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Does changing social influence engender changes in alcohol intake? A meta-analysis

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### Abstract

**Objective:** Past research has suggested that social influences on drinking can be manipulated with subsequent reductions in alcohol intake. However, the experimental evidence for this and the best strategies to positively change these social influences have not been meta-analyzed. This research addressed these gaps.

**Method:** Randomized controlled trials testing social influence-based interventions on adults' drinking were systematically reviewed and meta-analyzed. The behavior change techniques used in each study were coded and the effect sizes showing the impact of each intervention on (a) social influence and (b) alcohol intake were calculated. Meta-regressions identified the association between these effect sizes, as well as the effect of specific behavior change techniques on social influences.

**Results:** Forty-one studies comprising 17445 participants were included. Changes in social influences were significantly associated with changes in alcohol intake. However, even moderate-to-large changes in social influences corresponded with only a small change in drinking behavior and changing social influences did not reduce alcohol-related problems. Providing normative information about others' behavior and experiences was the most effective technique to change social influences.

**Conclusions:** Social influences and normative beliefs can be changed in drinkers, particularly by providing normative information about how much others' drink. However, even generating large changes in these constructs are likely to engender only small changes in alcohol intake.

**Keywords:** review; meta-analysis; alcohol; social influence; norms

### Public Health Significance Statements

This study shows that beliefs concerning how much other people drink (or approve of drinking) can be changed in drinkers (including problem drinkers) but even moderate-to-large changes in these beliefs lead to only small reductions in alcohol intake. To maximize reductions in drinking, strategies designed to change these beliefs should be delivered alongside strategies targeting other factors that influence alcohol intake.

## Introduction

Several theories highlight the role of social influences on behavior (e.g., Reasoned Action Approach, Fishbein & Ajzen, 2010; Focus Theory of Normative Control, Cialdini, Kallgren, & Reno, 1991) including theories specific to drinking (e.g., theory of collectivity of drinking cultures, Skog, 1985). Social influences represent a range of constructs including injunctive norms (beliefs regarding whether drinking is typically approved or disapproved by others) and descriptive norms (perception of how much other people drink) as well as social support (the extent to which others help their efforts to reduce drinking or encourage actual drinking). Empirical evidence verifies the association between these types of social influences (descriptive and injunctive norms: e.g., Larimer, Turner, Mallett, & Geisner, 2004; social support: e.g., Havassy, Hall, & Wasserman, 1991) and drinking behaviors.

Correlational studies suggest social influence variables are related with drinking behavior but making causal inferences from such evidence is problematic. First, correlational designs incur self-presentational or consistency biases which inflate the strength of the association between cognitions and behavior (Budd, 1987). Second, cross-sectional designs cannot determine whether social influences cause drinking behavior, or vice-versa. Longitudinal designs may help, to an extent, but social influences and drinking could be associated because both are caused by a third variable. Experimental evidence helps to address whether social influence causes drinking behavior.

Interventions can change both social influence and drinking levels suggesting there is a causal relation between social influence and drinking behavior. For example, giving heavy drinking students a printout showing how their drinking perceptions compared against actual norms and how their own drinking compared against other students' drinking, resulted in students drinking fewer drinks at follow-up compared to those in a control group (Neighbors et al., 2006). This effect was mediated by changes in perceived norms. Such experiments testing the effect of changing social influence on changes in alcohol intake have not been meta-analyzed to examine the causal role of social influence on alcohol drinking.

Identifying whether changes in social influences engender changes in alcohol intake represents an important test of elements of theories that note the role of social influences on drinking.

Regarding descriptive norms, individuals such as college students tend to overestimate the amount of alcohol consumed by their peers (e.g., Perkins & Berkowitz, 1986). Interventions can be developed to revise these misperceptions in order to reduce drinking (see Lewis & Neighbors, 2006). Non-randomized controlled trials of interventions reducing overestimates of typical drinking are associated with reduced drinking (e.g., LaBrie, Hummer, Huchting, & Neighbors, 2009; Mattern & Neighbors, 2004) and randomized controlled trials show both descriptive norms and alcohol intake can be changed in this way (e.g., LaBrie, Hummer, Neighbors, & Pedersen, 2008). Similar interventions have reduced drinkers' overestimates of how much their peers approve of drinking (injunctive norms, Prince & Carey, 2010).

Previous reviews have demonstrated that behavioral interventions have a small but significant impact on drinking outcomes in college students (Scott-Sheldon et al., 2014) and that personalized drinking feedback can be effective in reducing drinking (Miller et al., 2013). Although the studies included in these reviews test a number of techniques that could change social influences, it is not clear whether they successfully changed social influences or what the impact of changing social influences may have been on subsequent alcohol intake.

Considering the experimental evidence can also identify the behavior change techniques (BCTs) that most effectively change social influence-related constructs. This is useful for a number of reasons. First, this evidence aids the development of personalized or tailored interventions potentially more successful for reducing alcohol intake. Second, identifying BCTs that change social influences informs the potential mechanisms underlying the impact of BCTs on behavior. BCTs that change social influences may also change behavior because of their impact on social influences. BCTs that do not change social influences, but do change behavior, must impact on other determinants.

Previous work attempted to identify the most effective techniques to change key determinants of behavior. For example, Michie et al. (2008) adopted a consensus approach to identify the BCTs most

likely to change various specific behavioral determinants, including social influences. In this study, four experts responded to the question, “Which techniques would you use as part of an intervention to change [determinant]?” by rating a list of BCTs where blank=no; 1=possibly; 2=probably and 3=definitely. Agreed use was identified when at least 3 of the 4 experts rated a BCT as 2 or 3. On this basis, ‘social processes of encouragement, pressure or support’ and ‘modelling/demonstration of the behavior by others’ were the only BCTs that the experts agreed should be used in interventions to change social influences. This work provides a very useful starting point in linking theory to techniques and in developing theory-based interventions but, having relied on personal judgements (albeit by experts), this approach was not (directly) evidence-based. Moreover, changing specific behaviors were not considered; the most effective methods to change social influences for alcohol intake may differ from those required to change social influences for other behaviors. In addition, this task was completed without definitions of each BCT. Thus the experts may have interpreted the BCTs differently during coding. Investigating the effectiveness of BCTs is now an easier task following the development of tools comprising standardized definitions of BCTs including one specifically for tackling alcohol intake (Michie, Whittington, Hamoudi, Zarnani, Tober, & West, 2012).

Systematic reviews testing which BCTs best change specific determinants of drinking such as social influence-related constructs should aid the development of more effective, theory- and evidence-based behavioral interventions (e.g., Michie & Johnston, 2012; Prestwich, Webb, & Conner, 2015). While some meta-analyses have identified which BCTs change other determinants of health-related behaviors such as self-efficacy (Ashford, Edmunds, & French, 2010; Olander, Fletcher, Williams, Atkinson, Turner & French, 2013; Prestwich et al., 2014; Williams & French, 2011) and motivation (Webb & Sheeran, 2006), we are not aware of any review that has done this in relation to social influences.

Objectives

This review assessed the experimental evidence to identify: 1. whether changes in social influences (normative beliefs and social support) engender changes in alcohol intake (primary objective); 2. whether interventions incorporating specific BCTs are more effective in changing social influences than interventions that do not incorporate the specific BCT (secondary objective).

### Method

#### Eligibility criteria

Studies were included that met all of the following criteria: 1. involved random assignment of participants to a treatment group versus control group (including no intervention); 2. tested the effect of an intervention to reduce alcohol intake; 3. included a measure of social influence taken after the participants were exposed to the intervention; and 4. the effect size of the intervention on alcohol-related social influences could be calculated. Studies were excluded if: 1. the study was an existing review or think piece; 2. the main focus of the intervention was a test of a drug therapy/treatment (as the focus was on behavioral strategies); 3. the reference was a conference abstract; 4. the intervention was targeted at school-aged children; 5. the focus was on drink-driving; or 6. the study was not reported in the English language (there were no specific geographical restrictions).

#### Search Strategy

MEDLINE (1996-) and EMBASE (1996-) were searched using OVID (see Appendix 1). The search strategy was based around three filters to identify (1) randomized controlled trials (e.g., Lefebvre et al., 2008) (2) targeting alcohol drinking (Kaner et al., 2009) that (3) incorporate a measure of social influence. Search terms relating to constructs from prominent theories that incorporate social influence were added to increase sensitivity. Where studies met the inclusion/exclusion criteria and referred to associated papers for further methodological, statistical, or intervention-related details, these associated papers were retrieved and taken into account in the coding. The review of personalized normative feedback on drinking by Lewis and Neighbors (2006) was also checked for any additional studies. The searches were last run on the 5<sup>th</sup> October, 2012.



All of the titles and abstracts were screened independently by two raters. Studies identified as eligible for possible inclusion by either reviewer were included in the full-text screening. The full-texts were also independently double-screened and discrepancies were resolved through consensus. The review was registered at Prospero (registration number removed for masked review).

#### Data Coding Method

A single reviewer coded all of the studies meeting the inclusion/exclusion criteria. The reviewer was experienced in conducting systematic reviews and had been formally trained in coding behavior change techniques during the development of an extensive list of behavior change techniques (Michie et al., 2013). To maximize reliability, all elements of data extraction were checked by another member of the team. Each checker took responsibility for different aspects of the data extraction form. The person responsible for checking the BCT coding had undertaken the same formal training in BCT coding as the lead author. All coders held psychology degrees. All coders, except one, were qualified up to PhD level and had extracted data for other systematic reviews. The coder without prior experience of conducting systematic reviews held a BSc in Psychology and was trained over the course of several weeks by the lead author. Inter-rater agreement levels were at least substantial and in most cases perfect or near-perfect (all kappas > .78; Landis & Koch, 1977). All discrepancies were resolved through discussion.

#### Measures

The behavior change techniques (BCTs), other aspects of the intervention (duration; number of sessions; setting; mode of delivery; targeted behaviors), participants (type of sample; country), design, measures, and risk of bias were coded (see Tables 1-2). BCTs were identified in the treatment and comparison groups using a reliable tool comprising descriptions of 42 alcohol-specific techniques (Michie et al., 2012). Extra BCTs not covered in Michie et al.'s (2012) list (e.g., alcohol testing) were also coded.

Risk of bias was considered by coding separately whether authors claimed the following had occurred and whether or not an adequate method was reported: (a) randomization (participants were

allocated to condition using a random method such as a coin toss), (b) allocation concealment (those enrolling participants could not foresee which condition participants would be allocated should they be accepted onto the trial), (c) blinding (the participants, data collectors, people delivering the intervention or statistician were unaware of the condition to which specific participants were allocated during the study); or (d) other important methodological or statistical features (e.g., measuring behavior using validated measures). (In)adequate methods were coded as (high)/low risk of bias. Risk of bias was coded as 'unclear' when insufficient information was reported.

### Data Synthesis

Comprehensive Meta-Analysis (Borenstein, Hedges, Higgins, & Rothstein, 2005) was used to calculate effect sizes reflecting the effect of the interventions on social influence and alcohol intake. STATA version 13.1 was used to conduct random-effects meta-analyses and random effects meta-regressions. Random effect models (where each study estimates different underlying effect sizes) were used rather than fixed effects models (where all studies are assumed to be estimates of the same one true effect size) because (1) we assumed that the true effect should vary from study to study because the studies differ in important ways (e.g., they comprise different BCTs; the interventions were delivered for different durations) and (2) our sample of studies, selected systematically, should reflect a random sample of the relevant distribution of effects.

Effect sizes were calculated based on reported means and standard deviations and, when not available, were based on other statistical information (e.g., F- or p-values). For the purpose of calculating effect sizes, studies that only reported effects as significant were assumed to be  $p = .05$  while studies that only reported effects as non-significant were assumed to be  $p = .50$  (see Michie et al., 2009). Where applicable, for cluster trials (where participants are allocated to condition in groups rather than individually), standard errors were adjusted (Higgins, Deeks, & Altman, 2008). Some studies tested more than one intervention. In such instances, to avoid including the same participants from the comparison group more than once within the meta-analysis, we selected only one intervention group for

each study. The intervention that generated the largest effect on social influence was chosen because the secondary aim of the research was to identify the most effective techniques to change social influences. For the same reason, follow-ups were not taken into account if they occurred before each BCT had been delivered at least once to participants in the intervention. Where there were multiple follow-ups, the effect sizes were averaged across time-points using a random effects model. For a summary index of alcohol intake, measures of alcohol behavior were preferred over measures of alcohol dependence. For behavior, measures of total alcohol intake were preferred over measures of binge drinking due to the former capturing all drinking rather than a type of drinking. Measures of binge drinking were preferred over measures of alcohol-related problems. The summary measure ('social influences') represents all of the types of social influences reported in the studies (i.e., various types of normative beliefs and social support). Additional analyses were conducted to examine the results when focused on specific types of drinking (total alcohol intake, binge drinking and alcohol-related problems) and social influences (normative beliefs (thus excluding the studies that only measured social support); descriptive norms (thus excluding the studies that only measured social support or other types of normative beliefs); social support).

To test the primary objective, meta-regressions assessed the relationship between changes in social influence-related constructs and changes in alcohol intake. In these analyses,  $\beta$  reflects the change in alcohol intake associated with one-unit increase in the social influence-related construct. A positive  $\beta$  in these analyses indicates more positive changes in social influences (e.g., reducing the perceived amount that others drink) engender a more positive drinking outcome (i.e., reduced drinking). A negative  $\beta$  indicates that positively changing social influences adversely affects drinking. To test the secondary objective, meta-regressions assessed the relationship between the presence or absence of specific BCTs and changes in social influence. In these analyses,  $\beta$  reflects the change in social influence associated with one-unit increase in the predictor variables. A positive  $\beta$  indicates that interventions containing the specific BCT yield larger positive changes in social influences effect sizes than interventions that do not

contain this BCT. A negative  $\beta$  indicates that interventions containing the related BCT yield smaller positive changes in social influence effect sizes than interventions that do not contain this BCT.

As well as testing the impact of BCTs on effect sizes, univariate meta-regressions examined the impact of other features of the intervention (duration; number of sessions; setting; mode of delivery; targeted behaviors), participants (type of sample; country), design, and risk of bias on effect sizes. Where significant, these features were included in multivariate meta-regressions to control for these methodological characteristics when (a) examining the relationships between the various types of social influence and the various types of alcohol behavior effect sizes; (b) examining the effect of specific BCTs on the social influence effect size outcome.

Two additional sets of analyses examined other potential sources of bias. Given the BCTs were typically delivered in combination with other BCTs, chi-square analyses tested whether critical BCTs (i.e., those that significantly and positively affected social influences to reduce drinking) were particularly likely to be delivered alongside other specific BCTs. If they were, this would point to a potential risk of BCT confounding. Egger's regression assessed whether the risk of publication bias (the extent that the review is biased through the omission of unpublished studies) was significant by considering the extent of funnel plot asymmetry (see Figure 3). Duval and Tweedie's (2000) trim and fill analysis was conducted to estimate the impact of publication bias on the social influence effect size. This statistical technique assesses the impact of publication bias by estimating and adjusting for the number, and likely effects, of missing studies.

## Results

The numbers of studies considered at each stage of the review are summarized in Figure 1. Forty-one studies met our inclusion/exclusion criteria. Of these 41 studies, 34 targeted norm-based measures (e.g., estimates of how much other people drink) and the remaining 7 studies targeted social support for reducing alcohol consumption. Of the 41 studies, 36 also reported the effect of the intervention on alcohol intake with sufficient data to calculate effect sizes (see Table 2).

### Study Characteristics

The study characteristics are summarized in Table 1. All studies were RCTs (9 cluster trials, 31 non-cluster trials, 1 unclear) and reported post-intervention measures of social influence within alcohol-related trials. The majority of samples were recruited from university-based populations ( $k = 31$ , 75.6%). About half of the studies clearly excluded non-drinkers ( $k = 18$ , 43.9%) and about a third were comprised exclusively of problem drinkers ( $k = 13$ , 31.7%). Most of the interventions were delivered in educational settings ( $k = 32$ , 78.0%). The majority of the studies were conducted in the US ( $k = 35$ , 85.4%). Ten studies (24.3%) tried to change other health-related behaviors (usually other drug use) in addition to drinking. The maximum total number of participants on which the analyses were based was  $N = 17445$  (for the analyses identifying the most effective techniques to change social influence-related variables). The average sample size of the included studies was  $N = 425$  ( $SD = 570$ ; median  $N = 216$ ).

On average, the behavior change content was delivered to intervention groups over more days (mean days = 115) than the comparison groups (mean days = 29) though the discrepancy in days was largely accounted for by the two 3-year studies by De Jong et al. (2006, 2009). Most of the interventions used printed materials ( $k = 36$ , 87.8%) and/or were delivered face-to-face ( $k = 22$ , 53.7%). A reasonably high proportion used the internet or computers ( $k = 17$ , 41.5%). Fewer of the interventions used the telephone ( $k = 3$ , 7.3%), mail ( $k = 6$ , 14.6%) or video ( $k = 3$ , 7.3%).

The most common BCTs delivered to the intervention group were: 'provide normative information about others' behavior and experiences' ( $k = 28$ , 68.3%), 'provide information on consequences of excessive alcohol use and drinking cessation' ( $k = 22$ , 53.7%), 'facilitate goal setting ( $k = 17$ , 41.5%)', and 'identify reasons for wanting and not wanting to reduce excessive alcohol consumption' ( $k = 16$ , 39.0%).

### Can social influences be changed?

Meta-analysis indicated that interventions impact social influences. The sample weighted average effect size was  $g = 0.29$  with a 95% confidence interval from 0.22 to 0.37, representing a small-to-

medium effect on social influences to drink less, based on 41 studies (see Figure 2). However, there was significant heterogeneity,  $I^2 = 83.3\%$ ;  $Q(40) = 240.03$ ,  $p < .001$ .

#### Clinically relevant moderators

Effects of the interventions on social influences depended on the setting and the sample.

Specifically, effects were larger in educational settings than non-educational settings (student versus non-student sample),  $B = .21$ ,  $S.E. = .10$ ,  $CI = .01 - .41$ ,  $p = .04$ , and when the sample comprised only drinkers,  $B = .24$ ,  $S.E. = .08$ ,  $CI = .08 - .40$ ,  $p = .004$ . In the sub-set of studies that comprised only drinkers, there was no difference between studies that comprised only problem drinkers vs. those that did not,  $B = -.10$ ,  $S.E. = .17$ ,  $CI = -.46 - .26$ ,  $p = .57$ . Effect sizes were not influenced by the mode of delivery (face-to-face; internet/PC; telephone; mail; print; video), whether the intervention comprised one session or multiple sessions, or whether norm-based or social support measures assessed social influences.

#### Risk of bias moderators

The majority of studies were at unclear or high risk of bias from inadequate allocation concealment ( $k = 35$ , 85.4%). All studies took inadequate steps to reduce contamination. None of the studies reported adequate blinding of the participants, intervention deliverer, or statistician while only one study (2.4%) took adequate steps to blind the data collector. Most studies were also at unclear or high risk of bias from using measures of social influence that were not internally reliable ( $k = 30$ , 73.2%) and not using intention-to-treat analyses ( $k = 28$ , 68.3%). About half of the studies were at unclear or high risk of bias from differences between dropouts and study completers ( $k = 24$ , 58.5%) and/or dropout rates across study conditions ( $k = 22$ , 53.7%), using non-validated measures of social influences ( $k = 22$ , 53.7%) and inadequate randomization ( $k = 22$ , 53.7%). Most studies reported obtaining informed consent ( $k = 26$ , 63.4%) and ethical approval ( $k = 27$ , 65.9%), and were not at risk of bias from potential differences between experimental groups at baseline ( $k = 35$ , 85.4%). Attrition rates were moderate (mean= 25.5%; median=19.5%). A summary of the risk of bias for each study is available from the lead

author upon request. The risk of bias factors did not moderate the effects of the interventions on social influences with three exceptions. Stronger changes in social influences were achieved when studies were at high risk of bias from inadequate randomization,  $B = -.19$ ,  $S.E. = .08$ ,  $CI = -.36 - .03$ ,  $p = .02$ , did not report any form of allocation concealment,  $B = -.23$ ,  $S.E. = .10$ ,  $CI = -.44 - .02$ ,  $p = .03$ , or had inadequate allocation concealment,  $B = -.23$ ,  $S.E. = .11$ ,  $CI = -.45 - .01$ ,  $p = .04$ . The effect of the interventions on social influences were not influenced by type of trial (cluster trial or not) or by differences in delivery duration between the intervention vs. control groups.

#### Objective 1: Relationship between changes in social influence and changes in alcohol intake

Based on all 36 studies which provided sufficient data to calculate effect sizes for both social influence and alcohol intake, changes in social influence and changes in alcohol intake were unrelated,  $B = .14$ ,  $S.E. = .15$ ,  $CI = -.15 - .44$ ,  $p = .33$ . However, one study (Litt et al., 2007, 2009) was a multivariate outlier as indexed in a plot of social influence effect sizes against alcohol intake effect sizes. Once this study was removed, a significant relationship emerged for the remaining 35 studies showing that positive changes in social influences (to reduce drinking) were associated with positive changes in alcohol intake (reduced alcohol intake),  $B = .20$ ,  $S.E. = .08$ ,  $CI = .04 - .35$ ,  $p = .02$ .

Based on all 36 studies, a change of  $g = .29$  in social influence corresponded with a change of  $g = .18$  in alcohol intake. Repeating these analyses only on the studies that detected a significant effect of the intervention on at least 50% of the social influence follow-up measures ( $k = 17$ ), a change of  $g = .51$  in social influence corresponded with a change of  $g = .26$  in drinking behavior. Selecting only the studies that produced at least a moderate sized effect change in the social influence measures ( $d = .5$  to 1 decimal place,  $k = 11$ ), a change of  $g = .66$  in social influence corresponded with a change of  $g = .22$  in drinking behavior. Thus, small and moderate sized changes in social influence-related constructs correspond with a change in alcohol intake that is roughly half in size. When changes in social influence are greater (moderate-to-large), there was little additional change in alcohol intake.

#### Relationship between changes in normative beliefs and changes in alcohol intake

Based on the 30 studies which provided sufficient data to calculate effect sizes for both changes in any type of normative belief and changes in alcohol intake, there was a significant relationship between changes in norms and changes in alcohol intake,  $B = .20$ ,  $S.E. = .07$ ,  $CI = .05 - .35$ ,  $p = .01$ , with a change of  $g = .33$  in norms corresponding with a change of  $g = .16$  in alcohol intake. Based on 26 studies, changes in descriptive norms also engendered changes in alcohol intake,  $B = .23$ ,  $S.E. = .07$ ,  $p = .002$ , with a change in descriptive norms of  $g = .36$  corresponding with a change of  $g = .15$  in alcohol intake.

When based only on the studies that detected a significant effect of the intervention on at least 50% of the norm follow-up measures ( $k = 16$ ), a change of  $g = .54$  in normative beliefs (or  $g = .55$  in descriptive norms) corresponded with a change of  $g = .19$  in drinking behavior. Selecting only the studies that produced at least a moderate sized effect change in the norm measures ( $k = 12$ , all of which assessed descriptive norms only), a change of  $g = .67$  in norms corresponded with a change of  $g = .21$  in drinking behavior. Thus, small sized changes in norm-related constructs correspond with a change in alcohol intake that is roughly half that magnitude in size. Moderate sized change in norm-related constructs corresponded with a change in alcohol intake that is roughly two and a half to three times smaller. When changes in norms are greater (moderate-to-large), changes in norm-related constructs correspond with a change in alcohol intake that is roughly a third of this magnitude.

#### Relationship between changes in social support and changes in alcohol intake

Based on the 6 studies which provided sufficient data to calculate effect sizes for both changes in social support and changes in alcohol intake, there was no relationship between changes in social support and changes in alcohol intake,  $B = -.35$ ,  $S.E. = 1.75$ ,  $CI = -5.22 - 4.52$ ,  $p = .85$ .

#### Clinically relevant sensitivity analyses

Separating out the various types of drinking behavior (total drinking; binge drinking; alcohol-related problems) and social influences (social influences, norms, descriptive norms), the relationship between drinking behavior effect sizes and the various social influence effect sizes were further considered. The results are summarized in Table 3. The associations between the social influence effect



sizes and alcohol-related effect sizes were broadly similar (i.e., significant) for binge drinking, total drinking and the summary measure (following exclusion of the multivariate outlier study by Litt et al. or the studies measuring abstinence). However, there was no association between changes in social influence and changes in alcohol-related problems.

Sensitivity analyses tested whether the association between social influence effect sizes and drinking outcome effect sizes changed as a result of co-varying each of the clinically-relevant potential confounds (educational setting and drinking status; see Table 3). Co-varying the setting (educational vs. non-educational) did not alter the findings (see sensitivity analysis 1). Co-varying drinking status (all drinkers: yes/no) changed only 4 out of 16 sensitivity analyses. In all of these instances, the effects just drifted to non-significance ( $.05 < p < .10$ ; see sensitivity analysis 2).

#### Risk of bias sensitivity analyses

Co-varying the risk of bias moderators (inadequate randomization; not reporting the allocation sequence was concealed; inadequate allocation sequence concealment) did not alter the findings (i.e. all significant relationships remained significant and all non-significant relationships remained non-significant; see sensitivity analyses 3-5 in Table 3).

#### Objective 2: Effective techniques to change social influence

The effects of the most commonly used BCTs (i.e., those presented uniquely to either the intervention or control conditions in at least 5 studies) on social influences are summarized in Table 4. Data relating to all of the BCTs are available from the first author upon request (though none of the BCTs not reported in Table 4 were significantly associated with changes in social influences). Provide *normative information about others' behavior and experiences* was the most used BCT for social influence and there was a significant association between this BCT and outcome ( $B = .21, p = .02$ ). Studies using this BCT exclusively in the treatment group (see Table 1 for BCTs) yielded variable effects on this outcome (see Table 2) with several studies reporting large effects (e.g., LaBrie et al., 2008,  $g = .70$ ; Lewis et al., 2008,  $g = .71$ ; Neighbors et al., 2006,  $g = .72$ ) with others reporting only small effects

(e.g., Larimer et al., 2007,  $g = .04$ ; Martens et al., 2010,  $g = .07$ ; Moreira et al., 2012,  $g = .03$ ). There were no other significant, positive associations between the remaining BCTs and social influence though goal-setting was negatively associated with social influence.

#### Clinically relevant sensitivity analyses

The effect of '*Provide normative information about others' behavior and experiences*' on social influences became non-significant when controlling for either of the clinically-relevant confounds (intervention delivered in educational settings,  $p = .24$ ; sample comprised only drinkers,  $p = .12$ ).

#### Risk of bias sensitivity analyses

The effect of '*Provide normative information about others' behavior and experiences*' on social influences became marginally significant when controlling for each of the risk of bias confounds (inadequate randomization,  $p = .06$ ; not claiming the allocation sequence was concealed,  $p = .09$ ; inadequate allocation sequence concealment,  $p = .09$ ). In a final sensitivity analysis (controlling for the use of '*Provide normative information about others' behavior and experiences*' in the comparison group), the effect of '*Provide normative information about others' behavior and experiences*' on social influence remained significant (see Table 4).

#### Additional risk of bias analyses

As '*provide normative information about others' behavior and experiences*' was the technique identified to be particularly effective in changing social influence variables, additional analyses were conducted to identify whether this technique was confounded with other BCTs. While there were some BCTs which were less likely to be used in studies that applied '*provide normative information about others' behavior and experiences*' to their intervention group (e.g., '*prompt use of imagery*',  $\chi^2(1)=9.55$ ,  $p = .007$ ), there were no techniques that were significantly more likely to be used alongside '*provide normative information about others' behavior and experiences*'.

Regarding publication bias, Egger's regression coefficient was significant for social influence ( $p = .002$ ) but not alcohol behavior ( $p = .82$ ). Duval and Tweedie's (2000) trim and fill analysis imputed

51 additional effect sizes for the effect of the interventions on social influence, resulting in an overall effect size of  $g = .16$  (CI = 0.08 – 0.25). Thus, while there was some evidence for publication bias (see Figure 3), this was restricted to the social influence measure. Moreover, even after the trim and fill analysis was conducted, the effect of the interventions on social influence remained significant (though the effect size was reduced from small-to-moderate to small).

### Discussion

Based on the findings of this review, interventions that produce changes in social influences engender reductions in alcohol intake, but even moderate-to-large changes in social influences correspond with only small reductions in alcohol intake. When the analyses were repeated with only the norm-based measures and the descriptive norm measures, the results remained unaffected. Specifically, both improvements in norm-based and descriptive norm effect sizes led to reduced alcohol intake but even with moderate-to-large changes in norms, there were only small reductions in alcohol intake. Changes in social support were not associated with changes in alcohol intake though this was based on only six studies. ‘Providing normative information about others’ behavior and experiences’ was the most effective technique to positively change social influences. ‘Goal-setting’, which was negatively associated with related effect sizes, was the least effective.

While changes in social influences (most clearly descriptive norms) engendered reductions in total alcohol intake and binge drinking, it was not associated with reductions in alcohol-related problems. While this could be partly attributable to fewer studies examining alcohol-related problems, the strength of the effect on alcohol-related problems was still weak. It cannot be inferred from the review why changing social influences do not reduce alcohol-related problems. One possibility is that the measures of alcohol-related problems are less sensitive to detect changes. Alternatively, changing social influences may be insufficient to tackle alcohol-related problems. Reducing alcohol-related problems does appear a challenging task. For instance, Scott-Sheldon et al.’s (2014) review of techniques to reduce alcohol

misuse in college students showed no effect of interventions on alcohol-related problems though the review detected changes on other measures of drinking.

The majority of studies in this review were delivered indirectly rather than face-to-face and used printed materials rather than other approaches such as videos. Consequently, the approaches adopted are probably best described as being generally low-cost with good potential reach. Indeed, the mean average sample size (intervention and comparison groups combined) was reasonably large (over 400 participants though the median sample size was about half of that). So, despite the average change in social influence variables being small-to-moderate, and even moderate-to-large changes in social influence variables corresponding with only small changes in alcohol intake, the potential use of these techniques should not be dismissed. Most interventions were brief, delivered in a single session and nearly half (46%) were not delivered face-to-face. Thus, many of the interventions reported in this review have good levels of scalability. Moreover, some studies reported quite substantial changes in social influence variables though these all were in relation to changes in descriptive norms (Collins et al., 2002; Hagman et al., 2007; LaBrie et al., 2008; Lewis et al. 2007b, 2008; Neighbors et al., 2006). The effects did not vary across duration of delivery or the number of sessions (single session vs. multi-session) suggesting similar effects can be achieved through brief and long interventions as well as single and multi-session interventions. Mode of delivery did not moderate the effects either. However, these results should be treated with caution given few studies used certain modes of delivery (in particular, telephone, mail, or video) uniquely in the experimental or control groups which restricted the power of these analyses.

This review revealed that making individuals more aware that their drinking exceeds that of others changes descriptive norms. Consistent with a norm-based theory of behavior (Cialdini et al., 1991), combining this technique with another BCT to ensure that these descriptive norms are activated in critical situations (i.e., when an individual could begin drinking) could produce stronger, more robust reductions in alcohol intake. For example, implementation intentions (Gollwitzer et al., 1993), strategies that involves individuals planning how they will act in a critical situation, could be modified to link the

critical situation to descriptive norms ('If I feel like a drink then I will say to myself that my peers drink less than me'; see Prestwich, Sheeran, Webb, & Gollwitzer, 2015). Alternatively, these techniques could be combined with other BCTs that target other determinants of behavior. Theories such as the Health Action Process Approach (Schwarzer, 1992) or the Reasoned Action Approach (Fishbein & Ajzen, 2010) which incorporate norm-based constructs alongside other constructs could provide a useful guide for identifying additional, complementary BCTs to maximise behavior change.

After taking a consensus approach, 'social processes of encouragement, pressure or support' and 'modelling/demonstration of the behavior by others' were the only BCTs that were recommended by Michie et al. (2008) to change social influences. Neither of these approaches was supported in this review though the techniques used in the Michie et al. (2008) study do not map clearly onto Michie et al.'s (2012) list of alcohol-related BCTs. In addition, few of the studies included in our review tested modelling or techniques linked with providing support and most studies targeted descriptive norms. Providing support and modelling may be more effective for other types of social influence.

The impact of some BCTs (e.g., provide information on withdrawal symptoms) could not be examined as they were not utilized uniquely in any of the intervention or comparison groups. In addition, some other BCTs were rarely used (e.g., 'prompt commitment from the client there and then') and as such any interpretations associated with such techniques should be treated with caution. Related to this, any conclusions regarding the relationship between changes in social support and changes in alcohol intake should be treated in the same way. Further research is needed to examine these relationships.

As with other reviews, the statistics reported represent estimates of the true effects. For instance, the relationship between changes in social influences and changes in drinking may be underestimated because the interventions may have also changed other determinants of drinking that further impacted on drinking behavior. Alternatively, by not considering unpublished studies, the estimated effects in this review may be overestimates, on the basis that published articles may be more likely to report significant effects than non-published articles. However, given unpublished studies had not been peer reviewed and

could contain insufficient information, we anticipated that attempting to include unpublished studies could result in inaccurate coding of BCTs and other content. There is also the possibility that there may be differences between the unpublished data/studies that authors were willing to share and those studies for which authors were not willing to share. In addition, there was only some limited evidence for publication bias in this review on the basis of the related analyses.

Analyses were conducted to statistically control for methodological features that could confound the impact of providing normative information about others' behavior and experiences on social influence outcomes. The effect of this BCT on the social influence changed little (i.e., the effects drifted to between  $.10 > p > .05$  from  $p = .02$ ) when potential risk of bias confounds (i.e., inadequate randomization; not claiming the allocation sequence was concealed; inadequate allocation sequence concealment) were statistically controlled. However, the effects of this BCT on social influence were affected slightly more after controlling for whether or not the intervention was delivered in educational settings or whether or not the sample only comprised drinkers (i.e., both effects  $p > .10$ ). All of the studies that 'provided normative information about others' behavior and experiences' to participants in experimental conditions were delivered in educational settings. Consequently, it is unclear whether this technique is effective for older, chronic drinkers. This represents a gap in the literature for those attempting to design public health or counselling interventions. Experimental tests of this technique on both social influences and drinking outcomes in clinical and other settings are needed.

The 41 studies included in the review were identified via search terms in two databases. Re-running searches in additional databases, or including additional search terms, could have identified further papers. However, the search strategy was built on search filters utilized in other related reviews that were modified, where appropriate, to increase the sensitivity of the search. In addition, the papers identified through the databases were independently double-screened to reduce the likelihood that papers were excluded in error.

Coding of BCTs and risk of bias were based on the lead author's interpretations of the contents of the publication and, where available, associated publications and materials. Consequently, the codes are at risk of error. To minimize this risk, however, all elements of the data extraction were checked by another member of the review team. In addition, methodological biases which could confound the impact of specific BCTs on social influences were statistically controlled. This approach, as well as accounting for features (e.g., BCTs, mode of treatment) in the comparison group, helps to overcome limitations in related reviews of the effects of BCTs that did not account for these characteristics of the comparison groups (e.g., Dombrowski et al., 2012; Michie et al., 2009).

As with other reviews, this contribution failed to address all sources of heterogeneity. However, the heterogeneity caused by variation in the measures of social influence and drinking were accounted for, in part, through sensitivity analyses. These analyses considered various types of social influences (norms and descriptive norms) and drinking (total alcohol intake, binge drinking and alcohol-related problems). Moreover, it did consider other factors such as the broad categories of populations (university students/staff; clinical samples; community samples) as well as categories more specific to drinking (whether the sample comprised any non-drinkers; only comprised problem drinkers). These variables were largely unrelated to social influence effect sizes. An interesting exception was that the largest changes in social influences were identified in educational settings. Changing social influences on drinking may be more difficult outside of educational settings.

The present review is unique in various ways. First, no other review, to the best of our knowledge, has presented a meta-analytic test of the experimental evidence regarding the impact of changing social influences on drinking behavior. Changing social influences to reduce drinking can engender reductions in alcohol intake but not alcohol-related problems. Moreover, even moderate-to-large changes in social influences are associated with only small reductions in drinking. Second, it tested the impact of BCTs on social influences on drinking rather than on drinking behavior directly. Providing normative information about others' behavior and experiences was the most effective BCT to change

norms. However, given even moderate-to-large changes in norms lead to only small reductions in drinking, the best techniques to change social influences should be paired with the best techniques to change other determinants to produce large changes in drinking behavior. Other rigorous reviews to elucidate the most efficacious BCTs to change other key determinants of drinking are needed.



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Table 1 (part a): Characteristics of Included Studies

Study	Design	Setting	Participants	Country	BCTs (Experimental)	BCTs (Control)
Barnett (2007)	RCT	Educational	Problem drinking students	USA	1,2,3,4,9,14,35,37,39	1,4,27
Bennett (2004)	CRCT	Other	Employees	USA	7,12,15,21,24,26,36	-
Borsari (2000)	RCT	Educational	College binge drinkers	USA	1,2,4,14,15,43	-
Burke (2008)	RCT	Medical	Drug-treated hypertensives	Australia	1,14,24,26,27,29	29
Cimini (2009)	RCT	Educational	Problem drinking students	USA	1,2,4,9,36,37	1,4
Collins (2002)	RCT	Educational	College binge drinkers	USA	4	1
DeJong (2006)	CRCT	Educational	University students	USA	4	-
DeJong (2009)	CRCT	Educational	University students	USA	4	-
Glasner-Edwards (2007)	-	Medical	Substance using veterans	USA	1,2,7,8,10,13,14,15,16, 17,20,21,24,25,26,27,30, 31,34,35,36,37,38,39,40, 41,45	1,2,3,7,8,10,11,12,13,14,15, 16,17,19,20,21,22,24,25,26, 27,34,35,36,37,38,39,40,41, 42,59,60
Graham (1996)	CRCT	Medical	Drug/alcohol addicts	Canada	11,14,15,19,20,23,24,26	11,14,15,19,20,23,24
Graham (2004)	CRCT	Educational	University students	USA	1,4,15,36	-
Guydish (1998)	RCT	Medical	Clients with drug-related issues	USA	10,26,34	10,26,34
Hagger (2011)	RCT	Other	Corporate employees	UK	1,2,11,14,29	1,14,29
Hagger (2012a)	CRCT	Educational	Undergraduate students	UK	1,2,11,14,29	1,29
Hagger (2012b)	RCT	Educational	Undergraduate students	Multiple	1,14,15,29	29
Hagman (2007)	RCT	Educational	Psychology students	USA	1,4	-
Henslee (2006)	RCT	Educational	Student binge drinkers	USA	1,4,30	1,30
LaBrie (2008)	CRCT	Educational	University students	USA	4	-
LaChance (2009)	RCT	Educational	Problem drinking students	USA	1,2,27,29,40	1,27,29,40
Larimer (2007)	RCT	Educational	University students	USA	1,2,4,14,54	-
Lewis (2007a)	RCT	Educational	High-risk drinking students	USA	4	-
Lewis (2007b)	RCT	Educational	Binge drinking students	USA	4	-
Lewis (2008)	RCT	Educational	Students turning 21	USA	4,54	-
Litt (2007, 2009)	RCT	Community	Alcohol dependent adults	USA	19,22,26,42,45,53	12,18,21,30,53
Martens (2010)	RCT	Educational	University athletes	USA	1,4,5	-
Mensingher (2007)	RCT	Medical	Alcohol and/or cocaine addicts	USA	14,15,20,26,27,29,35	1,24,26,29
Moore (2012)	RCT	Educational	University students	USA	1,2,8,14	-

Table 1 (part a, Cont.): Characteristics of Included Studies

Study	Design	Setting	Participants	Country	BCTs (Experimental)	BCTs (Control)
Moreira (2012)	RCT	Educational	University students	UK	1,2,4,14	-
Murphy (2010, Study 1)	RCT	Educational	Binge drinking students	USA	1,2,4,9,14,28,54	1,4,27
Murphy (2010, Study 2)	RCT	Educational	Binge drinking students	USA	1,2,4,9,14,28,54	1,2,4
Neighbors (2004)	RCT	Educational	Heavy drinking students	USA	4	-
Neighbors (2006)	RCT	Educational	Heavy drinking students	USA	4	-
Neighbors (2009)	RCT	Educational	Students turning 21	USA	1,2,4,14,17,20,26,54	-
Neighbors (2010)	RCT	Educational	Heavy drinking students	USA	4	-
Prince (2010)	RCT	Educational	University students	USA	4	-
Reilly (2008)	CRCT	Educational	University students	USA	4,21	4
Sarrazin (2004)	RCT	Community	Substance abusers	USA	3,14,18,21,26,27,36	-
Turrisi (2009)	RCT	Educational	University students	USA	1,2,4,9,14,26,27,36	-
Werch (2000)	RCT	Educational	University students	USA	3,4,12	1
Wood (2007)	RCT	Educational	Heavy drinking students	USA	1,2,4,9,20	-
Wood (2010)/Fernandez (2011)	CRCT	Educational	University students	USA	1,2,4,9,17,19,20,21,35, 36,54	-

Note: BCTs= behavior change techniques; RCT= randomized controlled trial; CRCT=cluster randomized trial. Note (for BCTs): 1=provide information on consequences of excessive alcohol use and drinking cessation; 2=identify reasons for wanting and not wanting to reduce excessive alcohol use; 3=boost motivation and self-efficacy; 4=provide normative information about others' behavior and experiences; 5=provide feedback on performance; 6=provide information on withdrawal symptoms; 7=provide rewards contingent on effort or progress; 8=prompt commitment from the client there and then; 9=motivational interviewing; 10=provide rewards contingent on successfully reducing excessive alcohol use/abstaining; 11=prompt use of imagery; 12=model/demonstrate the behavior; 13=explain the importance of abrupt cessation; 14=facilitate goal-setting; 15=facilitate action planning/know how to help identify relapse triggers; 16=advise on avoidance of social cues for drinking; 17=behavior substitution; 18=prompt review of goals; 19=facilitate relapse prevention and coping; 20=prompt self recording; 21=facilitate barrier identification and problem solving; 22=advise on environmental restructuring; 23=set graded tasks; 24=advise on conserving mental resources; 25=change routine; 26=advise on/facilitate use of social support; 27=give options for additional and later support; 28=emphasise choice; 29=assess current readiness and ability to reduce excessive alcohol use; 30=offer/direct towards appropriate written materials; 31=assess current and past drinking behavior; 32=assess past history of attempts to reduce excessive alcohol use; 33=assess withdrawal symptoms; 34=explain expectations regarding treatment programme; 35=tailor interactions appropriately; 36=build general rapport; 37=use reflective listening; 38=provide reassurance; 39=summarise information/confirm client decisions; 40=elicit and answer questions; 41=elicit client views; 42=general communication skills training;

EXTRA BCTs: 43=harm reduction approach; 44=use of graphic images; 45=genogram; 46=expectancy challenge; 47=motivational enhancement therapy; 48=credible message; 49=self-affirmation; 50=FRAMES; 51=evaluative conditioning; 52=cue exposure therapy; 53=alcohol testing; 54=teach how to calculate BAC; 55=trained in refusal skills; 56=self-forgiveness therapy; 57=attentional bias training; 58=behavioral self-control training; 59=functional analyses; 60=behavioral couples therapy

Table 1 (Part B): Characteristics of Included Studies

Study	Delivery duration (days) (Experimental)	Delivery duration (days) (Control)	Mode of Delivery (Experimental)	Mode of Delivery (Control)	Behavior Targeted
Barnett (2007)	1	1	face-to-face; print	computer; print; video	Alcohol
Bennett (2004)	14	1	face-to-face; print; video	face-to-face; print	Alcohol/drugs
Borsari (2000)	1	0	face-to-face	-	Alcohol
Burke (2008)	487	426	face-to-face; telephone; print	face-to-face; print	various health
Cimini (2006)	1	1	face-to-face	face-to-face; print; video	Alcohol
Collins (2002)	1	1	mail; print	mail; print	Alcohol
DeJong (2006)	1095	0	computer; print	-	Alcohol
DeJong (2009)	1095	0	computer; print	-	Alcohol
Glasner-Edwards (2007)	168	168	face-to-face; print	face-to-face; telephone; print	Alcohol/Drugs/Depression
Graham (1996)	84	84	face-to-face; computer; print	face-to-face; computer; print	Alcohol/drugs
Graham (2004)	unclear	0	face-to-face; print	-	Alcohol
Guydish (1998)	183	183	face-to-face	face-to-face	Alcohol/drugs
Hagger (2011)	1	1	print	print	Alcohol
Hagger (2012a)	1	1	computer; print	computer; print	Alcohol
Hagger (2012b)	1	0	print	-	Alcohol
Hagman (2007)	1	1	face-to-face; print	face-to-face; video	Alcohol
Henslee (2006)	1	1	face-to-face; mail; print	face-to-face; mail; print; video	Alcohol
LaBrie (2008)	1	1	face-to-face; computer; print	computer; print	Alcohol
LaChance (2009)	unclear	1	face-to-face; print; video	face-to-face; print	Alcohol
Larimer (2007)	84	0	computer; mail; print	-	Alcohol
Lewis (2007a)	1	0	computer; print	-	Alcohol
Lewis (2007b)	1	0	computer; print	-	Alcohol
Lewis (2008)	1	0	mail; print	-	Alcohol
Litt (2007, 2009)	84	84	face-to-face; print	face-to-face; print	Alcohol
Martens (2010)	1	1	computer; print	computer; print	Alcohol
Mensingher (2007)	84	84	face-to-face; telephone; print	face-to-face	Alcohol/drugs
Moore (2012)	1	1	computer; print	computer; print	various health/well-being
Moreira (2012)	1	0	computer; print	-	Alcohol
Murphy (2010, Study 1)	1	1	face-to-face; print	computer; print	Alcohol

Table 1 (Part B, Cont.): Characteristics of Included Studies

Study	Delivery duration (days) (Experimental)	Delivery duration (days) (Control)	Mode of Delivery (Experimental)	Mode of Delivery (Control)	Behavior Targeted
Murphy (2010, Study 2)	1	1	face-to-face; print	computer; print	Alcohol
Neighbors (2004)	1	0	computer; print	-	Alcohol
Neighbors (2006)	1	0	computer; print	-	Alcohol
Neighbors (2009)	1	0	computer; print	-	Alcohol
Neighbors (2010)	548	1	computer; print	computer; print	Alcohol
Prince (2010)	1	0	computer; print	-	Alcohol
Reilly (2008)	1	1	face-to-face	face-to-face	Alcohol/drugs/sex
Sarrazin (2004)	365	unclear	face-to-face	-	Alcohol/drugs
Turrisi (2009)	unclear	0	face-to-face; mail; print	-	Alcohol
Werch (2000)	unclear	unclear	telephone; mail; print	face-to-face; print	Alcohol
Wood (2007)	1	0	face-to-face; print	-	Alcohol
Wood (2010)/Fernandez (2011)	183	0	face-to-face; computer; print	-	Alcohol

Table 2: Effect sizes for changes in social influence and changes in alcohol intake

Study	Type of measure Social Influence	Type of measure Alcohol intake	Expt. N	Control N	Effect size Social influence	Effect size Alcohol intake
Barnett (2007)	Descriptive Norms	average BAC from TLFB	111	111	.13	.27
Bennett (2004)	Social Norms	frequent drinking	109	120	.10	.25
Borsari (2000)	Descriptive Norms	DDQ (drinks per week)	29	30	.39	.44
Burke (2008)	Social support	7-day diary (g/day)	123	118	.11	.15
Cimini (2009)	Descriptive Norms	DDQ (drinks per week)	157	157	.08	.08
Collins (2002)	Descriptive Norms	drinks/heaviest wk + freq. heavy drinking + peak BAC (binge)	49	51	.76	.18
DeJong (2006)	Descriptive Norms	drinks/wk	1536	1365	.17	.08
DeJong (2009)	Descriptive Norms	drinks/wk	979	1063	.07	-.06
Glasner-Edwards (2007)	Social support	% days abstinent (drink & drugs)	70	78	.11	-.36
Graham (1996)	Social support	drinks/day	66	66	.08	.14
Graham (2004)	Descriptive Norms	none	512	511	.14	-
Guydish (1998)	Social support	dependence (ASI)	115	101	.39	.06
Hagger (2011)	Subjective Norms	units/wk	86	73	.01	.18
Hagger (2012a)	Subjective Norms	total units	60	81	.28	.59
Hagger (2012b)	Subjective Norms	units/wk	249	238	.06	.21
Hagman (2007)	Descriptive Norms	none	20	20	.84	-
Henslee (2006)	Descriptive Norms	total alcohol consumed	12	9	.52	.33
LaBrie (2008)	Descriptive Norms	drinks/week	404	463	.70	.43
LaChance (2009)	Descriptive Norms	drinks/drinking day (binge)	80	58	.14	.07
Larimer (2007)	Descriptive Norms	drinks/week	737	751	.04	.12
Lewis (2007a)	Descriptive Norms	drinks/week	70	84	.56	.45
Lewis (2007b)	Descriptive Norms	drinks/week	58	51	1.01	.85
Lewis (2008)	Descriptive Norms	drinks/21 <sup>st</sup> + eBAC/21 <sup>st</sup> (binge)	94	93	.71	.10
Litt (2007, 2009)	Social support	proportion of days abstinent	71	69	.12	.92
Martens (2010)	Descriptive Norms	drinks/week	80	76	.11	.11
Mensingher (2007)	Social support	% total abstinent + % days abstinent (alcohol+cocaine)	77	100	.09	.14
Moore (2012)	Descriptive Norms	none	102	98	.35	-

Table 2: Effect sizes for changes in social influence and changes in alcohol intake

Study	Type of measure Social influence	Type of measure Alcohol intake	Expt. N	Control N	Effect size Social influence	Effect size Alcohol intake
Moreira (2012)	Descriptive Norms	quant./session + freq. drinking/wk + weekly drinking (high/low)	395	402	.06	.08
Murphy (2010, Study 1)	Descriptive Norms	drinks/week	38	35	.67	.05
Murphy (2010, Study 2)	Descriptive Norms	drinks/week	46	45	.19	.21
Neighbors (2004)	Descriptive Norms	typical weekly drinking	126	126	.63	.26
Neighbors (2006)	Descriptive Norms	units/week	91	91	.72	.23
Neighbors (2009)	Descriptive Norms	BAC/21 <sup>st</sup> birthday + no. drinks/ 21 <sup>st</sup> birthday (binge)	144	138	.59	.18
Neighbors (2010)	Descriptive Norms	units/week	164	164	.19	.16
Prince (2010)	Various Norms	none	133	132	.25	-
Reilly (2008)	Descriptive Norms	drinks/week	243	259	.55	-.10
Sarrazin (2004)	Social support	none	85	85	.22	-
Turrisi (2009)	Various Norms	drinks/weekend + drinks/week	342	340	.13	.15
Werch (2000)	Various Norms	frequency + quantity	266	255	.05	-.02
Wood (2007)	Descriptive Norms	drinks/30 days	144	144	.60	.20
Wood (2010)/Fernandez (2011)	Descriptive Norms	heavy drinking (binge)	445	476	.13	.12

Table 3: Summary of meta-regression analyses

Predictor	Outcome	Studies	Main		Sensitivity Analysis 1		Sensitivity Analysis 2		Sensitivity Analysis 3		Sensitivity Analysis 4		Sensitivity Analysis 5	
			B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Soc. Inf.	Summary	Full (k = 36)	.14	.15	.19	.15	.00	.16	.24	.15	.14	.16	.13	.16
		Exc. Litt et al. (k = 35)	.20*	.08	.19*	.08	.17	.10	.25**	.08	.24*	.09	.21*	.09
		Exc. Abstinence % DV (k = 33)	.19*	.07	.19*	.07	.17	.09	.27**	.08	.23*	.08	.20*	.08
Soc. Inf.	Total Drinking	Full (k = 30)	.24	.19	.32	.19	.08	.19	.39	.19	.25	.21	.23	.20
		Exc. Litt et al. (k = 29)	.29**	.10	.29*	.11	.24	.12	.38**	.11	.35**	.11	.33*	.12
		Exc. Abstinence % DV (k = 27)	.28**	.09	.29**	.10	.24*	.11	.42***	.10	.35**	.11	.31**	.11
Soc. Inf.	Binge Drinking	Full (k = 27)	.31***	.08	.30**	.08	.43***	.07	.37***	.09	.31**	.09	.32**	.09
Soc. Inf.	Drink Problems	Full (k = 18)	.04	.12	.08	.11	.04	.15	.06	.14	-.03	.13	.01	.13
Norms	Summary	Full (k = 30)	.20*	.07	.21**	.07	.19	.10	.28**	.08	.25**	.09	.22*	.09
Norms	Total Drinking	Full (k = 25)	.28**	.10	.30**	.10	.25*	.11	.41**	.10	.35**	.11	.31*	.11
Norms	Binge drinking	Full (k = 26)	.31***	.08	.30**	.07	.43***	.07	.36***	.09	.30**	.09	.32**	.09
Norms	Drink Problems	Full (k = 17)	.06	.12	.09	.10	.14	.16	.07	.14	.01	.13	.04	.13
Desc. Norms	Summary	Full (k = 26)	.23**	.07	.23**	.07	.21*	.09	.29**	.08	.28**	.08	.24**	.08
Desc. Norms	Total Drinking	Full (k = 21)	.31**	.09	.31**	.09	.27*	.11	.41***	.09	.38**	.10	.34**	.11
Desc. Norms	Binge drinking	Full (k = 23)	.33***	.07	.33***	.07	.44***	.07	.36***	.08	.31**	.09	.33**	.09
Desc. Norms	Drink Problems	Full (k = 16)	.11	.10	.11	.10	.18	.14	.19	.12	.10	.12	.13	.12

Note: \*p < .05; \*\*p < .01; \*\*\* p < .001. Soc. Inf.= Social influence measure (any norms + descriptive norms only + social support); Desc. Norms = Descriptive norms. Sensitivity analysis 1: controls for setting (educational vs. non-educational); Sensitivity analysis 2: controls for sample (all drinkers: yes vs. no); Sensitivity analysis 3: controls for inadequate randomization; Sensitivity analysis 4: controls for allocation concealment reporting; Sensitivity analysis 5: controls for inadequate allocation concealment. Betas and Standard Errors are identical in the descriptive norm analyses for the main analyses and sensitivity analyses 1 because all descriptive norm studies took place in educational settings.

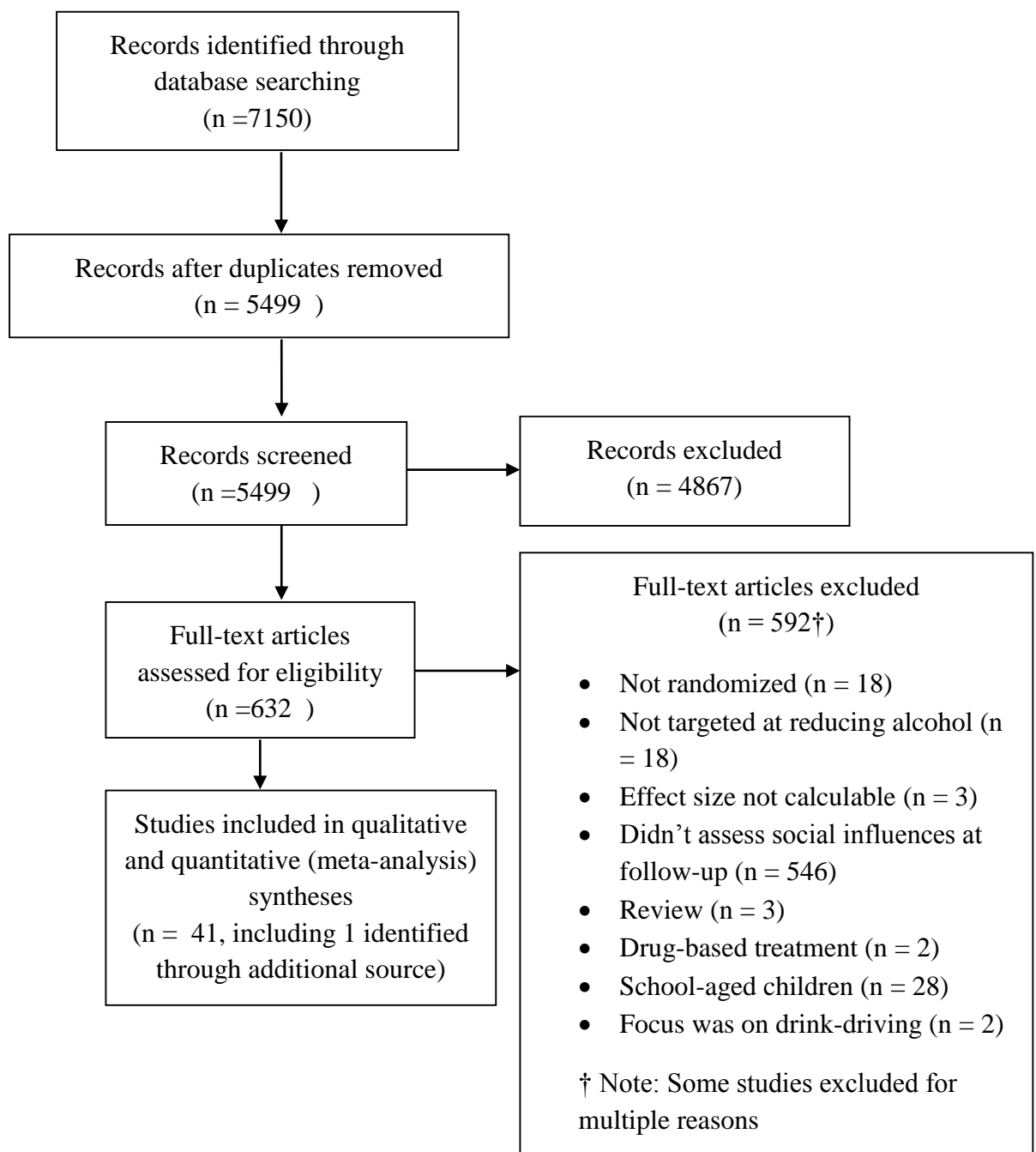


**Table 4: Meta-regressions. BCTs regressed on social influence effect sizes**

Predictor	Expt. group only	Both groups	Control Group only	Neither group	Social Influence (BCT use in experimental group only)			Social Influence (controlling for BCT use in control group)				
					$\beta$	95% CI		p- value	$\beta$	95% CI		p- value
						Lower limit	Upper limit			Lower limit	Upper limit	
1. Provide info. on consequences of excessive alcohol use and drinking cessation	13	9	3	16	-.15	-.32	.13	.07†	-.14	-.31	.03	.11
2. Identify reasons for wanting and not wanting to reduce excessive alcohol consumption	14	2	0	25	-.11	-.29	.06	.20	-.10	-.29	.08	.26
4. Provide normative information about others' behavior and experiences	23	5	0	13	.21	.03	.39	.02*	.22	.04	.41	.02*
9. Motivational Interviewing	7	0	0	34	-.06	-.29	.17	.61	-	-	-	-
14. Facilitate goal setting	14	3	0	24	-.19	-.35	-.02	.03*	-.16	-.34	.02	.07†
15. Facilitate action planning/know how to help identify relapse triggers	5	2	0	34	-.20	-.42	.02	.07†	-.19	-.44	.06	.13
20. Prompt self recording	4	2	0	35	-.03	-.28	.21	.79	.04	-.25	.32	.79
21. Facilitate barrier i.d. and problem solving	4	1	1	35	-.10	-.36	.16	.45	-.07	-.34	.19	.58
26. Advise/facilitate social support	7	3	0	31	-.15	-.34	.05	.14	-.15	-.37	.07	.18
27. Give options for additional and later support	4	2	2	33	-.20	-.43	.04	.098 †	-.20	-.45	.05	.12
29. Assess current readiness and ability to reduce excessive alcohol use	0	6	0	35	-.22	-.46	.01	.07†	-	-	-	-
36. Build general rapport	6	1	0	34	-.21	-.42	.003	.05†	-.21	-.43	.02	.07†
Teach how to calculate BAC	6	0	0	35	.06	-.19	.31	.61	-	-	-	-

Note: \*  $p < .05$ ; \*\*  $p < .01$ ; †  $p < .10$

Figure 1: Flow diagram



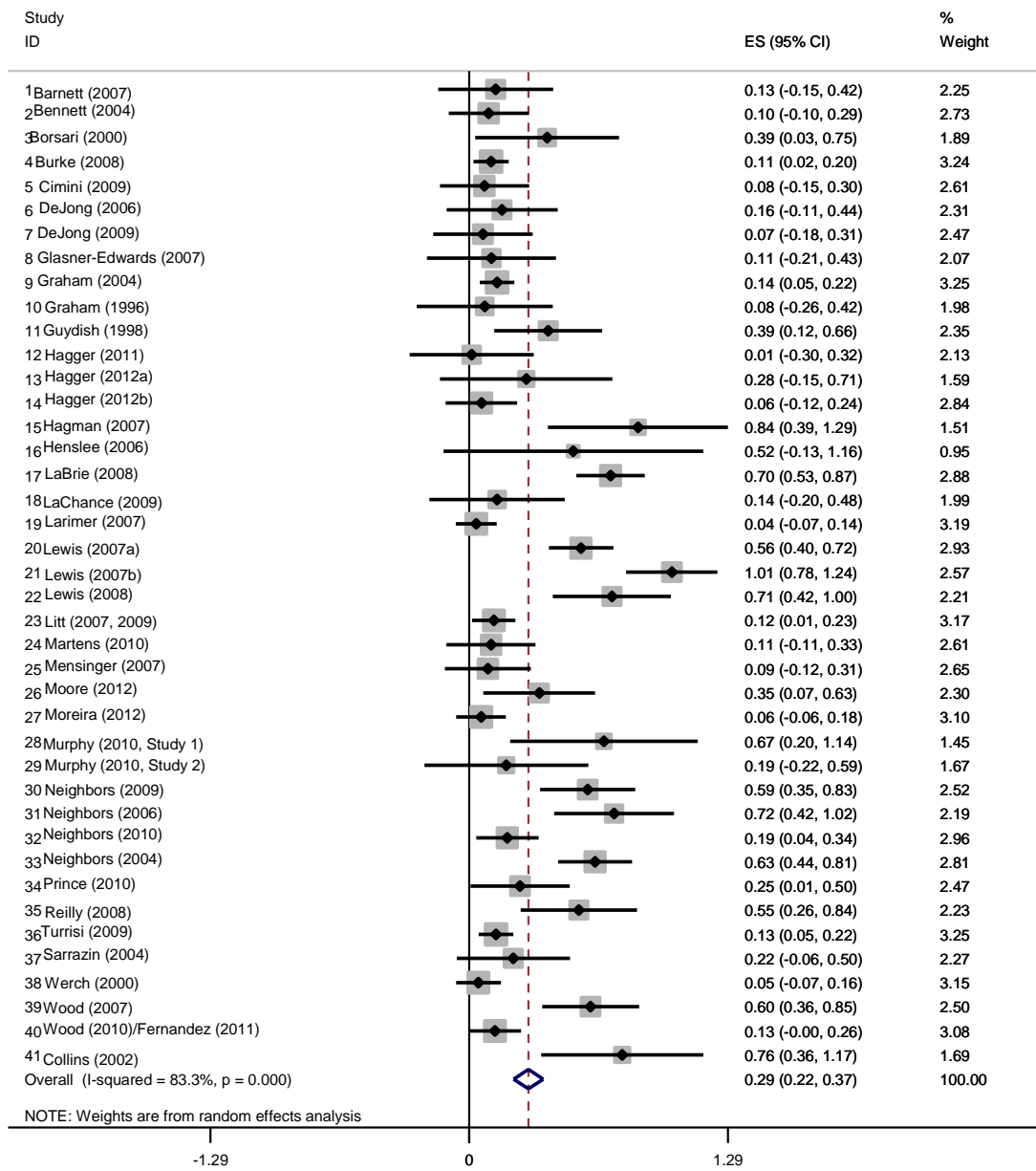


Figure 2: Forest plot of social influence effect sizes

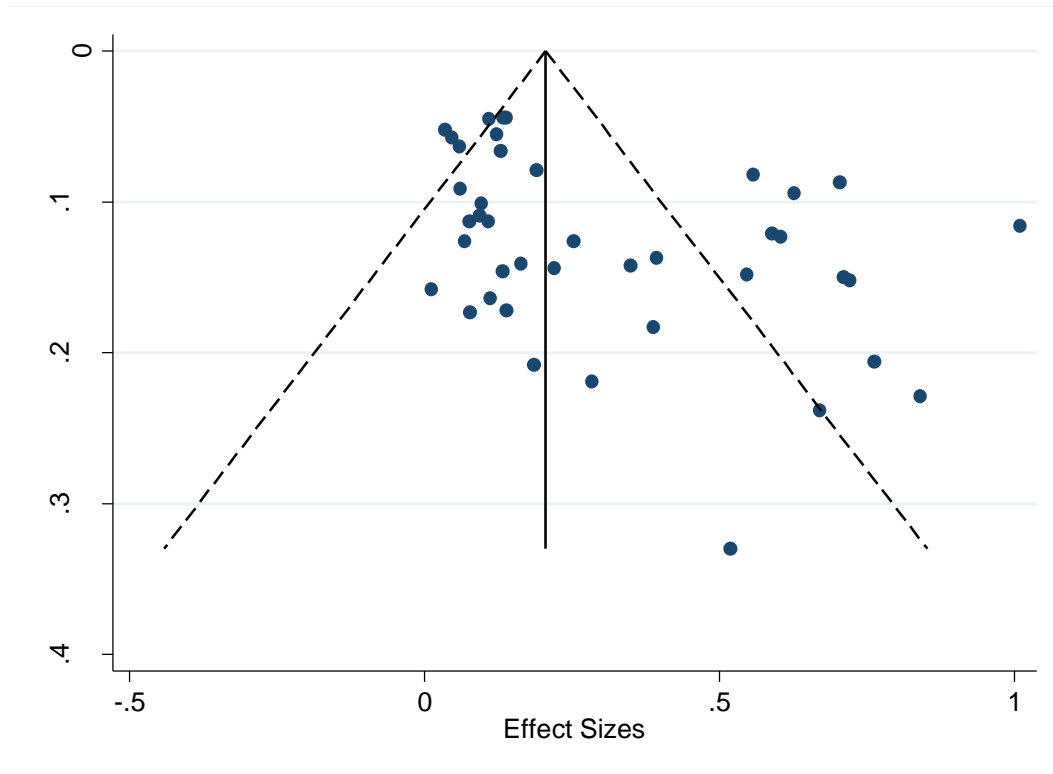


Figure 3: Funnel plot for social influence effect sizes

## Appendix 1: Search Strategy (MEDLINE)

1. randomized controlled trial.pt
2. controlled clinical trial.pt
3. randomized.ab
4. placebo.ab
5. clinical trials as topic.sh
6. randomly.ab
7. trial.ti
8. 1 or 2 or 3 or 4 or 5 or 6 or 7
9. exp animals/ not humans.sh
10. 8 not 9
11. Social support\$.mp. or Social Support/
12. Social Control, Informal/ or Social Values/ or social norm\$.mp
13. group norm\$.mp. or Group Processes/
14. Social Conformity/ or group conformity.mp
15. social pressure.mp
16. Patient Advocacy/ or champion\$.mp
17. Social Perception/ or social comparison\$.mp
18. Social Identification/ or Social Behavior/ or group identit\$.mp
19. social identit\$.mp
20. subjective norm\$.mp
21. organization\$ commit\$.mp
22. descriptive norm\$.mp
23. injunctive norm\$.mp
24. social motive\$.mp
25. theory of planned behavio?r.mp
26. theory of reasoned action.mp
27. precaution adoption process.mp
28. social cognitive theory.mp
29. motivat\$.mp.
30. goal\$.mp.
31. intention\$.mp.
32. commit\$.mp.
33. desire\$.mp.
34. theory of planned behavio?r.mp.
35. theory of reasoned action.mp.
36. health belief model.mp.
37. protection motivation theory.mp.
38. Self-efficacy
39. social cognitive theory
40. vicarious learning
41. mastery experience
42. verbal persuasion
43. persuasion
44. protection motivation theory
45. perceived behavio?ral control
46. PBC
47. theory of planned behavio?r
48. health belief model
49. transtheoretical model
50. stage\$ of change
51. outcome expectanc\$.mp
52. attitud\$.mp. or exp Attitude to Health/
53. belief\$.mp
54. or/11-52
55. exp alcohols/
56. alcohol\$.tw
57. 55 or 56
58. 10 and 54 and 57