Determining the Relative Importance of the Mechanisms of Behavior Change within Alcoholics Anonymous: A Multiple Mediator Analysis

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Abstract

Aims—Evidence indicates AA participation reduces relapse risk but less is known about the mechanisms through which AA confers this benefit. Initial studies indicate self-efficacy, negative affect, adaptive social networks, and spiritual practices are mediators of this effect, but because these have been tested in isolation, their relative importance remains elusive. This study tested multiple mediators simultaneously to help determine the most influential pathways.

Design—Prospective, statistically controlled, naturalistic investigation examined the extent to which purported mechanisms mediated the effect of AA attendance on alcohol outcomes controlling for baseline outcome values, mediators, treatment, and other confounders.

Setting—Nine clinical sites within the United States.

Participants—Adults (N=1,726) suffering from alcohol use disorder (AUD) with varying levels of severity initially enrolled in a randomized study with two arms: Aftercare (n=774); and Outpatient (n-952) comparing three outpatient treatments (Project MATCH)

Measurements—AA attendance during treatment; mediators at 9 months; and, outcomes (Percent Days Abstinent [PDA] and Drinks per Drinking Day [DDD]) at 15 months.

Findings—Among outpatients the effect of AA attendance on alcohol outcomes was explained primarily by adaptive social network changes and increases in social abstinence self-efficacy. Among more impaired aftercare patients, in addition to mediation through adaptive network changes and increases in social self-efficacy, AA lead to better outcomes through increasing spirituality/religiosity and by reducing negative affect. The degree to which mediators explained the relationship between AA and outcomes ranged from 43%–67%.

Conclusion—AA facilitates recovery by mobilizing several processes simultaneously, however it is changes in social factors which appear to be of primary importance.

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Keywords

Alcoholics Anonymous; social network; Spirituality; self-help groups; alcoholism; alcohol dependence; addiction; depression

Introduction

Alcohol is the third leading risk factor for disease and disability globally (1, 2). Also, 4% of all deaths worldwide are attributable to alcohol, greater than those due to HIV/AIDS, violence or tuberculosis, and alcohol is the leading risk factor for death among males aged 15–59 (1). In the United States, alcohol is the third leading actual cause of death (3) and alcohol misuse and related disorders confer an extraordinary negative social strain and economic impact approaching $200 billion annually (4). In partial response, most societies provide some form of professionally-delivered treatment to address these problems. However, due to the often chronic nature of alcohol use disorders (AUD) and difficulties in accessing professional services, a network of peer-led mutual-help organizations have emerged and grown providing additional support (5, 6).

In 2009, approximately 2.3 million individuals with a substance use disorder attended a formal treatment program, and 5 million attended a peer-led mutual-help group for an alcohol or other drug problem (7). By far the largest of these groups is Alcoholics Anonymous (AA) with 1.3 million US members meeting in 57,000 groups each week (8). It is the most commonly sought source of help for alcohol-related problems (9, 10). Given AA's potential public health significance in reducing alcohol-related harm, in 1990 the Institute of Medicine (11) called for more research on AA, specifically on its mechanisms, to help elucidate how it works and for whom. A subsequent scientific monograph summarized the state of the science as well as further research opportunities (12). The intervening 20 year period has seen a significant increase in scientific interest and rigor focused on the study of AA. This body of work has indicated that AA confers short and long-term therapeutic benefit on par with professional interventions (13–16) and there are now numerous empirically-supported interventions designed specifically to increase AA participation (17–22). AA has been shown also to reduce health care costs while enhancing treatment outcomes (14, 23). It is only recently, however, that research has begun to examine mechanisms through which AA confers these benefits (see 63 for a review).

Initial studies indicate that AA helps individuals recover in several ways. One is by facilitating changes in social networks (25–27), especially by helping individuals drop pro-drinking ties and gain pro-abstinence ties (28). Further investigations have examined whether AA mobilizes salutary psychological mechanisms. These studies have included coping, abstinence motivation, and self-efficacy in the ability to abstain in high risk situations, as when exposed to alcohol in social contexts or when experiencing negative affect (29–32). Given AA's focus on working the 12-steps to alleviate and/or better tolerate sources of tension and distress (33), another mechanism through which AA may work is by reducing negative affect and increasing psychological well-being. While this latter theory has received only limited attention, initial studies indicate that AA does lead to improved alcohol outcomes through this path (34). Finally, AA itself purports to help individuals recover primarily by enhancing spirituality. Specifically, AA states that it helps individuals recover through a broadly defined, "spiritual awakening" or "spiritual experience"(33; Appendix II). The few formal mediational studies conducted using this construct have shown that AA appears to work in part through this mechanism (24, 35).

Many, but not all, of these studies used appropriate prospective statistically controlled designs to enhance causal inference and conducted state of the art mediational analyses (36). Their combined results suggest that participation in AA provides a complex and multifaceted experience that helps individuals recover through several different mechanisms. While this research has been illuminating, the *relative* importance of these mechanisms has remained unclear as often the mediators have been tested in isolation. The goal of this study, therefore, was to determine the most influential pathways by which AA attendance is likely to affect alcohol outcomes. Using a uniquely large, multisite, clinical AUD sample (20), we fit a multiple mediator model for two types of patients (i.e., a more severe 'Aftercare' sample and a less severe 'Outpatient' sample) and for two alcohol outcomes, which capture alcohol use frequency (i.e., percent of days abstinent (PDA)) and alcohol use intensity (i.e., number of drinks per drinking day (DDD)).

Methods

Participants

Participants consisted of an 'Aftercare' sample (*n*=774), recruited directly from inpatient treatment, and a less severe 'Outpatient' (*n*=952) sample from Project MATCH (20). Inclusion criteria were: current DSM-III-R AUD diagnosis; alcohol as primary drug; drinking 3 months prior to study; 18 or older; minimum sixth grade reading level. Exclusion criteria were: current DSM-III-R diagnosis of dependence on sedative-hypnotics, stimulants, cocaine or opiates; intravenous drug use in prior 6 months; danger to self/others; probation/ parole requirements that might interfere with participation; risk of residential instability; inability to identify at least one "locator" person to assist tracking; psychosis/organic impairment; involvement in alternative treatment (i.e., >6hours, except for self-help groups). Outpatients were significantly younger, more residentially stable, and less alcohol dependent than Aftercare (37). In addition, relative to Aftercare patients, Outpatients reported significantly fewer prior treatments, lower depression symptoms, and lower DDD and higher PDA at intake (see Table 1).

Procedure

Subjects were randomly assigned to 1 of 3 psychosocial interventions: cognitive behavioral therapy (CBT; 38), motivational enhancement therapy (MET; 15), and 12-step facilitation therapy (TSF; 39) and were reassessed at 3, 6, 9, 12, and 15 months following study intake, with follow-up rates over 90%. More details can be found elsewhere including psychometric properties of the measures (40). This study focused on baseline, 3-, 9-, and 15-month follow-ups because only these time points contained the variables needed for our lagged model.

Measures

Alcohol Use—Alcohol consumption was assessed using the Form 90 (41), which combines an interview procedure with calendar-based and drinking pattern estimation methods. Two drinking outcomes were based on past 90 days: percent days abstinent (PDA) and number of drinks per drinking day (DDD).

Alcoholics Anonymous Attendance—AA attendance was also assessed using the Form 90, which captured the number of AA meetings attended during the past 90 days at intake and 3, 9, and 15 months. The proportion of days attending AA was created by dividing the number of days attended by the total number of days in the period.

Self-efficacy—The Alcohol Abstinence Self-Efficacy Scale (42) is a 20-item scale that assesses self-efficacy using four subscales (Negative Affect, Social/Positive, Physical and

Other Concerns, Withdrawal and Urges). Each item is rated on a 5-point Likert scale ("not at all confident" to "extremely confident"). In this study, two subscales were included (Negative Affect: α=0.88; Social/Positive: α=0.82), shown to be mediators of the effect of AA attendance on alcohol outcomes (32).

Spiritual/Religious practices—Spirituality/religiousness was assessed with the religious background and behavior instrument(RBB; 43). Total scores were based on religious status on a 5-point scale ["I do not believe in God," (Atheist) coded "0," "I believe we can't really know about God" (Agnostic) coded "1," through "Unsure," coded "2," "I believe in God, but I'm not religious (Spiritual) coded "3," "I believe in God and practice religion (religious), coded "4"], and past 90-day religious and spiritual practices (i.e.,: "thought about God", "prayed", "meditated", "attended worship services", "read or studied scriptures/holy writings", and "had direct experiences of God"), rated on 8-point Likert-scale ("never" to "more than once a day"). As in previous research (44), RBB questions pertaining to lifetime religious practices were excluded from the total score, because we examined *changes* in spirituality/religiousness.

Depression—Depression symptoms were assessed using the Beck Depression Inventory (BDI; 45). This 21-item measure assesses past-week depression symptom severity.. The measure is well established psychometrically, with good internal consistency, test-retest stability and construct validity (46).

Social Networks—The Important People and Activities Instrument (IPA; 47) was used to assess social networks on two dimensions: "pro-drinking" and "pro-abstinence". Patients are asked to name the four most important people of the past 6 months, and asked to rate how each reacted to their abstinence or drinking. A person was coded as "pro-abstinence" if s/he either encouraged abstinence or discouraged drinking, or both. A person was coded as "pro-drinking" if s/he either encouraged drinking or discouraged abstinence, or both. The number of each type of network members was summed to produce a scale range 0–4. Someone could list four people all neutral about drinking, in which case they would get a count of 0 for both measures. Based on previous research (28), these variables were chosen as the most salient social network descriptor, as they mediated the relationship between AA and alcohol outcomes.

Baseline Characteristics—At intake, demographic information and number of prior alcohol treatments were recorded. Gender, marital status, and employment status were coded as binary variables; race was coded as a 3-level categorical variable, dummy-coded in the SEM (see Table 1 for details). The number of prior alcohol treatments was capped at four (range 0–4).

Analytic Strategy

Data Preparation—The dependent variables (i.e., PDA & DDD) and the independent AA attendance variable were transformed (PDA/arcsine transformed; DDD/square root transformed, and AA attendance/log transformed).

Mediational Analyses—To test whether the previously identified mediators of the effect of AA attendance on alcohol outcomes (24, 28, 32, 34) uniquely contributed to the mediation in combination with the other mediators, a multiple mediator model was fit. In separate analyses, the same model (Figure 1) was fit for both samples (i.e., Aftercare and Outpatient) and both alcohol outcomes (i.e., PDA and DDD). Baseline values of alcohol outcomes and the mediating variables were included as covariates, as were demographic variables, prior alcohol treatment, treatment assignment, and study site. To test mediation,

we used the product-of-coefficients approach (48, 49). This approach extends directly to multiple mediator models, where the total indirect effect is simply the sum of mediator-specific indirect effects (50, 51). Instead of fitting four linear regression models per mediator, we used structural equation modeling implemented by SAS 9.2 TCALIS to fit all paths simultaneously (Figure 1). Then, using equations provided by MacKinnon (50), we calculated the indirect effects, where we constructed 95% confidence intervals using the Monte Carlo Method for Assessing Mediation (MCMAM), as first evaluated by MacKinnon, Lockwood, & Williams (52), and implemented using the interactive tool by Selig and Preacher (53).

Missing Data—Missing data were 3.6% at 3-month, 9.5% (for social networks) to 13.6% (for self-efficacy) at 9-month, and 9.1% at 15-month. To address missing data, we used the maximum likelihood estimation approach (54), where we first estimated the variance-covariance matrix using all available data points (using the iterative expectation-maximization (EM) algorithm [SAS 9.2 Proc MI]), and then used this matrix as the input data for fitting the SEM (Figure 1).

Results

Structural Equation Model: Total, direct, and indirect, effects on alcohol outcomes

Taken together, mediation through the six variables was statistically significant (Zs range = −4.24 to 5.77, p <.001) and explained a substantial proportion of the relationship between AA and outcomes (i.e., the ratio of the indirect/total effect). This ranged from 43% for PDA in the Outpatient sample to 67% for DDD in the Outpatient sample (Table 2). The standardized parameters in Table 2 also indicate that AA attendance had a larger influence on PDA (0.22 and 0.25 for AC and OP, respectively) than on DDD (−0.18 and −0.12 for AC and OP, respectively), but that a greater proportion of this smaller effect on DDD was explained by the mediators, especially among the outpatients (e.g., 42.91% for PDA vs. 66.58% for DDD).

Individual Paths of the Multi-Mediator Models

AA attendance predicting mediators—AA attendance predicted changes (i.e., statistically significant above and beyond variance accounted for by baseline values, MATCH treatment, and other control variables) in all of the mediating variables, though not consistently so across samples (Table 3). In the Aftercare sample, standardized parameter estimates were largest for increases in spirituality/religiousness followed by increases in the number of pro-abstinence network members. In the Outpatient sample, standardized estimates were largest for increases in number of pro-abstinence network members, followed by decreases in number of pro-drinking network members, followed by increases in spirituality/religiousness.

Mediators predicting alcohol outcomes—Not all mediating variables predicted alcohol outcomes, given the simultaneous presence of the other mediators in the model. Furthermore, significant predictors varied by sample. Consistently across both samples and both alcohol outcomes, however, higher self-efficacy in social situations and a lower number of pro-drinking social network members, at 9-month, predicted better outcomes, measured at 15-month. In general, the standardized parameter estimates for both these mediating variables were of comparable magnitude across samples and outcomes, suggesting that both variables strongly and uniquely are related to subsequent alcohol use. Of note, the number of pro-abstinent network members predicted alcohol outcomes in the Aftercare sample for PDA only, but in the Outpatient sample for both PDA and DDD, above and beyond the effect of the number of pro-drinking network members.

More sample-specific were the results for spirituality/religiousness, self-efficacy in negative affect situations, and depression. Spirituality/religiousness, which was strongly predicted by AA attendance in both samples, was only significantly related to alcohol outcomes in the Aftercare sample. Similarly, self-efficacy for negative affect situations was significantly predicted by AA attendance in the Aftercare sample only, and was the best predictor of DDD in the Aftercare sample. In the Outpatient sample, greater depression was significantly associated with lower PDA and higher DDD, but was itself not predicted by AA.

Mediation tests and the relative proportion of the mediated (indirect) effect attributable to each mediator

The relative contribution of each of the six mediating variables to the overall mediated effect along with their significance tests is shown in Table 4; Figure 2 illustrates these relative proportions. Among Aftercare patients there were significant effects for all mediators except negative affect-related self-efficacy and depression for PDA, and pro-abstinence social network for DDD. Of the significant mediators of AA on PDA, the social constructs explained 70% of the mediational effect (pro-drinking network =23%, pro-abstinent network =15%, and social self-efficacy =32%); and spirituality/religiosity explained a further 22%. As shown in Figure 2, for DDD among Aftercare patients, the significant mediational effects were more evenly distributed among the variables with a more prominent mediational effect for the negative affect constructs (negative affect self-efficacy = 20%; depression=11%). In contrast, in the Outpatient sample the only significant mediators between AA and outcomes were those related to the social domains, which in combination explained 91% of the total mediated effect of AA on PDA (pro-drinking network = 33%; pro-abstinent network =31%; and, social self-efficacy=27%); and 85% of total mediated effect of AA on DDD (pro-drinking network 29%; pro-abstinent network =17%; and, social self-efficacy = 39%). Unlike the Aftercare sample, neither the spiritual/religious nor the negative affect-related variables were significant mediators between AA and outcomes.

Discussion

Using a uniquely large clinical multisite sample of alcohol dependent adults, this investigation found that AA attendance during the first three months was associated with recovery-related benefits one year later over and above the effects attributable to the study's professionally-delivered outpatient treatments and a variety of other predictor confounds. Furthermore, 43–67% of these AA-related benefits were found to be explained by the six mediating variables examined.

The strongest mediational pathways through which AA was related to outcomes across both samples were observed for social variables; namely, through reductions in pro-drinking network members and enhancements in self-efficacy in high risk social situations. Notably, positive changes in pro-abstinent network members was an additional, non-redundant pathway through which AA attendance was related to outcomes, with the exception of DDD among Aftercare patients. Thus, the most consistent pathway overall through which AA confers its recovery benefits is by facilitating changes in the social networks of its members and by simultaneously enhancing abstinence self-efficacy in high risk social contexts. These findings are consistent with recent research that has highlighted the importance of social networks on health (e.g., obesity, 55) and substance use (e.g., smoking, 56). Notably, these effects can be both positive (e.g., decreasing smoking/drinking) and negative (e.g., increasing obesity/drinking). Consistent with such findings, we observed an independent and additive effect of social networks, where both *decreasing* the number of *pro-drinking* social network members and *increasing* the number of *pro-abstinence* social network members positively impacted outcomes. When one considers the common precursors to relapse (i.e., cue-induced; stress-induced; and drug-induced -through a priming dose of the substance), it

may be that the downstream mechanisms by which these adaptive social network changes attenuate relapse risk is by helping AA attendees avoid alcohol-related environmental cues, gain social support to cope with stress, and maintain greater abstinence, further reducing the potential for priming doses to kindle craving and lead to more intensive use and relapse/ reinstatement. Alterations in individuals' social environments also may produce influential changes at the biological level. Extrapolating from addiction-focused social neuroscience research with primates, for example, it is plausible that the rich social integration that occurs in AA may accelerate up-regulation of dopamine D2 receptors, a higher density of which has been shown to protect against relapse (57). The dominance of these social pathways highlights the importance of the group and fellowship dimensions of AA in facilitating recovery from AUD.

As noted previously, spirituality/religiosity is AA's own stated chief mechanism by which recovery is purported to occur. In line with this notion, we found that the beneficial effect of AA attendance on alcohol outcomes was indeed mediated by spiritual/religious practices, while controlling for the other mediational paths. Unlike the mediation through social variables, however, this was only evident in the Aftercare sample, which consisted of more severely alcohol impaired patients. Changing spiritual beliefs and shifting one's world view are not trivial matters. The motivation to embrace such a change would have to be compelling, and we speculate that the toll that AUD may have had on the lives of more severe patients may be so much graver as to stimulate a new openness and motivation to embrace a new outlook. Furthermore, the disinhibiting effects of alcohol on behavior can lead many individuals to behave in ways inconsistent with their own values or moral code. Frequent deviations of this sort along with functional decline over years can lead to self-criticism and suicidal tendencies. The spiritual framework of AA may provide a compassionate structure that facilitates self-forgiveness (24).

In the context of the other mediators in the model, while greater AA attendance was shown to attenuate depression, a complete mediational pathway was observed only among Aftercare patients and only in reducing intensity of alcohol use. Thus, among more severe alcohol-impaired individuals, an additional way that AA appeared to help, was by decreasing depression symptoms which, in turn, decreased DDD. Assuming at least some of the alcohol consumption may have been an attempt by patients to mitigate negative affect through self-medication, the AA-associated decrease in depression may have thus required less intense "medication". It is possible that this effect as well was caused by changes in social networks, which can influence depression (58) and happiness (59). Similar to reductions in depression, a complete independent pathway was observed for negative affect self-efficacy only among the Aftercare patients and only on reducing DDD. This finding suggests that for the more severe patients, attending AA reduces DDD by simultaneously reducing depression symptoms and increasing confidence in individuals' ability to resist alcohol when experiencing negative affect.

In sum, AA appears to lead to greater rates of abstinence and less intensive alcohol consumption through multiple mechanisms simultaneously. Most consistently and strongly, this beneficial effect occurs through mobilizing adaptive changes in the social networks of attendees and enhancing socially relevant abstinence self-efficacy. Among the more severely alcohol-impaired patients, AA additionally increases alcohol abstinence by enhancing individuals' spiritual/religious practices and decreases alcohol use intensity by reducing depression and increasing negative affect-relevant abstinence self-efficacy. The clinical implications of these mediational findings are that providers wishing to facilitate patients' involvement in AA could emphasize the multiple recovery-related benefits that might be obtained from attending, including finding supportive friends, increasing a sense of mastery

and competence in coping with sobriety, increasing meaning and purpose in life, and enhancing psychological well-being and the ability to cope with negative affect.

Limitations

While there are several strengths of the current study, some limitations should be noted. First, patients self-select into AA and we cannot rule out "third" variables that may be responsible for at least some of the observed effects. There were limitations too in the availability of certain measures at certain time points limiting control of constructs that might have strengthened conclusions and there were long time lags between measures. Future research should examine relationships using finer temporal resolutions. Also, mechanisms were examined concurrently and it is likely that some mechanisms may act as precursors to changes in others.. Additionally, the measure of spirituality/religiosity used may not be consistent with AA's own idea of "spirituality", which may be a more subtle phenomenon captured in its later publications (e.g., 60). Finally, only a handful of simply measured constructs were examined here as mediators and it is likely that, even among examined constructs, influential nuances across areas of the construct domain may further relate to AA and outcome.

Conclusions

In a 1961 letter to AA's co-founder, Bill W., the renowned psychoanalyst, Carl Jung, described two main ways individuals with severe alcohol addiction might recover. One was through "real religious insight"; the other was through "the protective wall of human community" characterized by a "personal and honest contact with friends" (AA, 1963)(62). Although AA has more earnestly expressed the former as being the principal pathway to recovery in its main texts (33, 61), perhaps inadvertently, stemming from its social orientation and structure, it has tapped also into the curative facets of the latter – protective and positive social influence. While other factors are certainly involved to varying degrees, this AA-facilitated combination, in particular, appears to help individuals suffering from alcohol addiction to find and sustain recovery.

Acknowledgments

References

1. World Health Organization. Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death. 10. Geneva, Switzerland: World Health Organization; 1992.

2. Babor, TF.; Caetano, R.; Casswell, S.; Edwards, G.; Giesbrecht, N.; Graham, K., et al. Alcohol: No Ordinary Commodity-Research and Public Policy. 2010.

3. Mokdad AH, Marks JS, Stroup DF, Gerberding JL. Actual causes of death in the United States, 2000. JAMA. 2004 Mar 10; 291(10):1238–45. [PubMed: 15010446]

4. Harwood H. Updating estimates of the economic costs of alcohol abuse in the United States: Estimates, update methods and data. NIoAAa Alcoholism. 2000

5. Kelly, JF.; Yeterian, JD. Mutual-help groups. In: O'Donohue, W.; Cunningham, JA., editors. Evidence-Based Adjunctive Treatments. New York, NY: Elsevier; 2008.

6. Humphreys K, Wing S, McCarty D, Chappel J, Gallant L, Haberle B, et al. Self-help organizations for alcohol and drug problems: toward evidence-based practice and policy. J Subst Abuse Treat. 2004 Apr; 26(3):151–8. discussion 9–65. [PubMed: 15063905]

7. Substance Abuse and Mental Health Services Administration. The NSDUH Report: Participation in Self-Help Groups for Alcohol and Illicit Drug Use: 2006 and 2007. Rockville, MD: Office of Applied Studies; 2008.

8. Alcoholics Anonymous. 2007 Membership Survey: A Snapshot of AA Membership. Alcoholics Anonymous World Services; New York, NY: 2008.

9. Room R, Greenfield T. Alcoholics anonymous, other 12-step movements and psychotherapy in the US population, 1990. Addiction. 1993 Apr; 88(4):555–62. [PubMed: 8485433]

10. Weisner C, Greenfield T, Room R. Trends in the treatment of alcohol problems in the US general population, 1979 through 1990. Am J Public Health. 1995 Jan; 85(1):55–60. [PubMed: 7832262]

11. Institute of Medicine. Broadening the Base of Treatment for Alcohol Problems. Washington, DC: National Academy Press; 1990.

12. McCrady, B.; Miller, WR. Research on Alcoholics Anonymous: Opportunities and Alternatives. 1993.

13. Ferri M, Amato L, Davoli M. Alcoholics Anonymous and other 12-step programmes for alcohol dependence. Cochrane Database Syst Rev. 2006; 3:CD005032. [PubMed: 16856072]

14. Humphreys K, Moos RH. Encouraging posttreatment self-help group involvement to reduce demand for continuing care services: two-year clinical and utilization outcomes. Alcohol Clin Exp Res. 2007 Jan; 31(1):64–8. [PubMed: 17207103]

15. Miller, WR. Motivational Enhancement Therapy manual: A Clinical Research Guide for Therapists Treating Individuals with Alcohol Abuse and Dependence. 1992.

16. Moos RH, Moos BS. Participation in treatment and Alcoholics Anonymous: a 16-year follow-up of initially untreated individuals. J Clin Psychol. 2006 Jun; 62(6):735–50. [PubMed: 16538654]

17. Kahler CW, Read JP, Ramsey SE, Stuart GL, McCrady BS, Brown RA. Motivational enhancement for 12-step involvement among patients undergoing alcohol detoxification. J Consult Clin Psychol. 2004 Aug; 72(4):736–41. [PubMed: 15301659]

18. Kaskutas LA, Subbaraman MS, Witbrodt J, Zemore SE. Effectiveness of Making Alcoholics Anonymous Easier: a group format 12-step facilitation approach. J Subst Abuse Treat. 2009 Oct; 37(3):228–39. [PubMed: 19339148]

19. Litt MD, Kadden RM, Kabela-Cormier E, Petry NM. Changing network support for drinking: network support project 2-year follow-up. J Consult Clin Psychol. 2009 Apr; 77(2):229–42. [PubMed: 19309183]

20. Project MATCH Research Group. Project MATCH (Matching Alcoholism Treatment to Client Heterogeneity): rationale and methods for a multisite clinical trial matching patients to alcoholism treatment. Alcohol Clin Exp Res. 1993 Dec; 17(6):1130–45. [PubMed: 8116822]

21. Timko C, Debenedetti A, Billow R. Intensive referral to 12-Step self-help groups and 6-month substance use disorder outcomes. Addiction. 2006 May; 101(5):678–88. [PubMed: 16669901]

22. Walitzer KS, Dermen KH, Barrick C. Facilitating involvement in Alcoholics Anonymous during out-patient treatment: a randomized clinical trial. Addiction. 2009 Mar; 104(3):391–401. [PubMed: 19207347]

23. Humphreys K, Moos R. Can encouraging substance abuse patients to participate in self-help groups reduce demand for health care? A quasi-experimental study. Alcohol Clin Exp Res. 2001 May; 25(5):711–6. [PubMed: 11371720]

24. Kelly JF, Stout RL, Magill M, Tonigan JS, Pagano ME. Spirituality in Recovery: A Lagged Mediational Analysis of Alcoholics Anonymous' Principal Theoretical Mechanism of Behavior Change. Alcohol Clin Exp Res. 2010 Dec 16.

25. Bond J, Kaskutas LA, Weisner C. The persistent influence of social networks and alcoholics anonymous on abstinence. J Stud Alcohol. 2003 Jul; 64(4):579–88. [PubMed: 12921201]

26. Humphreys K, Mankowski ES, Moos RH, Finney JW. Do enhanced friendship networks and active coping mediate the effect of self-help groups on substance abuse? Ann Behav Med. 1999 Spring;21(1):54–60. [PubMed: 18425655]

27. Kaskutas LA, Bond J, Humphreys K. Social networks as mediators of the effect of Alcoholics Anonymous. Addiction. 2002 Jul; 97(7):891–900. [PubMed: 12133128]

28. Kelly JF, Stout RL, Magill M, Tonigan JS. The role of Alcoholics Anonymous in mobilizing adaptive social network changes: a prospective lagged mediational analysis. Drug Alcohol Depend. 2011 Apr 1; 114(2–3):119–26. [PubMed: 21035276]

29. Kelly JF, Myers MG, Brown SA. A multivariate process model of adolescent 12-step attendance and substance use outcome following inpatient treatment. Psychol Addict Behav. 2000 Dec; 14(4):376–89. [PubMed: 11130156]

30. Kelly JF, Myers MG, Brown SA. Do adolescents affiliate with 12-step groups? A multivariate process model of effects. J Stud Alcohol. 2002 May; 63(3):293–304. [PubMed: 12086130]

31. Morgenstern J, Labouvie E, McCrady BS, Kahler CW, Frey RM. Affiliation with Alcoholics Anonymous after treatment: a study of its therapeutic effects and mechanisms of action. J Consult Clin Psychol. 1997 Oct; 65(5):768–77. [PubMed: 9337496]

32. Owen PL, Slaymaker V, Tonigan JS, McCrady BS, Epstein EE, Kaskutas LA, et al. Participation in alcoholics anonymous: intended and unintended change mechanisms. Alcohol Clin Exp Res. 2003 Mar; 27(3):524–32. [PubMed: 12658120]

33. Alcoholics Anonymous. Alcoholics Anonymous: The story of how thousands of men and women have recovered from alcoholism. 2001.

34. Kelly JF, Stout RL, Magill M, Tonigan JS, Pagano ME. Mechanisms of behavior change in alcoholics anonymous: does Alcoholics Anonymous lead to better alcohol use outcomes by reducing depression symptoms? Addiction. 2010 Apr; 105(4):626–36. [PubMed: 20102345]

35. Zenmore SE. A role for spiritual change in the benefits of 12-step involvement. Alcoholism: Clinical and Experimental Research. 2007; 31(Supplment 3):76S–9S.

36. Kazdin AE, Nock MK. Delineating mechanisms of change in child and adolescent therapy: methodological issues and research recommendations. J Child Psychol Psychiatry. 2003 Nov; 44(8):1116–29. [PubMed: 14626454]

37. Timko C, Finney JW, Moos RH, Moos BS, Steinbaum DP. The process of treatment selection among previously untreated help-seeking problem drinkers. J Subst Abuse. 1993; 5(3):203–20. [PubMed: 8312728]

38. Kadden, RMaa. Cognitive-behavioral coping skills therapy manual: a clinical research guide for therapists treating individuals with alcohol abuse and dependence. Project MATCH Monograph Series. 1992:4. (DHHS Publication No. (ADM) 92-1895).

39. Nowinski J, Baker S, Carroll K. Twelve-Step facilitation therapy manual: A clinical research guide for therapists treating individuals with alcohol abuse and dependence. Project MATCH Monograph Series. 1992:4.

40. Project MATCH Research Group. Matching Alcoholism Treatments to Client Heterogeneity: Project MATCH posttreatment drinking outcomes. J Stud Alcohol. 1997 Jan; 58(1):7–29. [PubMed: 8979210]

41. Miller WR, Del Boca FK. Measurement of drinking behavior using the Form 90 family of instruments. J Stud Alcohol Suppl. 1994 Dec.12:112–8. [PubMed: 7722987]

42. DiClemente CC, Carbonari JP, Montgomery RPG, Hughes SO. The Alcohol Abstinence Self-Efficacy scale. Journal of Studies on Alcohol. 1994; 55(2):141–8. [PubMed: 8189734]

43. Connors GJJ, Tonigan S, Miller WR. Measure of religious background and behavior for use in behavior change research. Psychology of Addictive Behaviors. 1996; 10(2):90–6.

44. Yung, Y-F. Testing and contrasting mediation or indirect effects in SEM: An analytic approach and its implementation. 73rd Annual Meeting of the Psychometric Society; Durham, NC. 2008, July;

45. Beck AT, Ward CH, Mendelson M, Mock J, Erbaugh J. An inventory for measuring depression. Arch Gen Psychiatry. 1961 Jun.4:561–71. [PubMed: 13688369]

46. Beck ATR, Steer A, Garbin MG. Psychometric properties of the Beck Depression Inventory: Twenty-five years of evaluation. Clinical Psychology Review. 1988; 8(1):77–100.

47. Clifford, PR.; Longabaugh, R. Manual for the administration of the Important People and Activities Instrument: Adapted for use by Project MATCH for NIAAA 5R01AA06698-05. Providence, RI: Center for Alcohol and Addiction Studies, Brown University; 1991.

48. Sobell, ME. Asymptotic confidence intervals for indirect effects in structural equations models. In: Leinhart, S., editor. Sociological Methodology 1982. San Francisco: Jossey-Bass; 1982. p. 290-312.

49. Sobel, ME. Some new results on indirect effects and their standard errors in covariance structure models. In: Tuma, N., editor. Sociological Methodology 1986. Washington, DC: American Sociological Association; 1986. p. 159-86.

50. MacKinnon, DP. Introduction to statistical mediation analysis. New York, NY: Taylor & Francis Group/Lawrence Erlbaum Associates; 2008.

51. Preacher KJ, Hayes AF. Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. Behavior Research Methods. 2008; 40(3):879–91. [PubMed: 18697684]

52. MacKinnon DP, Lockwood CM, Williams J. Confidence Limits for the Indirect Effect: Distribution of the Product and Resampling Methods. Multivariate Behavioral Research. 2004; 39(1):99–128. [PubMed: 20157642]

53. Selig, JP.; Preacher, KJ. Monte Carlo method for assessing mediation: An interactive tool for creating confidence intervals for indirect effects [Computer software]. 2008 June. Available from http://quantpsy.org/

54. Schafer JL, Graham JW. Missing data: Our view of the state of the art. Psychological Methods. 2002; 7(2):147–77. [PubMed: 12090408]

55. Christakis NA, Fowler JH. The spread of obesity in a large social network over 32years. N Engl J Med. 2007 Jul 26; 357(4):370–9. [PubMed: 17652652]

56. Christakis NA, Fowler JH. The collective dynamics of smoking in a large social network. N Engl J Med. 2008 May 22; 358(21):2249–58. [PubMed: 18499567]

57. Morgan D, Grant KA, Gage HD, Mach RH, Kaplan JR, Prioleau O, et al. Social dominance in monkeys: dopamine D2 receptors and cocaine self-administration. Nat Neurosci. 2002 Feb; 5(2): 169–74. [PubMed: 11802171]

58. Rosenquist JN, Fowler JH, Christakis NA. Social network determinants of depression. Mol Psychiatry. Mar; 16(3):273–81. [PubMed: 20231839]

59. Fowler JH, Christakis NA. Dynamic spread of happiness in a large social network: longitudinal analysis over 20 years in the Framingham Heart Study. BMJ. 2008; 337:a2338. [PubMed: 19056788]

60. Alcoholics Anonymous. Living Sober. New York, NY: Alcoholics Anonymous World Services; 1975.

61. Alcoholics Anonymous. Twelve steps and twelve traditions. New York, NY: Alcoholics Anonymous World Services; 1953.

62. The Bill W. -Carl Jung Letters. Alcoholics Anonymous Grapevine. January. 1963

63. Kelly JF, Magill M, Stout RL. How do people recover from alcohol dependence? A systematic review of the mechanisms of behavior change within Alcoholics Anonmyous (AA). Addiction Research and Theory. 2009; 17(3):236–259.
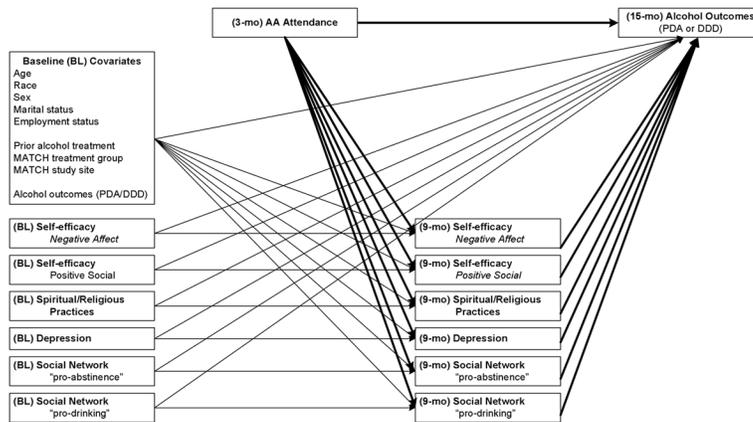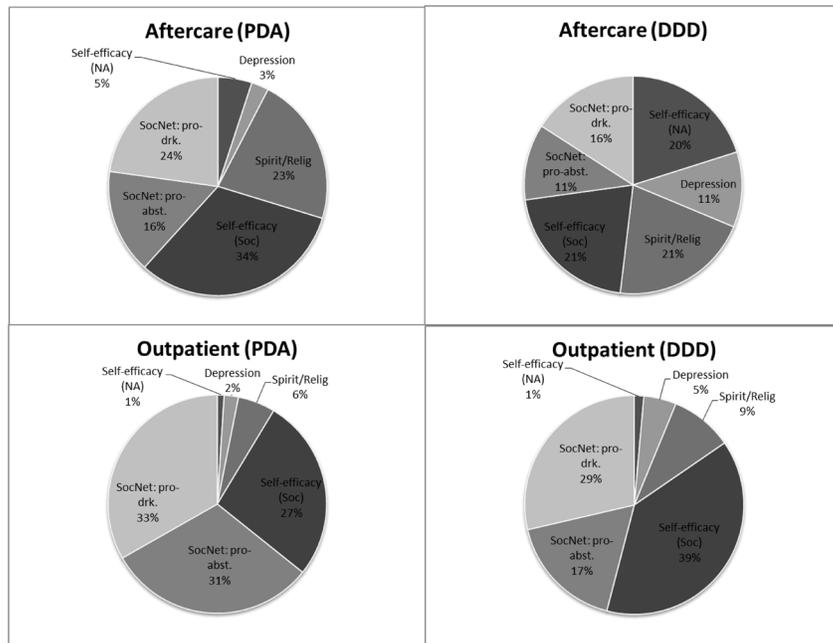
Figure 1.
Tested Multi-Mediator Model

Figure 2.
The specific contribution of each mediator in explaining the overall mediated effect between AA attendance and alcohol outcomes

Table 1

Sample description at Baseline

	Aftercare		Outpatient		t/χ^2
	$n=764$		$n=942$		
	mean/%	SD	mean/%	SD	
Demographics					
Age	41.9	11.1	38.9	10.7	5.76**
Gender (% female)	20.0		27.7		13.79**
Race (%)					77.69**
White	81.5		82.3		
Hispanic	15.0		5.6		
Black	3.5		12.2		
Marital Status (% married/cohabiting)	33.7		35.8		0.83
Employment Status (% full-time)	47.8		51.0		1.69
Baseline Clinical Descriptors					
Beck Depression Inventory (BDI)†	10.6	8.6	9.8	8.0	1.96
Percent Days Abstinent (PDA)	26.8	29.6	34.3	29.8	−5.92**
Drinks per Drinking Day (DDD)†	20.5	12.1	13.5	8.0	14.38**
# of prior alcohol treatments *(max=4)*†	1.2	1.4	0.9	1.2	5.37**

Note:

*
$p < 0.05$,

**
$p < 0.01$;

†
Satterthwaite *t*-test for unequal variances was used

Table 2

Partitioning of the standardized effect of AA on drinking outcome: Total, direct and indirect effects

Drinking Outcome Sample	Total	Direct	Indirect	% Mediated
Percent of Days Abstinent				
Aftercare	0.22**	0.11**	0.11**	50.8%
Outpatient	0.25**	0.14**	0.11**	42.9%
Drinks per Drinking Day				
Aftercare	−0.18**	−0.08*	−0.10**	55.0%
Outpatient	−0.12**	−0.04	−0.08**	66.6%

Note:

*
$p < 0.05$,

**
$p < 0.01$

Table 3

Standardized path parameter estimates of the multiple mediator model

| Type of Path | Percent of Days Abstinent | | | | | | Drinks per Drinking Day | | | | | |
| | Aftercare (*adj. n*=688) | | | Outpatient (*adj. n*=856) | | | Aftercare (*adj. n*=688) | | | Outpatient (*adj. n*=856) | | |
Path	EST	SE	t	EST	SE	t	EST	SE	t	EST	SE	t
Direct effect: AA attendance predicting alcohol outcomes												
AA attendance → PDA/DDD	0.11	0.04	2.92*	0.14	0.04	3.77*	−0.08	0.04	−2.07*	−0.04	0.04	−0.93
Mediational path: AA attendance predicting mediators												
AA attendance → Self-Efficacy (NA)	0.10	0.04	2.75*	0.01	0.04	0.38	0.11	0.04	2.86*	0.02	0.04	0.56
AAattendance → Self-Efficacy (Soc)	0.16	0.04	4.30*	0.12	0.04	2.94*	0.16	0.04	4.43*	0.12	0.04	2.86*
AA attendance → Spirituality/Relig	0.19	0.03	6.72*	0.14	0.03	5.55*	0.18	0.03	6.69*	0.14	0.03	5.34*
AA attendance → Depression	−0.10	0.04	−2.73*	−0.02	0.04	−0.51	−0.10	0.04	−2.87*	−0.02	0.04	−0.64
AA attendance → SocNet: pro-abst.	0.16	0.04	4.37*	0.20	0.04	5.14*	0.17	0.04	4.51*	0.20	0.04	5.10*
AA attendance → SocNet: pro-drk.	−0.12	0.04	−3.12*	−0.15	0.04	−3.82*	−0.13	0.04	−3.32*	−0.14	0.04	−3.57*
Mediational path: Mediators predicting alcohol outcomes												
Self-Efficacy (NA) → PDA/DDD	0.06	0.04	1.67	0.07	0.03	2.43*	−0.18	0.04	−5.13*	−0.05	0.03	−1.48
Self-Efficacy (Soc) → PDA/DDD	0.24	0.03	6.92*	0.24	0.03	8.28*	−0.13	0.04	−3.45*	−0.26	0.03	−8.04*
Spirituality/Relig → PDA/DDD	0.14	0.05	2.95*	0.04	0.05	0.86	−0.11	0.05	−2.20*	−0.05	0.05	−0.99
Depression → PDA/DDD	0.03	0.04	0.85	−0.12	0.03	−3.71*	0.11	0.04	2.84*	0.16	0.04	4.37*
SocNet: pro-abst. → PDA/DDD	0.11	0.04	3.24*	0.17	0.03	5.40*	−0.07	0.04	−1.83	−0.07	0.03	−1.98*
SocNet: pro-drk. → PDA/DDD	−0.23	0.03	−6.76*	−0.23	0.03	−7.85*	0.12	0.03	3.49*	0.15	0.03	4.72*

Note: "adj. n" refers to the average number of participants who had data for the 8 structural variables; not shown but included in model are baseline covariates (see Figure 1).

*
$p < 0.05$.

Self-efficacy (NA): abstinence self-efficacy in situations involving experiencing negative affect; Self-efficacy (Soc): abstinence self-efficacy in situations involving coping with high risk social situations. SocNet: pro-abst:number of Pro-abstainers in the social network; SocNet: pro-drk: number of pro-drinkers in the social network.

Table 4

Test of mediation for specific indirect (i.e., mediated) effects using the Product of Coefficients approach

Drinking Outcome	Aftercare (adj. n=688)				Outpatient (adj. n=856)			
Mediator	EST	SE	95% CI [†]	% [‡]	EST	SE	95% CI [†]	% [‡]
Percent of Days Abstinent (PDA)								
Self-Efficacy (NA)	0.001	0.00	−0.0001–0.0024	5.3%	0.000	0.00	−0.0006–0.0010	1.0%
Self-Efficacy (Soc)	0.006	0.00	0.0028–0.0091 *	33.7%	0.004	0.00	0.0011–0.0062 *	27.0%
Spirituality/Relig	0.004	0.05	0.0013–0.0070 *	23.3%	0.001	0.03	−0.0009–0.0025	5.5%
Depression	0.000	0.03	−0.0018–0.0006	2.7%	0.000	0.00	−0.0008–0.0015	2.1%
SocNet: pro-abst.	0.003	0.00	0.0009–0.0051 *	16.3%	0.004	0.00	0.0021–0.0064 *	30.9%
SocNet: pro-drk.	0.004	0.00	0.0014–0.0071 *	24.0%	0.004	0.00	0.0020–0.0070 *	33.1%
Drinks per Drinking Day (DDD)								
Self-Efficacy (NA)	−0.012	0.01	−0.0216–0.0032 *	20.1%	0.000	0.00	−0.0027–0.0013	1.4%
Self-Efficacy (Soc)	−0.012	0.01	−0.0222–0.0042 *	20.9%	−0.012	0.01	−0.0208–0.0035 *	38.6%
Spirituality/Relig	−0.012	0.05	−0.0239–0.0012 *	20.6%	−0.003	0.03	−0.0089–0.0029	9.2%
Depression	−0.006	0.03	−0.0139–0.0012 *	11.2%	−0.001	0.00	−0.0064–0.0031	4.8%
SocNet: pro-abst.	−0.007	0.01	−0.0151–0.0004	11.3%	−0.005	0.00	−0.0114–0.0000 *	17.3%
SocNet: pro-drk.	−0.009	0.01	−0.0177–0.0027 *	15.9%	−0.009	0.01	−0.0155–0.0032 *	28.6%

Note: "adj. n" refers to the average number of participants who had data for the 8 structural variables;

[†] MCMAM estimates;

[‡] percentage of total indirect effects attributable to specific mediators, which add to more than 100%, if specific indirect effects were in opposite directions;

*
$p < 0.05$.

Self-efficacy (NA): abstinence Self-efficacy in situations involving experiencing negative affect; Self-efficacy (Soc): abstinence self-efficacy in situations involving coping with high risk social situations. SocNEt: Pro-abst:number of Pro-abstainers in the network; SocNet: pro-drk: number of pro-drinkers in the network.