



Interventions to reduce college student drinking: State of the evidence for mechanisms of behavior change



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HIGHLIGHTS

- A systematic review examined support for mediation in college drinking interventions.
- Twenty-two mediators were examined in 61 trials.
- Descriptive norms consistently mediated intervention efficacy.
- Motivation to change consistently failed to mediate intervention efficacy.
- Only descriptive norms partially met criteria for serving as a mechanism of change.

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ABSTRACT

Interventions to reduce college student drinking, although efficacious, generally yield only small effects on behavior change. Examining mechanisms of change may help to improve the magnitude of intervention effects by identifying effective and ineffective active ingredients. Informed by guidelines for establishing mechanisms of change, we conducted a systematic review of alcohol interventions for college students to identify (a) which constructs have been examined and received support as mediators, (b) circumstances that enhance the likelihood of detecting mediation, and (c) the extent of evidence for mechanisms of change. We identified 61 trials that examined 22 potential mediators of intervention efficacy. Descriptive norms consistently mediated normative feedback interventions. Motivation to change consistently failed to mediate motivational interviewing interventions. Multiple active ingredient interventions were not substantially more likely to find evidence of mediation than single ingredient interventions. Delivering intervention content remotely reduced likelihood of finding support for mediation. With the exception of descriptive norms, there is inadequate evidence for the psychosocial constructs purported as mechanisms of change in the college drinking literature. Evidence for mechanisms will be yielded by future studies that map all active ingredients to targeted psychosocial outcomes and that assess potential mediators early, inclusively, and at appropriate intervals following interventions.

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1. Introduction

Alcohol use increases markedly following the transition from high school to college in the United States (Baer, Kivlahan, Blume, McKnight, & Marlatt, 2001; Sher & Rutledge, 2007). College students misuse alcohol to a greater extent than their non-college attending peers (Blanco et al., 2008; Slutske, 2005), with almost 45% of college students reporting a recent episode of heavy alcohol consumption (Hingson, Zha, & Weitzman, 2009). These instances of heavy drinking are implicated in the 1825 deaths, 599,000 injuries, 696,000 physical assaults, and 97,000 sexual assaults that occur among U.S. college students as a result of drinking each year (Hingson et al., 2009; Johnston, O'Malley, Bachman, & Schulenberg, 2011). Therefore, optimizing the efficacy of alcohol interventions for college students is an important goal.

Interventions aim to reduce alcohol use among college students as a means for reducing the likelihood of experiencing these serious negative consequences. These interventions reflect a range of active ingredients and delivery modalities (Carey, Scott-Sheldon, Carey, & DeMartini, 2007; Cronce & Larimer, 2011). Although meta-analyses support that interventions significantly reduce quantity and frequency of alcohol use, effect sizes tend to be small and few effects remain after 1 year (Carey, Scott-Sheldon, Elliott, Garey, & Carey, 2012; Carey et al., 2007).

Improving intervention efficacy is most likely to be achieved by examining mechanisms of change (Kazdin & Nock, 2003). Mechanisms are the psychosocial processes that are targeted in and altered by the intervention (e.g., expectancies and norms), and in turn, effect change in alcohol use or consequences. Examining mechanisms may improve intervention efficacy by identifying which intervention ingredients are effective and which should be abandoned. The importance of examining mechanisms has been emphasized in the mental health treatment

literature (Kazdin, 2007; Kazdin & Nock, 2003; Kraemer, Wilson, Fairburn, & Agras, 2002; La Greca, Silverman, & Lochman, 2009; Silverman & Hinshaw, 2008), but has also received attention in the alcohol abuse treatment literature (Longabaugh, 2007; Nock, 2007).

Recent reviews have described the magnitude of intervention-induced change in alcohol-related behavior, consequences, and psychosocial constructs (e.g., Carey et al., 2012; Scott-Sheldon, Demartini, Carey, & Carey, 2009). However, the extent of support for the mechanisms through which college alcohol interventions reduce drinking has not been examined. The present systematic review examines support for mechanisms of change in college drinking interventions.

Kazdin and Nock (Kazdin, 2007; Kazdin & Nock, 2003; Nock, 2007) outlined requirements for establishing a construct as a mechanism of change. Most important, studies must (a) demonstrate a strong association between the intervention and change in the mechanism. In turn, change in the mechanism must be associated with change in the outcome. A mechanism must minimally satisfy three additional criteria: (b) an experimental design is required to demonstrate intervention-induced change in the mechanism, (c) measurement of the mediator must temporally precede measurement of the outcome, and (d) a specific active ingredient must demonstrate a unique effect on a specific mechanism, and the mechanism must have a unique effect on the outcome. Evidence for a mechanism is further enhanced if it also demonstrates (e) plausibility, (f) consistency across trials, and (g) a dose-response relationship, such that higher doses of the treatment lead to greater change in the mediator and outcome. Our review focuses on randomized controlled trials, satisfying criterion (b). The extent to which studies demonstrate strong associations between the intervention, mechanism, and outcome constitutes the majority of this review. Support for the remaining criteria is also explored.

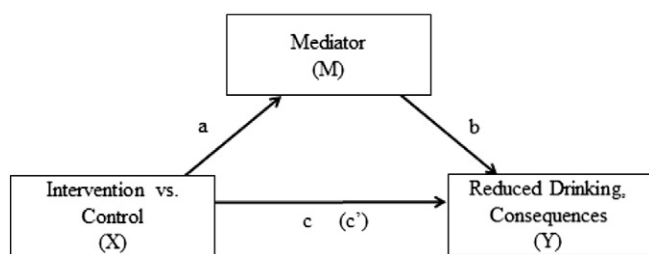


Fig. 1. Path diagram of mediation of intervention effects by a single mediator. The *a* path reflects the effect of the intervention on changes in the mediator, the *b* path, the effect of changes in the mediator on changes in the outcomes, the *c* path, the effect of the intervention on changes in the outcomes before accounting for the mediator, and the *c'* path, the effect of the intervention on changes in the outcomes controlling for the effect of the mediator.

2. Basics of mediation analysis

Providing statistical support for the strong association criterion requires conducting a mediation analysis. Fig. 1 diagrams the single mediator model using the terminology of MacKinnon (2008) for variables and paths. The seminal work of Baron and Kenny (1986) on mediation, a causal steps approach, required that in order to test mediation, a significant relationship must exist between the intervention (*X*) and the outcome (*Y*; step 1). In addition, the intervention (*X*) must significantly change the mediator (*M*; step 2), and the mediator must be related to change in the outcome (*Y*) while controlling for the intervention effect (step 3). Full mediation occurs if the intervention effect is reduced to non-significance when controlling for the mediator (step 4). Partial mediation occurs when the intervention effect is reduced but remains significant.

The “*c*” path in Fig. 1 reflects step 1, the total effect of the intervention on the outcome before accounting for the mediator. The “*c'*” path reflects step 4, the relationship of the intervention to the outcome after accounting for the mediator. The “*a*” path (step 2) tests the action theory, assessing whether the active ingredient altered the targeted psychosocial construct. The “*b*” path (step 3) tests the conceptual theory, assessing the theory that proposes a causal influence of the mediator on the outcome. If change in the mediator is not associated with reduced drinking, the mediator may not be a causal determinant of alcohol use.

Causal steps approaches have low power for detecting mediation when the mediated effect or sample size is small (Fritz & MacKinnon, 2007; MacKinnon, 2008). Thus, current recommendations favor product of the coefficients methods (Fritz & MacKinnon, 2007; MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002), which test mediation by multiplying the coefficients for the “*a*” and “*b*” paths and dividing by a standard error. Unstandardized coefficients are most commonly employed. Significance tests that utilize bias-corrected bootstrapped confidence intervals or alternative approaches that generate asymmetric confidence intervals (e.g., PRODCLIN, *z'*; MacKinnon, Fritz, Williams, & Lockwood, 2007; MacKinnon et al., 2002) are recommended to account for the non-normal distribution that results when multiplying the two coefficients (Fritz & MacKinnon, 2007; MacKinnon, Lockwood, & Williams, 2004; MacKinnon et al., 2002). Although recommendations against causal steps approaches have been in the literature for over 10 years, these methods may persist due to researcher familiarity, inexperience with bootstrapping, or alternative views on the importance of the total effect of the intervention. This reluctance may lead to missed opportunities for enhancing knowledge of mechanisms of change by testing mediation.

3. Purpose of the present review

The present systematic review examines support for mechanisms of change in alcohol interventions for college students. Specifically, we

identified all randomized college drinking intervention trials that reported a planned test of mediation. In the **Results** section, we summarize the mechanisms examined, support for the strong association criterion as indicated by the extent to which each construct mediates intervention efficacy, and conditions that facilitate or hinder the likelihood of finding support for mediation (e.g., construct measurement). We then examine, overall, whether support for mediation depended on methodology. In the **Discussion** section, we summarize the extent of adherence to the criteria for identifying mechanisms of change and provide suggestions for future research.

4. Method

4.1. Inclusion criteria and study identification

Inclusion in the review required that studies (a) examined an alcohol intervention delivered individually or in a group setting, (b) targeted college students, (c) evaluated a randomized controlled trial, (d) assessed alcohol-related behavior and/or consequences following the intervention, and (e) explicitly sought to examine mediation of intervention efficacy. Studies were not included if they examined change in process variables but did not explicitly intend to examine whether the process variables explained intervention efficacy. Inclusion in the review did not require that studies be conducted in the United States or any specific location.

Relevant articles were first identified by examining existing databases of alcohol interventions for college students held by the Substance Use Risk Education Meta-Analytic Team at Brown University. This database, which was last updated in May 2010, has produced a number of comprehensive meta-analyses examining the efficacy of alcohol interventions for college students (Carey, Scott-Sheldon, Elliott, Bolles, & Carey, 2009; Carey et al., 2007; Carey et al., 2012; Scott-Sheldon, Carey, Elliott, Garey, & Carey, 2014; Scott-Sheldon, Terry, Carey, Garey, & Carey, 2012; Scott-Sheldon et al., 2009). Next, relevant articles published and dissertations defended between January 1, 2010 and January 18, 2014 were identified. Studies were retrieved from (a) PsycInfo, PubMed, Dissertation Abstracts, ERIC, CINAHL, and The Cochrane Library using a Boolean search strategy with the following truncated and full search terms: (alcohol or drink* or binge) and (college or university) and (intervention* or prevent*); (b) reference sections of relevant manuscripts; and (c) recent publications of relevant journals.

When faced with decisions of whether to treat results from a single article as one or multiple trials, we followed guidelines for systematic reviews (Card, 2011). When multiple publications reported mediation analyses for the same trial, information was pooled across sources and treated as a single trial. When mediation was reported separately by gender, we treated this as two separate trials. A number of trials reported on three or more conditions. Mediation analyses in these cases included separate comparisons of each treatment against one control (e.g., Wood, Capone, Laforge, Erickson, & Brand, 2007), comparing one treatment against the average of two controls (e.g., Martens, Kilmer, Beck, & Zamboanga, 2010), and comparing the average of two treatment conditions against one control (e.g., Kulesza, McVay, Larimer, & Copeland, 2013). Only in the first case, where two treatments were separately compared to the control condition, did we treat the study as reflecting more than one trial.

Our search yielded 47 studies, reflecting 61 distinct trials that examined 22 hypothesized mediators. Appendix A, available for download in the supplementary materials, contains references for included studies. Mediators examined included the following: descriptive norms, protective behavioral strategies, outcome expectancies, self-efficacy, emotion, coping motives, injunctive norms, intention, parent–child communication, self-regulation, recall of intervention content, motivation to change, cognitive dissonance, drinking approval, goal commitment, pros or cons, self-monitoring, study abroad adjustment, defensiveness, expectancy awareness,

Table 1
Mediator definitions and study-specific operationalizations.

Construct	Definition
Descriptive norms	Perceptions of level and frequency of peer alcohol use (variations: self-other discrepancy; behavior-norm discrepancy)
Protective behavioral strategies	Behaviors used while drinking or instead of drinking as a means for reducing consumption and/or negative consequences
Outcome expectancies	Outcomes individuals expect to experience as a result of drinking (variations: positive, negative, social/physical, social assertiveness, sexual enhancement, aggression, relaxation, implicit arousal expectancies)
Self-efficacy	Confidence in one's ability for performing the behavior (variations: refusal, moderation self-efficacy)
Emotion, mental health	Frequency of experiencing emotions or symptoms of poor mental health functioning (variations: anger, self-esteem, distress, loneliness, regret, depression)
Coping motives	Consuming alcohol as a means for coping with negative life experiences
Injunctive norms	Perceived approval among others for drinking and experiencing negative consequences that result from heavy drinking (variations: friend, parent injunctive norms)
Intention	Plans for reducing drinking in the future (variations: intentions for reducing drinking, moderation)
Parent-child communication	Communication with parent, monitoring child's behavior (variations: general communication, alcohol-specific communication, parental monitoring, permissiveness)
Self-regulation	Ability to effectively control behavior and emotions and to favor future, over immediate, rewards (variations: future time perspective, delay discounting, emotion regulation)
Recall intervention content	Ability to recall content delivered in intervention
Motivation and readiness to change	Stage of preparedness for changing behavior, ranging from not thinking about changing to already taking action
Cognitive dissonance	Unpleasant affective reaction as a result of realizing that one's beliefs and behavior are discrepant (variations: actual-ideal drinking discrepancy, dissonance-related negative affect, discomfort)
Drinking approval, attitude	Approval of drinking, attitude toward drinking
Goal commitment/priority	Commitment to or priority placed on alcohol-related goals (variations: goal commitment, reduced drinking; goal priority, reduced drinking; goal priority, disinhibition)
Pros and cons	Benefits and drawbacks of drinking
Self-monitoring	Awareness of and reflection on one's own quantity and frequency of alcohol use
Study abroad adjustment	Integration into host community while studying abroad
Defensiveness	Resistance to and derogation of intervention content
Expectancy awareness	Consideration of effects expectancies have on drinking
Perceived risk	Perceptions of likelihood of experiencing negative consequences
Substance free reinforcement	Pleasure and enjoyment derived from activities performed in the absence of alcohol and other substances

perceived risk, and substance free reinforcement. [Table 1](#) provides definitions for each mediator and variations in operationalization across studies.

4.2. Evaluating support for mediators

For each identified construct, we tallied the number of trials that have versus have not found support for mediation (see [Table 2](#)). Some trials tested more than one operationalization of a single construct (e.g., descriptive norms for students vs. friends). If at least one operationalization found support for mediation, the trial was counted

Table 2
Extent of support for mediation by each construct.

Construct	Number of trials	
	Supported mediation	Did not support mediation
<i>Supported mediators</i>		
Descriptive norms	25	14
<i>Mediators with mixed but promising support</i>		
Protective behavioral strategies	6	6
Outcome expectancies	4	6
Self-efficacy	3	2
Emotion, mental health	2	2
<i>Mediators with limited support</i>		
Coping motives	2	0
Injunctive norms	1	5
Intention	1	1
Parent-child communication	1	1
Self-regulation	1	1
Recall intervention content	1	0
<i>Unsupported mediators</i>		
Motivation and readiness to change	0	11
Cognitive dissonance	0	3
Drinking approval, attitude	0	3
Goal commitment/priority	0	2
Pros and cons	0	2
Self-monitoring	0	2
Study abroad adjustment	0	2
Defensiveness	0	1
Expectancy awareness	0	1
Perceived risk	0	1
Substance free reinforcement	0	1

Note. "Supported mediators" reflect constructs for which the majority of trials support mediation. "Mediators with mixed but promising support" include constructs examined in three or more trials, with support in at least two trials. "Mediators with limited support" reflect constructs examined in one or two trials or that have only yielded support for mediation in one trial. "Unsupported mediators" reflect constructs that have not received support in any trials.

as finding support for mediation. This tally allowed for categorizing whether each construct has received positive, mixed but promising, limited, or no support as a mediator. "Supported mediators" include constructs for which the majority of trials support mediation (as documented in [Table 2](#)). "Mediators with mixed but promising support" have been examined in three or more trials, with evidence of mediation in at least two trials. "Mediators with limited support" have been examined in only one or two trials or have only yielded support for mediation in one trial. "Unsupported mediators" have not received support in any trials thus far.

In structuring the results, we first describe the included studies and then discuss support for mediation by each construct. For each construct, we describe methodological features, including active ingredients, construct operationalization, and alcohol outcomes tested, that appeared to facilitate or hinder finding support for mediation. When the literature allowed, we also examined whether the type of sample influenced support for mediation. Sample type was divided into no criteria/drinkers, heavy drinkers, and mandated students. Sample size did not allow for separating the no criteria and drinker categories. Regarding the criteria for identifying mechanisms, we discuss support for the temporal precedence criterion for constructs examined in five or more trials and note any instances in which the plausibility criterion was violated.

5. Results

5.1. Characteristics of included studies

Appendix B, available for download in the supplementary materials, provides details on included trials. It lists the active ingredients in the treatment and control conditions and the mediators examined in each

trial. When support was obtained for a mediator, outcomes for which mediation was or was not supported are specified (e.g., quantity and frequency). When support was not obtained for a mediator, we indicate whether each path in the mediational chain was significant to facilitate examination of why the mediational relationship failed. The table also indicates the method used to test mediation, distinguishing between the Baron and Kenny causal steps approach, tests based on the normal distribution, and tests that account for the asymmetric distribution of the product of coefficients. The final column reports whether trials included temporal separation of the mediators and outcomes and the timing of assessments.

Interventions were primarily single session (82%) and comprised of multiple active ingredients (66%). Interventions were delivered face-to-face (50%), as well as over the web (26%), by computer (15%), and by mail (8%). One intervention was delivered by pamphlet. Most trials delivered content individually (90%), rather than in a group setting. Control conditions often consisted of active treatments (59%; e.g., alcohol education and computer-delivered interventions), though assessment only controls were also common. Trials were slightly more likely to examine only one mediator (56%), sometimes with multiple operationalizations (e.g., social and tension reduction expectancies), rather than multiple potential mediators. All but four trials were conducted in the United States (Murgraff, McDermott, & Abraham, 2004; Scott, Brown, Phair, Westland, & Schüz, 2013; Wiers, Van De Luitgaarden, Van Den Wildenberg, & Smulders, 2005; Men, Women). In all, 26% of trials assessed mediators at a follow-up of less than 1 month, 33% utilized a 1 month assessment, and 41% assessed mediators beyond 1 month. In only 36% of trials did assessment of the mediators temporally precede outcome assessment.

5.2. Supported mediators

5.2.1. Descriptive norms

Descriptive norms were examined as a mediator in 64% of all trials, making it the most examined mediator in the college drinking literature. Among the 39 trials that examined descriptive norms, 64% found support for mediation (see Table 2). Thus, among constructs examined in at least three trials, descriptive norms are also the most strongly supported mediator. Descriptive norms have been assessed at different levels (e.g., for close friends, local students, and national students; Carey, Henson, Carey, & Maisto, 2010). However, mediation was most often supported for local students, capturing perceived alcohol use among students at a participant's college or university. Support for mediation by descriptive norms was robust for quantity, frequency, and composite measures but equivocal for problems.

Descriptive norms were not supported as a mediator in 14 out of 39 trials. In the majority of these cases ($k = 9$), interventions failed to alter descriptive norms (no *a* paths). In one trial, the content of normative feedback was not specified (Logan, 2013). Among the remaining eight trials, four provided feedback on the local norms but were delivered via mail or the internet (Larimer et al., 2007; Neighbors et al., 2010, Conditions 1, 4; Pedersen, 2012, Condition 1). Four trials, three of which were face-to-face, provided feedback on national norms (Barnett, Murphy, Colby, & Monti, 2007; LaChance, Feldstein Ewing, Bryan, & Hutchison, 2009; Martens et al., 2010; Murphy, Dennhardt, Skidmore, Martens, & McDevitt-Murphy, 2010). Across delivery modalities, five trials that did not alter norm perceptions did not provide gender-specific feedback (LaChance et al., 2009; Larimer et al., 2007; Martens et al., 2010; Neighbors et al., 2010, Condition 4; Pedersen, 2012). Thus, it may prove more difficult to change descriptive norms (a) when interventions are delivered remotely to students who may be distracted (Lewis & Neighbors, 2014; Rodriguez et al., 2015); (b) when national rather than local norms serve as the basis for normative feedback; and (c) when gender non-specific normative feedback is utilized.

Only 2 of the 14 trials that did not support mediation failed to observe the *b* path, the relationship of change in descriptive norms to

change in the outcomes (Collins, Carey, & Sliwinski, 2002; Pedersen, 2012). Notably, these trials examined alternative operationalizations of descriptive norms, including perceived discrepancy from the norm and descriptive norms for study abroad students. These operationalizations may be less influential on behavior than norms for the typical student at one's college or university. Given that relatively few studies failed to observe the *b* path and that these failures may be due to measurement, results support the conceptual theory indicating a causal influence of descriptive norms on alcohol use. Three trials did not fully test mediation due to lack of intervention effects on outcomes (no *c* path) or poor model fit (Lewis & Neighbors, 2007; Murphy et al., 2010; Neighbors et al., 2010).

Overall, support for mediation by descriptive norms varied by sample type: 69% of no criteria/drinker trials, 63% of heavy drinker trials, and 57% of mandated student trials found that descriptive norms mediated intervention efficacy. Given that few studies failed to observe the *b* path, this suggests that the likelihood of altering descriptive norms (a path) may depend on sample type. Further, the vast majority of studies (74%) have examined mediation by descriptive norms using cross-sectional data. Despite the strong support for mediation by descriptive norms, to what extent changing this construct drives subsequent behavior change remains unclear. Accordingly, enhancing the impact of normative feedback in riskier samples and examining mediation by descriptive norms longitudinally are important goals for future research.

5.3. Mediators with mixed but promising support

5.3.1. Protective behavioral strategies

Protective behavioral strategies, reflecting strategies that individuals might use to limit their alcohol consumption (see Pearson, 2013; Prince, Carey, & Maisto, 2013), were examined as a mediator in 12 trials, with six trials supporting its mediational role. Among the supporting trials, four provided personalized feedback on strategies (Barnett et al., 2007; Braitman, 2012, Condition 2; Kulesza et al., 2013; Larimer et al., 2007), and one trial provided a list of strategies (Braitman, 2012, Condition 1). One trial reviewed a list of protective strategies with both intervention and control participants but also highlighted for intervention participants the discrepancy between alcohol use and career goals (Murphy et al., 2012). Potentially, this focus on career goals spurred greater use of protective strategies to facilitate achieving those goals. Most trials drew on multi-faceted scales to assess strategies (e.g., Martens et al., 2005; Sugarman & Carey, 2007) but examined summary scores rather than scores on the subscales. Mediation was robust across outcomes, with most trials examining quantity of alcohol consumption.

Mediation by protective behavioral strategies was not supported in 6 out of 12 trials. Among the four trials that failed to change strategies (no *a* paths), none provided personalized feedback on strategies participants had previously used (Neighbors, Lee, Lewis, Fossos, & Walter, 2009; Sugarman, 2009; Walters, Vader, Harris, Field, & Jouriles, 2009; Wood et al., 2010). Personalized feedback may therefore be a key for inducing change in strategies. One of these trials did not address protective strategies in the intervention (Walters et al., 2009), violating the plausibility criterion. Two trials improved use of protective strategies but failed to support mediation. One trial that did not observe the *b* path (Martens, Smith, & Murphy, 2013, Condition 1) also did not directly address protective strategies, violating the plausibility criterion. The second trial provided personalized feedback on strategies (Martens et al., 2013, Condition 2) but did not fully test mediation due to lack of change in outcomes (no *c* path). All six non-supporting trials also assessed multi-faceted scales. A single trial examined mediation by each subscale but did not induce change in any of subscales (Sugarman, 2009). Recent studies highlight differential associations between certain types of protective strategies and drinking (Frank, Thake, & Davis, 2012; Napper, Kenney, Lac, Lewis, & LaBrie, 2014). Examination

of protective strategy subscales in interventions may enhance sensitivity for detecting change.

Support for mediation by protective behavioral strategies varied by sample type. A significant mediated effect was obtained in 60% of no criteria/drinker trials and 43% of heavy drinker/mandated student trials. The small number of trials available prohibited separating heavy drinkers and mandated students. Results are, nonetheless, consistent with those for descriptive norms, suggesting that mechanisms may be more difficult to alter among riskier participants. Further, 50% of protective strategies trials examined mediation with cross-sectional data. Thus, future research on protective strategies would benefit from considering how to increase use among riskier drinkers and conducting longitudinal tests of mediation.

5.3.2. Outcome expectancies

Ten trials examined the mediational role of outcomes individuals expect to experience as a result of drinking. Four trials found support for mediation, primarily for social outcome expectancies, capturing the expected effects of alcohol on social interactions. Two of these trials utilized one or two session expectancy challenge paradigms (Lau-Barraco & Dunn, 2008; Wiers et al., 2005). The two additional trials that supported mediation by expectancies examined a brief motivational BASICS-style intervention ([Brief Alcohol Screening and Intervention for College Students; Dimeff, Baer, Kivlahan, & Marlatt, 1999]; Turrisi et al., 2009) and an intervention targeting social anxiety and coping motives for drinking (Black et al., 2012). Expectancies consistently mediated quantity and heavy frequency outcomes but were equivocal for problems.

Mediation by expectancies failed to receive support in six out of ten trials. Four of these trials did not change expectancies (no a paths). Three of the four trials were BASICS-style interventions that assessed general positive, rather than social expectancies (Borsari & Carey, 2000; LaChance et al., 2009; Logan, 2013). Thus, although expectancy challenge paradigms alter positive expectancies (Scott-Sheldon et al., 2012), general positive expectancies may be less amenable to change in personalized feedback interventions. The fourth trial provided a strong test, assessing the expectancies targeted in an expectancy challenge intervention (Wood et al., 2007) but nonetheless failed to alter expectancies. Among the remaining two trials, one failed to observe a relationship of change in positive expectancies to change in drinking (no b path; Kulesza et al., 2013). The final trial did not fully test mediation due to lack of intervention effects on drinking (no c path; Wiers et al., 2005). With 60% of trials relying on cross-sectional data, this subset of the literature would also benefit from longitudinal examinations.

5.3.3. Self-efficacy

Five trials examined whether change in self-efficacy mediated intervention efficacy, with three finding support for mediation. Trials considered both refusal self-efficacy, reflecting confidence in one's ability to resist drinking, and moderation self-efficacy, reflecting confidence for engaging in moderate levels of drinking. Among the three supporting trials (Black et al., 2012; LaChance et al., 2009; Murgraff et al., 2004), active ingredients varied, addressing how to decline alcohol offers and coping with social anxiety. However, self-efficacy was consistently assessed using the Drink Refusal Self-Efficacy Scale (Young, Oei, & Crook, 1991) or a measure with similar content. The Drink Refusal Self-Efficacy Scale assesses ability to resist drinking across various social and emotional states.

Among the two trials that failed to support mediation by self-efficacy, measurement was a key. One study, which did not alter self-efficacy (no a path; Kulesza et al., 2013), assessed ability to resist heavy drinking if, for example, "I unexpectedly found a bottle of my favorite booze" (Annis & Davis, 1988). This scale may be more appropriate for alcohol dependent populations than college students. The second study that failed to support mediation improved self-efficacy for achieving the moderate drinking goals set during the intervention but found that moderation self-efficacy was unrelated to change in drinking (no

b path; Lozano & Stephens, 2010). Similarly, Murgraff et al. (2004) found that refusal but not moderation self-efficacy mediated intervention efficacy. As definitions of moderate drinking likely vary across researchers and students, moderation self-efficacy may be a poor candidate for interventions. In sum, self-efficacy can be improved, but doing so depends on operationalization and measurement. Overall, self-efficacy research has primarily utilized longitudinal data (60%). However, given that only five studies have examined mediation by self-efficacy, additional longitudinal tests of mediation are needed.

5.3.4. Emotion and mental health

Four trials examined whether changes in emotion constructs, including depression, anger, and regret, mediated intervention effects on alcohol use. Two trials found support for depression and anger as mediators (Barber, 2011; Whiteside, 2010). These trials enrolled students who had recently ended a romantic relationship or who reported at least mild levels of depression or anxiety. The active intervention ingredients included coping with negative emotional states through journaling in one study and use of mindfulness and opposite action in the other. In a third trial, depression was not influenced by the intervention (no a path; Murphy et al., 2012). This trial incorporated techniques used in behavioral activation, a common treatment for depression, but study inclusion did not require heightened levels of depression. The fourth trial (Murgraff et al., 2004) targeted anticipated regret among a general population by asking participants to anticipate their emotional response if they incurred serious health consequences due to heavy drinking. Feelings of regret were not affected by this information (no a path). Although only limited research has examined mediation by emotion-focused constructs, the existing studies suggest that stress management techniques can effectively reduce both negative emotions and drinking. However, observing mediational effects may be contingent on targeting samples experiencing heightened levels of negative affect.

5.4. Mediators with limited support

5.4.1. Coping motives

Two trials examined and found support for a mediational role of coping motives, reflecting drinking to cope with negative experiences, in explaining changes in alcohol-related problems (Shamaley, 2013; Whiteside, 2010). Consistent with literature that has demonstrated that drinking to cope is associated with problems and extreme levels of consumption (Carey & Correia, 1997; Park & Levenson, 2002), neither trial examined a consumption outcome. Shamaley observed an iatrogenic effect, with coping motives and problems increasing as a function of the intervention. This study provided feedback on norms for stress and drinking to cope to a general student population. Similar to Schultz, Nolan, Cialdini, Goldstein, and Griskevicius (2007), the iatrogenic effects may reflect that many students received feedback that they were below the norm for drinking to cope (cf. Prince, Reid, Carey, & Neighbors, 2014). Conversely, Whiteside targeted heavy drinking anxious and depressed students. These students were likely in fact relying on alcohol as a coping mechanism. As with the emotion-focused constructs, the utility of addressing coping motives may depend on baseline levels of drinking to cope.

5.4.2. Injunctive norms

Of six trials that examined injunctive norms, reflecting perceptions of others' approval of alcohol use, only one found support for mediation (Turrisi et al., 2009). This trial targeted peer descriptive norms and parent injunctive norms but observed mediation by both peer injunctive and descriptive norms. This may reflect that, although distinct, descriptive and injunctive norms are cognitively linked (Prince & Carey, 2010). However, three additional trials targeted descriptive norms but did not influence injunctive norms (no a paths; Carey et al., 2010; Men, Women; Logan, 2013). A single study specifically aimed to change

perceptions of peer injunctive norms but failed to alter them (no a path; Schroeder & Prentice, 1998). Change in injunctive norms was assessed only at a 4 to 6 month follow-up with a single item. The lack of change in injunctive norms may reflect insensitive measurement or the long time span between intervention and follow-up. Given that only one out of six studies included an active ingredient targeting injunctive norms, these trials have generally violated the plausibility criterion for establishing injunctive norms as a mechanism of change. Injunctive norms may yet hold promise. Research in other domains supports that personalized injunctive norm feedback can change behavior and does so by altering perceptions of injunctive norms (Reid & Aiken, 2013).

A final study examined the role of parent injunctive norms in mediating effects of a parent handbook intervention (Wood et al., 2010). Although parent injunctive norms changed (supported a path) and change in injunctive norms was related to outcomes (supported b path), the mediation analysis was not significant. This study analyzed latent growth models and may have lacked power to detect mediation (Fan, 2003; Fritz & Mackinnon, 2007). Turrisi et al. (2009) also examined parent injunctive norms as a mediator of the parent handbook but observed no change in parent injunctive norms (no a path). Accordingly, additional research is needed on whether parent injunctive norms transmit the effects of parent-based interventions. Longitudinal examinations of mediation are also needed, as 83% of studies examining mediation by peer and parent injunctive norms have utilized cross-sectional data.

5.4.3. Additional constructs

Two trials examined whether intentions explained intervention efficacy; support for mediation was split. Scott et al. (2013) found that intentions for reducing alcohol use mediated the effects of an intervention designed to affirm participants' self-worth. Murgraff et al. (2004) examined mediation by intentions for both reducing drinking and drinking moderately. Despite encouraging formation of implementation intentions, neither measure changed (no a paths). Nonetheless, intentions may mediate the influence of most psychosocial interventions (Fishbein & Ajzen, 1975). Interventions that incorporate goal setting may yield the largest changes in intentions. However, this has not been explored thus far.

Two studies have examined communication between students and their parents as a mediator of parent-based interventions, with mixed results. Testa, Hoffman, Livingston, and Turrisi (2010) examined both general and alcohol-specific parent-child communication. General communication explained intervention effects, but alcohol-specific communication was not affected by the intervention (no a path). Wood et al. (2010) assessed only alcohol-specific communication. Consistent with Testa et al., the intervention produced no change in this type of communication (no a path). Thus, improving overall communication between parents and students, rather than conversations specifically about alcohol, appears to be a viable means for reducing student drinking.

Two trials have examined mediation by self-regulation, reflecting ability to control one's behavior and emotions and to attend to future rewards. One trial obtained support for mediation; the second did not. Consistent with the broader literature on effects of mindfulness (Lutz et al., 2013), Whiteside (2010) found that mindfulness-based techniques increased depressed and anxious students' ability to regulate emotions, which explained decreased alcohol use. In contrast, Murphy et al. (2012) found that future time perspective (no b path) and delay discounting (no a path) did not mediate reduced drinking. These studies suggest that self-regulation may not drive alcohol use among fairly high functioning students. As with emotion and mental health, additional research is needed to shed light on whether active ingredients that aim to improve self-regulation are efficacious only among students with deficits in this area.

A single trial examined and found support for mediation via participants' ability to recall intervention content, normative feedback in this

case (Jouriles et al., 2010). This mechanism may play a role in the efficacy of many interventions. Consistent with the elaboration likelihood model (Petty & Cacioppo, 1986), actively engaging with and processing intervention content should result in better recall. Improved recall may enhance intervention effects by facilitating ability to revisit intervention content in an unbiased way at a later time.

5.5. Unsupported mediators

5.5.1. Motivation and readiness to change

Among 11 trials that examined motivation or readiness to change as a mediator of intervention efficacy, none found support. All of the trials evaluated motivational interviewing interventions. Only two trials improved motivation to change (supported a paths). In one trial, motivation did not predict reduced drinking (no b path; Borsari & Carey, 2000; Borsari, Murphy, & Carey, 2009). The second trial did not alter drinking and did not further test mediation (no c path; Murphy et al., 2010). The remaining nine trials did not increase motivation (no a paths). Consistent with research on treatment seeking populations (Apodaca & Longabaugh, 2009), there is no evidence that the effects of motivational interviewing are transmitted by motivation to reduce drinking. Potentially, more sensitive measures of motivation may yield better results. Alternatively, a certain threshold of pre-intervention motivation may be required to be able to further improve motivation (Stein et al., 2009). As this literature has utilized both cross-sectional (45%) and longitudinal data, the failure of motivation as a mediator is not the result of carrying out more rigorous tests of mediation.

5.5.2. Dissonance

Three trials tested whether dissonance processes, including feelings of discomfort and actual vs. ideal self-discrepancy in drinking, explained the effects of motivational interviewing interventions. All three trials observed changes in dissonance (a paths). One trial found that dissonance was unrelated to drinking outcomes (no b path; McNally, Palfai, & Kahler, 2005). The remaining two trials did not improve outcomes and did not further test mediation (no c paths; Murphy et al., 2010; Study 1, 2). Given that dissonance processes are amenable to change, additional research on the role of dissonance in motivational interviewing is warranted.

5.5.3. Drinking approval, attitude

Personal approval of and attitude toward drinking were tested as mediators in three trials. None changed attitudes (no a paths). One trial, used a traditional attitude change approach and listed positive outcomes of reducing drinking (Murgraff et al., 2004). The second trial targeted injunctive norms and found no effects on attitudes 4 to 6 months later (Schroeder & Prentice, 1998). Although this violates plausibility, Reid and Aiken (2013) found that post-test attitudes mediated the effect of an injunctive norm intervention on sun-protection. Thus, earlier measurement may reveal a role for attitudes in injunctive norm alcohol interventions. The third trial tested a motivational interviewing intervention and assessed attitudes toward drinking at a bar and going to a party to get drunk (Turrisi et al., 2009). To the extent that motivational interviewing approaches are expected to change attitudes, additional tests of mediation are warranted with expanded measures of attitudes.

5.5.4. Goal commitment, pros and cons, self-monitoring, study abroad adjustment

Two trials each examined but did not find support for mediation by commitment to or perceived priority of goals, pros and cons, self-monitoring, and study abroad adjustment. Murgraff et al. (2004) and Lozano and Stephens (2010) examined whether encouraging participants to set goals for reducing drinking was associated with greater commitment to or priority placed on those goals. Both studies improved goal commitment/priority (a paths). However, goal commitment was

not related to drinking outcomes (no b paths), suggesting that enhancing commitment to alcohol-related goals does not necessarily translate into reduced drinking.

Pros and cons, reflecting benefits and drawbacks of heavy drinking, were examined as distinct mediators in two motivational interviewing trials (Carey et al., 2010; Men, Women). Pros did not decrease in either trial (no a paths). Cons decreased in one trial, but were unrelated to outcomes (no b path). Pros and cons may not be strongly influenced by motivational approaches, particularly when decisional balance techniques that encourage weighing pros and cons of heavy drinking are not incorporated. However, decisional balance may in fact reduce intervention efficacy among individuals who are resistant to change (Carey, Carey, Maisto, & Henson, 2006; Miller & Rose, 2013). Future research may provide insight into whether decisional balance effectively alters pros and cons among certain individuals.

With respect to self-monitoring, neither of the two motivational interviewing trials testing this mediator improved self-monitoring (no a paths). Wood et al. (2010) directly addressed self-monitoring, encouraging participants to actively monitor their alcohol consumption. A second study by the same group did not explicitly address self-monitoring (Wood et al., 2007), reflecting either a violation of plausibility or simply failure to report that active ingredient. Accordingly, the utility of self-monitoring for effecting change in alcohol use remains unclear.

Finally, two trials addressed adjusting to new situations while studying abroad but did not influence study abroad adjustment (no a paths; Pedersen, 2012; Conditions 1, 2). Extrapolating from this context, providing a list of tips for adjusting when transitioning into new situations (e.g., graduating) may not be sufficient for improving the adjustment experience.

5.5.5. Additional constructs

As shown in Table 2, defensiveness, expectancy awareness, perceived risk, and substance free reinforcement were evaluated in single trials only. Substance free reinforcement, the extent to which individuals find alcohol-free activities enjoyable, was not affected by the intervention (no a path; Murphy et al., 2012). Perceived risk and expectancy awareness (i.e., knowledge of how expectations can affect alcohol use) improved but were unrelated to behavior change (no b paths; LaChance et al., 2009; Wood et al., 2007, Condition 2). Logan (2013) reduced defensiveness following a brief motivational intervention but did not test mediation due to lack of change in alcohol use (no c path). Additional research is needed on each of these constructs to better understand their potential contributions to reducing drinking.

5.6. Impact of methodology on detecting mediation

Below, we examine whether support for mediation depended on number of active ingredients, mode of delivery, sample type, and method of testing mediation. These details are provided for each trial in Appendix B (available in the online supplementary materials).

5.6.1. Multi- versus single-component interventions

The majority of interventions consisted of multiple active ingredients (62%). Mediation was not substantially more likely to hold in multi-component interventions, as 61% of single component and 68% of multiple component interventions found support for mediation. This in part reflects that some mediators targeted primarily in multi-component interventions are more difficult to change (e.g. protective behavioral strategies and motivation). More concerning, however, 40% of multi-component interventions tested only one mediator. Identification of efficacious active ingredients may be enhanced by conducting intervention mapping, linking each active ingredient to the construct it is expected to affect (Bartholomew, Parcel, Kok, Gottlieb, & Fernandez, 2011), and testing mediation for all active ingredients. For example, personalized feedback on blood alcohol content is included in many studies

and may communicate risk for experiencing negative events. Yet, only one study has examined perceived risk as a mediator.

5.6.2. Mode of delivery

Intervention content was delivered via counselor in 31 trials, internet (remotely) in 16 trials, computer in 9 trials, mail in 5 trials, and in-person pamphlet in 1 trial. Mode of delivery exceeds 61 trials because one trial included active ingredients delivered via different modes (Turrisi et al., 2009). In all, 89% of computer-delivered and 65% of counselor-delivered trials found support for at least one mediator. In contrast, 56% of internet-delivered and 40% of mailed trials found evidence of mediation. Among the internet and mailed trials that did not find evidence of mediation, six of seven internet and two of three mailed trials had at least one mediator that was not affected by the intervention (no a paths). Psychosocial constructs may be more difficult to change when content is delivered remotely because students are often distracted by other activities (Lewis & Neighbors, 2014), preventing the deep processing required for effecting change (Petty & Cacioppo, 1986). Altering mediators does not require delivering content via counselor, as evidenced by the computer-delivered trials. Rather, having participants in a setting where they are focused on the intervention content may be sufficient.

Six trials (10%) delivered interventions in a group setting. Group interventions were as likely to find support for at least one mediator (67%) as all individually-delivered interventions (69%) and individual, counselor-delivered interventions (64%). With the caveat that there were few group trials, group settings do not appear to diffuse the impact of intervention content.

5.6.3. Type of sample

Support for at least one mediator was found in 76% of no criteria/drinker trials, 55% of heavy drinker trials, and 86% of mandated student trials. These results differ from those reported for descriptive norms and protective behavioral strategies. However, all seven mandated student trials included multiple active ingredients, and 71% examined more than one mediator. Across all trials, 62% included multiple active ingredients and 49% examined multiple mediators. The high rate of mediation may be due to mandated student trials having targeted more constructs and tested more mediators. Nonetheless, the results for heavy drinkers further support that altering constructs may be more difficult in riskier samples.

5.6.4. Method of testing mediation

Support for mediation was obtained in 71% of trials that used a test of mediation that accounted for the asymmetric nature of the mediated effect ($k = 17$) and in 75% of trials using tests based on the standard normal distribution ($k = 16$). Consistent with MacKinnon et al. (2002), studies that employed a Baron and Kenny, causal steps approach ($k = 26$) were slightly less likely to obtain support for mediation (62%). For two trials, the authors were not able to provide the method used to test mediation. Notably, the causal steps approach was used in 43% of trials, appearing in studies published as recently as 2013. Potentially, journal editors and reviewers might suggest use of currently recommended methods, especially when a study reports a failed test of mediation.

6. Discussion

The preceding review suggests that, with the exception of descriptive norms, we have limited understanding of the processes through which alcohol interventions change college students' behavior. Additional tests of many of the putative mechanisms of change are needed. Intervention efficacy should be enhanced when the more efficacious active ingredients and scales for measurement highlighted above are employed. Perhaps the only mediator we can recommend against

examining further in its current form is motivation to change. More sensitive measures of motivation may yield more promising results.

By and large, when trials failed to find evidence of mediation, it was not due to the conceptual theory (the b paths). Rather, failed attempts reflected problems with the action theory (the a paths)—interventions simply do not alter the proposed mediators. The reasons for this are at least threefold. First, the active ingredients may be insufficient for altering the mediator. For example, listing protective strategies appears to be less likely to increase strategy use than personalized feedback. Second, operationalization of the mediator may not be ideal. For example, mediation was more likely to hold for refusal self-efficacy, rather than other forms of self-efficacy. Third, timing of assessment may be important.

The importance of timing was evident in a recent intervention for community-dwelling young adults. Colby et al. (2012) found that the post-test psychosocial variables that mediated intervention efficacy at 6 weeks differed from those that mediated effects at 3 months. These results suggest complicated, underexplored temporal relationships between intervention content, mediators, and reduced drinking. Optimal timing remains unclear, as some trials found null effects with post-test mediators, while others found significant effects with 3 month mediators. Nonetheless, greater consideration of post-test to 1 month change in mediators may be useful. This will require a shift in design, as 41% of trials first assessed mediators beyond 1 month.

6.1. Evidence for mechanisms of change

Below, we examine the extent to which the criteria for mechanisms of change have been satisfied across the literature. These include temporal relation, specificity, plausibility, gradient, and consistency (Kazdin, 2007; Nock, 2007). The additional criteria of experimental design and strong associations have been addressed above and will not be discussed further.

It is worth noting that while Kazdin (2007) and Nock (2007) require a significant total effect of the intervention on the outcome, MacKinnon (2008) suggests testing mediation in the absence of a total effect because studies often lack power to detect the effect. Indeed, due to reliance on causal steps approaches (i.e., Baron & Kenny, 1986), the literature is replete with missed opportunities for examining mediation in the absence of a total effect. Such tests may reveal a significant indirect effect in multi-component interventions. This would suggest the presence of active ingredients that are increasing rather than decreasing alcohol use, mitigating benefits gained from effective active ingredients (MacKinnon, Krull, & Lockwood, 2000). However, tests of mediation in the absence of a total effect are more likely to be diagnostic, indicating whether the “a” or “b” path failed. Although the majority of failed tests to date indicate lack of change in mechanisms, unpublished failed tests of mediation may reveal issues with both the action and conceptual theories and would reduce the extent of support for each mediator. Identifying counter-productive ingredients and advancing our understanding of moderating factors requires examining mediation in the absence of a total effect and for each active ingredient, in addition to reporting failed tests of mediation.

6.1.1. Temporal separation of mediators and outcomes

Temporal relation is perhaps the most important criteria to address moving forward, given that the majority of our knowledge of mechanisms in college drinking interventions comes from cross-sectional data. In some trials, outcomes were assessed later but only demonstrated significant intervention effects at earlier time points (e.g., Carey et al., 2010). Moreover, change in mechanisms may initially spur behavior change, but maintenance of change may be more so driven by recent past behavior (e.g., LaChance et al., 2009). Consideration is therefore needed regarding the time frame when intervention effects and mediator-outcome relationships should be evident. As noted previously, more frequent short-term assessments may be necessary (Nock, 2007).

6.1.2. Specificity

Specificity of mediational effects has received little attention. Such a test would demonstrate that an active ingredient uniquely affects the mediator and the mediator uniquely affects the outcome. For example, although descriptive norm feedback changes descriptive norms, protective behavioral strategies (Martens et al., 2013) and injunctive norms (Carey et al., 2010; Prince & Carey, 2010), only descriptive norms mediate effects. However, mediational chains may be quite long (MacKinnon, 2008). For example, the effect of injunctive norm feedback is mediated by injunctive norms, attitudes, and intentions (Reid & Aiken, 2013). Accordingly, as demonstrated by Martens et al., single component studies would prove useful in ruling out confounding mechanisms. It would also be useful to theorize about and test sequential pathways through which a single active ingredient affects multiple constructs en route to behavior change. Both approaches are likely to enhance our understanding of specificity.

6.1.3. Plausibility

The literature has generally demonstrated support for the plausibility criterion. The mechanisms examined have been derived from theoretical and empirical research indicating that these psychosocial processes predict college student alcohol use. In addition, active ingredients reflect reasonable attempts at altering mechanisms. Dismantling studies will aid in identifying the most effective specifications of the active ingredients.

6.1.4. Gradient

The gradient criterion requires that inducing higher levels of the mediator is associated with larger change in the outcome. A single study has examined gradient. LaBrie et al. (2013) theorized that greater identification with a reference group might produce greater reductions in descriptive norms and therefore, greater reductions in drinking. Contrary to hypotheses but supporting gradient, enhanced identification decreased change in descriptive norms, which explained decreased change in drinking. Alternatively, transmitting more of a mechanism via boosters at short-term intervals may lead to greater change. While these are two possibilities, how to effectively transmit more or less of a mechanism remains an open question.

6.1.5. Consistency

Only by looking at a full body of literature can we gauge whether an effect is consistent across trials. Consistency holds only for descriptive norms and motivation to change. Among the remaining constructs, there are too few tests to gauge consistency. Additional tests of mediation are needed to shed light on whether the remaining constructs are viable mechanisms, and if not, whether this reflects an issue with the action or conceptual theory.

6.2. Recommendations for future research

With respect to individual constructs, optimizing the design of active ingredients will enhance support for mediation. Descriptive norm feedback should utilize campus- and gender-specific norms and should maximize attention to content. Likewise, personalized feedback may be beneficial for altering both protective strategies and injunctive norms. Enhancing the impact of active ingredients on heavier drinkers is also an important goal for future research. For other constructs, measurement is important. Non-expectancy challenge interventions should focus on social expectancies, and refusal self-efficacy should be assessed in a manner appropriate for college students (e.g., Young et al., 1991). Further, new measures of motivation to change may improve identification of mechanisms of motivational interviewing. In general, additional research will assist with identifying optimal strategies for targeting and assessing constructs.

Regarding the college drinking literature overall, that many multiple component studies test only one mediator indicates the importance of

mapping each active ingredient to its expected effect on a psychosocial process (Bartholomew et al., 2011). Consistent with recommendations in the broader health behavior change literature (Abraham & Michie, 2008), this process will lead to more comprehensive understanding of mechanisms. The majority of constructs have been examined in the context of multiple component interventions. Therefore, dismantling studies are also needed to verify that a specific ingredient alters a specific construct. Dismantling studies will also allow for better comparison of alternative specifications of active ingredients and may yield identification of techniques that are in fact detrimental.

The majority of our knowledge of mechanisms of change draws on cross-sectional data. As intervention efficacy begins to dissipate as early as 3 months (Carey et al., 2012), earlier, more frequent follow-up assessments are needed. Planned missing data designs, in which only a subset of participants are contacted for each follow-up, may be useful for limiting participant burden when increasing the number of assessments (Enders, 2010; Graham, Taylor, & Cumsille, 2001). Finally, modern techniques and recommendations for assessing mediation should be employed more widely. Current recommendations suggest use of bias-corrected bootstrapped confidence intervals (MacKinnon et al., 2004) and examining mediation in the absence of an intervention effect on behavior (MacKinnon, 2008). Comprehensive examinations of mediation for null intervention effects will be particularly informative in multiple component studies.

6.3. Limitations

Most trials were conducted in the United States, and results may differ in countries where culture and legality of alcohol use differ. We did not examine effect sizes for mediators due to the limited number of studies that have examined most mechanisms. In future research, effect sizes may clarify the most potent mechanisms. Similarly, interpreting the relative importance of each mechanism is made difficult by variations in active ingredients, mode of delivery, and operationalization. A larger literature may increase power for examining support for mediation under specific circumstances. Further, publication bias, wherein researchers do not publish non-significant findings, may have biased results. As failed tests of mediation are informative, supplementary files may be useful for reporting additional analyses.

7. Conclusions

Our review identified 61 independent trials that examined the extent to which at least one psychosocial construct explained effects of a college drinking intervention. Given that this is comparable to the number of trials identified in the most recent comprehensive reviews of college drinking interventions (Carey et al., 2007; Crouce & Larimer, 2011), an impressive number of trials have examined mediators of intervention efficacy. Nonetheless, there is room for improving our understanding of intervention efficacy. Taking a more systematic and comprehensive approach to assessing mediation is necessary for achieving the ultimate goal of increasing the effects of interventions on behavior change.

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Contributors

Allecia Reid and Kate Carey determined the inclusion criteria and structure of the review. Allecia Reid conducted literature searches, compiled study data, and wrote the first draft of the manuscript. Both authors contributed to and have approved the final manuscript.

Conflict of interest

Both authors declare that they have no conflicts of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <http://dx.doi.org/10.1016/j.cpr.2015.06.006>.

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