Published in final edited form as:

Addiction. 2010 December ; 105(12): 2120–2127. doi:10.1111/j.1360-0443.2010.03076.x.

Quality vs. Quantity: Acquisition of Coping Skills Following Computerized Cognitive Behavioral Therapy for Substance Use Disorders

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Abstract

Aims—To evaluate the changes over time in quality and quantity of coping skills acquired following cognitive behavioral therapy (CBT), and examine potential mediating effects on substance use outcomes.

Design—A randomized controlled trial (RCT) evaluating the effectiveness of a computerized version of CBT (CBT4CBT) as an adjunct to standard outpatient treatment over an 8-week period.

Setting—Data were collected from individuals seeking treatment for substance dependence in an outpatient community setting.

Participants—Fifty-two substance abusing individuals (50% African American), with an average age of 42 years, and a majority reporting cocaine as their primary drug of choice.

Measurements—Participants' responses to behavioral role-plays of situations associated with high risk for drug and alcohol use were audio-taped and independently rated to assess their coping responses.

Findings—There were statistically significant increases in mean ratings of the quality of participants' coping responses for those assigned to CBT4CBT compared to treatment as usual, and these differences remained significant three months after treatment completion. Moreover, quality of coping responses mediated the effect of treatment on participants' duration of abstinence during the follow-up period.

Conclusions—These findings suggest that assignment to the computerized CBT program improved participants' coping skills, as measured by independent ratings of a role playing task. It is also the first study to test and support quality of coping skills acquired as a mediator of the effect of CBT for substance use.

Keywords

Coping skills; Mediator; Computer-assisted therapy; CBT; Substance Use

Introduction

Cognitive-behavioral therapy (CBT) approaches have comparatively high levels of empirical support across a wide range of psychiatric disorders (1,2), including addiction (3–5). In contrast to ample evidence of efficacy, little is known about how and why CBT actually

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Conflict of Interest Statement: None

works in the treatment of substance use disorders. This lack of understanding of CBT's mechanisms of action undermines the replicability criterion of scientific research (6,7) and contributes to the failure to generalize research findings to clinical practice (8,9).

Although both theory and research evidence suggest that coping skills play a role in the relationship between CBT and substance use treatment outcomes, statistical demonstration that acquisition of coping skills mediates outcome in CBT has been largely elusive. Morgenstern and Longabaugh's review of CBT for alcohol dependence (8) found no study that met the full criteria for demonstrating statistical mediation using Baron and Kenny's classic causal steps approach (10). The most frequent patterns of failed causal steps observed were either substance use outcomes were not related to a change in coping skills, or coping skills did not change differentially in the CBT condition compared to comparison conditions (8). However, there has been comparatively little attention in the literature to the careful assessment of potential mediators, including acquisition of coping skills. For example, most behavioral role-play assessments measure self-reported urges, anxiety levels, or the quantity/number of coping skills acquired (11,12), but not the participants' ability to effectively implement the coping skills targeted, that is, the quality of coping skills learned.

To address this issue, we developed a measure that emphasized the quality of coping, the Cocaine Risk Response Test (CRRT) (13), which involves a series of audio-taped role-plays of situations associated with a high risk for relapse, adapted from the Situational Competency Test for alcohol (SCT) (14). A prior study using the CRRT with cocaine dependent individuals participating in a randomized clinical trial demonstrated significant increases in the number and quality of coping responses between pre- and post-treatment (15). Although correlational analysis suggested that better quality of coping responses at post-treatment was significantly associated with percentage of days of cocaine abstinence, no direct test of mediation was conducted to determine whether quality of coping responses mediated the effects of treatment on substance use outcomes.

Using data from a randomized clinical trial evaluating the efficacy of a computer-based version of CBT (CBT4CBT) (15), we examined changes in both the quantity and quality of coping skills acquired using an adapted version of the CRRT, and tested for mediation using several analytic strategies. We hypothesized first that, compared with participants assigned to standard treatment, CBT4CBT would be associated with larger increases in the quality of coping skills after treatment. Second, higher quality of coping skills would be associated with better substance use outcomes, and finally, controlling for the effect of quality of coping skills would account for CBT4CBT's effect on substance use outcomes; hence quality of study participants' coping responses would mediate the effects of CBT4CBT on substance use outcomes.

Methods

Participants

Participants were 77 individuals seeking treatment for substance abuse at a community based outpatient treatment center (15). These participants were drawn from a larger pool of 155 individuals screened, and were excluded if: 1) they had not used alcohol or illegal drugs within the past 28 days or failed to meet DSM-IV criteria for a current substance dependence disorder, 2) had an untreated psychotic disorder which precluded outpatient treatment, or 3) were unlikely to be able to complete 8 weeks of outpatient treatment due to a planned move or pending court case from which incarceration was likely.

Treatments

All participants were offered standard treatment at the outpatient clinic, which consisted of weekly individual and group sessions of general drug counseling. Participants were randomized to either standard treatment (i.e., treatment as usual: TAU), or standard treatment plus biweekly access to an interactive, multimedia computer-based training version of CBT (CBT4CBT). Briefly, the CBT4CBT program consisted of six lessons based closely on a NIDA-published CBT manual (16) covering the following core concepts: 1) understanding and changing patterns of substance use, 2) coping with craving, 3) refusing offers of drugs and alcohol, 4) problem-solving skills, 5) identifying and changing thoughts about drugs and alcohol, and 6) improving decision-making skills. Each lesson, or module, was intended to require about 45 minutes to complete, included assignments of homework, and could be accessed in any order or repeated as many times as participants wished.

Assessments

Participants were assessed before treatment, weekly during treatment, at the 8-week treatment termination, and at follow-up interviews conducted up to 3 months after the treatment termination point by an independent clinical evaluator. The Substance Use Calendar, similar to the Timeline Follow Back (17,18), was administered weekly during treatment to collect self-reports of drug and alcohol use during the 28-day period prior to randomization, throughout the 8-week treatment period, as well as through the 20-week follow-up. Urine toxicology screens and Breathalyzer samples were obtained at every assessment visit to verify participant self-report of illegal drug use. Of the 578 urine specimens collected during the treatment phase of the study, 90% were consistent with participant self-report data (15), which is consistent with previous studies of substance-dependent samples (19–21).

Drug Risk Response Test (DRRT)—The DRRT was adapted from the Cocaine Risk Response Test (13) and involved a series of audio-taped role plays of six situations that corresponded closely to the learning objectives of the modules included in the computer training program. The six audio-taped situations were played for the participant, and a tape recorder was used to record the participant's response. Participants were instructed to imagine themselves in each situation and indicate how they would respond to the situation if it were occurring at that moment. The DRRT required about 8–10 minutes to administer and approximately 15–20 minutes to score. It was administered at treatment entry (week 0), end-of-treatment (week 8), and three months post-treatment (week 20).

The DRRT scoring manual provided clarification of the intent of each scoring dimension, anchor points for Likert scale ratings, and example responses and ratings. Participants' responses to each of the six situations were scored on the following variables: 1) *number of coping responses provided* – the number of plans articulated toward not using drugs or alcohol, or for solving a problem for each situation; 2) *number of activities in each response* – the number of articulated activities involved within each coping plan; 3) *quality of best coping response* – the quality of the best response provided in terms of likelihood of drug use. This was rated on a 7-point Likert scale ranging from 1- “*would definitely use drugs or alcohol*” to 7- “*excellent response indicated complete confidence, no chance of using*”; 4) *quality of overall response* – the overall quality of all responses given to each situation was scored according to same 7-point Likert scale. In cases when participants offered only one response, the quality of overall response would be the same as the quality of best response.

Three independent evaluators who were unaware of each participant's treatment assignment rated the DRRT responses. Raters were trained through a didactic seminar that included review of the scoring manual and group practice ratings on five tapes until consensus was

achieved. Given that these were experienced raters who had participated in multiple previous trials using these instruments, a reliability sample of four additional tapes (total of nine tapes) was deemed adequate based on expected intraclass correlation coefficients (ICC) of .87, with an alpha of .05 and a confidence interval width of .3 (22). The calculated ICC estimates for the reliability sample of 4 tapes (each rated by all 3 raters) were as follows: number of plans = .90, number of activities = .86, quality of best response = .85, and quality of overall response = .86. Each rater rated a similar proportion of tapes at admission, end of treatment, and follow-up.

Data analysis

Chi-square tests and analysis of variance (ANOVA) tests were used to evaluate the representativeness of the sample that completed both a pre- and post-treatment DRRT compared with all participants randomized to treatment, and to examine the treatment effects in this subsample. Repeated measures ANOVAs were used to evaluate differences in coping skills acquisition over time by treatment condition, and Pearson Product Moment Correlations were used to assess the relationship between coping skills acquisition and treatment outcomes (amount of substance use during the 8-week treatment period; consistent with main study report (15)).

Mediation analyses were conducted using the DRRT variables assessing quality and quantity of coping skills as potential mediators of the effect of treatment assignment on the amount of substance use during a post-treatment follow-up period. The approaches used to test for mediation effects were: the difference in coefficients method (23), and the product of coefficients method (24).^a Each approach uses information from three regression equations: 1) $Y = i_1 + cX + e_1$; 2) $Y = i_2 + c'X + bM + e_2$; 3) $M = i_3 + aX + e_3$. In these equations, i_1 , i_2 , and i_3 are intercepts, Y is the dependent variable, X is the independent variable, M is the mediator, c is the coefficient relating the direct effect of the independent variable to the dependent variable, c' is the coefficient for the effect of the independent variable to the dependent variable adjusted for the mediator, b is the coefficient relating the effect of the mediator to the dependent variable adjusted for the independent variable, a is the coefficient relating the effect of the independent variable to the mediator, and e_1 , e_2 , and e_3 are residuals (25). Both the difference in coefficients and product of coefficients approaches test the significance of the mediated effect by incorporating standard errors, and comparing the calculated values to a standard normal distribution (26). The different variants of these approaches are based on different calculations of the standard error formula (26–28).

Results

Sample

A total of 73 participants initiated treatment, with 60 completing the 8-week post-treatment interview, of which 52 (CBT4CBT = 24; TAU = 28) completed DRRT at both baseline and post-treatment (week 8); thus the subsample of 52 participants were used in the subsequent analyses regarding acquisition of coping skills. As for the full randomized sample, for the 52 participants in the DRRT sample, there were no significant differences between treatment groups with respect to demographic and drug use variables at baseline (see Table 1). In terms of outcome for the subsample, participants assigned to CBT4CBT submitted a significantly lower proportion of urines that were positive for any drug than those assigned to TAU (29% versus 58%; $F(1, 50) = 7.4$, $p < .01$, $d = .46$), and the duration of longest

^aThe causal steps approach (10) was also used to test for the presence of mediation, however there was not a significant effect of treatment assignment on the maximum days of consecutive abstinence during the follow-up period ($c = 0.65$, s.e. = 2.64, $t = 0.25$, $p = .81$). Therefore, the full analyses were not reported.

continuous period of abstinence (urine confirmed) during the 8-week treatment was significantly longer for those assigned to CBT4CBT than TAU (26 days versus 16 days; $F(1, 50) = 4.9, p < .05, d = .45$). These results parallel those from the full randomized sample (15).

Acquisition of Coping Skills and Within-Treatment Substance Use

Repeated measures ANOVAs indicated no significant treatment condition by time effects for the DRRT variables measuring number of coping responses, or number of activities involved in each coping response. However, as shown in Table 2, participants assigned to CBT4CBT demonstrated a significantly greater increase in the quality of their overall response and the quality of their best response compared with participants assigned to TAU. Correlations of the end-of-treatment DRRT ratings with the primary substance use outcome measures for the trial (15) are presented in Table 3. There were no significant correlations between number of coping skills and the primary outcomes for either of the treatment groups. Significant correlations were present between the quality of overall response and the consecutive days of abstinence in treatment for the CBT4CBT group, but not for those assigned to TAU.

Analysis of Coping Skills at Follow-Up

Forty-eight participants (CBT4CBT = 19; TAU = 29) completed the DRRT at the 3-month follow-up time point (week 20). ANOVAs suggested significant differences between treatment groups on the quality of overall response ($F(1, 46) = 5.91, p < .05$), as well as the quality of best response ($F(1, 46) = 5.48, p < .05$), but no group differences for the number of activities ($F(1, 46) = .04, p = .84$) or number of coping responses ($F(1, 46) = 0.94, p = .34$). Forty-one participants (CBT4CBT = 17; TAU = 24) completed the DRRT at all three time points (week 0, week 8, week 20). Repeated measures ANOVAs indicated no significant treatment condition by time effects for the number of coping responses or number of activities. However once again, significant treatment by time effects were present for the quality of best response ($F(2, 78) = 5.44, p < .01$), and quality of overall response ($F(2, 78) = 5.20, p < .01$). To correct for the reduced sample size, we also conducted random effects regression analyses for the 59 participants (CBT = 26; TAU = 33) who completed the DRRT on at least one of the three timepoints (week 0, week 8, or week 20). As shown in Table 4 and consistent with the repeated measures ANOVAs, results indicated a greater increase in quality of overall and quality of best response over time for those assigned to CBT4CBT compared to those assigned to TAU (group by time: $t = 3.45, p < .001$; and $t = 3.53, p < .001$, respectively, number of observations = 152). No significant condition by time effects were present for the number of coping responses or number of activities.

Test for Mediation Effects of Treatment on Substance Use During Follow-up

Forty-eight participants (CBT4CBT = 22; TAU = 26) who completed DRRT at week 8 had substance use data collected during a 56-day period immediately following treatment termination, which was used as an outcome variable in the series of regression equations described above. The mean quality of participants' overall coping responses at week 8 was examined as the mediator, with the quality of overall response at week 0 included as a covariate to support temporal causation. Results of the regression equations can be seen in Figure 1. Although no direct effect of treatment assignment on substance use was demonstrated, some have argued that mediation can still be present even in the absence of a significant direct effect (25,29). The difference in coefficients method (23), which is equal to the reduction in the IV effect on DV when adjusted for M, was calculated by: $[(c - c') / (s.e. c - s.e. c')]$. This resulted in $z = 36.50$, which falls in the range of significance when compared to a standard normal distribution ($z > 1.96$). Additionally, the product of coefficients method (24), which is another test to determine if the mediated effect is

significantly different from zero, was calculated by $[(a * b) / (s.e. a * s.e. b)]$. This resulted in $z = 6.64$, which is significant at the .05 level based on a standard normal distribution ($z > 1.96$). Finally, confidence limits for the mediated effect were computed based on the distribution of the product of the coefficient method using the computer program PRODCLIN (28,30). This resulted in upper and lower confidence intervals of 5.39 and 0.31, which are consistent with a statistically significant mediated effect.

To assess the specificity of the mediation effect, these analyses were repeated using quantity of coping skills at week 8, rather than quality, as the mediator between treatment assignment and the maximum days of consecutive abstinence during the 56-day period following treatment termination (with quantity of coping skills at week 0 as a covariate). Results of the regression equations can be seen in Figure 2, indicating that in contrast to the measure of quality of coping responses, quantity of coping responses in week 8 did not mediate the treatment effect on drug use outcomes during the follow-up period.^b

Discussion

Data from a randomized clinical trial evaluating computer-assisted CBT as an adjunct to addiction treatment suggested, first, that independent ratings of the *quality* of participants' coping responses to high-risk situations increased during the treatment period for those who received CBT4CBT compared to those who received standard treatment only. Moreover, these differences were evident at both treatment termination and three month follow-up. No such differences were evident for the number of coping responses provided by participants either across treatment groups or across time points. Second, mean ratings of the quality of coping responses at treatment termination were associated with substance use outcomes within treatment and during a follow-up period only for those who received CBT4CBT. Finally, two powerful methods for evaluating mediated effects (26,29) suggested that treatment assignment had a significant indirect effect on substance use outcomes through ratings of the quality of coping responses. Interpreted another way, CBT4CBT's effect on substance use outcomes was due in part to improvement in the quality of coping skills acquired.

To our knowledge, this is the first study to examine the quality of coping responses following a randomized trial of CBT for addiction, the first to do so using a computerized version of CBT, as well as the first to fully test a mediation model supporting quality of coping responses mediating the effects of CBT for addiction. In contrast, the majority of literature that has failed to find evidence of mediation has largely relied on the quantity of coping skills acquired, rather than quality as the mediator, which is consistent with the findings presented here. When examining the quality of coping skills, however, we found differential treatment effects across time, relationships with the amount of within-treatment substance use, as well as evidence of a mediated effect on substance use after treatment. Therefore, our findings suggest that quality of coping skills may prove to be a fruitful avenue for future work on examining the acquisition of coping skills following CBT, and may be a more pertinent construct than dimensions such as quantity of coping skill acquisition.

^bAlthough the effect of treatment assignment on outcome was reduced by the mediator ($c < c'$), neither the a nor b path coefficients were significant suggesting treatment assignment did not have an effect on the quantity of coping responses at week 8 (controlling for quantity of coping responses at week 0), nor did the quantity of coping responses at week 8 have an effect on the amount of substance use during a follow-up period. Also, when computing the product of coefficients ($[a * b] / [se_a * se_b]$), the resulting z is 1.23, which suggests the indirect effect is not significantly different than zero, based on a standard normal distribution ($z > 1.96$). Additionally, the confidence limits using PRODCLIN resulted in upper and lower confidence intervals of 2.32 and -0.92 , which since they contain zero, would not be consistent with a statistically significant mediated effect.

Although the evidence of mediation in this study is promising, it can be argued that statistical mediation has not been demonstrated due to the lack of a direct effect of treatment assignment on substance use outcomes. Although the causal steps approach (10) would require a direct effect of treatment on drug use, simulation studies have shown this approach to be among the lowest in power for testing intervening variable effects (26,31). To support this notion, outcome analyses for the full sample (N=60) indicated a significant effect of CBT4CBT over a 6-month follow-up period (32) with a comparable effect size (d within small range) to the current analyses when examining the same 56-day time period, suggesting the subsample (N=48) used here may have limited power to detect an effect. To compensate for the shortcomings of the causal steps approach, different techniques (26–28,30) were used to quantify the mediated effect rather than merely infer its existence from a set of tests on the constituent paths (31). These tests are considered to be more powerful and valid for testing intervening variable effects, and the results here indicated a significant mediated effect using those methods.

A key limitation of the study is its small sample size due to the exclusion of some participants who dropped out of treatment, although differential dropout or data collection by treatment condition did not appear to occur. Moreover, outcomes for the sample contributing to the mediational analyses were comparable to those for the full sample. Another potential limitation is that the putative mediator is based on subjective ratings from a role play measure, which may differ from the ability to utilize such skills *in vivo*. Nevertheless, independent ratings of these skills were reliable and strongly associated with outcome at the end of treatment and follow-up. Finally, Tonigan (33) suggests partitioning alpha to a critical value of 0.01 for each test of mediation, however, findings regarding low Type I error rates and low power (26) would indicate a more conservative critical value is not necessary.

Beyond being one of the first clinical trials to suggest the promise of evaluating quality of coping skills acquisition, and providing support for demonstration of mediation in CBT, this study is notable in that such data emerged from a newly developed computer-delivered version of CBT. Therefore, the variability typically present in therapist-delivered CBT was presumably minimized, as were traditional nonspecific factors of therapy, raising the possibility that a more standardized delivery of CBT facilitated detection of changes in skill acquisition and mediating effects. The apparent ability of a computer-assisted CBT training program to confer coping skills underscores both the potential utility of these approaches and the promise that they may provide high quality and more standardized means of evaluating treatment mechanisms for some forms of treatment. Given the effectiveness of CBT4CBT at improving the quality of coping skills and substance use outcomes through a follow-up period, future studies are needed to examine what components of the treatment are most relevant for changes in this potential mediator, and whether or not the computerized version is more effective at improving the quality of coping skills than a standard clinician-delivered CBT format.

Acknowledgments

This study was supported by National Institute of Drug Abuse (NIDA) grants: R37-DA 015969, K05-DA00457, K05-DA00089, and P50-DA09241. Special thanks goes to Tami Frankforter and Karen Hunkele for their assistance with tape rating.

References

1. DeRubeis RJ, Crits-Christoph P. Empirically supported individual and group psychological treatments for adult mental disorders. *Journal of Consulting and Clinical Psychology*. 1998; 66:37–52. [PubMed: 9489261]

2. Roth, A.; Fonagy, P. What Works for Whom? A Critical Review of the Psychotherapy Literature. Second Edition. New York: The Guilford Press; 2005.
3. Dutra L, Stathopoulou G, Basden SL, et al. A meta-analytic review of psychosocial interventions for substance use disorders. *American Journal of Psychiatry*. 2008; 165:179–187. [PubMed: 18198270]
4. Carroll KM, Onken LS. Behavioral therapies for drug abuse. *American Journal of Psychiatry*. 2005; 162:1452–1460. [PubMed: 16055766]
5. Irvin JE, Bowers CA, Dunn ME, Wong MC. Efficacy of relapse prevention: A meta-analytic review. *Journal of Consulting and Clinical Psychology*. 1999; 67:563–570. [PubMed: 10450627]
6. Greenberg, LS.; Pinsof, WM. Process research: Current trends and future perspectives. In: Greenberg, LS.; Pinsof, WM., editors. *The Psychotherapeutic Process: A Research Handbook*. New York: Guilford Press; 1986. p. 3-20.
7. Kazdin AE. Mediators and mechanisms of change in psychotherapy research. *Annu Rev Clin Psychol*. 2007; 3:1–27. [PubMed: 17716046]
8. Morgenstern J, Longabaugh R. Cognitive-behavioral treatment for alcohol dependence: A review of the evidence for its hypothesized mechanisms of action. *Addiction*. 2000; 95:1475–1490. [PubMed: 11070524]
9. Kazdin AE, Nock MK. Delineating mechanisms of change in child and adolescent therapy: Methodological issues and research recommendations. *Journal of Child Psychology & Psychiatry*. 2003; 44:1116–1129. [PubMed: 14626454]
10. Baron RM, Kenny DA. The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*. 1986; 51:1173–1182. [PubMed: 3806354]
11. Monti PM, Rohsenow DJ, Abrams DB, et al. Development of a behavior analytically derived alcohol-specific role-play assessment. *Journal of Studies on Alcohol*. 1993; 54:710–721. [PubMed: 8271807]
12. Condiotte MM, Lichtenstein E. Self-efficacy and relapse in smoking cessation programs. *Journal of Consulting and Clinical Psychology*. 1981; 49:648–658. [PubMed: 7287974]
13. Carroll KM, Nich C, Frankforter TL, Bisighini RM. Do patients change in the way we intend? Treatment-specific skill acquisition in cocaine-dependent patients using the Cocaine Risk Response Test. *Psychological Assessment*. 1999; 11:77–85.
14. Chaney EF, O'Leary MR, Marlatt GA. Skill training with problem drinkers. *Journal of Consulting and Clinical Psychology*. 1978; 46:1092–1104. [PubMed: 701544]
15. Carroll KM, Ball SA, Martino S, et al. Computer-assisted cognitive-behavioral therapy for addiction. A randomized clinical trial of 'CBT4CBT'. *American Journal of Psychiatry*. 2008; 165:881–888. [PubMed: 18450927]
16. Carroll, KM. *A Cognitive-Behavioral Approach: Treating Cocaine Addiction*. Rockville, Maryland: NIDA; 1998.
17. Sobell, LC.; Sobell, MB. Timeline followback: A technique for assessing self-reported alcohol consumption. In: Litten, RZ.; Allen, J., editors. *Measuring alcohol consumption: Psychosocial and biological methods*. New Jersey: Humana Press; 1992. p. 41-72.
18. Fals-Stewart W, O'Farrell TJ, Freitas TT, McFarlin SK, Rutigliano P. The timeline followback reports of psychoactive substance use by drug-abusing patients: Psychometric properties. *Journal of Consulting and Clinical Psychology*. 2000; 68:134–144. [PubMed: 10710848]
19. Ehrman RN, Robbins SJ. Reliability and validity of 6-month timeline reports of cocaine and heroin use in a methadone population. *Journal of Consulting and Clinical Psychology*. 1994; 62:843–850. [PubMed: 7962889]
20. Zanis DA, McLellan AT, Randall M. Can you trust patient self-reports of drug use during treatment? *Drug and Alcohol Dependence*. 1994; 35:127–132. [PubMed: 8055734]
21. Hersh D, Mulgrew CL, Van Kirk J, Kranzler HR. The validity of self-reported cocaine use in two groups of cocaine abusers. *Journal of Consulting and Clinical Psychology*. 1999; 67:37–42. [PubMed: 10028207]
22. Bonett DG. Sample size requirements for estimating intraclass correlations with desired precision. *Stat Med*. 2002; 21:1331–1335. [PubMed: 12111881]

23. Freedman LS, Schatzkin A. Sample size for studying intermediate endpoints within intervention trials of observational studies. *American Journal of Epidemiology*. 1992; 136:1148–1159. [PubMed: 1462974]
24. MacKinnon, DP. Contrasts in multiple mediator models. In: Rose, JS.; Chassin, L.; Presson, CC.; Sherman, SJ., editors. *Multivariate applications in substance use research: New methods for new questions*. Mahway, NJ: Erlbaum; 2000. p. 141-160.
25. MacKinnon DP, Fairchild AJ, Fritz MS. Mediation analysis. *Annual Review of Psychology*. 2007; 58:593–614.
26. MacKinnon DP, Lockwood CM, Hoffman JM, West SG, Sheets V. A comparison of methods to test mediation and other intervening variable effects. *Psychological Methods*. 2002; 7:83–104. [PubMed: 11928892]
27. Sobel, ME. Asymptotic confidence intervals for indirect effects in structural equation models. In: Leinhardt, S., editor. *Sociological methodology*. Washington: American Sociological Association; 1982. p. 290-312.
28. MacKinnon DP, Lockwood CM, Williams J. Confidence limits for the indirect effect: Distribution of the product and resampling methods. *Multivariate Behavioral Research*. 2004; 39:99–128. [PubMed: 20157642]
29. Hayes AF. Beyond Baron and Kenny: Statistical mediation analysis in the new millennium. *Communication Monographs*. 2009; 76:408–420.
30. MacKinnon DP, Fritz MS, Williams J, Lockwood CM. Distribution of the product confidence limits for the indirect effect: Program PRODCLIN. *Behavior Research Methods*. 2007; 39:384–389. [PubMed: 17958149]
31. Fritz MS, MacKinnon DP. Required sample size to detect the mediated effect. *Psychological Science*. 2007; 18:233–239. [PubMed: 17444920]
32. Carroll KM, Ball SA, Martino S, et al. Enduring effects of a computer-assisted training program for cognitive-behavioral therapy: A six-month follow-up of CBT4CBT. *Drug and Alcohol Dependence*. PMC journal in process. 2009; 100:178–181.
33. Tonigan JS. Statistical considerations in identifying mechanisms of change. *Alcoholism: Clinical and Experimental Research*. 2007; 31:55S–56S.

Figure 1.
Quality of coping response at post-treatment as a mediator of the effect of treatment assignment on the consecutive days of abstinence (N = 48).
* $p < .05$. ** $p < .01$.

Figure 2.

Number of coping responses at post-treatment as a mediator of the effect of treatment assignment on the consecutive days of abstinence (N = 48).

* $p < .05$. ** $p < .01$.

Table 1

Between Groups Comparisons for Baseline Variables

Variable	CBT4CBT			TAU			Total			χ^2	df	p
	n	%	N = 24	n	%	N = 28	n	%	N = 52			
Number (%) female	8	33.3	13	46.4	21	40.4	0.92	1	.34			
Ethnicity												
African American	12	50	14	50	26	50	0.52	3	.91			
European American	8	33.3	11	39.3	19	36.5						
Latin American	3	12.5	2	7.1	5	9.6						
Native American	1	4.2	1	3.6	2	3.8						
Married or in stable relationship	7	29.2	6	21.4	13	25	0.41	1	.52			
Employed, full or part time	11	45.8	10	35.7	21	40.4	0.55	1	.46			
Completed high school education	18	75	22	78.6	40	76.9	0.09	1	.96			
Primary substance use problem												
Cocaine	13	54.2	15	53.6	28	53.8	1.85	3	.61			
Alcohol	6	25	4	14.3	10	19.2						
Marijuana	2	8.3	2	7.1	4	7.7						
Opioids	3	12.5	7	25	10	19.2						
Continuous variables, mean and sd							F	df	p			
Age	41.2	13.1	43.2	8.6	42.3	10.8	0.44	1,50	.51			
Years primary substance used	16.4	11.6	17.1	11.1	16.8	11.2	0.06	1,50	.81			
Mean Shipley	100.9	14.4	97.5	13.2	99.1	13.8	0.77	1,50	.38			

Table 2

Drug Risk Response Test (DRRT) Pre- and Post-treatment Scores

DRRT Variable	CBT4CBT		TAU		Total		Group x Time	
	Mean	SD	Mean	SD	Mean	SD	F	p
Number of coping responses								
Pre-tx	1.0	.55	1.0	.34	1.0	.45	3.20	.08
Post-tx	1.3	.70	1.0	.30	1.1	.54		
Number of activities per response								
Pre-tx	1.1	.67	1.1	.51	1.1	.58	2.56	.12
Post-tx	1.4	.87	1.1	.51	1.2	.71		
Quality of best response								
Pre-tx	3.7	.80	4.0	.78	3.8	.8	9.28	.01
Post-tx	4.5	1.0	4.0	.84	4.2	1.0		
Quality of overall response								
Pre-tx	3.7	.76	3.8	.80	3.8	.78	6.77	.02
Post-tx	4.4	1.0	3.8	.82	4.1	.90		

Table 3

Correlations of Substance Use Outcomes with DRRT Variables

DRRT Variables	CBT4CBT N = 24		TAU N = 28	
	Consecutive days of abstinence	% Positive urines submitted	Consecutive days of abstinence	% Positive urines submitted
Number of coping responses per situation	.29	-.28	.11	-.19
Number of activities per situation	.33	-.28	-.03	-.12
Quality of best response per situation	.44 *	-.27	.14	-.21
Quality of overall response per situation	.54 **	-.31	.16	-.21

*
 $p < .05$.**
 $p < .01$.

Table 4

Estimated Means from Random Effects Regression of DRRT Variables Across Time

	CBT N = 26	TAU N = 33	Group x Time	
DRRT Variables	Estimated Mean	Estimated Mean	<i>t</i>	<i>p</i>
Number of Responses				
Week 0	1.05	0.95	0.87	.38
Week 8	1.15	0.99		
Week 20	1.25	1.03		
Number of Activities				
Week 0	1.23	1.13	0.86	.39
Week 8	1.24	1.06		
Week 20	1.25	0.99		
Quality of Overall Response				
Week 0	3.77	3.85	3.45	<.001
Week 8	4.25	3.89		
Week 20	4.73	3.93		
Quality of Best Response				
Week 0	3.82	3.92	3.53	<.001
Week 8	4.28	3.94		
Week 20	4.74	3.96		