsden et al. (2006)	18.40	66.37	76.02	—	—
Martin et al. (2008)	16.50	67.50	—	Yes	—
Martino et al. (2006)	31.70	72.73	31.80	Yes	—
McKee et al. (2007)	34.95	72.97	44.60	Yes	8.75
Morgenstern et al. (2009)	37.80	100.00	36.30	No	—
Mujika et al. (2014)	40.15	.00	—	No	—
Noknoy et al. (2010)	36.96	91.45	.00	Yes	—
Okuyemi et al. (2013)	44.40	74.70	35.60	Yes	9.10
Peterson et al. (2006)	17.40	54.70	72.30	No	—
Rohsenow et al. (2004)	34.20	68.00	88.00	Yes	—
Rohsenow et al. (2014)	33.74	57.57	86.08	Yes	—
Rohsenow et al. (2015)	34.53	44.58	83.17	Yes	5.05
Romanowich and Lamb (2015)	41.40	54.11	67.12	Yes	—
Soria et al. (2006)	38.52	47.47	—	No	—
Stephens et al. (2007)	31.83	74.50	87.20	Yes	—
Babor and the MTPRG (2004)	36.10	68.40	69.30	Yes	—
Wakefield et al. (2004)	52.28	62.24	—	Yes	—
Winhusen et al. (2008)	26.22	.00	39.71	Yes	—

chemically validated self-reported use. If trials reported abstinence proportions based on the retained sample only, the missing participants were considered nonabstinent for purposes of effect size calculation (e.g., Hughes et al., 2003). If outcomes were measured using multiple biochemical or biochemically verified methods, or if there were multiple CM or MI conditions, one composite effect size for each trial was calculated in order to avoid violating the assumption of independence.

Statistical Analyses

We calculated pooled effect sizes (Cohen's *d*) for MI and CM trials at F1 or F2 using Comprehensive Meta-Analysis (CMA; Borenstein, Hedges, Higgins, & Rothstein, 2005). Random-effects models were used to account for the variability in true effect sizes (Hunter & Schmidt, 2000) because initial fixed-effects models indicated significant heterogeneity (Hedges & Olkin, 1985). We followed Cohen's (1988) guidelines for interpreting magnitude of effects (i.e., $d = .20$ is a small effect, $d = .50$ is a medium effect, and $d = .80$ is a large effect). We characterized the extent of heterogeneity using the I^2 statistic. $I^2 = 25$ indicates low heterogeneity, $I^2 = 50$ indicates medium heterogeneity, and $I^2 = 75$ indicates high heterogeneity (Higgins & Thompson, 2002). Next, we calculated a pooled effect size for CM or MI for each substance type at each time period, as long as there were two or more studies contributing effect sizes (Valentine, Pigott, & Rothstein, 2010). Conducting statistical tests comparing the effect sizes of MI and CM was deemed inappropriate due to the extensive inherent differences between the two approaches, the targeted substances, and the enrolled samples.

Results

Eighty-two articles met inclusion criteria for this meta-analysis, containing information about 84 contrasts of an MI or CM condition versus a control condition. One article contained information

Table 2
Characteristics of Contingency Management Trials

Trials	Age	%Male	%White	Treatment-seeking	Baseline motivation	Maximum daily financial reward
Alessi et al. (2008)	36.60	100.00	54.00	Yes	—	$10.83
Bowers et al. (1987)	—	—	—	—	—	—
Brooner et al. (2007)	38.46	54.00	35.00	Yes	—	$19.05
Budney et al. (2006)	33.13	76.67	95.67	Yes	—	$6.78
Carroll et al. (2002)	33.86	65.45	83.64	Yes	—	$13.71
Carroll et al. (2006b)	21.20	89.60	21.75	Yes	—	$9.64
Dallery et al. (2013)	39.69	51.99	77.95	Yes	5.00	$11.52
Dunn et al. (2008)	29.75	40.00	—	Yes	9.00	$25.89
Dunn et al. (2010)	31.00	33.00	—	Yes	—	$25.89
Epstein et al. (2003)	39.00	57.00	—	Yes	—	$13.75
Ghitza et al. (2008)	37.00	56.00	—	Yes	—	—
Iguchi et al. (1996)	34.80	67.00	77.00	Yes	—	—
Iguchi et al. (1997)	36.60	63.00	85.00	Yes	—	$2.14
Heil et al. (2008)	24.31	.00	93.68	Yes	9.63	$16.73
Higgins et al. (1986)	32.40	100.00	51.33	Yes	—	—
Higgins et al. (1994)	31.35	67.50	85.00	Yes	—	$6.08
Higgins et al. (2004)	22.67	.00	94.30	Yes	9.75	$3.12
Higgins et al. (2014)	24.56	.00	92.97	Yes	—	—
Kadden et al. (2007)	32.70	71.00	60.00	Yes	—	$7.86
Ledgerwood et al. (2014)	44.84	38.27	33.33	Yes	—	—
McDonell et al. (2013)	42.74	65.34	53.98	Yes	—	—
McKay et al. (2010)	40.96	42.00	8.00	Yes	—	$13.69
Peirce et al. (2006)	42.01	55.94	26.14	Yes	—	$5.00
Petry and Martin (2002)	38.55	28.71	—	Yes	—	—
Petry et al. (2005a)	36.62	45.78	26.77	Yes	—	$5.43
Petry et al. (2005b)	39.52	27.26	19.47	Yes	—	—
Petry et al. (2006)	37.22	60.31	53.44	Yes	—	—
Petry et al. (2007)	41.54	43.24	21.62	Yes	—	$6.96
Petry et al. (2012a)	36.73	53.08	71.54	Yes	—	—
Petry et al. (2012b) Study 1	37.93	36.70	32.11	Yes	—	$6.67
Petry et al. (2012b) Study 2	36.47	47.15	47.45	Yes	—	$2.86
Petry et al. (2015)	40.79	50.42	46.67	Yes	—	$10.71
Poling et al. (2006)	34.59	70.03	75.53	Yes	—	$5.08
Rawson et al. (2002)	43.58	55.00	39.25	Yes	—	$11.41
Rohsenow et al. (2015)	34.53	44.58	83.17	Yes	5.05	$22.79
Roll et al. (2005)	16.50	62.00	68.18	Yes	—	$8.57
Rowan-Szal et al. (1997)	38.00	91.00	37.00	Yes	5.00	$5.00
Rowan-Szal et al. (2005)	33.00	62.00	20.00	Yes	—	$.45
Shoptaw et al. (2002)	44.01	60.56	38.86	Yes	—	$5.33
Shoptaw et al. (2005)	37.17	100.00	79.63	—	—	$11.41
Silverman et al. (1998)	37.83	66.05	37.34	Yes	—	$23.21

about two separate CM trials (Petry, Barry, Alessi, Rounsaville, & Carroll, 2012b), and another contained information to calculate an MI effect size and a CM effect size (Rohsenow et al., 2015). In total, these articles provided sufficient data to calculate 31 MI effect sizes at *F*1, 20 MI effect sizes at *F*2, 35 CM effect sizes at F1, and 18 CM effect sizes at F2. Tables 1 and 2 present characteristics of each trial. The total number of participants included in these trials was 13,291. The average age across all participants was 36.56 years old, adjusted for differences in sample size across trials. The overall percentage of male participants was 55.71% and the percentage of White participants was 46.81%. MI trials were more likely to target tobacco, $\chi^2 = 4.18$ $p < .05$, and alcohol use, $\chi^2 = 6.16$, $p = .03$, whereas CM trials were more likely to target stimulant use, $\chi^2 = 9.60$, $p < .01$. In addition, CM trials were more likely to enroll treatment-seeking samples, $\chi^2 = 21.74$ $p < .001$. MI interventions were significantly shorter than CM interventions, $t(80) = 8.51$, $p < .001$. Rohsenow et al. (2015) was excluded from MI versus CM comparisons because this article contained information used to calculate an effect size for MI and CM, which violated the assumption of independence.

Based on the CCCRG method, study descriptions suggested little bias in how participants were randomized ($n = 5$ at high risk, 5.95%) or in how incomplete data was handled ($n = 4$ high risk, 4.76%). The most frequent biases observed were in the selection of outcome measures ($n = 10$ high risk, 11.90%) and keeping participants and treatment providers blind to condition ($n = 84$ high risk, 100%). Most articles did not include sufficient information to determine whether random assignment was kept secure before allocation to conditions ($n = 63$ unclear, 75.00%) and whether outcome assessors were kept blind to study condition ($n = 56$ unclear, 66.67%). About one third of the trials ($n = 34$, 40.48%) used a treatment manual, and 37 (44.05%) assessed fidelity. MI trials were more likely than CM trials to use a treatment manual, $\chi^2 = 8.96$, $p < .01$, and assess fidelity, $\chi^2 = 9.98$, $p < .01$.

Raters achieved excellent reliability when coding effect sizes (ICC = .92). The effect sizes and 95% confidence intervals are included for each MI and CM trial, organized by target substance in Tables 3, 4, and 5. Across all substance types, CM had a significant medium effect at F1 ($d = .43$, 95% CI[.19, .66], $p < .001$), but not at F2 ($d = .06$, 95% CI[−.10, .22], $p = .47$). In contrast, MI did not have a significant effect at F1 ($d = .10$, 95% CI[−.02, .22], $p = .12$), but did have a significant small effect at F2 ($d = .22$, 95% CI[.11, .32], $p < .001$). The I^2 statistic indicated medium heterogeneity for both MI ($I^2 = 48.00$) and CM ($I^2 = 77.28$) at F1, and low heterogeneity for MI ($I^2 = 18.83$) and CM

Table 3
Effect Sizes for Contingency Management (CM) and Motivational Interviewing (MI) Trials Targeting Tobacco

Intervention	Study	Follow-up 1 *d* (95% CI)	Follow-up 2 *d* (95% CI)
MI ($n = 22$)	Ahluwalia et al. (2006)	−.39 [−.62, .16]	—
	Bernstein et al. (2011)	−.07 [−.42, .27]	—
	Bock et al.(2008)	.30 [.08, .52]	.10 [−.13, .34]
	Bolger et al. (2010)	−.21 [−.83, .42]	—
	Borrelli et al. (2010)	.27 [−.10, .64]	—
	Colby et al. (1998)	.45 [−.56, 1.45]	—
	Colby et al. (2004)	−.01 [−1.12, 1.09]	.79 [−.44, 2.02]
	Colby et al. (2012)	−.50 [−1.42, .42]	.26 [−.74, 1.26]
	Curry et al. (2003)	.48 [−.11, 1.07]	—
	Davis et al. (2011)	—	.60 [−1.17, 2.37]
	Gariti et al. (2002)	—	.85 [−.84, 2.55]
	Haug et al. (2004)	.03 [−.34, .40]	—
	Helstrom et al. (2007)	.28 [−.69, 1.25]	.28 [−.69, 1.25]
	Ingersoll et al. (2009)	−.51 [−1.19, .17]	—
	Manuel et al. (2012)	.64 [−1.17, 2.45]	—
	Mujika et al. (2013)	1.23 [−.02, 2.49]	—
	Okuyemi et al. (2013)	—	.30 [−.11, .71]
	Rohsenow et al. (2014)	.66 [−.61, 1.93]	.03 [−1.06, 1.13]
	Rohsenow et al. (2015)	−.94 [−2.63, .75]	−.44 [−1.78, .91]
	Romanowich and Lamb (2015)	—	−.14 [−.80, .53]
	Soria et al. (2006)	—	1.01 [.32, 1.70]
	Wakefield et al. (2004)	−.09 [−.88, .69]	—
CM ($n = 12$)	Alessi et al. (2008)	1.22 [−.47, 2.92]	—
	Bowers et al. (1987)	.81 [.04, 1.58]	.83 [.06, 1.60]
	Dallery et al. (2013)	.52 [−.28, 1.31]	−.45 [−1.26, .36]
	Dunn et al. (2008)	1.00 [−.74, 2.75]	—
	Dunn et al. (2010)	.63 [−1.64, 2.43]	—
	Heil et al. (2008)	.68 [−.59, 1.96]	—
	Higgins et al. (2004)	1.59 [−.02, 3.19]	—
	Higgins et al. (2014)	.47 [−.25, 1.20]	—
	Ledgerwood et al. (2014)	.38 [1.28, 2.04]	−.13 [−1.42, 1.15]
	Rohsenow et al. (2015)	−.94 [−2.63, .75]	−.84 [−2.63, .75]
	Roll et al. (2005)	.61 [−.36, 1.57]	—
	Shoptaw et al. (2002)	−.81 [−2.04, .43]	—

Table 4
Effect Sizes for Contingency Management (CM) and Motivational Interviewing (MI) Trials Targeting Stimulants, Opiates, or Polysubstances

Substance	Intervention	Study	Follow-up 1 *d* (95% CI)	Follow-up 2 *d* (95% CI)
Stimulants	MI (n = 3)	Ingersoll et al. (2011)	−.27 [−.88, .35]	—
		McKee et al. (2007)	−.24 [−.75, .28]	—
		Rohsenow et al. (2004)	.05 [−.49, .59]	—
	CM (n = 14)	Epstein et al. (2003)	.27 [−.24, .77]	.31 [−.24, .86]
		Higgins et al. (1994)	.60 [−.13, 1.33]	.60 [−.13, 1.33]
		McDonell, (2013)	.25 [−.09, .58]	—
		McKay et al. (2010)	.39 [−.22, 1.01]	.13 [−.48, .74]
		Petry et al. (2005b)	.48 [−.17, 1.12]	—
		Petry et al. (2007)	.57 [−.09, 1.24]	−.41 [−1.07, .25]
		Petry et al. (2012b) Study 1	—	−.09 [−.38, .20]
		Petry et al. (2012b) Study 2	—	−.07 [−.60, .46]
		Petry et al. (2015)	3.58 [3.01, 4.16]	—
		Poling et al. (2006)	−.32 [−1.03, .39]	—
		Rawson et al. (2002)	.31 [−.27, .88]	—
		Rowan-Szal et al. (2005)	.47 [−.40, 1.34]	—
		Shoptaw et al. (2005)	—	.00 [−.58, .58]
		Silverman et al. (1998)	.19 [−.52, .91]	—
Opiates	MI (n = 0)	—	—	—
	CM (n = 1)	Higgins et al. (1986)	.00 [−1.08, 1.08]	—
Polysubstances	MI (n = 8)	Baer et al. (2007)	−.35 [−.70, .01]	—
		Bernstein et al. (2005)	—	.07 [−.27, .42]
		Carroll et al. (2006a)	.07 [−.14, .28]	—
		Marsden et al. (2006)	—	.12 [−.02, .27]
		Martino et al. (2006)	.28 [−.06, .62]	—
		Morgenstern et al. (2009)	.23 [−.22, .68]	.37 [−.08, .82]
		Peterson et al. (2006)	.12 [−.12, .36]	—
		Winhusen et al. (2008)	.21 [−.17, .59]	—
	CM (n = 10)	Brooner et al. (2007)	.29 [−.11, .69]	—
		Ghitza et al. (2008)	.03 [−1.31, 1.37]	—
		Iguchi et al. (1996)	.19 [−.29, .67]	—
		Iguchi et al. (1997)	—	−.10 [−.86, .66]
		Peirce et al. (2006)	.05 [−.19, .30]	—
		Petry and Martin (2002)	.33 [−.28, .94]	—
		Petry et al. (2005a)	.05 [−.41, .52]	.35 [−.12, .81]
		Petry et al. (2006)	−.03 [−.51, .46]	−.35 [−.84, .14]
		Petry et al. (2012a)	—	−.15 [−.53, .24]
		Rowan-Szal et al. (1997)	.36 [−.04, .77]	—

(I^2 = 23.56) at F2. The funnel plots at each time were roughly symmetrical, indicating low likelihood of a publication bias.

Separate pooled effect sizes for MI and CM on each substance type at each time period are presented in Table 6. Pooled effect sizes were not calculated for any substance at any time when there were fewer than two trials (i.e., MI on alcohol at F1, CM on alcohol at any time, MI on marijuana at F2, MI or CM on opiates at any time, MI on stimulants at F2). MI had a significant medium effect on marijuana at F1, and a significant small effect on alcohol, polysubstances, and tobacco at F2. At F1, CM had a significant small effect on marijuana and polysubstances, and a significant medium effect on tobacco and stimulants. There were sufficient trials to estimate pooled effect sizes for MI on polysubstances at F1, CM on polysubstances at F2, MI on stimulants at F1, CM on stimulants at F2, MI on tobacco at F1, and CM on tobacco at F2, but these effects were all nonsignificant.

Discussion

This meta-analysis offers important insight into the clinical significance of MI and CM as substance use treatments. Results demonstrated that both CM and MI promoted reductions in use of a wide range of substances, even months after the intervention concluded. The smallest effects were found for polysubstance use, whereas the largest effects were found for marijuana, tobacco, and stimulants. In terms of the size and durability of CM and MI effects, this meta-analysis suggests that CM often produced significant follow-up effects in the first 3 months after treatment, but not in the next 3 months. In contrast, MI often produced significant follow-up effects between 3 and 6 months after treatment, but not in the first 3 months. This finding suggests that extrinsic reinforcement for reducing use or abstaining from substances may be effective in the short-term, but improvements may not be maintained long after reinforcers are withdrawn. MI showed efficacy during the 3-to-6-month follow-up assessment period, which suggests that cultivating intrinsic motivation may be important for promoting sustainable reductions in substance use. However, any differences in effect sizes observed for MI and CM cannot necessarily be attributed to intrinsic versus extrinsic motivation, because the interventions differed in terms of treatment length, target populations, and target substance.

Table 5
Effect Sizes for Contingency Management (CM) and Motivational Interviewing (MI) Trials Targeting Alcohol or Marijuana

Substance	Intervention	Study	Follow-up 1 *d* (95% CI)	Follow-up 2 *d* (95% CI)
Alcohol	MI (n = 6)	Bager and Vilstrup (2010)	—	.64 [.00, 1.28]
		Brown et al. (2010)	—	.27 [−.03, .56]
		Dieperink et al. (2014)	.20 [−.32, .71]	—
		Emmen et al. (2005)	—	−.19 [−.54, .17]
		Joya et al. (2016)	—	.52 [.18, .87]
		Noknoy et al. (2010)	—	.42 [.06, .79]
	CM (n = 0)	—	—	—
Marijuana	MI (n = 4)	Jungerman et al. (2007)	1.43 [−.15, 3.10]	—
		Martin et al. (2008)	.71 [.07, 1.34]	—
		Stephens et al. (2007)	.37 [.02, .73]	.15 [−.20, .50]
		Babor and the MTPRG (2004)	.57 [−.02, 1.15]	—
	CM (n = 3)	Budney et al. (2006)	.62 [−.02, 1.25]	.65 [−.07, 1.37]
		Carroll et al. (2006b)	−.02 [−.71, .67]	.11 [−.43, .66]
		Kadden et al. (2007)	.45 [−.11, 1.01]	.36 [−.18, .90]

This meta-analysis examined results for MI and CM separately to explore how interventions that target intrinsic versus extrinsic motivation might impact follow-up treatment effects. However, it is quite possible that an intervention targeting extrinsic motivation might ultimately increase intrinsic motivation, as well. Self-Determination Theory characterizes change as a developmental process through which externally regulated behaviors can be integrated with a person's own values and goals (Deci & Ryan, 1985). Although no CM trials have demonstrated an increase in intrinsic motivation to date, self-reported motivation is not often measured in CM trials (Ellis, 2011), and even when it is, motivation measures may not be valid for use with participants who have recently completed CM (Walter & Petry, 2015).

The results of this meta-analysis could provide a rationale for combining CM and MI to capitalize on the strengths of each approach and compensate for the shortcomings of either intervention. An intervention combining CM and MI could target all three needs posited by Self-Determination Theory: autonomy, competence, and relatedness. For instance, CM could use extrinsic reinforcement to build clients' feelings of competence by helping them achieve initial abstinence and see the proof of their efforts in the form of tangible rewards. MI could promote autonomy by eliciting and reinforcing clients' internal motivation for change. Both CM and MI could promote a sense of relatedness through the provider-client or agency–client relationships. However, the existing research on combining CM and MI to reduce substance use is sparse and mixed. For tobacco use, Tevyaw and colleagues (2009) found the combination of MI and CM did not result in significant, sustained abstinence. In contrast, Rohsenow and colleagues (2015) found that combining CM with MI did produce longer-lasting smoking cessation than CM alone. For marijuana, Stewart, Felleman, and Arger (2015) did find that adding CM to MI enhanced the size of effects at the end of treatment, yet it no longer did so at a 4-month follow-up.

Limitations

This meta-analysis had several limitations. First, the number of studies included in this meta-analysis for each substance type at each time period was quite small in many categories. Therefore,

Table 6
Pooled Effect Sizes for Contingency Management (CM) and Motivational Interviewing (MI) by Substance Type and Follow-Up Time Period

		Follow-up 1			Follow-up 2		
Substance	Intervention	n	*d* (95% CI)	p	n	*d* (95% CI)	p
Alcohol	MI	1	—	—	5	.30 [.03, .57]	.03
	CM	0	—	—	0	—	—
Marijuana	MI	4	.50 [.23, .77]	<.001	1	—	—
	CM	3	.37 [.02, .73]	.04	3	.33 [−.01, .67]	.06
Opiates	MI	0	—	—	0	—	—
	CM	1	—	—	0	—	—
Polysubstance	MI	6	.09 [−.07, .25]	.27	3	.14 [.01, .26]	.04
	CM	8	.15 [.00, .30]	<.05	4	−.06 [−.36, .25]	.71
Stimulants	MI	3	−.15 [−.46, .17]	.37	0	—	—
	CM	11	.62 [.01, 1.24]	<.05	7	.01 [−.18, .19]	.95
Tobacco	MI	17	.04 [−.17, .24]	.71	11	.20 [.03, .38]	.02
	CM	12	.52 [.20, .84]	<.01	4	−.04 [−.83, .75]	.92

the confidence intervals were very large in some cases, and in others, no pooled effect size could be calculated. Consequently, the results for specific substances should be interpreted cautiously. Further, it was not appropriate to conduct statistical tests between MI and CM effect sizes because of the differences in treatment duration, substances targeted, and samples recruited. Lastly, because consistent measures of intrinsic and extrinsic motivation, autonomy, competence, and relatedness were lacking, differences between interventions related to Self-Determination Theory could not be investigated in depth.

Conclusions

This meta-analysis generally supports the use of MI and CM for the treatment of substance use disorders. Both interventions showed significant reductions in use of a wide variety of substances, even months after treatment ended. Overall, the effects of CM appeared to be relatively large, but diminished over time. The effects of MI appeared to be relatively small, but more durable. These comparisons were not based on statistical tests, but the observed pattern of results lays the ground work for future quantitative comparisons. Future research should investigate the follow-up effects of different substance use treatments in greater detail to develop a better understanding of the clinical utility of various interventions. Specifically, investigators should test whether combining MI and CM can promote initial and sustained abstinence across the entire range of substances. In addition, researchers should measure intrinsic and extrinsic motivation throughout treatment and at follow-up to clarify how lasting change can be achieved. The optimal treatment approach for substance use disorders may need to combine aspects of different interventions such as MI and CM that target a range of motivational and behavior change dynamics.

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*Asterisks indicate trials included in meta-analysis.

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