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Computer-delivered interventions for reducing alcohol consumption: meta-analysis and meta-regression using behaviour change techniques and theory

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The current aim was to examine the effectiveness of behaviour change techniques (BCTs), theory and other characteristics in increasing the effectiveness of computer-delivered interventions (CDIs) to reduce alcohol consumption. Included were randomised studies with a primary aim of reducing alcohol consumption, which compared self-directed CDIs to assessment-only control groups. CDIs were coded for the use of 42 BCTs from an alcohol-specific taxonomy, the use of theory according to a theory coding scheme and general characteristics such as length of the CDI. Effectiveness of CDIs was assessed using random-effects meta-analysis and the association between the moderators and effect size was assessed using univariate and multivariate meta-regression. Ninety-three CDIs were included in at least one analysis and produced small, significant effects on five outcomes ($d_+ = 0.07–0.15$). Larger effects occurred with some personal contact, provision of normative information or feedback on performance, prompting commitment or goal review, the social norms approach and in samples with more women. Smaller effects occurred when information on the consequences of alcohol consumption was provided. These findings can be used to inform both intervention- and theory-development. Intervention developers should focus on, including specific, effective techniques, rather than many techniques or more-elaborate approaches.

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Excessive alcohol consumption can cause significant negative health consequences, such as cardiovascular disease, some cancers, liver cirrhosis and injuries, as well as financial costs associated with lost productivity, health-care and law-enforcement (Rehm et al., 2009). In recent decades, there appears to have been a dramatic increase in the interest in computer-delivered interventions (CDIs) for reducing alcohol consumption. CDIs are those interventions in which a participant interacts with technology (e.g., desktop/laptop computers, smart phones or tablets), rather than with a therapist, to receive the intervention content. Further, this content is relatively automated in that a therapist is not required to deliver or modify content for each individual participant. If effective, CDIs might offer an accessible, cost-effective and appealing means of reducing alcohol consumption (for a review, see Vernon, 2010).

Current knowledge

When evaluating interventions, at least three questions must be considered: *do they work*, *how well do they work* and *how do they work?* (Michie & Abraham, 2004). Regarding the first two questions,

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existing meta-analyses suggest that, amongst both college students (Carey, Scott-Sheldon, Elliott, Bolles, & Carey, 2009; Carey, Scott-Sheldon, Elliott, Garey, & Carey, 2012) and the wider population (Rooke, Thorsteinsson, Karpin, Copeland, & Allsop, 2010), CDIs have some small, positive effects on a range of drinking outcomes. A medium effect has also been found amongst adults with problem drinking (Riper et al., 2011); although, the authors note that the high motivation of this self-referred sample could explain this larger effect. However, the third question remains unanswered and it is imperative that the intervention components that are associated with the greatest behaviour change are identified.

Existing meta-analyses have identified some moderators that are associated with larger CDI effects on alcohol consumption. Regarding sample characteristics, CDIs appear to be more effective amongst samples which include more heavy drinkers (Carey et al., 2012) and fewer students (Carey et al., 2009). There are mixed results regarding gender; one study suggests that CDIs are more effective amongst samples with more men (Carey et al., 2012), whereas others suggest no gender differences (Carey et al., 2009; Rooke et al., 2010). Regarding CDI components, poorer outcomes have been associated with the provision of feedback on alcohol-related problems (Carey et al., 2009), identifying high-risk situations, and including decisional-balance or values-clarification exercises (Carey et al., 2012). Finally, there are also mixed results regarding length of the CDI; whilst Riper et al. (2011) found that single-session, personalised-normative-feedback CDIs were less effective than extended self-help CDIs, Carey et al. (2012) found that length of the CDI in general was not associated with effectiveness. As such, it is still unclear whether it is the CDI content or the length that drives effectiveness.

Questions remaining

Whilst existing meta-analyses have identified some characteristics that are associated with CDI effects on alcohol consumption, typically investigation of such moderators has been a secondary aim. As such, a more systematic approach to this question is essential and timely. Systematic approaches to classifying intervention components include consideration of behaviour change techniques (BCTs) and of the theoretical basis employed.

A BCT is a 'specific, irreducible component of an intervention designed to change behaviour and a putative active ingredient in an intervention' (Michie et al., 2012, p. 1432). A number of BCT taxonomies have been developed, including one specifically targeting excessive alcohol consumption (Michie et al., 2012). At the level of individual reports, these taxonomies support the detailed and reproducible description of intervention content. At the meta-analytic level, coding of interventions by BCTs allows the presence or absence of these techniques to be included in a meta-regression to identify the effective components of CDIs. This knowledge can then be used in the future development and refinement of interventions.

Theoretical basis refers to the extent that theory was used to inform interventions and can be reliably quantified using Michie and Prestwich's (2010) theory coding scheme. A large number of theories have been identified (Davis, Campbell, Hildon, Hobbs, & Michie, 2015) and these theories describe the mechanisms by which behaviours are thought to occur. As such, interventions that target the constructs identified by theories should be more effective in changing behaviour, and interventions that involve more-extensive use of effective theories should be more effective than those that involve less-extensive use. In practice, reviews have generated mixed results. Across health behaviours broadly, meta-regressions have demonstrated both positive associations (Webb, Joseph, Yardley, & Michie, 2010) and no association (Prestwich, Sniehotta, et al., 2014) between the degree of theoretical basis and intervention outcomes. It might be that where no association was found, this was due to the use of ineffective specific theories. Indeed, the most-commonly used theories in Prestwich, Sniehotta, et al.'s (2014) review, social cognitive theory and the trans-theoretical model, were not associated with improved outcomes. Further, these theories are less-commonly applied to the prediction of alcohol consumption than are other theories such as the theory of planned behaviour (Cooke, Dahdah, Norman, & French, 2014) and prototype willingness model (van Lettow, de Vries, Burdorf, & van Empelen, 2014; Todd, Kothe, Mullan, & Monds, 2016). Thus identifying those theories that are effective in reducing alcohol consumption is an essential step towards optimising interventions.

Current aim and original contribution

The aim of this review is to identify the general study characteristics, BCTs and theories that are associated with CDI effectiveness in reducing alcohol consumption. This review extends upon previous reviews in the following ways: First, it involves the systematic search for the individual components that impact behaviour change, by applying a full, alcohol-specific BCT taxonomy (Michie et al., 2012). Previous reviews were initiated before the publication of this taxonomy, and hence, were unable to take such an approach to answering this question. Second, it investigates the role of specific theories and the extent of theory use, using a theory coding scheme (Michie & Prestwich, 2010). No meta-analysis has utilised this method to examine the impact of theory on the effectiveness of CDIs for alcohol consumption.

Third, it utilises an improved statistical approach. When identifying moderators of CDI effectiveness, it is important to examine the relationship between multiple important moderators simultaneously. Such an approach allows for the identification of the moderators with the strongest effects (i.e., those that remain when controlling for other moderators) on alcohol consumption. Only one review of CDIs for alcohol consumption has used such a multivariate approach (Carey et al., 2012). Indeed, whilst Carey et al. (2012) identified a number of CDI components and sample characteristics associated with effectiveness, only the proportion of women remained significant when simultaneously testing all identified moderators. This difference highlights the importance of taking a multivariate approach.

Method

The preferred reporting items for systematic reviews and meta-analyses (Liberati et al., 2009) checklist for this review is provided in Supplemental Table 1.

Selection of studies

Computerised searches of PsycINFO (1806-present), Medline (1950-present), Global Health (1910–present) and Web of Science Core Collection (1900-present) were conducted in October 2015. Search terms for alcohol consumption (e.g., alcohol consumption, binge drink*)[1] were combined with technology (e.g., internet, computer*, phone application) and intervention (e.g., intervention*, treatment) terms. Results were limited to English-language papers and studies with humans. Full search terms are presented in Supplemental Table 2.

As seen in Figure 1, 3062 records were identified and 261 full-text records were assessed for eligibility. Studies were excluded if they did not involve random allocation to at least one CDI and control group. Relevant CDIs were those that: (1) primarily targeted reduction or prevention of alcohol consumption, (2) were delivered by computers, mobile phones, the internet or other similar digital media, (3) could be completed with minimal involvement from experimenters or therapists (i.e., the experimenter or therapist did not direct the participant through the intervention or deliver the intervention content), (4) were individual-patient level (i.e., were not mass-media campaigns or provider-directed CDIs) and (5) were non-pharmacological. Relevant control groups were those that involved either (1) alcohol-assessment-only or (2) alcohol-assessment plus intervention for unrelated health behaviour. Studies were also excluded if (1) alcohol consumption was not reported, (2) the CDI required specialised medical equipment or (3) participants had a mental illness or impairment. This search process resulted in 93 CDIs included in at least one analysis.

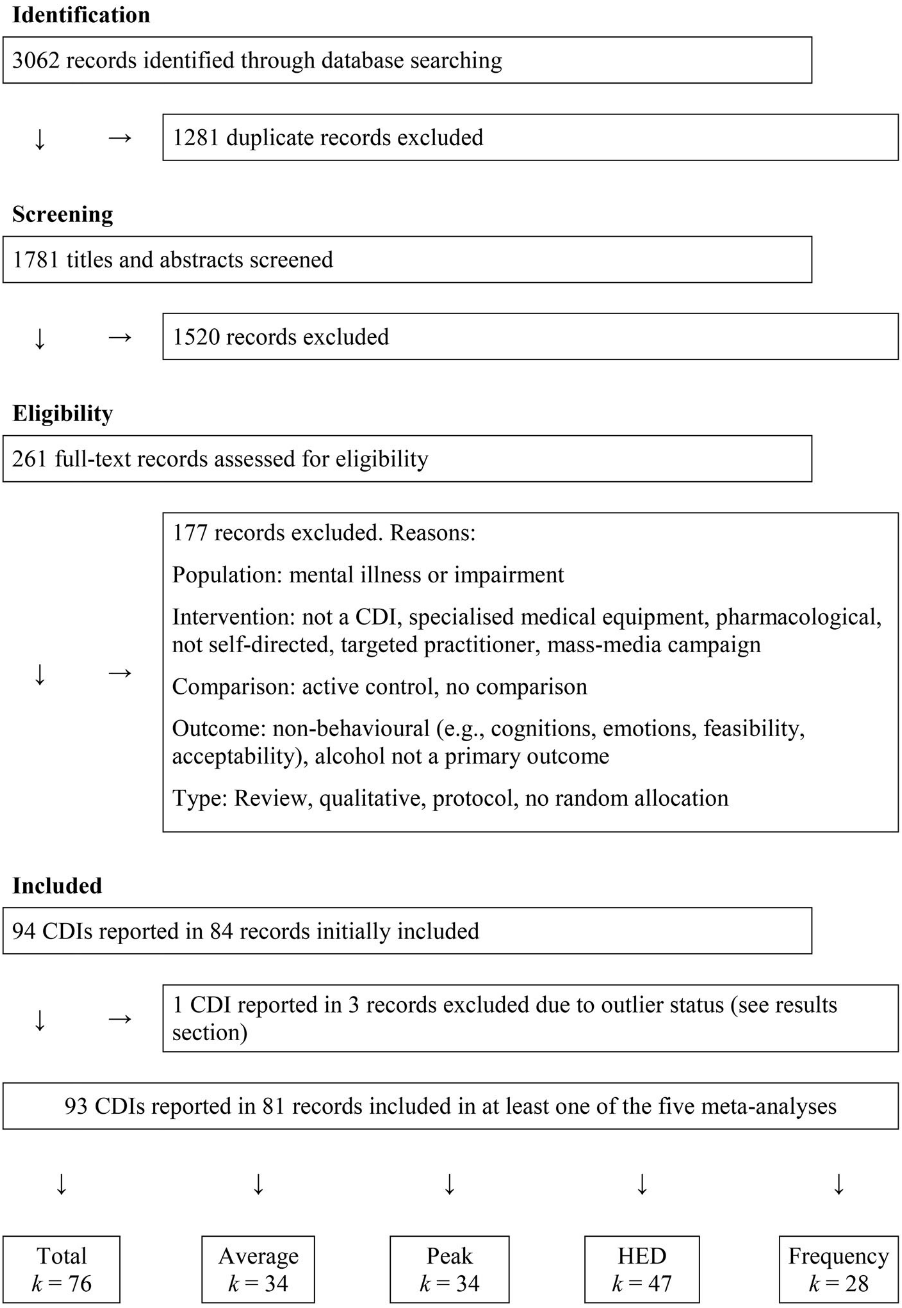

Figure 1. Identification and selection process for studies included in the meta-analyses and meta-regressions.

Coding of moderators

Studies were coded for the following sample and study characteristics: age (mean), gender (% women), university sample (1 = yes, 0 = no), mandated participants (1 = mandated, 0 = not mandated), heavy drinker status (% of sample reported as heavy drinkers, as defined by the original authors), location (by country). The following CDI characteristics were also coded: personal contact (1 = some, 0 = none), length (1 = >30 min, 0 = ≤30 min), number of sessions (1 = >1 sessions, 0 = 1 session) and length of follow-up (1 = >1 month, 0 = ≤1 month). Such groupings allow comparison between brief and extended CDIs and between immediate and long-lasting effects.

BCTs were coded using Michie et al.'s (2012) 42-item taxonomy of techniques to reduce excessive alcohol consumption. For half ($k = 47$) of the CDIs, the CDI itself, the CDI-mapping paper, the study protocol or other resources that provided detailed CDI descriptions were freely available online. In these instances, both these and the manuscript/s were accessed to code the use of BCTs. Both the intervention and control group procedures were coded along all 42 items (1 = present, 0 = absent). For each item, the control score was subtracted from the intervention score for use in the moderator analyses. As such, techniques that were present in both groups would not be considered to affect effect size.

If a theory or theories were used to develop the intervention, then this theory was recorded to test whether use of specific theories (each coded 1) was associated with larger CDI effects than use of no theory (coded 0). Secondly, the extent of theoretical basis was coded according to the presence of each of the first 11 items (1 = yes, 0 = no, for each item) of Michie and Prestwich's (2010) theory coding scheme (with slight modifications to items 8 and 11 as per Webb et al. (2010)). The first 11 refer to intervention development and participant selection, which are factors that could influence intervention effects. The 11 items were summed to compute an overall use-of-theory score. Where a theory was used, then this use-of-theory score was used to determine whether *more-extensive* use of that theory improved CDI outcomes.

All coding was conducted by the first author and 20 (21.5%) of the CDIs and corresponding control groups were independently second-coded for BCTs and theory. Gwet's (2001) AC1 statistic was used to indicate inter-rater reliability. AC1 is more reliable than Cohen's κ under high trait prevalence (Wongpakaran, Wongpakaran, Wedding, & Gwet, 2013), which was the case here. AC1 was initially high (BCTs: 0.92; theory: 0.77), indicating substantial to near-perfect agreement, and was improved following double-checking of discrepant items (BCTs: 1.00; theory: 0.94). Perfect agreement was easily achieved through discussion of remaining discrepancies. The coding of the other 73 CDIs was then checked and updated by the first author, for consistency with the decisions agreed upon by both coders.

Calculation of effect sizes

Dependent variables were grouped into five categories to examine differential CDI effects on different drinking behaviours: (1) *total consumption*: total quantity per extended period of time (e.g., per week), (2) *average consumption*: average quantity per drinking occasion or drinking day, (3) *peak consumption*: the maximum quantity of alcohol consumed on one occasion, (4) *heavy episodic drinking (HED) frequency:* frequency of heavy episodic drinking (or 'binge' drinking) and (5) *frequency*: frequency of any alcohol consumption. Where a study reported multiple outcomes within a category, these were averaged into a single effect size for that category.

The primary effect-size estimate was the standardised mean difference (Cohen's d) with Hedges' g adjustment. Positive effect sizes indicate better outcomes for the CDI group than for the control group. Where possible, effect sizes were computed whilst controlling for baseline differences. Where multiple time points were reported, the longest follow-up was used. Where studies included multiple, different, relevant CDIs, all CDIs were included separately and the sample size of the control group was reduced, to control for multiple comparisons. If the CDIs within a study differed only on characteristics not of interest (e.g., gender-specific vs. gender-neutral feedback), these were combined into a single CDI. Where data were presented separately for different groups within a paper (e.g., women and men), these were combined into a single group. Where there were insufficient data to calculate effect sizes, study authors were contacted and the data requested.[2] Effect sizes were interpreted using Cohen's (1992) guidelines of $d = 0.2$, 0.5 and 0.8 indicating small, medium and large effects, respectively.

Outlier detection

Two methods were used for identifying outlier effect sizes. First, z-scores of the effect sizes were calculated to identify extreme values at the $\alpha = .001$ level (i.e., $|z| > 3.30$). Second, the sample-adjusted meta-analytic deviancy statistic (SAMD) was calculated for each study. The magnitude of the SAMD indicates the degree of deviance of the study effect size, relative to that expected by chance (whilst considering sample size and average effect size; Huffcutt & Arthur, 1995). The absolute values of the SAMDs were inspected via scree plot and those values rising above the flat portion were flagged. Only studies identified by both methods were considered outliers, to minimise the chance of erroneous exclusion of studies.

Inspection of z-scores was conducted to identify outliers on the continuous moderators. Where outliers were detected, the univariate meta-regressions were conducted both with and without the outlier value. Results were compared to ensure that outliers were not producing spuriously large effects. Analyses conducted without the outlier value/s were considered to be the main analyses, to reduce the possibility of Type I errors induced by one or two outliers.

Meta-analytic strategy

Analyses were conducted using Comprehensive Meta-Analysis, version 3 (Borenstein, Hedges, Higgins, & Rothstein, 2014). Meta-analyses and meta-regressions were conducted separately for each of the five dependent variables. Random-effects models were chosen to incorporate the assumption that studies were likely to differ in complex ways uncaptured by the examined moderators (Cooper & Hedges, 1994). The possibility of publication bias was assessed using Begg and Mazumdar's (1994) rank correlation test and, when significant, Duval and Tweedie's (2000) trim-and-fill was used to adjust the effect sizes. To assess the presence and degree of heterogeneity, the Q and I^2 statistics were used. I^2 indicates the proportion of between-study variance attributable to heterogeneity, where 25%, 50% and 75% are considered low, moderate and high values, respectively (Higgins, Thompson, Deeks, & Altman, 2003).

For each dependent variable, univariate meta-regressions were conducted to examine the effect of individual moderators on CDI effectiveness. Moderators were tested only when they contained a sufficient range of values (for categorical moderators this meant they were present and absent in at least four studies). Within each univariate meta-regression, the strength of association between the moderator and effect size was assessed as the coefficient, β, and the proportion of heterogeneity accounted for by the moderator was assessed using the adjusted R^2.

Within each dependent variable, multivariate meta-regressions were conducted using all moderators that demonstrated meaningful ($|\beta| > 0.10$) and/or statistically significant ($p < .05$) associations with effect sizes in the univariate analyses. This approach allowed the identification of those moderators most strongly associated with CDI effectiveness, whilst controlling for other important moderators. Upon running these analyses, those moderators that no longer demonstrated meaningful or significant associations were removed to create the final models. Where there were missing values for a moderator, the analyses were conducted both with and without this moderator, to examine any differences that occurred as a result of the reduced power. Where multi-collinearity between moderators was present, analyses were conducted separately by correlated moderators to eliminate this problem. Subgroup meta-analyses were conducted within moderators that were significant in the multivariate analyses.

Results

Outlier detection

One study was identified as an outlier on both tests. This study (Schinke, Schwinn, Noia, & Cole, 2004) reported large effects on both HED ($d = 2.31$, $z = 5.60$, SAMD = 18.49) and drinking frequency ($d =$

2.49, $z = 4.60$, SAMD = 19.76) and was inspected for features that might have contributed to the effects (as per Huffcutt & Arthur, 1995). This study was unique in terms of its long follow-up (7 years cf. 2 years for the next longest), young participants ($M = 11$ years at baseline cf. the next youngest $M = 14$ years) and relatively infrequent baseline alcohol consumption ($M = 0.5$ occasions in past 30 days). For these reasons, the study was deemed sufficiently divergent from the other studies and was removed so that the sample of included studies would be more representative of the true population of interest.

Four studies had outlier values on the moderator age. Specifically, one study reported significantly higher age of participants for each of the datasets of total consumption (Hansen et al., 2012), peak consumption (Hester & Delaney, 1997), HED frequency (Montag et al., 2015) and drinking frequency (Hester & Delaney, 1997). Results for the corresponding univariate meta-regressions are presented both with and without these outliers.

Description of studies, samples and CDIs

Studies were published between August 1997 and July 2015. Most of the 93 CDIs were conducted in the USA ($k = 55$), were brief (≤30 min; $k = 66$), contained a single session ($k = 67$), involved no personal contact ($k = 69$) and were conducted with university students ($k = 70$) and those who were not mandated to complete the CDI ($k = 88$). Median age of samples was 20 years and median proportion of women was 55%.

All CDI and control groups received BCT31 (assess drinking), due to the required nature of the study designs included. Excluding BCT31, the CDIs utilised a median of six BCTs (range: 1–22). Used by more than 75% of CDIs, the most-commonly used techniques were BCT5 (provide feedback on performance; $k = 79$), BCT4 (provide normative information; $k = 75$) and BCT1 (provide information on consequences; $k = 75$). Seven techniques were never used (BCTs 6, 13, 25, 32, 36, 37 and 38).

CDIs scored a median of 5 (range: 0–8) of a possible 11 on the theory-use variable. The most common theories used were the social norms approach ($k = 31$; see Perkins (2002) for a review), the theory of planned behaviour ($k = 13$; Ajzen, 1991) and social cognitive theory ($k = 9$; Bandura, 1986). Full study characteristics are reported in Supplemental Tables 3–5.

Effect of CDIs on alcohol consumption

As seen in Table 1, CDIs had small effects on alcohol consumption, averaging across time points. The smallest effect was on HED frequency ($d_+ = 0.07$) and the largest effect was on total consumption ($d_+ = 0.15$). Publication bias was indicated for three of the dependent variables: total (Kendall's $\tau = .31$, $p < .001$), average (Kendall's $\tau = .32$, $p = .007$) and peak consumption (Kendall's $\tau = .37$, $p = .002$). Subsequent trim-and-fill resulted in lower effect sizes and the effect on peak consumption was no longer significant. Significant, moderate-high heterogeneity ($I^2 = 41$–69%) was present in four of the five analyses. Effect sizes for individual CDIs are seen in Supplemental Table 6 and funnel plots in Supplemental Figure 1.

CDIs produced small-to-medium ($d_+ = 0.16$–0.31), significant effects on all outcomes except drinking frequency, in the short term. In the medium-to-long term, CDIs produced small ($d_+ = 0.07$–0.12), significant effects on all outcomes. As reported in Table 2, effects on total consumption, average consumption and HED frequency were significantly larger at short term than at medium-to-long term.

Moderators of CDI effectiveness step one: univariate analyses

Table 2 presents the univariate meta-regression results using general study characteristics, BCTs and theory to predict the five outcomes. For age, results presented in the body of Table 2 are those after excluding outliers; whereas corresponding analyses including outliers are presented in the notes of Table 2.

Table 1. CDI effects on five alcohol consumption measures overall and by time point.

Outcome	K	Effect d_+ (95% CI)	Heterogeneity I^2 (%)	Heterogeneity Q	Trimmed d_+ (95% CI)
All time points					
Total	76	0.15 (0.11, 0.18)***	61	193.84***	0.08 (0.03, 0.12)***
Average	34	0.09 (0.05, 0.13)***	24	43.17	0.06 (0.01, 0.10)**
Peak	34	0.13 (0.07, 0.20)***	53	69.55***	0.07 (−0.00, 0.14)
HED frequency	47	0.07 (0.04, 0.10)***	41	78.31**	
Frequency	28	0.12 (0.05, 0.18)***	69	87.58***	
Short term (≤1 month)					
Total	21	0.31 (0.18, 0.43)***	66	58.05***	
Average	14	0.18 (0.09, 0.27)***	0	8.32	
Peak	13	0.19 (0.07, 0.31)**	17	14.45	
HED frequency	19	0.16 (0.04, 0.28)**	52	37.70**	
Frequency	5	0.06 (−0.22, 0.35)	59	9.87*	
Medium-to-long term (>1 month)					
Total	55	0.12 (0.08, 0.16)***	58	127.19***	
Average	20	0.07 (0.03, 0.12)***	36	29.82	
Peak	21	0.11 (0.03, 0.19)**	63	53.58***	
HED frequency	28	0.07 (0.03, 0.10)***	8	29.23	
Frequency	23	0.12 (0.05, 0.19)***	71	77.09***	

Notes: Total = total quantity of alcohol consumed per extended period of time (e.g., per week); average = average quantity of alcohol consumed per drinking occasion; peak = highest quantity of alcohol consumed on one occasion; HED frequency = frequency of heavy episodic drinking; frequency = frequency of alcohol consumption; k = number of evaluations; d_+ = pooled effect size; I^2 = percentage of between-study variance that is due to heterogeneity; Q = heterogeneity statistic.
*$p < .05$.
**$p < .01$.
***$p < .001$, two-tailed.

CDIs produced significantly greater reductions in peak consumption amongst younger samples than amongst older samples. Significantly larger reductions in HED frequency and drinking frequency also occurred in samples with higher proportions of women. CDIs conducted in the USA resulted in significantly greater reductions in average consumption, peak consumption and HED frequency, and CDIs conducted in Sweden resulted in significantly smaller reductions in drinking frequency, than did CDIs conducted elsewhere. CDIs that involved some personal contact resulted in significantly reduced total consumption, average consumption and peak consumption compared to those without personal contact.

One BCT was significantly associated with negative outcomes; providing information on the consequences of alcohol consumption (BCT1) resulted in smaller reductions in total consumption and drinking frequency. Four BCTs were significantly associated with positive outcomes. Providing normative information (BCT4) was associated with greater reductions in peak consumption and drinking frequency. Prompting commitment (BCT8) and review of goals (BCT18) were associated with greater reductions in total consumption. Providing options for additional support (BCT27) was associated with greater reductions in HED frequency.

CDIs based on social cognitive theory resulted in significantly larger reductions in drinking frequency and those based on motivational interviewing theory or the social norms approach resulted in significantly larger reductions in average consumption, than those based on *no* theory. Further, of those CDIs that used the social norms approach, *more-extensive* use was associated with significantly greater reductions in total consumption.

Moderators of CDI effectiveness step two: multivariate analyses

Table 3 presents the effect sizes within each subgroup of the individual moderators that remained significant in the multivariate analyses. For the regression coefficients and statistics associated with these analyses, see Supplemental Table 7. For the full factorial effect sizes by moderators that remained significant in the multivariate analyses, see Supplemental Table 8.

Table 2. Univariate meta-regressions predicting five alcohol consumption measures by study characteristics, BCTs and theory.

	Total			Average			Peak			HED frequency			Frequency		
	k	β (95% CI)	R^2 (%)	*k*	β (95% CI)	R^2 (%)	*k*	β (95% CI)	R^2 (%)	*k*	β (95% CI)	R^2 (%)	*k*	β (95% CI)	R^2 (%)
Sample															
Age[a]	74	0.00 (0.00, 0.01)	0	34	−0.01 (−0.03, 0.01)	0	33	−0.02 (−0.04, 0.00)*	27	46	−0.01 (−0.02, 0.01)	0	27	−0.02 (−0.05, 0.01)	0
Women	76	0.00 (0.00, 0.00)	0	34	0.00 (0.00, 0.00)	0	34	0.00 (−0.01, 0.00)	0	47	0.00 (0.00, 0.01)*	18	28	0.01 (0.00, 0.01)*	20
University	76	−0.03 (−0.13, 0.06)	0				34	−0.08 (−0.29, 0.12)	0	47	−0.01 (−0.12, 0.09)	0			
Mandated	76	−0.07 (−0.22, 0.08)	0							47	0.08 (−0.02, 0.19)	3			
Heavy drinkers	66	0.00 (0.00, 0.00)	1	26	0.00 (0.00, 0.00)	0				34	0.00 (0.00, 0.00)	0			
Location															
USA	76	0.07 (−0.01, 0.15)	7	34	0.09 (0.02, 0.17)**	59	**34**	**0.16 (0.02, 0.29)***	**8**	47	0.09 (0.01, 0.17)*	14	28	0.08 (−0.04, 0.21)	13
England	76	−0.10 (−0.21, 0.01)	6	34	−0.05 (−0.16, 0.05)	0				47	−0.03 (−0.20, 0.13)	0			
Sweden	**76**	**−0.11 (−0.22, 0.01)**	**0**	34	−0.05 (−0.13, 0.04)	0	**34**	**−0.14 (−0.29, 0.02)**	**2**	**47**	**−0.10 (−0.22, 0.01)**	**5**	**28**	**−0.17 (−0.31, −0.03)***	**13**
Netherlands	76	0.07 (−0.08, 0.21)	0												
Canada	76	0.00 (−0.19, 0.19)	0												
Intervention															
Contact	**76**	**0.18 (0.08, 0.28)*****	**19**	**34**	**0.15 (0.03, 0.27)***	**58**	**34**	**0.30 (0.15, 0.45)*****	**46**	47	0.05 (−0.06, 0.16)	0			
Length	76	0.02 (−0.07, 0.11)	0	34	0.01 (−0.08, 0.09)	0	34	−0.01 (−0.15, 0.12)	0	47	0.05 (−0.03, 0.13)	1	28	−0.07 (−0.22, 0.08)	0
Sessions	76	−0.01 (−0.10, 0.08)	0	34	−0.02 (−0.09, 0.06)	0	**34**	**−0.11 (−0.26, 0.04)**	**13**	47	−0.05 (−0.14, 0.03)	0	28	0.00 (−0.14, 0.14)	0
Follow-up	**76**	**−0.14 (−0.25, −0.04)****	**3**	**34**	**−0.11 (−0.21, −0.01)***	**39**	34	−0.09 (−0.24, 0.06)	0	**47**	**−0.11 (−0.20, −0.02)***	**30**	28	0.08 (−0.15, 0.30)	0
BCTs															
BCT1	**76**	**−0.18 (−0.28, −0.09)*****	**22**				**34**	**−0.16 (−0.37, 0.06)**	**0**	47	0.07 (−0.05, 0.20)	0	**28**	**−0.18 (−0.31, −0.05)****	**35**
BCT2	76	0.02 (−0.07, 0.12)	0	34	0.05 (−0.03, 0.12)	0	34	0.02 (−0.14, 0.19)	0	47	0.04 (−0.05, 0.13)	0	**28**	**−0.13 (−0.29, 0.03)**	**0**
BCT3	76	0.07 (−0.02, 0.16)	0	34	0.06 (−0.03, 0.15)	0	**34**	**0.14 (−0.04, 0.31)**	**7**	47	−0.05 (−0.13, 0.04)	0	**28**	**0.10 (−0.05, 0.25)**	**16**
BCT4	76	0.05 (−0.05, 0.16)	0	34	0.08 (−0.05, 0.21)	4	**34**	**0.22 (0.06, 0.38)****	**38**	**47**	**0.10 (−0.01, 0.22)**	**8**	**28**	**0.22 (0.04, 0.39)***	**22**
BCT5	76	−0.07 (−0.22, 0.07)	0	34	−0.08 (−0.26, 0.10)	0	34	−0.01 (−0.25, 0.23)	0	**47**	**0.10 (−0.04, 0.24)**	**3**	28	0.05 (−0.14, 0.23)	0
BCT8	**76**	**0.31 (0.12, 0.5)****	**15**												
BCT9	76	−0.05 (−0.19, 0.10)	0	**34**	**0.11 (−0.01, 0.23)**	**25**				47	0.00 (−0.11, 0.11)	0			
BCT14	76	−0.02 (−0.10, 0.07)	0	34	0.03 (−0.04, 0.11)	0	34	0.02 (−0.13, 0.16)	0	47	0.01 (−0.07, 0.09)	0	28	−0.06 (−0.20, 0.08)	0
BCT15	76	0.04 (−0.05, 0.13)	0	34	0.06 (−0.03, 0.15)	4	**34**	**0.17 (−0.04, 0.38)**	**1**	47	0.03 (−0.05, 0.12)	0			
BCT16	76	−0.05 (−0.16, 0.07)	0	34	0.00 (−0.08, 0.09)	0				47	−0.01 (−0.11, 0.10)	0	28	−0.06 (−0.23, 0.10)	0
BCT17	76	−0.07 (−0.14, 0.01)	0	34	−0.08 (−0.16, 0.01)	20	34	0.04 (−0.10, 0.17)	0	47	0.04 (−0.04, 0.12)	0	28	−0.06 (−0.19, 0.08)	0
BCT18	**76**	**0.18 (0.03, 0.33)***	**2**							47	0.00 (−0.13, 0.13)	0	**28**	**0.16 (0.00, 0.32)**	**15**
BCT19	**76**	**0.11 (−0.03, 0.25)**	**0**												
BCT20	76	0.01 (−0.11, 0.13)	0	34	−0.02 (−0.11, 0.07)	0	**34**	**−0.13 (−0.31, 0.04)**	**9**	47	−0.06 (−0.16, 0.04)	0	28	−0.07 (−0.23, 0.09)	0
BCT21	76	−0.02 (−0.13, 0.09)	0	34	−0.01 (−0.10, 0.08)	0	**34**	**0.15 (−0.05, 0.34)**	**0**	47	0.02 (−0.06, 0.11)	0	28	0.09 (−0.06, 0.25)	0
BCT23	76	−0.02 (−0.15, 0.11)	0							47	−0.08 (−0.21, 0.04)	0			
BCT24	76	−0.05 (−0.21, 0.12)	0	34	0.07 (−0.04, 0.19)	2	34	0.04 (−0.20, 0.27)	0	47	0.10 (0.00, 0.20)	8	28	−0.07 (−0.27, 0.14)	0
BCT26	76	0.01 (−0.08, 0.11)	0	34	0.01 (−0.07, 0.09)	0				47	−0.03 (−0.13, 0.06)	0	28	0.07 (−0.07, 0.21)	0
BCT27	76	−0.07 (−0.15, 0.01)	0	34	−0.06 (−0.14, 0.01)	20	34	0.02 (−0.12, 0.16)	0	47	0.09 (0.01, 0.17)*	14	28	−0.01 (−0.15, 0.13)	0

(*Continued*)

Table 2. Continued.

	Total			Average			Peak			HED frequency			Frequency		
	k	*β* (95% CI)	R^2 (%)	*k*	*β* (95% CI)	R^2 (%)	*k*	*β* (95% CI)	R^2 (%)	*k*	*β* (95% CI)	R^2 (%)	*k*	*β* (95% CI)	R^2 (%)
BCT28	76	−0.05 (−0.14, 0.05)	0	34	0.06 (−0.03, 0.14)	2	34	0.06 (−0.11, 0.22)	0	47	0.03 (−0.06, 0.12)	0	28	−0.02 (−0.17, 0.13)	0
BCT29	76	−0.04 (−0.15, 0.08)	0	34	0.05 (−0.05, 0.15)	0	**34**	**0.17 (−0.01, 0.35)**	**1**	47	0.07 (−0.02, 0.17)	0	28	0.07 (−0.10, 0.24)	1
BCT30	76	0.08 (0.00, 0.17)	9	34	0.04 (−0.04, 0.12)	0	34	−0.01 (−0.16, 0.14)	0	47	0.03 (−0.08, 0.13)	0	28	0.05 (−0.10, 0.20)	0
BCT33	76	−0.06 (−0.20, 0.08)	0							47	0.09 (−0.04, 0.22)	0			
BCT34	76	−0.07 (−0.21, 0.08)	0	34	0.02 (−0.10, 0.14)	0				47	0.10 (−0.01, 0.21)	4			
BCT35	76	−0.03 (−0.13, 0.07)	0	34	0.03 (−0.06, 0.12)	0				47	−0.04 (−0.13, 0.05)	0	28	0.05 (−0.11, 0.21)	0
BCT41	76	−0.05 (−0.21, 0.12)	0							47	0.10 (−0.01, 0.21)	4			
Total BCTs	76	0.00 (−0.01, 0.01)	0	34	0.00 (0.00, 0.01)	0	34	0.01 (−0.01, 0.03)	0	47	0.01 (0.00, 0.01)	0	28	0.00 (−0.01, 0.02)	0
Theory use															
HBM	35	−0.02 (−0.17, 0.13)	0												
MI	35	−0.04 (−0.21, 0.12)	0	**16**	**0.20 (0.04, 0.35)***	**66**				28	−0.04 (−0.17, 0.09)	0			
Norms	58	0.06 (−0.03, 0.15)	4	23	0.09 (0.02, 0.17)*	76	27	0.01 (−0.12, 0.14)	0	**30**	**−0.10 (−0.25, 0.04)**	**6**	19	0.06 (−0.05, 0.16)	0
SCT	36	−0.06 (−0.20, 0.08)	0							26	−0.09 (−0.21, 0.02)	5	**12**	**0.19 (0.04, 0.35)***	**53**
TPB	41	−0.03 (−0.15, 0.08)	0	17	0.03 (−0.08, 0.15)	0				33	−0.07 (−0.16, 0.02)	6			
TTM	35	−0.02 (−0.17, 0.13)	0												
Theory extent															
Norms	27	0.07 (0.01, 0.12)*	25	11	0.00 (−0.05, 0.05)	0	14	−0.01 (−0.11, 0.10)	0				11	0.04 (−0.04, 0.12)	0
TPB	10	−0.00 (−0.08, 0.08)	0							11	−0.01 (−0.03, 0.02)	0			

Notes: Blank cells and BCTs and theories not listed indicate there was insufficient variability in the moderator to conduct the analysis. Bold indicates a meaningful effect ($|\beta| > 0.10$). Total = total quantity of alcohol consumed per extended period of time (e.g., per week); average = average quantity of alcohol consumed per drinking occasion; peak = highest quantity of alcohol consumed on one occasion; HED frequency = frequency of heavy episodic drinking; frequency = frequency of alcohol consumption; *β* = regression coefficient, CI = confidence interval; *k* = number of evaluations; R^2 = adjusted proportion of heterogeneity accounted for by moderator; Contact = some personal contact; total BCTs = total number of BCTs used; HBM = health belief model; MI = motivational interviewing theory; norms = social norms approach; SCT = social cognitive theory; TPB = theory of planned behaviour; TTM = transtheoretical model.

*$p < .05$.

**$p < .01$.

***$p < .001$, two-tailed.

[a]Results including outliers for age were as follows: total: *β* (95% CI) = 0.00 (0.00, 0.01), $k = 76$, $R^2 = 0\%$; peak: β (95% CI) = 0.00 (−0.02, 0.01), $k = 34$, $R^2 = 0\%$; HED frequency: *β* (95% CI) = 0.00 (−0.02, 0.02), $k = 47$, $R^2 = 0\%$; frequency: *β* (95% CI) = −0.01 (−0.04, 0.01), $k = 28$, $R^2 = 0\%$.

Table 3. CDI Effects by subgroups of moderators significant in multivariate analyses.

DV	Conditions	*k*	d_+ (95% CI)	I^2	*Q*
Total					
	Some personal contact	20	0.30 (0.19, 0.41)***	46%	35.15*
	No personal contact	56	0.11 (0.07, 0.15)***	59%	133.93***
	BCT1 present	59	0.11 (0.07, 0.15)***	59%	141.90***
	BCT1 absent	17	0.29 (0.20, 0.38)***	33%	23.94
	BCT8 present	6	0.44 (0.07, 0.81)*	80%	24.50***
	BCT8 absent	70	0.13 (0.09, 0.16)***	54%	150.00***
Average					
	Norms	11	0.14 (0.08, 0.20)***	0%	7.91
	No theory	12	0.05 (0.00, 0.10)	25%	14.66
Peak					
	Some personal contact	10	0.41 (0.23, 0.59)***	50%	18.00*
	No personal contact	24	0.07 (0.01, 0.13)*	31%	33.30
	BCT4 present	29	0.16 (0.10, 0.22)***	37%	44.16*
	BCT4 absent	5	−0.03 (−0.22, 0.15)	57%	9.30
HED					
	<50% women	13	0.04 (−0.02, 0.09)	0%	6.94
	>50% women	34	0.11 (0.06, 0.16)***	51%	67.18***
	BCT5 present	38	0.10 (0.06, 0.14)***	49%	73.06***
	BCT5 absent	9	0.00 (−0.12, 0.11)	0%	2.61
Frequency					
	BCT1 present	19	0.06 (0.00, 0.12)	57%	41.62**
	BCT1 absent	9	0.24 (0.10, 0.38)***	64%	21.95**
	BCT4 present	24	0.14 (0.08, 0.21)***	65%	65.40***
	BCT4 absent	4	−0.08 (−0.24, 0.09)	51%	6.15
	BCT18 present	5	0.26 (0.02, 0.50)*	86%	28.87***
	BCT18 absent	23	0.08 (0.02, 0.14)**	50%	44.02**

Notes: Length of follow-up was also a significant moderator in total and peak consumption analyses, but these data are already presented in Table 1. Whilst gender was a continuous variable in the regression analyses, it has been dichotomised here for illustration. DV = dependent variable; conditions = subgroups of moderators; k = number of evaluations; d_+ = pooled effect size; Q = heterogeneity statistic; I^2 = percentage of between-study variance that is due to heterogeneity; total = total alcohol consumed per extended period of time (e.g., per week); BCT = behaviour change technique; average = average alcohol consumed per drinking occasion; norms = social norms approach; peak = highest quantity of alcohol consumed on one occasion; HED frequency = frequency of heavy episodic drinking; frequency = frequency of alcohol consumption.
*$p < .05$.
**$p < .01$.
***$p < .001$, two-tailed.

CDIs conducted with some personal contact were significantly *better* at reducing total consumption than those conducted remotely. CDIs produced significantly *larger* reductions in total consumption in the short term than the longer term. CDIs that provided information on the consequences of excessive alcohol consumption (BCT1) were significantly *worse* at reducing total consumption than those that did not use this technique. CDIs that prompted commitment from the client (BCT8) were significantly *better* at reducing total consumption than those that did not use this technique. Despite the smaller effect sizes of CDIs that were entirely online, at longer term, that used BCT1 or that did not use BCT8, these effects were all significant. Location, prompting review of goals (BCT18), facilitating relapse prevention and coping (BCT19) and the social norms approach were not significantly associated with total consumption when controlling for the four significant moderators.

CDIs that were based on the social norms approach were significantly *better* at reducing average consumption than those not based on theory. Those not based on theory did not significantly reduce average consumption. Location, length of follow-up, personal contact and motivational interviewing (BCT9 or theory) were no longer significant.

CDIs conducted with some personal contact were significantly *better* at reducing peak consumption than those conducted remotely. CDIs that provided normative information (BCT4) were significantly *better* than those that did not use this technique. CDIs that did not provide normative information did not significantly reduce peak consumption. Age, location, number of CDI sessions, boosting motivation (BCT3), facilitating action planning (BCT15) or barrier identification (BCT21) and assessing readiness to reduce consumption (BCT29) were not significant when controlling for personal contact and BCT4.

CDIs were significantly *poorer* at reducing HED frequency in the longer compared to shorter term, and amongst samples with more men compared to those with more women. CDIs that provided feedback on performance (BCT5) produced significantly *greater* reductions than those that did not use this technique. Further, only those CDIs that provided feedback to samples of majority women significantly reduced HED frequency. Location, providing normative information (BCT4), providing options for additional or later support (BCT27) and the social norms approach were no longer significant.

CDIs that provided information on consequences (BCT1) produced significantly *smaller*, non-significant reductions in drinking frequency than those that did not use this technique. CDIs that provided normative information (BCT4) or prompted review of goals (BCT18) each produced *larger* reductions than those that did not use these techniques. CDIs that did not provide normative information did not significantly reduce drinking frequency. Gender, location, identifying reasons for wanting and not wanting to reduce consumption (BCT2), boosting motivation (BCT3) and social cognitive theory were no longer significant.

Discussion

CDIs produced small, significant effects on total, average and peak consumption, and HED and drinking frequency. The following sections discuss moderators of CDI effectiveness.

Moderators of CDI effectiveness: general study characteristics

CDIs were more effective at reducing HED frequency amongst samples with higher proportions of women. It might be that men tend to be less responsive to the BCTs used in CDIs. Indeed, whilst providing feedback on performance effectively reduced HED frequency amongst samples with majority women, this was not the case amongst samples with more men. This interpretation might explain previous mixed findings regarding gender (Carey et al., 2009, 2012; Rooke et al., 2010). Future research should identify those techniques that effectively reduce HED frequency amongst men. No other sample characteristics were associated with CDI outcomes; CDIs appear equally effective in reducing alcohol consumption regardless of location, age, university student status, proportion of sample who were heavy drinkers and whether or not participants were mandated to complete the CDI. Although it must be noted that it was not possible to test the association between each of these moderators and all five outcomes. As such, these conclusions stand only for the testable outcomes.

In line with Carey et al. (2012), there was no association between length of the CDI or number of sessions and any outcomes. It seems that there was no benefit in administering multiple-session and longer CDIs, compared to administering single-session and shorter CDIs, respectively. In contrast, personal contact did appear to be important. CDIs that involved some personal contact demonstrated significantly greater reductions in total consumption and peak consumption (but not average consumption or HED frequency), compared to those conducted entirely remotely. It is unclear why such personal contact might offer benefit, given that all contact was minimal (e.g., greeting participants, directing towards a computer). It might be that those participants who are willing to overcome time and practical barriers to attend in-person CDIs have pre-existing higher levels of motivation for change and, hence, are more responsive to BCTs. Alternatively, it is possible that there are aspects of the social interaction that facilitate behaviour change, but that are not captured in the extant literature and therefore not able to be identified by meta-regression, however it appeared that the control groups typically received the same personal contact as their CDI counterparts, so this explanation seems less likely. Finally, CDIs were also significantly more effective in reducing total consumption and HED frequency in the short term than in the longer term.

Moderators of CDI effectiveness: BCTs and theory

Positive outcomes

Across three outcomes, it appeared that normative information (e.g., information on peers' consumption) was beneficial in reducing alcohol consumption. Specifically, use of the social norms approach was associated with greater reductions in average consumption and provision of normative information was associated with greater reductions in peak consumption and drinking frequency. This is in line with a meta-analysis linking norms with intention to consume alcohol (Cooke et al., 2014). Further, that CDIs that did not use this strategy did not significantly reduce consumption might suggest that normative information is crucial; however, this interpretation should be considered in light of the small number of CDIs that did not provide this information.

Providing feedback on performance appeared effective in reducing HED frequency. Such feedback typically consisted of graphical displays of the participant's alcohol consumption and sometimes included information such as the equivalent amount of money spent or calories consumed. It is possible that such summary information allows the participant to evaluate how this behaviour aligns with other goals that they might hold, including financial or health goals, and to develop cognitive dissonance between their goals and behaviour.

Prompting review of progress towards goals appeared effective in reducing drinking frequency. Such review typically involved comparison of current consumption with previous consumption. If consumption has decreased, it is possible that such comparisons instil a sense of achievement, which increases self-efficacy and motivates further reductions in consumption (e.g., Ashford, Edmunds, & French, 2010; Prestwich, Kellar, et al., 2014). Lastly, prompting commitment from the client there and then appeared effective in reducing total consumption. As discussed by Lokhorst, Werner, Staats, van Dijk, and Gale (2011), it is possible that such prompts influence subsequent behaviour through a desire for self-consistency.

Negative outcomes

Provision of information about the consequences of alcohol consumption was associated with *smaller* reductions in total consumption and drinking frequency and those CDIs utilising this technique did not significantly reduce drinking frequency. This aligns with results of a meta-analysis on the role of threatening communication (or 'fear appeals') and efficacy in changing behaviour (Peters, Ruiter, & Kok, 2013), which demonstrated that threatening communication had positive effects on behaviour when response- and/or self-efficacy was high, but had no effect when efficacy was low. It might be that efficacy was low amongst participants in the current meta-analyses, given that the majority of samples were not treatment-seeking and that only one-third (31%) of CDIs attempted to boost motivation and self-efficacy. If so, the current results extend upon those of Peters et al. (2013), suggesting that under low efficacy, not only does threatening communication have no positive effect on alcohol consumption, it might have a negative effect.

Null results

Fourteen techniques (BCTs 2, 3, 14, 15, 16, 17, 20, 21, 24, 26, 28, 29, 30 and 35) were tested in at least four of the five analyses and demonstrated no relationship with any outcome. There is no evidence to suggest that inclusion of these techniques in CDIs offers any benefit in reducing alcohol consumption. Further, in contrast to previous findings (Webb et al., 2010), CDIs that used more BCTs did not lead to greater reductions than those that used fewer. It is possible that previous results were driven by the use of specific, effective BCTs, rather than the larger numbers of BCTs. As such, it might be important for intervention developers to focus on including specific, effective techniques, rather than trying to include many techniques.

Six theories were tested in their associations with reductions in alcohol consumption. As described above, the social norms approach led to positive outcomes; however, there was little-to-no evidence that use of the other tested theories – the health belief model, motivational interviewing theory, social cognitive theory, the theory of planned behaviour or the transtheoretical model – improved CDI outcomes, compared to no theory. Whilst use of motivational interviewing theory and social cognitive theory initially appeared to lead to greater reductions, these effects did not remain when controlling for other important moderators. It seems likely that the apparent positive effect of social cognitive theory was due to its negative correlation with provision of information on the consequences of alcohol consumption. CDIs based on social cognitive theory tended to not use this BCT, and those not based on social cognitive theory tended to use this BCT. Finally, there was also no evidence that more-extensive use of the theory of planned behaviour improved outcomes over less-extensive use. Overall, these findings are in line with a broader review of the role of theory in health–behaviour interventions (Prestwich, Sniehotta, et al., 2014), which found that use of social cognitive theory or the transtheoretical model did not improve intervention effectiveness.

It may be that whilst these more-elaborate theories provide good descriptions of *behaviour*, they might not provide good explanations of *behaviour change* (see e.g., Sniehotta, Presseau, & Araújo-Soares, 2014). Second, any discrepancies between individual CDI protocols, delivery and reporting can lead to noise and increase the chance of null results. Third, some analyses in this study might have been underpowered to detect true effects. This seems possible in the case of the health belief model, motivational interviewing theory, social cognitive theory and the transtheoretical model. The analyses using these theories were each based on four-to-six CDIs that utilised the theories. Conversely, this explanation seems less likely in the case of the social norms approach and the theory of planned behaviour, which were mostly based on larger numbers of CDIs.

Limitations

It should be noted that the design of this study does not allow inferences of causality to be drawn. Moderators that varied between studies were identified, and the associations between these moderators and treatment outcomes were examined. As such, significant results provide direction regarding possible techniques to test using randomised controlled designs, rather than techniques that are necessarily causing behaviour change.

As is the case with any review of this nature, there are also a number of possible sources of error in the moderator analyses. These include insufficient information in the original manuscripts and poor fidelity between reporting and practice. Efforts were made to overcome these issues, by directly accessing the intervention content wherever possible; however, null results should nonetheless be considered tentatively.

Finally, the effect of measuring alcohol (BCT31) was not evaluated, as all CDI and control groups utilised this BCT.[3] Of the remaining 41 BCTs, 15 (BCTs 6, 7, 10, 11, 12, 13, 22, 25, 32, 36, 37, 38, 39, 40 and 42) were not tested due to their rare or non-existent use. As such, this study provides no evidence regarding their effectiveness. Similarly, eight BCTs (BCTs 8, 9, 18, 19, 23, 33, 34 and 41) were tested in one-three analyses, based on small numbers (4–7) of CDIs using the technique. Therefore, non-significant associations between these BCTs and outcomes should be interpreted with caution.

Practical recommendations

The strongest positive evidence from this review supports the provision of normative information in reducing average consumption, peak consumption and drinking frequency.

Secondly, results also suggest that providing feedback on performance, prompting commitment and prompting review of goals might be effective strategies for reducing HED frequency, total consumption and drinking frequency, respectively. Finally, the evidence does *not* support the provision of information about the consequences of alcohol consumption. Whilst CDIs utilising this technique effectively reduced total consumption, they did not reduce drinking frequency, and effect sizes were larger across both outcomes when this technique was not used.

Future research directions

Three key areas for future research stem from this review. First, this review identified 23 BCTs (i.e., more than half the taxonomy) for which it was not possible to conduct well-powered analyses. Further, other techniques not in the taxonomy have been used to address alcohol consumption, such as training executive function (e.g., Black & Mullan, 2015; Houben, Wiers, & Jansen, 2011). Indeed, a recent meta-analysis found that such training appears to be effective in changing health behaviours generally (Allom, Mullan, & Hagger, 2015). More individual trials are required to test the effectiveness of these techniques, and the 23 under-tested BCTs, in the context of CDIs for alcohol consumption.[4] Second, this review provided the first step in examining the relationship between BCTs and CDI alcohol outcomes in an individual and additive manner. It is now important to identify specific combinations or interactions between BCTs that are most effective in CDIs for alcohol consumption. Such a question could be addressed via reviews (e.g., see Dusseldorp, van Genugten, van Buuren, Verheijden, & van Empelen (2014) and Peters et al., 2013 for two different approaches) or using individual factorial designs. Finally, this review identified that, of the theories tested, only the social norms approach improved CDI outcomes. It might be wise to focus on simpler approaches to changing behaviour, such as the social norms approach and specific BCTs, rather than more-elaborate theories, such as the theory of planned behaviour and the transtheoretical model, until such time that more-useful, elaborate theories can be built. At the same time, knowledge gained from existing theories can inform this process of furthering the search for specific techniques. Alternatively, more individual trials based on newer theories of health behaviour (e.g., temporal self-regulation theory, Hall & Fong, 2007; dual process models, Hofmann, Friese, & Wiers, 2008, 2011), would allow examination of whether use of these other theories improve CDI outcomes compared to both older theories and no theory.

Conclusion

The main aim of this review was to identify the BCTs and theories that are effective in CDIs for reducing alcohol consumption. The small, significant effects found here align with earlier meta-analyses; however, there were three major and novel findings. First, personal contact, normative information, prompting commitment and goal review and providing feedback on performance were associated with improved outcomes. Second, provision of information about the consequences of alcohol consumption was associated with poorer outcomes. This finding is important as in many alcohol settings, providing information on consequences is the first line of intervention; however, in this context it appears unhelpful. Third, use of more-elaborate theories and more-extensive use of BCTs do not appear to affect CDI outcomes. Finally, the fact that more than half of the BCT taxonomy was not included in a sufficient number of CDIs to allow evaluation highlights the need for further research.

Notes

1. Asterisks indicate truncation. For example, drink* would yield results for drink, drinker, drinking, etc.
2. Four of the five contacted authors responded and provided data for five of the seven CDIs. The remaining two CDIs were still included in at least one meta-analysis, due to available data for other outcomes.
3. For those interested, BCT31 has previously been assessed via meta-analysis (McCambridge & Kypri, 2011).
4. Though, some BCTs might be difficult to adapt to this medium (e.g., BCT37: using reflective listening).

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