Variability and effectiveness of comparator group interventions in smoking cessation trials: A systematic review and meta-analysis

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Abstract

**Aims:** To examine variability and effectiveness of interventions provided to comparator (control) groups in smoking cessation trials. **Methods:** Systematic review with meta-analysis of randomised controlled trials (RCTs) of behavioural interventions for smoking cessation, with or without stop-smoking medication. We searched the Cochrane Tobacco Addiction Group Specialized Register for RCTs with objective outcomes measured at ≥6 months. Study authors were contacted to obtain comprehensive descriptions of their comparator interventions. Meta-regression analyses examined the relationships of smoking cessation rates with stop-smoking medication and behaviour change techniques. **Results:** 104 of 142 eligible comparator groups (*N*=23706) had complete data and were included in analyses. There was considerable variability in the number of behaviour change techniques delivered (*M*=15.97, *SD*=13.54, range:0-45) and the provision of smoking cessation medication (43% of groups received medication) across comparator groups and within categories of comparator groups (e.g., usual care, brief advice). Higher smoking cessation rates were predicted by provision of medication (*B*=0.334, 95%CI: 0.030-0.638, *p*=.031) and number of behaviour change techniques included (*B*=0.020, 95%CI: 0.008-0.032, *p*<.001). Modelled cessation rates in comparator groups that received the most intensive support were 15 percentage points higher than those that received the least (23% versus 8%). **Conclusions:** Interventions delivered to comparator groups in smoking cessation randomised controlled trials vary considerably in content, and cessation rates are strongly predicted by stop-smoking medication and number of behaviour change techniques delivered.

Key words: systematic review, meta-analysis, meta-regression, smoking cessation, control group, comparator group, behaviour change techniques
Introduction

Tobacco smoking is a leading cause of premature mortality, disease, and health care expenditures [1, 2]. Numerous smoking cessation interventions have been developed and their evidence synthesised in systematic reviews, including multiple Cochrane reviews [3-11]. The evidence generated has informed smoking cessation guidelines and healthcare services, and helped numerous people quit smoking [12, 13]. Accurate evidence can optimise effectiveness of these interventions and ensure services offered are those which are most cost-effective.

The effectiveness of smoking cessation interventions is commonly determined by comparing them with an active control. As such, the observed effect sizes will be a function of the effectiveness of the intervention provided to the experimental group, but also the intervention provided to the corresponding control group, or comparator group, as well as of other variables. Study aims vary from trial to trial, and the type of comparator employed should covary with these aims [14]. At the most minimal, comparator groups receive no support and simply report their outcomes (which arguably could be considered very brief support in itself) [15]. At the more intensive, comparator groups might receive many counselling sessions. Systematic reviews of behavioural interventions tend to either ignore the variability in comparator interventions or try to address it by organising comparator groups into broad categories, such as no behavioural support, self-help (e.g., pamphlets, self-directed workbooks, apps), brief advice/counselling (e.g., a short, typically less than 30 minutes, amount of advice/counselling), extended counselling (longer, often multiple sessions, of counselling), usual care (any support already typically delivered in practice), and/or some combination of these categories [3-8]. This approach might not fully account

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a We use the term comparator group in recognition of the fact that many of these groups receive (comparator) interventions.
for the variability between comparator groups, as evidence from other areas shows that intervention content delivered to ‘usual care’ groups can vary considerably between trials [16]. In a previous systematic review of HIV medication adherence interventions, this variability in usual care content explained up to 34% points differences in the clinical outcomes observed in the comparator groups and influenced trial effect sizes [16, 17]. This suggests that, without accounting for the differences in the intervention content provided to comparator groups, it might not be possible to directly synthesise experimental intervention effects from these trials. Further, for readers of these trials—such as those assessing whether a given intervention will improve outcomes over their current practice—it might also not be possible to interpret, compare, or generalise the results.

The present aim was to examine the variability and effectiveness of comparator intervention content in a much larger and more heterogeneous body of randomised controlled trials (RCTs) of behavioural interventions for smoking cessation amongst adults [18]. Based on previous research, our pre-registered (https://osf.io/24pzj/) primary hypotheses were that provision of pharmacological support (i.e., smoking cessation medication) and behavioural support [i.e., higher number of smoking cessation behaviour change techniques [BCTs]; 19, 20] would vary between comparator groups and predict higher smoking cessation. We also predicted that BCTs delivered in a personalised manner would be more effective than those delivered in a non-personalised manner (i.e., a one-size-fits-all approach). Secondary hypotheses were that behavioural support delivered by a person would be more effective than support delivered in writing (digital and/or print), that more adjuvant support to engage participants with the intervention would predict higher cessation rates, and that, amongst those who received medication, more adjuvant support to increase medication adherence would predict higher cessation rates.

**Methods**
Reporting Standards

This study is part of a larger systematic review of behavioural smoking cessation trials [IC-SMOKE; 18]. The project is registered on PROSPERO (CRD42015025251) and the Open Science Framework (https://osf.io/23hfv/). The completed PRISMA checklist is in Appendix A [21].

Eligibility

The Cochrane Tobacco Addiction Group Specialized Register was searched on November 1st, 2015 for RCTs assessing the impact of behavioural interventions (with or without smoking cessation medication) on biochemically verified smoking cessation at six months or longer. Trials without biochemically verified outcomes were excluded to protect against multiple sources of bias [22, 23]. Trials were excluded if they were published before 1996, were not reported in English (as resources for translation of documentation were not available) or in peer-reviewed journals, or if participants were aged under 18 years. Trials published before 1996 were excluded because older trials of behavioural interventions are less relevant in a continually changing social and policy environment, and because preliminary work indicated it was very difficult to retrieve the required materials from authors of trials published beyond 20 years earlier. The comparator groups included in the present analyses were the single least intensive groups in each RCT (i.e., one comparator group per RCT), which could have included no support, medication, usual care, or comparator interventions introduced by the researchers. Detailed methods are described in the IC-SMOKE protocol [18].

Procedure

Data were first extracted from published materials (e.g., primary articles, appendices, protocols, intervention development papers). Then, a comprehensive procedure of contacting authors of all included trials was executed to retrieve additional,
unpublished materials [24]. First/corresponding authors were contacted by email (including several reminders), followed by telephone as required. If the first/corresponding author did not reply or was unable to help, second/last authors were contacted, followed by middle authors, as required. Authors were asked to provide additional materials on the intervention provided to their comparator group (e.g., manuals, practitioner training materials, self-help materials, website content) and to complete a comparator intervention checklist. The comparator intervention checklist (https://osf.io/e834t/) was a purpose-built questionnaire capturing smoking cessation activities [25]. We developed it based on international stop smoking treatment manuals, input from advisory board members (of smokers/ex-smokers, smoking cessation professionals, and policy makers), expertise within the study team, and smoking cessation examples provided in previous BCT taxonomies. A similar approach was shown to be reliable and valid in the previous HIV medication adherence systematic review [16].

The active content provided to comparator groups (viz., BCTs and smoking cessation medications) was extracted from the above-described materials. Two researchers independently and reliably [26] used the BCT taxonomy (BCTTv1; Appendix A) [19]—with one BCT added and one BCT removed—to code the presence/absence of 93 individual BCTs, the behaviour targeted by each BCT (smoking cessation behaviours: making a quit attempt, remaining abstinent; adjuvant behaviours: adhering to medication, engaging in treatment), and whether the BCT delivery was personalised (i.e., individually tailored or requiring active recipient involvement). Examples of BCTs are reducing prompts or cues that might trigger smoking, considering the pros and cons of quitting, and verbally persuading the person that they are capable of quitting. Following retrieval and coding of all available materials, the extent to which these materials comprehensively described the active intervention content was determined using independent double coding (see Appendix A for the decision model
The comparator interventions were labelled as well-described if the coders judged the materials to be of sufficient detail and clarity to identify all or almost all the BCTs that were delivered to that comparator group. Finally, comparators were also coded as to whether the BCTs were primarily delivered in writing (digital/print) or by a person (face-to-face or via telephone).

**Data Analysis**

The *a priori* prepared analysis plan was published on the Open Science Framework before conducting the analyses (https://osf.io/23hfv/). Analyses were conducted using the metafor package in R [27]. The analysis script and data (https://osf.io/gk56j/) are also available on the Open Science Framework. Multi-level, mixed-effects meta-regression models were used to examine the association between comparator intervention content and (logit transformed) smoking cessation rates. Outcome time points were all those at six months (±1 month) to post-randomisation or later (i.e., multiple time points per study were permitted). Multiple outcome time points were included as this provides a more thorough synthesis of the available evidence than would be afforded by omitting all data other than those of a single timepoint. The model included random intercepts for studies (to account for between-study heterogeneity), correlated random effects for multiple observations (i.e., logit rates) within studies with a continuous time autoregressive structure (to account for heterogeneity in multiple observations corresponding to the same group), and correlated sampling errors for multiple observations within studies (to account for the dependency between multiple observations corresponding to the same group). For the sampling errors, we conservatively assumed an autocorrelation coefficient of $\rho = 0.9$ for a

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b To allow for variation between studies in the exact time at which follow-up assessments were conducted, we allowed all time points at five months or later to be included.

c As each study contributed a single comparator group to the analyses, study and group are synonymous in this context.
lag of one month. The smoking cessation rates extracted from the studies were based on intent-to-treat analyses with missing responses treated as smokers [assumption: missing = smoking; 28]. Only those comparator groups rated as well-described were included in the primary analyses. Various sensitivity analyses were conducted, including fitting the models while controlling for attrition, including all comparator groups, and using robust variance estimation [29]. These are described in full in the analysis plan.

In the first primary model, smoking cessation rates were regressed on the degree of behavioural support (number of smoking cessation BCTs, i.e., those targeting quitting or abstinence) and the provision of medication (0 = no, 1 = yes; Model 1). In the second primary model, smoking cessation rates were regressed on the number of personalised BCTs, the number of non-personalised BCTs, and the provision of medication (Model 2).

In the secondary analyses, we first examined (Models 3 and 4) whether the effect of BCTs on smoking cessation depends on the mode of delivery (i.e., whether comparator interventions were primarily delivered in writing [= 0] or by a person [= 1]), by adding a mode of delivery main effect and its interaction with smoking cessation BCTs to Models 1 and 2. To investigate the additional value of supporting the adjuvant behaviours (Models 5 and 6), we added number of treatment engagement BCTs, number of medication adherence BCTs, and the interaction between medication provision and number of medication adherence BCTs (as adherence BCTs should primarily benefit people who were provided with medication) to Models 1 and 2, respectively. Exploratory analyses were also conducted; namely, to investigate potential differences over time, differences by quitting versus abstinence BCTs, and interactions between smoking cessation BCTs and medication in determining smoking cessation. The results of these are described in Appendix B.

All analyses were controlled for potential confounding variables that we identified through literature review and input from our advisory board panel [30-32]. These control
variables were: (1) mean age (in years), (2) mean nicotine dependence [using the Fagerström Test for Nicotine Dependence; theoretical range: 0-10; missing values imputed based on cigarettes per day, where available; 33], (3) length of follow-up (coded in six-month units to facilitate interpretation; log transformed to pre-emptively avoid any undue influence of a few very long follow-up assessments), (4) cotinine verification (1 = yes, 0 = no, where no includes less stringent biochemical verification types, such as exhaled CO), and (5) type of abstinence assessed (1 = sustained, 0 = point prevalence). The selection of these variables is discussed further in the analysis plan.

Results

Study Identification

Initially, 5992 records were identified (Figure 1). Following screening and eligibility assessment, 142 unique trials were included (see Appendix B for a list of included studies). 110/142 (77%) comparator groups were rated as well-described, after retrieving additional information from authors on 93/142 (65%) of comparator groups. Of the 110 well-described comparator groups, complete data on all primary predictor and control variables were available for 104 groups, and these are analysed here. This included $N = 23706$ participants and 161 time points ranging 22-130 weeks post-randomisation (one study contributed five timepoints, three contributed four timepoints, six contributed three timepoints, 32 contributed two timepoints, and the remaining 62 contributed a single timepoint).

Variability in Behavioural and Pharmacological Support

There was considerable variability between the 104 comparator groups in the number of smoking cessation BCTs delivered ($M = 15.97, SD = 13.54$, range: 0-45), number of personalised smoking cessation BCTs delivered ($M = 3.12, SD = 3.93$, range: 0-16), and provision of medication (43%). The most commonly delivered smoking cessation BCTs were unspecified social support, tell to act, and information about health consequences
Identification

Records identified through database searching \((n = 5989)\)

Additional records sent by authors or identified via citations in other included manuscripts \((n = 3)\)

Records after duplicates removed \((n = 5992)\)

Screening

Records screened \((n = 5992)\)

Records excluded \((n = 4473)\)

Eligibility

Full-text articles assessed for eligibility \((n = 1519)\)

Full-text articles excluded \((n = 1377)\)

Included

Studies included in review \((n = 142)\)

Incomplete data \((n = 38)\):
- BCTs not well-described \((n = 32)\)
- Incomplete control variable data \((n = 6)\)

Well-described comparator groups included in meta-analyses \((n = 104)\)

*Figure 1. PRISMA flow diagram.*

*Note. BCTs = behaviour change techniques*
(delivered to 81%, 67%, and 67% of comparator groups, respectively). The most commonly
delivered personalised smoking cessation BCTs were unspecified social support, behavioural
goal setting, and reducing exposure to cues (delivered to 50%, 27%, and 23% of comparator
groups, respectively).

Further, when grouping the comparators in categories typically used in systematic
reviews of smoking cessation trials, variability in the number of BCTs delivered to ‘no
behavioural support’ comparator groups was low ($M = 1.38$, $SD = 2.48$, range: 0-9, $k = 21$),
but considerable variability remained within the other categories: ‘self-help’ ($M = 18.00$, $SD$
= 8.54, range: 5-32, $k = 10$), ‘brief advice’ ($M = 12.11$, $SD = 11.08$, range: 0-45, $k = 37$),
‘extended counselling’ ($M = 27.89$, $SD = 9.99$, range: 5-43, $k = 36$), and ‘usual care’ ($M$
= 12.07, $SD = 13.50$, range: 0-45, $k = 28^d$). Hence, even within these typical categories, some
comparator groups receive little to no support, whereas others receive extensive support.

**Association between Intervention Active Content and Smoking Cessation**

Provision of smoking cessation medication and more smoking cessation BCTs
predicted higher smoking cessation rates (Model 1, Table 1). The BCT-smoking cessation
association seemed to be driven both by personalised BCTs and non-personalised BCTs, as
these associations with cessation rates were not significantly different ($p = .400$; Model 2).
Given that these two predictors were correlated ($r = .49$, $p < .001$), we re-ran the models
with each predictor separately, which gave slightly larger differences in effect sizes and
smaller p-values (personalised: $B = 0.057$, $p = .004$; non-personalised: $B = 0.022$, $p = .002$),
suggesting that both variables were competing for the same variance. These results suggest
that delivering more personalised and non-personalised BCTs, as well as smoking cessation
medication, predicts higher smoking cessation rates in these comparator groups.

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^d The categories no behavioural support, self-help, brief advice, and extended counselling are mutually
exclusive of each other but not of usual care. Usual care could consist of any of the other four.
Table 1
**Meta-Regression Results [B (SE)] Predicting (Logit-Transformed) Comparator Group Smoking Cessation Rates from Active Content Provided**

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Received medication (1 = yes, 0 = no)</td>
<td>0.334 (0.155)*</td>
<td>0.346 (0.156)*</td>
<td>0.266 (0.166)</td>
<td>0.231 (0.164)</td>
<td>0.429 (0.251)†</td>
<td>0.399 (0.260)</td>
</tr>
<tr>
<td>Total smoking cessation BCTs</td>
<td>0.020 (0.006)**</td>
<td>-0.020 (0.027)</td>
<td>0.010 (0.008)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personalised smoking cessation BCTs</td>
<td>0.038 (0.022)†</td>
<td>-0.131 (0.068)†</td>
<td>0.021 (0.023)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-personalised smoking cessation BCTs</td>
<td>0.016 (0.008)*</td>
<td>0.031 (0.038)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mode of delivery (1 = person-delivered, 0 = written)</td>
<td>-0.605 (0.546)</td>
<td>-0.235 (0.564)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total smoking cessation BCTs × mode of delivery</td>
<td>0.042 (0.028)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personalised smoking cessation BCTs × mode of delivery</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-personalised smoking cessation BCTs × mode of delivery</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment engagement BCTs</td>
<td></td>
<td></td>
<td>0.176 (0.079)**</td>
<td>0.171 (0.080)**b</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medication adherence BCTs</td>
<td></td>
<td></td>
<td>0.044 (0.078)</td>
<td>0.046 (0.078)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medication adherence BCTs × received medication</td>
<td></td>
<td></td>
<td>-0.067 (0.089)</td>
<td>-0.057 (0.092)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Model**

<table>
<thead>
<tr>
<th></th>
<th>Primary Models</th>
<th>Secondary Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groups</td>
<td>104</td>
<td>104</td>
</tr>
<tr>
<td>Time points</td>
<td>161</td>
<td>161</td>
</tr>
</tbody>
</table>

**Note.** BCT = behaviour change technique. All models were controlled for mean age, mean Fagerström Test for Nicotine Dependence, length of follow-up, cotinine verification, and point prevalence vs. sustained abstinence. **p < .001, *p < .01, *p < .05, † p < .1.

a. Variables that formed part of interaction terms were not mean-centred. The ‘main’ effects of these variables should be interpreted as the effect of that variable when the other from the interaction term = 0. E.g., in Model 3, the ‘main’ effect of BCTs is the simple effect when mode of delivery is written (mode of delivery = 0) and the ‘main’ effect of mode of delivery is the simple effect when no BCTs were delivered (BCTs = 0); b. Removal of one influential case resulted in the interaction term becoming non-significant (B = .145, p = .102) and cluster robust re-estimation resulted in this effect becoming significant again (B = .145, p = .003); c. Removal of one influential case resulted in the effect of treatment engagement BCTs becoming non-significant (5: B = .182, p = .081; 6: B = .170, p = .115) and this remained non-significant following cluster robust re-estimation (5: B = .182, p = .074; 6: B = .170, p = .097); d. Sample size reduced because model includes only active comparator groups (passive comparator groups do not have a mode of delivery).
Interaction between Mode of Delivery and BCTs in Predicting Smoking Cessation

Whether smoking cessation BCTs are more strongly predictive of smoking cessation when delivered by a person than when delivered in writing (digital and/or print) was tested in Models 3 and 4. The association between smoking cessation rates and number of BCTs delivered was evident for those BCTs delivered by a person ($B = 0.022$, $p = .001$) but not those delivered in writing ($B = -0.020$, $p = .452$); although, the direct interaction test did not suggest that these association differed (Model 3).

When BCTs were personalised, the association with higher smoking cessation was again evident when they were delivered by a person ($B = 0.055$, $p = .013$) but not when delivered in writing ($B = -0.131$, $p = .052$), and these associations were significantly different (Model 4). There was no evidence that non-personalised BCTs delivered in writing ($B = 0.031$, $p = .416$) or by a person ($B = 0.015$, $p = .072$) predicted smoking cessation. Together, these results show that personalised and person-delivered BCTs are associated with higher smoking cessation, with no support found for non-personalised BCTs or those delivered in writing.

Association between BCTs Targeting Adjuvant Behaviours and Smoking Cessation

The associations between BCTs targeting adjuvant behaviours and smoking cessation rates were tested in Models 5 and 6. Higher smoking cessation rates were predicted by provision of more BCTs to engage the participant in the treatment (Models 5-6), but not by more BCTs to aid medication adherence (Model 5: $B = -0.022$, $p = .698$; Model 6: $B = -0.011$, $p = .861$; amongst those groups who were provided medication). The association between number of treatment engagement BCTs and smoking cessation was attenuated by the removal of one influential case (Model 5: $B = .182$, $p = .081$; Model 6: $B = .170$, $p = .115$). The comparator group in this study [34] received a large number of treatment engagement BCTs relative to all other comparator groups (8 vs. range of others: 0-3) and this seemed to determine the results of this analysis.
Estimated Smoking Cessation Rates at Different Levels of Behavioural and Pharmacological Support

The predicted impact of varying levels of behavioural and pharmacological support on smoking cessation rates is shown in Figure 2. As seen, our models predicted that, on average, 8% of those who received no behavioural or pharmacological support will be abstinent. If participants received 45 BCTs (the observed maximum), then the predicted cessation rate increased to 18%. If participants also received smoking cessation medication, then this rate increased to 23%. Similarly, if participants received 16 personalised, person-delivered BCTs (the observed maximum), then the predicted cessation rate was 18% without medication and 22% with medication. Note the different scales on the x-axes in Figure 2a versus Figure 2b, illustrating that similar smoking cessation rates might be achieved using fewer BCTs if those BCTs are personalised and delivered by a person.

Discussion

Principal Findings

This study examined the variability in, and effectiveness of, the active content of interventions (viz. BCTs and smoking cessation medications) provided to comparator groups in RCTs of behavioural interventions for smoking cessation. The active content varied considerably across all comparator groups and within typical categories of comparator groups (e.g., usual care, brief advice). Further, delivery of smoking cessation medication and more behavioural support predicted higher smoking cessation rates in these comparator groups. The predicted effect of this variability was a 15%-point absolute difference in cessation rates between comparator groups, with the least and most intensive comparator interventions predicting 8% and 23% cessation, respectively. This difference between comparator groups is greater than the typical differences seen between experimental and comparator groups in smoking cessation trials [4, 5, 35].
Figure 2. Predicted smoking cessation rates across the observed range of (a) total BCTs, and (b) personalised, person-delivered BCTs. Dotted lines represent 95% confidence intervals. Estimated smoking cessation rates are computed at six-month follow-up, non-cotinine verified, point prevalence abstinence, and mean levels of age and nicotine dependence.
This study replicates and extends earlier work, in which the authors raised the issue of variability in interventions delivered to comparator groups of behavioural trials and its implications for interpreting and comparing effect sizes [16, 17]. This work was done in the area of HIV medication adherence interventions, in a small set of only usual care comparator groups. That these results have now also been obtained for a substance use/addictive behaviour (smoking) in a large set of studies with multiple categories of comparator groups clearly supports the idea that readers and systematic reviewers need to consider variability in comparator interventions when interpreting, comparing, and generalising trial effect sizes [17, 36].

This study also found support for the potential role of BCTs in increasing smoking cessation rates, particularly when personalised and delivered by a person, and did not find evidence that the effect of these BCTs on cessation declines over time (Appendix B). This adds to existing literature, which has shown stronger intervention effects when interventions are delivered, at least in part, by a person (compared to self-help alone) and when interventions are tailored to the participant [5, 37-39]. This study also adds to the mixed, broader health behaviour change literature, which has found some positive relationships between the number of BCTs used and smoking cessation [40] and other behaviours [e.g., 41, 42, 43], but which, overall, typically finds non-significant relationships with smoking cessation [44] and other outcomes [e.g., 37, 45-53]. Strengths of our methodology (retrieval of unpublished materials, restriction of analyses to well-described studies) might have increased the accuracy of our BCT data. Along with the much larger number of included studies, this would increase power to detect the BCTs-cessation relationship.

**Strengths and Limitations**

Key strengths of this study are, first, the retrieval of extensive, unpublished materials describing comparator interventions from authors and the restriction of analyses to well-
described comparators. Second, the inclusion of \textit{a priori} specified confounders and the observed dose-response relationship increase confidence in a potential causal link between comparator interventions and outcomes [54]. The key limitation is that analyses were correlational and unaddressed confounders could be driving the associations. Other intervention factors such as frequency or duration of interpersonal contact could influence outcomes. Nonetheless, if this is the case, the implication that variability in comparator interventions warrants consideration remains unchanged. Further, we included only English language publications, meaning that our review does not cover comparator groups from RCTs published exclusively in other languages. Finally, our BCT variable was a sum score, which therefore assumed that all BCTs are equally effective; this may not be the case. However, in the absence of evidence of the effectiveness of each BCT in this context, this pragmatic approach was judged to be most suitable.

\textbf{Implications for Policy and Practice}

Policy makers and practitioners use publications about trials and systematic reviews to evaluate which interventions to fund and implement. Our results indicate that, when doing so, it is key to consider against what comparators these interventions have been tested. We observed large (15% points) predicted differences in smoking cessation between comparator groups that were associated with the level of support received. This variability could make some experimental interventions look much stronger than others, whereas in fact this might have nothing to do with the experimental interventions; instead, it might be due to one trial having a minimal and another trial an intensive comparator intervention. Currently used methods for accounting for comparator group variability (i.e., separating meta-analyses by categories of comparator groups) may go some distance, but as variability in active content within commonly used categories is substantial, this is unlikely to fully address the issue. Hence, we recommend that researchers, policy makers, and practitioners
ensure that full information on the comparator interventions is available and considered when interpreting, comparing and generalising intervention effects, and when making decisions on which services to fund and implement.

**Future Research**

Smoking is a leading cause of premature mortality, disease, and health care expenditures [1, 2] and the current study suggests that existing smoking cessation intervention research might be overlooking an important source of clinical, and possibly statistical, heterogeneity. We are currently conducting analyses to determine if and how the observed variability in comparator groups impacts conclusions about the relative effectiveness of different types of interventions, with the goal of producing more accurate estimates of intervention effects (https://osf.io/khm8u/). Further, as the link between comparator interventions and outcomes has now been established in both the HIV medication adherence [16, 17] and smoking cessation domains, it will be important to investigate whether similar effects are occurring in other domains of behavioural interventions, and complex interventions more generally. To enable this, it is essential that trial authors provide detailed descriptions of their comparator interventions, as published descriptions are often incomplete [24, 55-58]. New tools such as Addiction Journal’s Paper Authoring Tool might facilitate this [59].

Results of this study highlight avenues for research into improving usual care for smoking cessation. Researchers could investigate whether adding additional BCTs—especially BCTs delivered by a person—into existing programmes leads to higher rates of smoking cessation. Further, to operationalise comparator group support we took a pragmatic approach using a simple sum score of BCTs. To provide better guidance on which support is most effective, it will be important to investigate which combinations of BCTs are associated with the highest smoking cessation rates (as we are currently doing: https://osf.io/m5vea/).
Finally, it will be important to investigate how BCTs can be best translated to be delivered in writing (digital and/or print), as we did not find evidence of an association with smoking cessation when delivered through these mediums. At present, such interventions produce small increases in smoking cessation [9, 10] and identifying which components of these are most effective could help us increase the effectiveness of these interventions.

Conclusions

Interventions provided to comparator groups in smoking cessation trials vary substantially and predict cessation rates in these groups. This variability should be considered when synthesising, interpreting, comparing, or generalising intervention effects.
References


interventions in systematic reviews of behavioural trials. under preparation.


50. Fredrix M, McSharry J, Flannery C, Dinneen S, Byrne M. Goal-setting in diabetes self-
management: A systematic review and meta-analysis examining content and effectiveness of goal-setting interventions. Psychol Health 2018;33:955-77.


APPENDIX FOR:

Variability and effectiveness of comparator group interventions in smoking cessation trials: A systematic review and meta-analysis

Black, Eisma, Viechtbauer, Johnston, West, Hartmann-Boyce, Michie, and de Bruin

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Appendix A: Additional methodological information

Supplemental Table A1.

Adapted Behaviour Change Technique Taxonomy Version 1 used in the Current Study

<table>
<thead>
<tr>
<th>BCT</th>
<th>BCTTv1 Example</th>
<th>Smoking Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Goals and planning</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1.1 Goal setting (behaviour)</strong></td>
<td>Set or agree on a goal defined in terms of the behaviour to be achieved</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Note: only code goal-setting if there is sufficient evidence that goal set as part of intervention; if goal unspecified or a behavioural outcome, code 1.3, Goal setting (outcome); if the goal defines a specific context, frequency, duration or intensity for the behaviour, also code 1.4, Action planning</em></td>
<td>Agree on a daily walking goal (e.g. 3 miles) with the person and reach agreement about the goal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Set the goal of eating 5 pieces of fruit per day as specified in public health guidelines</td>
</tr>
<tr>
<td><strong>1.2 Problem solving</strong></td>
<td>Analyse, or prompt the person to analyse, factors influencing the behaviour and generate or select strategies that include overcoming barriers and/or increasing facilitators (includes ‘Relapse Prevention’ and ‘Coping Planning’).</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Note: barrier identification without solutions is not sufficient. If the BCT does not include analysing the behavioural problem, consider 12.3, Avoidance/changing exposure to cues for the behaviour, 12.1, Restructuring the physical environment, 12.2, Restructuring the social environment, or 11.2, Reduce negative emotions</em></td>
<td>Identify specific triggers (e.g. being in a pub, feeling anxious) that generate the urge/want/need to drink and develop strategies for avoiding environmental triggers or for managing negative emotions, such as anxiety, that motivate drinking</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prompt the patient to identify barriers preventing them from starting a new exercise regime e.g., lack of motivation, and discuss ways in which they could help overcome them e.g., going to the gym with a buddy</td>
</tr>
<tr>
<td><strong>1.3 Goal setting (outcome)</strong></td>
<td>Set or agree on a goal defined in terms of a positive outcome of wanted behaviour</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Note: only code guidelines if set as a goal in an intervention context; if goal is a behaviour, code 1.1, Goal setting</em></td>
<td>Set a weight loss goal (e.g. 0.5 kilogram over one week) as an outcome of changed eating patterns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Set a goal with the client to have a CO-level of a non-smoker for the next meeting</td>
</tr>
</tbody>
</table>
Appendix: Black et al., Variability and effectiveness of comparator...

<table>
<thead>
<tr>
<th>BCT</th>
<th>BCTTv1 Example</th>
<th>Smoking Example</th>
</tr>
</thead>
</table>
| **Example** *(behaviour)*; if goal unspecified code 1.3,  
Goal setting (outcome)*  |
| 1.4 **Action planning**  
Prompt detailed planning of performance of the behaviour (must include at least one of context, frequency, duration and intensity). 
Context may be environmental (physical or social) or internal (physical, emotional or cognitive) (includes 'Implementation Intentions')  
*Note: evidence of action planning does not necessarily imply goal setting, only code latter if sufficient evidence*  |
| Encourage a plan to carry condoms when going out socially at weekends  
Prompt planning the performance of a particular physical activity (e.g. running) at a particular time (e.g. before work) on certain days of the week  |
| Prompt planning of preparatory behaviour to facilitate quitting smoking (e.g. remove tobacco products from the house, tell others about the quit attempt) on specific days during the coming week  |
| 1.5 **Review behaviour goals**  
Review behaviour goal(s) jointly with the person and consider modifying goal(s) or behaviour change strategy in light of achievement. This may lead to re-setting the same goal, a small change in that goal or setting a new goal instead of (or in addition to) the first, or no change  
*Note: if goal specified in terms of behaviour, code 1.5, Review behaviour goal(s), if goal unspecified, code 1.7, Review outcome goal(s); if discrepancy created consider also 1.6, Discrepancy between current behaviour and goal*  |
| Examine how well a person’s performance corresponds to agreed goals e.g. whether they consumed less than one unit of alcohol per day, and consider modifying future behavioural goals accordingly e.g. by increasing or decreasing alcohol target or changing type of alcohol consumed  |
| Review with the client if the main goal of abstinence from cigarettes has been achieved. This may lead to resetting a quit date if the client has lapsed.  |
| 1.6 **Discrepancy between current behaviour and goal**  
Draw attention to discrepancies between a person’s current behaviour (in terms of the form, frequency, duration, or intensity of that behaviour) and the person’s previously set outcome goals, behavioural goals or action plans (goes beyond self-monitoring of behaviour)  
*Note: if discomfort is created only code 13.3, Incompatible beliefs and not 1.6, Discrepancy between current behaviour and goal; if goals are modified, also code 1.5, Review behaviour goal(s) and/or 1.7, Review outcome goal(s); if feedback is*  |
<p>| Point out that the recorded exercise fell short of the goal set  |
| Draw attention to the fact that the client has not met the goal of not smoking after the quit date. |</p>
<table>
<thead>
<tr>
<th>BCT</th>
<th>BCTv1 Example</th>
<th>Smoking Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.7 Review outcome goal</strong>&lt;br&gt;Review outcome goal(s) jointly with the person and consider modifying goal(s) in light of achievement. This may lead to re-setting the same goal, a small change in that goal or setting a new goal instead of, or in addition to the first&lt;br&gt;Note: if goal specified in terms of behaviour, code 1.5, Review behaviour goal(s), if goal unspecified, code 1.7, Review outcome goal(s); if discrepancy created consider also 1.6, Discrepancy between current behaviour and goal</td>
<td>Examine how much weight has been lost and consider modifying outcome goal(s) accordingly e.g., by increasing or decreasing subsequent weight loss targets</td>
<td>Review with the client whether the goal set for CO-reading has been met. This may lead to re-setting the same goal with regard to CO-levels or a small change in the goal on CO-levels.</td>
</tr>
<tr>
<td><strong>1.8 Behavioural contract</strong>&lt;br&gt;Create a written specification of the behaviour to be performed, agreed on by the person, and witnessed by another&lt;br&gt;Note: also code 1.1, Goal setting (behaviour)</td>
<td>Sign a contract with the person e.g. specifying that they will not drink alcohol for one week</td>
<td>Sign a written contract with the client stating that the client will not smoke after their quit date</td>
</tr>
<tr>
<td><strong>1.9 Commitment</strong>&lt;br&gt;Ask the person to affirm or reaffirm statements indicating commitment to change the behaviour&lt;br&gt;Note: if defined in terms of the behaviour to be achieved also code 1.1, Goal setting (behaviour)</td>
<td>Ask the person to use an “I will” statement to affirm or reaffirm a strong commitment (i.e. using the words “strongly”, “committed” or “high priority”) to start, continue or restart the attempt to take medication as prescribed</td>
<td>Ask the person to use an “I will” statement to affirm or reaffirm a strong commitment (i.e. using the words “strongly”, “committed” or “high priority”) to quit smoking.</td>
</tr>
<tr>
<td><strong>2. Feedback and monitoring</strong></td>
<td>Watch hand washing behaviours among health care staff and make notes on context, frequency and technique used</td>
<td>Ask a household member monitor how much the client smokes each day</td>
</tr>
<tr>
<td><strong>2.1 Monitoring of behaviour by others without feedback</strong>&lt;br&gt;Observe or record behaviour with the person’s knowledge as part of a behaviour change strategy&lt;br&gt;Note: if monitoring is part of a data collection procedure rather than a strategy aimed at changing behaviour, do not code; if feedback given, code only 2.2, Feedback on behaviour, and not 2.1, Monitoring of behaviour by others</td>
<td>Ask a pharmacist record if and how often smoking cessation medication is being picked up by the client</td>
<td></td>
</tr>
<tr>
<td>BCT</td>
<td>BCTTV1 Example</td>
<td>Smoking Example</td>
</tr>
<tr>
<td>-----</td>
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<td>-----------------</td>
</tr>
<tr>
<td><strong>without feedback; if monitoring outcome(s) code 2.5, Monitoring outcome(s) of behaviour by others without feedback; if self-monitoring behaviour, code 2.3, Self-monitoring of behaviour</strong></td>
<td>Inform the person of how many steps they walked each day (as recorded on a pedometer) or how many calories they ate each day (based on a food consumption questionnaire).</td>
<td>Give evaluative feedback on the number of cigarettes that the client smoked this week as measured in a daily diary.</td>
</tr>
<tr>
<td><strong>2.2 Feedback on behaviour</strong></td>
<td>Monitor and provide informative or evaluative feedback on performance of the behaviour (e.g. form, frequency, duration, intensity)</td>
<td>Give feedback indicating how well the client is adhering to stop smoking medication as reported in a daily diary.</td>
</tr>
<tr>
<td><em>Note: if Biofeedback, code only 2.6, Biofeedback and not 2.2, Feedback on behaviour; if feedback is on outcome(s) of behaviour, code 2.7, Feedback on outcome(s) of behaviour; if there is no clear evidence that feedback was given, code 2.1, Monitoring of behaviour by others without feedback; if feedback on behaviour is evaluative e.g. praise, also code 10.4, Social reward</em>**</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2.3 Self-monitoring of behaviour</strong></td>
<td>Establish a method for the person to monitor and record their behaviour(s) as part of a behaviour change strategy</td>
<td>Ask the client to record how many cigarettes they smoke each day in a diary.</td>
</tr>
<tr>
<td><em>Note: if monitoring is part of a data collection procedure rather than a strategy aimed at changing behaviour, do not code; if monitoring of outcome of behaviour, code 2.4, Self-monitoring of outcome(s) of behaviour; if monitoring is by someone else (without feedback), code 2.1, Monitoring of behaviour by others without feedback</em>**</td>
<td>Ask the person to record daily, in a diary, whether they have brushed their teeth for at least two minutes before going to bed.</td>
<td>Ask the client to record daily medication adherence in a diary.</td>
</tr>
<tr>
<td><strong>2.4 Self-monitoring of outcomes of behaviour</strong></td>
<td>Establish a method for the person to monitor and record the outcome(s) of their behaviour as part of a behaviour change strategy</td>
<td>Give patient a pedometer and a form for recording daily total number of steps.</td>
</tr>
<tr>
<td><em>Note: if monitoring is part of a data collection procedure rather than a strategy aimed at changing behaviour, do not code; if monitoring behaviour, code 2.3, Self-monitoring of behaviour; if monitoring is by someone else (without feedback), code 2.5, Monitoring</em>**</td>
<td>Ask the person to weigh themselves at the end of each day, over a two-week period, and record their daily weight on a graph to increase exercise behaviours.</td>
<td>Ask the client to write down each week of the smoking program how much money they have saved by not smoking.</td>
</tr>
<tr>
<td>BCT</td>
<td>BCTTv1 Example</td>
<td>Smoking Example</td>
</tr>
<tr>
<td>-----</td>
<td>----------------</td>
<td>----------------</td>
</tr>
<tr>
<td><strong>outcome(s) of behaviour by others without feedback</strong></td>
<td>Record blood pressure, blood glucose, weight loss, or physical fitness</td>
<td>Record expired-air carbon monoxide concentration to assess the extent of smoking exposure without giving feedback</td>
</tr>
<tr>
<td><strong>2.5 Monitoring of behaviour by others without feedback</strong>&lt;br&gt;Observe or record outcomes of behaviour with the person’s knowledge as part of a behaviour change strategy&lt;br&gt;Note: if monitoring is part of a data collection procedure rather than a strategy aimed at changing behaviour, do not code; if feedback given, code only 2.7, Feedback on outcome(s) of behaviour; if monitoring behaviour code 2.1, Monitoring of behaviour by others without feedback; if self-monitoring outcome(s), code 2.4, Self-monitoring of outcome(s) of behaviour</td>
<td>Inform the person of their blood pressure reading to improve adoption of health behaviours</td>
<td>Inform the person of their measured expired-air carbon monoxide concentration to encourage smoking cessation</td>
</tr>
<tr>
<td><strong>2.6 Biofeedback</strong>&lt;br&gt;Provide feedback about the body (e.g. physiological or biochemical state) using an external monitoring device as part of a behaviour change strategy&lt;br&gt;Note: if Biofeedback, code only 2.6, Biofeedback and not 2.2, Feedback on behaviour or 2.7, Feedback on outcome(s) of behaviour</td>
<td>Inform the person of how much weight they have lost following the implementation of a new exercise regime</td>
<td>Inform the client about the amount of money they have saved by not smoking during the past weeks</td>
</tr>
<tr>
<td><strong>2.7 Feedback on outcome(s) of behaviour</strong>&lt;br&gt;Monitor and provide feedback on the outcome of performance of the behaviour&lt;br&gt;Note: if Biofeedback, code only 2.6, Biofeedback and not 2.7, Feedback on outcome(s) of behaviour; if feedback is on behaviour code 2.2, Feedback on behaviour; if there is no clear evidence that feedback was given code 2.5, Monitoring outcome(s) of behaviour by others without feedback; if feedback on behaviour is evaluative e.g. praise, also code 10.4, Social reward</td>
<td>Inform the client to ask for social support during the quit attempt from family</td>
<td></td>
</tr>
</tbody>
</table>

### 3. Social support

<p>| 3.1 Social support (unspecified) | Advise the person to call a ‘buddy’ when they experience an urge to smoke | Advise the client to ask for social support during the quit attempt from family |</p>
<table>
<thead>
<tr>
<th>BCT</th>
<th>BCTTv1 Example</th>
<th>Smoking Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>colleagues,</em> ‘buddies’ or staff) or non-contingent praise or reward for performance of the behaviour. It includes encouragement and counselling, but only when it is directed at the behaviour. Note: attending a group class and/or mention of ‘follow-up’ does not necessarily apply this BCT, support must be explicitly mentioned; if practical, code 3.2, Social support (practical); if emotional, code 3.3, Social support (emotional) (includes ‘Motivational interviewing’ and ‘Cognitive Behavioural Therapy’).</td>
<td>smoke</td>
<td>members, friends, or colleagues</td>
</tr>
<tr>
<td><strong>3.2 Social support (practical)</strong></td>
<td>Arrange for a housemate to encourage continuation with the behaviour change programme</td>
<td>Advise the person to call a ‘buddy’ when they experience an urge to smoke</td>
</tr>
<tr>
<td>Advise on, arrange, or provide practical help (e.g. from friends, relatives, colleagues, ‘buddies’ or staff) for performance of the behaviour. Note: if emotional, code 3.3, Social support (emotional); if general or unspecified, code 3.1, Social support (unspecified)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>If only restructuring the physical environment or adding objects to the environment, code 12.1, Restructuring the physical environment or 12.5, Adding objects to the environment; attending a group or class and/or mention of ‘follow-up’ does not necessarily apply this BCT, support must be explicitly mentioned.</td>
<td>Ask the partner of the patient to put their tablet on the breakfast tray so that the patient remembers to take it</td>
<td>Ask the partner of the client to put their stop smoking medication on the breakfast tray so that the client remembers to take it.</td>
</tr>
<tr>
<td><strong>3.3 Social support (emotional)</strong></td>
<td>Ask the patient to take a partner or friend with them to their colonoscopy appointment</td>
<td>Advise the client to contact a ‘buddy’ to provide emotional support if the client has a difficult time staying abstinent.</td>
</tr>
<tr>
<td>Advise on, arrange, or provide emotional social support (e.g. from friends, relatives, colleagues, ‘buddies’ or staff) for performance of the behaviour. Note: if practical, code 3.2, Social support (practical); if unspecified, code 3.1, Social support (unspecified)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 4. Shaping knowledge

#### 4.1 Instruction how to perform the behaviour
Advise or agree on how to perform the behaviour (includes ‘Skills training’)

*Note: when the person attends classes such as exercise or cookery, code 4.1, Instruction on how to perform the behaviour, 8.1, Behavioural practice/rehearsal and 6.1, Demonstration of the behaviour*

- Advise the person how to put a condom on a model of a penis correctly
- Advise that the most effective way of quitting is to stop abruptly rather than cut down gradually
- Advise how to use a Nicotine Replacement Therapy (NTR) product (e.g. an inhaler)

#### 4.2 Information about antecedents
Provide information about antecedents (e.g. social and environmental situations and events, emotions, cognitions) that reliably predict performance of the behaviour

- Advise to keep a record of snacking and of situations or events occurring prior to snacking
- Provide information about the situations, events and emotions that have led the client to starting smoking again
- Advise the client to keep a record of situations in which they crave a cigarette

#### 4.3 Re-attribution
Elicit perceived causes of behaviour and suggest alternative explanations (e.g. external or internal and stable or unstable)

- If the person attributes their over-eating to the frequent presence of delicious food, suggest that the ‘real’ cause may be the person’s inattention to bodily signals of hunger and satiety
- If the person attributes their smoking to the need for stress reduction, suggest that the real cause may be nicotine dependence

#### 4.4 Behavioural experiments
Advise on how to identify and test hypotheses about the behaviour, its causes and consequences, by collecting and interpreting data

- Ask a family physician to give evidence-based advice rather than prescribe antibiotics and to note whether the patients are grateful or annoyed
- If the client expects urges to smoke will become unbearable if they do not smoke, advise them to test this by waiting until urges dissipate when feeling the urge to smoke.

#### 4.5 Tell to act
Tell the person to perform the target behaviour. This would normally involve an expectation of compliance, especially if given by someone with formal or

- Tell the client to stop smoking.
- Advise client to take stop smoking medication.
5. Natural consequences

5.1 Information about health consequences
Provide information (e.g. written, verbal, visual) about health consequences of performing the behaviour

Note: consequences can be for any target, not just the recipient(s) of the intervention; emphasising importance of consequences is not sufficient; if information about emotional consequences, code 5.6, Information about emotional consequences; if about social, environmental or unspecified consequences code 5.3, Information about social and environmental consequences

Example
Explain that not finishing a course of antibiotics can increase susceptibility to future infection

Give the client a leaflet on the health consequences of smoking

5.2 Salience of consequences
Use methods specifically designed to emphasise the consequences of performing the behaviour with the aim of making them more memorable (goes beyond informing about consequences)

Note: if information about consequences, also code 5.1, Information about health consequences, 5.6, Information about emotional consequences or 5.3, Information about social and environmental consequences

Example
Produce cigarette packets showing pictures of health consequences e.g. diseased lungs, to highlight the dangers of continuing to smoke

Produce cigarette packets showing pictures of health consequences (e.g. diseased lungs), to highlight the dangers of continuing to smoke

Show the client a ‘tar jar’ which contains all tar that passes through the lungs in a year, to increase awareness of the health consequences of smoking

5.3 Information about social and environmental consequences
Provide information (e.g. written, verbal, visual) about social and environmental consequences of performing the behaviour

Note: consequences can be for any target, not just the recipient(s) of the intervention; if information about health or consequences, code 5.1, Information about health consequences; if about emotional consequences, code 5.6, Information about emotional consequences; if unspecified, code 5.3,

Example
Tell family physician about financial remuneration for conducting health screening

Inform a smoker that the majority of people disapprove of smoking in public places

Provide information to the client about the negative health consequences of second-hand smoke to other people

Tell the client that cigarette butts are toxic to the natural environment
### 5.4 Monitoring of emotional consequences

Prompt assessment of feelings after attempts at performing the behaviour

- Agree that the person will record how they feel after taking their daily walk
- Ask the client to record how they feel each morning after the quit attempt

### 5.5 Anticipated regret

Induce or raise awareness of expectations of future regret about performance of the unwanted behaviour

- Ask the person to assess the degree of regret they will feel if they do not quit smoking
- Ask the client to assess the degree of regret they will feel if they do not quit smoking

### 5.6 Information about emotional consequences

Provide information (e.g. written, verbal, visual) about emotional consequences of performing the behaviour

- Explain that quitting smoking increases happiness and life satisfaction
- Explain that quitting smoking increases happiness and life-satisfaction

---

#### 6. Comparison of behaviour

<table>
<thead>
<tr>
<th>BCT</th>
<th>BCTTv1 Example</th>
<th>Smoking Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1 Demonstration of the behaviour</td>
<td>Demonstrate to nurses how to raise the issue of excessive drinking with patients via a role-play exercise</td>
<td>Identify examples of celebrities who have quit smoking.</td>
</tr>
<tr>
<td></td>
<td>Demonstrate to the client how to use a specific Nicotine Replacement Therapy product (e.g. an inhaler)</td>
<td></td>
</tr>
</tbody>
</table>
### 6.2 Social comparison

Draw attention to others’ performance to allow comparison with the person’s own performance. *Note: being in a group setting does not necessarily mean that social comparison is actually taking place.*

**BCT**  
*perform, also code 4.1, Instruction on how to perform the behaviour*

**BCTTv1 Example**  
Show the doctor the proportion of patients who were prescribed antibiotics for a common cold by other doctors and compare with their own data.

**Smoking Example**  
Show the proportion of patients who have had previous failed quit attempts and have successfully quit smoking.

**Notes**  
- Draw attention to how well other group members have managed to use stop smoking medication and compare this with the person’s own performance.

### 6.3 Information about others’ approval

Provide information about what other people think about the behaviour. The information clarifies whether others will like, approve or disapprove of what the person is doing or will do.

**BCT**  
*Tell the staff at the hospital ward that staff at all other wards approve of washing their hands according to the guidelines*

**BCTTv1 Example**  
Tell the staff at the hospital ward that staff at all other wards approve of washing their hands according to the guidelines.

**Smoking Example**  
Tell the client that most people disapprove of smoking in public places.

**Notes**  
- Explain that children are usually happy to hear that their parent is quitting smoking.

### 7. Associations

#### 7.1 Prompts/cues

Introduce or define environmental or social stimulus with the purpose of prompting or cueing the behaviour. The prompt or cue would normally occur at the time or place of performance. *Note: when a stimulus is linked to a specific action in an if-then plan including one or more of frequency, duration or intensity also code 1.4, Action planning.*

**BCT**  
*Put a sticker on the bathroom mirror to remind people to brush their teeth*

**BCTTv1 Example**  
Put a sticker on the bathroom mirror to remind people to brush their teeth.

**Smoking Example**  
Place some alternative to cigarettes e.g. sweets, where cigarettes would normally have been kept.

**Notes**  
- Send a text message every morning to remind the client to take stop smoking medication.
- Advise the client to put stop smoking medication next to a toothbrush to remind them to take it in the morning.

#### 7.2 Cue signalling reward

Identify an environmental stimulus that reliably predicts that reward will follow the behaviour (includes *Discriminative cue*)

**BCT**  
*Advise that a fee will be paid to dentists for a particular dental treatment of 6-8-year-old, but not older,*

**BCTTv1 Example**  
Advise that a fee will be paid to dentists for a particular dental treatment of 6-8-year-old, but not older.

**Smoking Example**  
Advise that a financial incentive will be paid if the client is abstinent from smoking until delivery of the baby but not earlier.
<table>
<thead>
<tr>
<th>BCT</th>
<th>BCTTv1 Example</th>
<th>Smoking Example</th>
</tr>
</thead>
</table>
| **7.3 Reduce prompts/cues**  
Withdraw gradually prompts to perform the behaviour (includes 'Fading') | Reduce gradually the number of reminders used to take medication | Gradually reduce the number of days on which the client records data such as craving or goal progression which have been used to prompt smoking cessation. |
| **7.4 Remove access to the reward**  
Advise or arrange for the person to be separated from situations in which unwanted behaviour can be rewarded in order to reduce the behaviour (includes 'Time out') | Arrange for cupboard containing high calorie snacks to be locked for a specified period to reduce the consumption of sugary foods in between meals | Advise client to remove all cigarettes from the house |
| **7.5 Remove aversive stimulus**  
Advise or arrange for the removal of an aversive stimulus to facilitate behaviour change (includes 'Escape learning') | Arrange for a gym-buddy to stop nagging the person to do more exercise in order to increase the desired exercise behaviour | Arrange for the removal of something the client finds unpleasant (e.g. household chores) on adhering to stop smoking medication for a specified period of time |
| **7.6 Satiation**  
Advise or arrange repeated exposure to a stimulus that reduces or extinguishes a drive for the unwanted behaviour | Arrange for the person to eat large quantities of chocolate, in order to reduce the person’s appetite for sweet foods | Advise a person to smoke much more than usual, to extinguish the urge to smoke |
| **7.7 Exposure**  
Provide systematic confrontation with a feared stimulus to reduce the response to a later encounter | Agree a schedule by which the person who is frightened of surgery will visit the hospital where they are scheduled to | Agree a schedule by which a client, who fears they will start smoking again when visiting a pub, will systematically visit pubs to |
<table>
<thead>
<tr>
<th>BCT</th>
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</thead>
</table>
| 7.8 Associative learning | Present a neutral stimulus jointly with a stimulus that already elicits the behaviour repeatedly until the neutral stimulus elicits that behaviour (includes ‘Classical/Pavlovian Conditioning’)  
*Note: when a BCT involves reward or punishment, code one or more of: 10.2, Material reward (behaviour); 10.3, Non-specific reward; 10.4, Social reward, 10.9, Self-reward; 10.10, Reward (outcome)* | Present repeatedly fatty foods with a disliked sauce to discourage the consumption of fatty foods | When the client does not smoke when feeling sick; ask them to smoke rapidly, until they feel nauseous, so that smoking becomes associated with feeling sick. |
| 8. Repetition and substitution | | |
| 8.1 Behavioural practice/rehearsal | Prompt practice or rehearsal of the performance of the behaviour one or more times in a context or at a time when the performance may not be necessary, in order to increase habit and skill  
*Note: if aiming to associate performance with the context, also code 8.3, Habit formation* | Prompt asthma patients to practice measuring their peak flow in the nurse’s consulting room | Advise to practice or rehearse not smoking in a context or time prior to the quit date, to increase the habit of not smoking |
| 8.2 Behaviour substitution | Prompt substitution of the unwanted behaviour with a wanted or neutral behaviour  
*Note: if this occurs regularly, also code 8.4, Habit reversal* | Suggest that the person goes for a walk rather than watches television | Prompt the client to substitute smoking a cigarette with a wanted or neutral behaviour (e.g. brief physical exercise, eating a lollipop) |
| 8.3 Habit formation | Prompt rehearsal and repetition of the behaviour in the same context repeatedly so that the context elicits the behaviour  
*Note: also code 8.1, Behavioural practice/rehearsal* | Prompt patients to take their statin tablet before brushing their teeth every evening | Advise to practice or rehearse not smoking in the same context repeatedly, so that the context elicits abstinence |
| 8.4 Habit reversal | Prompt rehearsal and repetition of an alternative behaviour to replace an unwanted habitual behaviour  
*Note: also code 8.2, Behaviour substitution* | Ask the person to walk up stairs at work where they previously always took the lift | Prompt repetition of a wanted or neutral behaviour (e.g. brief physical exercise, eating a lollipop) at the time or places where the client |
<table>
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</thead>
</table>
| **8.5 Generalisation of target behaviour**  
Advise to perform the wanted behaviour, which is already performed in a particular situation, in another situation | Advise to repeat toning exercises learned in the gym when at home | Advise that since people already do not smoke in certain situations (e.g., on during travel in public transport, during dinner) to extend these non-smoking situations to another situation in which they usually smoke |
| **8.6 Graded tasks**  
Set easy-to-perform tasks, making them increasingly difficult, but achievable, until behaviour is performed | Ask the person to walk for 100 yards a day for the first week, then half a mile a day after they have successfully achieved 100 yards, then two miles a day after they have successfully achieved one mile | Ask the client to get through a morning without smoking, then to get through a whole day without smoking until one has achieved a larger target of not smoking for one week |
| **9. Comparison of outcomes**  
**9.1 Credible source**  
Present verbal or visual communication from a credible source in favour of or against the behaviour  
*Note: code this BCT if source generally agreed on as credible e.g., health professionals, celebrities or words used to indicate expertise or leader in field and if the communication has the aim of persuading; if information about health consequences, also code 5.1, Information about health consequences, if about emotional consequences, also code 5.6, Information about emotional consequences; if about social, environmental or unspecified consequences also code 5.3, Information about social and environmental consequences* | Present a speech given by a high-status professional to emphasise the importance of not exposing patients to unnecessary radiation by ordering x-rays for back pain | Present verbal or visual communication from a high-status health expert in favour of smoking cessation |
| **9.2 Pros and cons**  
Advise the person to identify and compare reasons for wanting (pros) and not wanting to (cons) change the | Advise the person to list and compare the advantages and disadvantages of | Advise the client to generate a list of reasons why they do and why they do not want to stop |
<table>
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<tr>
<th>BCT</th>
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</tr>
</thead>
</table>
| behaviour (includes ‘**Decisional balance**’)  
*Note: if providing information about health consequences, also code 5.1, Information about health consequences; if providing information about emotional consequences, also code 5.6, Information about emotional consequences; if providing information about social, environmental or unspecified consequences also code 5.3, Information about social and environmental consequences*  
| prescribing antibiotics for upper respiratory tract infections |  
| 9.3 Comparative imagining of future outcomes  
Prompt or advise the imagining and comparing of future outcomes of changed versus unchanged behaviour | Prompt the person to imagine and compare likely or possible outcomes following attending versus not attending a screening appointment | Prompt the client to imagine the possible future in which they have stopped smoking and compare it with a future where they continue to smoke. |
| 10. Reward and threat  
**10.1 Material incentive (behaviour)**  
Inform that money, vouchers or other valued objects **will be** delivered if and only if there has been effort and/or progress in performing the behaviour (includes ‘**Positive reinforcement**’)  
*Note: if incentive is social, code 10.5, Social incentive if unspecified code 10.6, Non-specific incentive, and not 10.1, Material incentive (behaviour); if incentive is for outcome, code 10.8, Incentive (outcome). If reward is delivered also code one of: 10.2, Material reward (behaviour); 10.3, Non-specific reward; 10.4, Social reward, 10.9, Self-reward; 10.10, Reward (outcome)* | Inform that a financial payment will be made each month in pregnancy that the woman has not smoked | Inform that a financial payment will be made each month in pregnancy that the woman has not smoked  
Inform the client that vouchers will be given for each week in which stop smoking medication is used correctly |
| **10.2 Material reward (behaviour)**  
Arrange for the delivery of money, vouchers or other valued objects if and only if there **has been** effort and/or progress in performing the behaviour (includes ‘**Positive reinforcement**’)  
*Note: If reward is social, code 10.4, Social reward, if unspecified code 10.3, Non-specific reward, and not 10.1, Material reward (behaviour)* | Arrange for the person to receive money that would have been spent on cigarettes if and only if the smoker has not smoked for one month | Arrange for the person to receive money that would have been spent on cigarettes if and only if the smoker has not smoked for one month |
<table>
<thead>
<tr>
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<th>Smoking Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>reward (behaviour); if reward is for <strong>outcome</strong>, code 10.10, Reward (outcome).</td>
<td>Identify something (e.g. an activity such as a visit to the cinema) that the person values and arrange for this to be delivered if and only if they attend for health screening</td>
<td>Identify something (e.g. an activity such as a visit to the cinema) that the person values and arrange for this to be delivered if and only if they have stayed abstinent for a week</td>
</tr>
</tbody>
</table>
| 10.3 Non-specific reward | Arrange delivery of a reward if and only if there has been effort and/or progress in performing the behaviour (includes ‘Positive reinforcement’)  
Note: if reward is material, code 10.2, Material reward (behaviour), if social, code 10.4, Social reward, and not 10.3, Non-specific reward; if reward is for **outcome** code 10.10, Reward (outcome).  
If informed of reward in advance of rewarded behaviour, also code one of: 10.1, Material incentive (behaviour); 10.5, Social incentive; 10.6, Non-specific incentive; 10.7, Self-incentive; 10.8, Incentive (outcome) | Congratulate the person for each day they eat a reduced fat diet | Congratulate the person for each week they do not smoke |
| 10.4 Social reward (behaviour) | Arrange verbal or non-verbal reward if and only if there has been effort and/or progress in performing the behaviour (includes ‘Positive reinforcement’)  
Note: if reward is material, code 10.2, Material reward (behaviour), if unspecified code 10.3, Non-specific reward, and not 10.4, Social reward; if reward is for **outcome** code 10.10, Reward (outcome).  
If informed of reward in advance of rewarded behaviour, also code one of: 10.1, Material incentive (behaviour); 10.5, Social incentive; 10.6, Non-specific incentive; 10.7, Self-incentive; 10.8, Incentive (outcome) | Congratulate the person for each day they eat a reduced fat diet | Give praise or encouragement for improving their adherence to stop smoking medication |
| 10.5 Social incentive | Inform that a verbal or non-verbal reward **will be** delivered if and only if there has been effort and/or progress in performing the behaviour (includes ‘Positive reinforcement’)  
Note: if incentive is material, code 10.1, | Inform that they will be congratulated for each day they eat a reduced fat diet | Inform the client that they will be congratulated by their partner each week they do not smoke |
<table>
<thead>
<tr>
<th>BCT</th>
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<th>Smoking Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Material incentive (behaviour), if unspecified code 10.6, Non-specific incentive, and not 10.5, Social incentive; if incentive is for outcome code 10.8, Incentive (outcome).</strong> If reward is delivered also code one of: 10.2, Material reward (behaviour); 10.3, Non-specific reward; 10.4, Social reward, 10.9, Self-reward; 10.10, Reward (outcome)</td>
<td>Identify an activity that the person values and inform them that this will happen if and only if they attend for health screening</td>
<td>Inform the client that something that they value (not money, e.g. an activity such as a visit to the cinema) will be given if and only if they have not smoked for a month</td>
</tr>
<tr>
<td><strong>10.6 Non-specific incentive</strong> Inform that a reward will be delivered if and only if there has been effort and/or progress in performing the behaviour (includes ‘Positive reinforcement’) Note: if incentive is material, code 10.1, Material incentive (behaviour), if social, code 10.5, Social incentive and not 10.6, Non-specific incentive; if incentive is for outcome code 10.8, Incentive (outcome). If reward is delivered also code one of: 10.2, Material reward (behaviour); 10.3, Non-specific reward; 10.4, Social reward, 10.9, Self-reward; 10.10, Reward (outcome)</td>
<td>Encourage to provide self with material (e.g., new clothes) or other valued objects if and only if they have adhered to a healthy diet</td>
<td>Ask the client to make a plan to give them self a reward (e.g. nice clothes) if and only if they have not smoked for 2 weeks</td>
</tr>
<tr>
<td><strong>10.7 Self-incentive</strong> Plan to reward self in future if and only if there has been effort and/or progress in performing the behaviour Note: if self-reward is material, also code 10.1, Material incentive (behaviour), if social, also code 10.5, Social incentive, if unspecified, also code 10.6, Non-specific incentive; if incentive is for outcome code 10.8, Incentive (outcome). If reward is delivered also code one of: 10.2, Material reward (behaviour); 10.3, Non-specific reward; 10.4, Social reward, 10.9, Self-reward; 10.10, Reward (outcome)</td>
<td>Inform the person that they will receive money if and only if a certain amount of weight is lost</td>
<td>Inform the client that a reward will be delivered if and only if they have made progress in reducing CO-levels of expired air.</td>
</tr>
<tr>
<td><strong>10.8 Incentive (outcome)</strong> Inform that a reward will be delivered if and only if there has been effort and/or progress in achieving the behavioural outcome (includes ‘Positive reinforcement’) Note: this includes social, material, self- and non-specific incentives for outcome; if incentive is for the behaviour code 10.5,</td>
<td></td>
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</tbody>
</table>
### Appendix: Black et al., Variability and effectiveness of comparator...

<table>
<thead>
<tr>
<th>BCT</th>
<th>BCTTv1 Example</th>
<th>Smoking Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Social incentive, 10.1, Material incentive (behaviour), 10.6, Non-specific incentive or 10.7, Self-incentive and not 10.8, Incentive (outcome).</strong> If reward is delivered also code one of: 10.2, Material reward (behaviour); 10.3, Non-specific reward; 10.4, Social reward; 10.9, Self-reward; 10.10, Reward (outcome)</td>
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</tbody>
</table>

**10.9 Self-reward**

Prompt self-praise or self-reward if and only if there has been effort and/or progress in performing the behaviour. **Note:** if self-reward is material, also code 10.2, Material reward (behaviour), if social, also code 10.4, Social reward, if unspecified, also code 10.3, Non-specific reward; if reward is for outcome code 10.10, Reward (outcome). If informed of reward in advance of rewarded behaviour, also code one of: 10.1, Material incentive (behaviour); 10.5, Social incentive; 10.6, Non-specific incentive; 10.7, Self-incentive; 10.8, Incentive (outcome) |

**10.10 Reward (outcome)**

Arrange for the delivery of a reward if and only if there has been effort and/or progress in achieving the behavioural outcome (includes ‘Positive reinforcement’). **Note:** this includes social, material, self- and non-specific rewards for outcome; if reward is for the behaviour code 10.4, Social reward, 10.2, Material reward (behaviour), 10.3, Non-specific reward or 10.9, Self-reward and not 10.10, Reward (outcome). If informed of reward in advance of rewarded behaviour, also code one of: 10.1, Material incentive (behaviour); 10.5, Social incentive; 10.6, Non-specific incentive; 10.7, Self-incentive; 10.8, Incentive (outcome) |

**10.11 Future punishment**

Inform that future punishment or removal of reward will be a consequence of performance of an unwanted behaviour (may include fear arousal) (includes ‘Threat’). Inform that continuing to consume 30 units of alcohol per day is likely to result in loss of employment if the person continues |

Encourage to reward self with material (e.g., new clothes) or other valued objects if and only if they have adhered to a healthy diet |

Encourage the client to praise themselves if and only if they have been abstinent for 2 days |

Arrange for the person to receive money if and only if a certain amount of weight is lost |

Arrange for the client to save all the money they would have spent on cigarettes and buy something they value with it (e.g. a book) if and only if they have received low readings on a carbon monoxide reader for a month |

Inform the client that smoking at work is likely to result in loss of employment with the NHS |
<table>
<thead>
<tr>
<th>BCT</th>
<th>BCTTv1 Example</th>
<th>Smoking Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>11. Regulation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>11.1 Pharmacological support</strong></td>
<td>Suggest the patient asks the family physician for</td>
<td>Enact the necessary procedures to ensure that the client gets their stop smoking medication easily and without charge where appropriate</td>
</tr>
<tr>
<td>Provide, or encourage the use of or</td>
<td>nicotine replacement therapy to facilitate smoking</td>
<td></td>
</tr>
<tr>
<td>adherence to, drugs to facilitate</td>
<td>cessation</td>
<td></td>
</tr>
<tr>
<td>behaviour change</td>
<td></td>
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<tr>
<td><strong>Note:</strong> if pharmacological support to</td>
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<tr>
<td>reduce negative emotions (i.e. anxiety)</td>
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</tr>
<tr>
<td>then also code <strong>11.2, Reduce negative</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>emotions</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>11.2 Reduce negative emotions</strong></td>
<td>Advise on the use of stress management skills, e.g.</td>
<td>Advise on the use of specific relaxation techniques to the client to make it easier to stay abstinent</td>
</tr>
<tr>
<td>Advise on ways of reducing negative</td>
<td>to reduce anxiety about joining Alcoholics Anonymous</td>
<td></td>
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<tr>
<td>emotions to facilitate performance of</td>
<td></td>
<td></td>
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<tr>
<td>the behaviour (includes ‘Stress</td>
<td></td>
<td></td>
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<tr>
<td>Management’)</td>
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<tr>
<td><strong>Note:</strong> if includes analysing the</td>
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<tr>
<td>behavioural problem, also code **1.2,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Problem solving</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>11.3 Conserving mental resources</strong></td>
<td>Advise to carry food calorie content information to</td>
<td>Advise the client to relax as much as possible and get a good night’s sleep while trying to stop smoking.</td>
</tr>
<tr>
<td>Advise on ways of minimising demands on</td>
<td>reduce the burden on memory in making food choices</td>
<td></td>
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<tr>
<td>mental resources to facilitate</td>
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<td></td>
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<tr>
<td>behaviour change</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>11.4 Paradoxical instructions</strong></td>
<td>Advise a smoker to smoke twice as many cigarettes</td>
<td>Advise the client to smoke twice as many cigarettes as they usually do to reduce the motivation to smoke</td>
</tr>
<tr>
<td>Advise to engage in some form of the</td>
<td>a day as they usually do</td>
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</tr>
<tr>
<td>unwanted behaviour with the aim of</td>
<td>Tell the person to stay awake as long as possible</td>
<td></td>
</tr>
<tr>
<td>reducing motivation to engage in that</td>
<td>in order to reduce insomnia</td>
<td></td>
</tr>
<tr>
<td>behaviour</td>
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<td></td>
</tr>
<tr>
<td><strong>12. Antecedents</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>**12.1 Restructuring the physical</td>
<td>Advise to keep biscuits and snacks in a cupboard</td>
<td>Advise the client to remove all tobacco products, lighters and ashtrays from their surroundings</td>
</tr>
<tr>
<td>environment**</td>
<td>that is inconvenient to get to</td>
<td></td>
</tr>
<tr>
<td>Change, or advise to change the physical</td>
<td>Arrange to move vending machine out of the school</td>
<td></td>
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<tr>
<td>environment in order to facilitate</td>
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<tr>
<td>performance of the wanted behaviour or</td>
<td></td>
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<tr>
<td>create barriers to the unwanted</td>
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<tr>
<td>behaviour (other than prompts/cues,</td>
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</tr>
<tr>
<td>rewards and punishments)</td>
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<tr>
<td><strong>Note:</strong> this may also involve <strong>12.3,</strong></td>
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</tr>
<tr>
<td><strong>Avoidance/reducing exposure to cues for</strong></td>
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<tr>
<td>BCT</td>
<td>BCTTv1 Example</td>
<td>Smoking Example</td>
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<tr>
<td>---------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>the behaviour; if restructuring of the social environment code 12.2, Restructuring the social environment; if only adding objects to the environment, code 12.5, Adding objects to the environment</td>
<td>Advise to minimise time spent with friends who drink heavily to reduce alcohol consumption</td>
<td>Advise the client to spend less time with friends who smoke.</td>
</tr>
<tr>
<td>12.2 Restructuring the social environment</td>
<td>Change, or advise to change the social environment in order to facilitate performance of the wanted behaviour or create barriers to the unwanted behaviour (other than prompts/cues, rewards and punishments)</td>
<td>Advise the client to ask smoking family members, housemates, friends and/or colleagues not to smoke in their presence</td>
</tr>
<tr>
<td>Note: this may also involve 12.3, Avoidance/reducing exposure to cues for the behaviour; if also restructuring of the physical environment also code 12.1, Restructuring the physical environment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.3 Avoidance/reducing exposure to cues for the behaviour</td>
<td>Advise on how to avoid exposure to specific social and contextual/physical cues for the behaviour, including changing daily or weekly routines</td>
<td>Suggest to a person who wants to quit smoking that their social life focus on activities other than pubs and bars which have been associated with smoking</td>
</tr>
<tr>
<td>Note: this may also involve 12.1, Restructuring the physical environment and/or 12.2, Restructuring the social environment; if the BCT includes analysing the behavioural problem, only code 1.2, Problem solving</td>
<td></td>
<td>Advise the client to avoid situations such as pubs in which common triggers to smoke occur by changing daily/weekly routines</td>
</tr>
<tr>
<td>12.4 Distraction</td>
<td>Advise or arrange to use an alternative focus for attention to avoid triggers for the unwanted behaviour</td>
<td>Suggest to a person who is trying to avoid between-meal snacking to focus on a topic they enjoy (e.g. holiday plans) instead of focusing on food</td>
</tr>
<tr>
<td>12.5 Adding objects to the environment</td>
<td>Add objects to the environment in order to facilitate performance of the behaviour</td>
<td>Provide free condoms to facilitate safe sex</td>
</tr>
<tr>
<td>Note: Provision of information (e.g. written, verbal, visual) in a booklet or leaflet is insufficient. If this is</td>
<td>Provide attractive toothbrush to improve tooth brushing technique</td>
<td>Arrange for cigarette packets to carry anti-smoking messages and images to encourage reduced smoking rates</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Give the client an</td>
</tr>
</tbody>
</table>
### 13. Identity

**13.1 Identification of self as a role-model**
Inform that one’s own behaviour may be an example to others

**13.2 Framing/reframing**
Suggest the deliberate adoption of a perspective or new perspective on behaviour (e.g. its purpose) in order to change cognitions or emotions about performing the behaviour (includes ‘Cognitive structuring’)

*Note: If information about consequences then code 5.1, Information about health consequences, 5.6, Information about emotional consequences or 5.3, Information about social and environmental consequences instead of 13.2, Framing/reframing

**13.3 Incompatible beliefs**
Draw attention to discrepancies between current or past behaviour and self-image, in order to create discomfort (includes ‘Cognitive dissonance’)

**13.4 Valued self-identity**
Advise the person to write or complete rating scales about a cherished value or personal strength as a means of affirming the person’s identity as part of a behaviour change strategy (includes ‘Self-affirmation’)

**13.5 Identity associated with changed behaviour**
Advise the person to construct a new self-identity as someone who ‘used to engage with the unwanted behaviour’

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### BCT

accompanied by social support, also code

**3.2, Social support (practical), if the environment is changed beyond the addition of objects, also code 12.1, Restructuring the physical environment**

### BCTv1 Example

Inform the person that if they eat healthily, that may be a good example for their children

Suggest that the person might think of the tasks as reducing sedentary behaviour (rather than increasing activity)

Draw attention to a doctor’s liberal use of blood transfusion and their self-identification as a proponent of evidence-based medical practice

Advise the person to write about their personal strengths before they receive a message advocating the behaviour change

Ask the person to articulate their new identity as an ‘ex-smoker’

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### Smoking Example

electronic medication monitoring device, which indicates whether or not they have taken their medication today.

Suggest the client that if they quit smoking, they would be a good role-model for smoking friends

Suggest the client deliberately adopts a different, more positive view on past failed quit attempts or lapses (e.g. advise that lapses can be viewed as a valuable learning experience that can help with this quit attempt)

Draw attention to the fact that the client sees themselves as athletic, but at the same time is reducing their athletic ability by smoking

Advise the client to write or talk about a cherished value or personal strength as a means to affirming their identity in order to strengthen their ability to quit smoking

Ask the person to articulate their new identity as an ‘ex-smoker’
## 14. Scheduled consequences

<table>
<thead>
<tr>
<th>BCT</th>
<th>BCTTv1 Example</th>
<th>Smoking Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>14.1 Behaviour cost</strong></td>
<td>Subtract money from a prepaid refundable deposit when a cigarette is smoked</td>
<td>Subtract money from a prepaid refundable deposit when a cigarette is smoked</td>
</tr>
<tr>
<td>Arrange for withdrawal of something valued if and only if an unwanted behaviour is performed (includes ‘Response cost’). Note if withdrawal of contingent reward code, <strong>14.3, Remove reward</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>14.2 Punishment</strong></td>
<td>Arrange for the person to wear unattractive clothes following consumption of fatty foods</td>
<td>Arrange that the client has to do their housemates tasks (e.g. the laundry) when they smoke a cigarette this week</td>
</tr>
<tr>
<td>Arrange for aversive consequence contingent on the performance of the unwanted behaviour</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>14.3 Remove reward</strong></td>
<td>Arrange for the other people in the household to ignore the person every time they eat chocolate (rather than attending to them by criticising or persuading)</td>
<td>Arrange for household members to ignore the client if the client is smoking a cigarette</td>
</tr>
<tr>
<td>Arrange for discontinuation of contingent reward following performance of the unwanted behaviour (includes ‘Extinction’)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>14.4 Reward approximation</strong></td>
<td>Arrange reward for any reduction in daily calories, gradually requiring the daily calorie count to become closer to the planned calorie intake</td>
<td>Arrange for money to be given to the client each week they successfully cut down smoking by any number of cigarettes gradually requiring this reduction in number of cigarettes to be greater and approach cessation.</td>
</tr>
<tr>
<td>Arrange for reward following any approximation to the target behaviour, gradually rewarding only performance closer to the wanted behaviour (includes ‘Shaping’)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>14.5 Rewarding completion</strong></td>
<td>Reward eating a supplied low-calorie meal; then make reward contingent on cooking and eating the meal; then make reward contingent on purchasing, cooking and eating the meal</td>
<td>Reward quitting in pregnant smokers; then make reward contingent on staying abstinent for a week; then make reward contingent on staying abstinent for a month; then make reward contingent on staying abstinent until the baby is born.</td>
</tr>
<tr>
<td>Build up behaviour by arranging reward following final component of the behaviour; gradually add the components of the behaviour that occur earlier in the behavioural sequence (includes ‘Backward chaining’)</td>
<td>Reward taking supplied stop smoking medication;</td>
<td>Reward taking supplied stop smoking medication;</td>
</tr>
<tr>
<td>Note: also code one of <strong>10.2, Material reward (behaviour); 10.3, Non-specific reward; 10.4, Social reward, 10.9, Self-reward; 10.10, Reward (outcome)</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### BCTTv1 Example

14.6 Situation-specific reward
Arrange for reward following the behaviour in one situation but not in another (includes ‘Discrimination training’)
*Note: also code one of 10.2, Material reward (behaviour); 10.3, Non-specific reward; 10.4, Social reward; 10.9, Self-reward; 10.10, Reward (outcome)*

14.7 Reward incompatible behaviour
Arrange reward for responding in a manner that is incompatible with a previous response to that situation (includes ‘Counter-conditioning’)
*Note: also code one of 10.2, Material reward (behaviour); 10.3, Non-specific reward; 10.4, Social reward; 10.9, Self-reward; 10.10, Reward (outcome)*

14.8 Reward alternative behaviour
Arrange reward for performance of an alternative to the unwanted behaviour (includes ‘Differential reinforcement’)
*Note: also code one of 10.2, Material reward (behaviour); 10.3, Non-specific reward; 10.4, Social reward; 10.9, Self-reward; 10.10, Reward (outcome); consider also coding 1.2, Problem solving*

14.9 Reduce reward frequency
Arrange for rewards to be made contingent on increasing duration or frequency of the behaviour (includes ‘Thinning’)
*Note: also code one of 10.2, Material*

### Smoking Example

then make reward contingent on prompted purchasing and taking medication; then make reward contingent on self-initiated purchasing of medication and taking medication.

Arrange for a reward to be given to the client for not smoking after a meal but do not give a reward for not smoking during a meal (when they would normally not not smoke).

Arrange for client to be rewarded for arranging to meet friends, whom they have previously met in a venue where smoking was allowed, in a non-smoking venue.

Arrange for the client to receive a reward if he eats a lollipop when feeling the urge to smoke rather than smoking a cigarette.

Arrange for the client to receive a reward if they buy something else (e.g. a magazine) at their local cigarette shop, rather than cigarettes.

Arrange reward for each day without smoking, then each week, then each month, then every 2 months and so on.
### Appendix: Black et al., Variability and effectiveness of comparator...

<table>
<thead>
<tr>
<th>BCT</th>
<th>BCTTv1 Example</th>
<th>Smoking Example</th>
</tr>
</thead>
</table>
| **14.10 Remove punishment**  
Arrange for removal of an unpleasant consequence contingent on performance of the wanted behaviour (includes *Negative reinforcement*) | Arrange for someone else to do housecleaning only if the person has adhered to the medication regimen for a week | Arrange that a housemate will take up some of the disliked household tasks (e.g. cleaning) if the client does not smoke for a week |

### 15. Self-belief

| 15.1 Verbal persuasion about capability  
Tell the person that they can successfully perform the wanted behaviour, arguing against self-doubts and asserting that they can and will succeed | Tell the person that they can successfully increase their physical activity, despite their recent heart attack. | Tell the person that they can quit smoking even though previous quit attempts have not been successful |
| 15.2 Mental rehearsal of successful performance  
Advise to practise imagining performing the behaviour successfully in relevant contexts | Advise to imagine eating and enjoying a salad in a work canteen | Advise the client to imagine successfully not smoking in specific situations in which one usually smokes (e.g. after dinner, at a party). |
| 15.3 Focus on past success  
Advise to think about or list previous successes in performing the behaviour (or parts of it) | Advise to describe or list the occasions on which the person had ordered a non-alcoholic drink in a bar | Ask the client to describe times when they have successfully gone without a cigarette in a situation in which they would normally have smoked |
| 15.4 Self-talk  
Prompt positive self-talk (aloud or silently) before and during the behaviour | Prompt the person to tell themselves that a walk will be energising | Prompt the client to tell themselves when they feel urges to smoke that they will be able to get through the day without smoking |

### 16. Covert learning
<table>
<thead>
<tr>
<th>BCT</th>
<th>BCTTv1 Example</th>
<th>Smoking Example</th>
</tr>
</thead>
</table>
| **16.1 Imaginary punishment**  
Advise to imagine performing the **unwanted** behaviour in a real-life situation followed by imagining an unpleasant consequence (includes *'Covert sensitisation'*). | Advise to imagine overeating and then vomiting. | Advise the client to imagine starting smoking again and feeling unhealthy, unhappy and low on energy. |
| **16.2 Imaginary reward**  
Advise to imagine performing the **wanted** behaviour in a real-life situation followed by imagining a pleasant consequence (includes *'Covert conditioning'*). | Advise the health professional to imagine giving dietary advice followed by the patient losing weight and no longer being diabetic. | Advise the client to imagine feeling healthier, happier and more energetic after successfully having quit smoking. |
| **16.3 Vicarious consequences**  
Prompt observation of the consequences (including rewards and punishments) for others when they perform the behaviour.  
*Note: if observation of health consequences, also code 5.1, Information about health consequences; if of emotional consequences, also code 5.6, Information about emotional consequences, if of social, environmental or unspecified consequences, also code 5.3, Information about social and environmental consequences.* | Draw attention to the positive comments other staff get when they disinfect their hands regularly. | Draw attention to compliments other people get when they quit smoking. |


Supplemental Figure A1.

Decision Tree used to Rate the Quality of Comparator (and Experimental) Group Intervention Descriptions

Has the content of (almost) all intervention materials and/or procedures been described (quantity) and in enough detail to allow for (almost) all BCTs to be coded (quality)?

Yes

Well-Described (3)

No

Has the content of less than half of the intervention materials and procedures been described (quantity), and/or do the content descriptions lack detail to allow for accurately coding at least half the content/BCTs (quality)?

No

Moderately Described (2)

Yes

Has the content of (almost) none of the materials been described (quantity), or do the content descriptions lack detail to allow for coding (almost) any BCTs (quality)?

No

Poorly Described (1)

Yes

Not Described (0)
### Supplemental Table A2.

**Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Checklist**

<table>
<thead>
<tr>
<th>Section/topic</th>
<th>#</th>
<th>Checklist item</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TITLE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Title</td>
<td>1</td>
<td>Identify the report as a systematic review, meta-analysis, or both.</td>
<td>1</td>
</tr>
<tr>
<td><strong>ABSTRACT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structured summary</td>
<td>2</td>
<td>Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.</td>
<td>2</td>
</tr>
<tr>
<td><strong>INTRODUCTION</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rationale</td>
<td>3</td>
<td>Describe the rationale for the review in the context of what is already known.</td>
<td>3-4</td>
</tr>
<tr>
<td>Objectives</td>
<td>4</td>
<td>Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).</td>
<td>4-5</td>
</tr>
<tr>
<td><strong>METHODS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protocol and registration</td>
<td>5</td>
<td>Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.</td>
<td>4-6</td>
</tr>
<tr>
<td>Eligibility criteria</td>
<td>6</td>
<td>Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.</td>
<td>5</td>
</tr>
<tr>
<td>Information sources</td>
<td>7</td>
<td>Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.</td>
<td>5</td>
</tr>
<tr>
<td>Search</td>
<td>8</td>
<td>Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.</td>
<td>NA</td>
</tr>
<tr>
<td>Study selection</td>
<td>9</td>
<td>State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).</td>
<td>9, Protocol</td>
</tr>
<tr>
<td>Data collection process</td>
<td>10</td>
<td>Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.</td>
<td>5-7</td>
</tr>
<tr>
<td>Data items</td>
<td>11</td>
<td>List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.</td>
<td>5-7</td>
</tr>
<tr>
<td>Risk of bias in individual studies</td>
<td>12</td>
<td>Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.</td>
<td>NA</td>
</tr>
<tr>
<td>Summary measures</td>
<td>13</td>
<td>State the principal summary measures (e.g., risk ratio, difference in means).</td>
<td>7</td>
</tr>
<tr>
<td>Section/topic</td>
<td>#</td>
<td>Checklist item</td>
<td>Page</td>
</tr>
<tr>
<td>-------------------------------</td>
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</tr>
<tr>
<td>Synthesis of results</td>
<td>14</td>
<td>Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I²) for each meta-analysis.</td>
<td>7-9</td>
</tr>
<tr>
<td>Risk of bias across studies</td>
<td>15</td>
<td>Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).</td>
<td>NA</td>
</tr>
<tr>
<td>Additional analyses</td>
<td>16</td>
<td>Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.</td>
<td>7-9</td>
</tr>
</tbody>
</table>

**RESULTS**

| Study selection               | 17 | Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram. | Figure 1 |
| Study characteristics         | 18 | For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations. | A29-A36, attached data |
| Risk of bias within studies   | 19 | Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12). | NA   |
| Results of individual studies | 20 | For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot. | Attached data |
| Synthesis of results          | 21 | Present results of each meta-analysis done, including confidence intervals and measures of consistency. | NA   |
| Risk of bias across studies   | 22 | Present results of any assessment of risk of bias across studies (see Item 15). | NA   |
| Additional analysis           | 23 | Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]). | 9-12, A37-A42 |

**DISCUSSION**

| Summary of evidence           | 24 | Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers). | 12-15 |
| Limitations                   | 25 | Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias). | 14   |
| Conclusions                   | 26 | Provide a general interpretation of the results in the context of other evidence, and implications for future research. | 12-16 |

**FUNDING**

| Funding                       | 27 | Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review. | 1    |
Appendix B: Additional results information

Studies Included in this Systematic Review


35. Danielsson T, Jones K, Rössner S, Westin Å. Open randomised trial of intermittent very low energy diet together with nicotine gum for stopping smoking in women who gained weight in previous attempts to quitCommentary: Results are unlikely to be as good in routine practice. *BMJ.* 1999;319(7208):490-494.

36. Davis JM, Goldberg SB, Anderson MC, Manley AR, Smith SS, Baker TB. Randomized trial on


73. Leischow SJ, Muramoto ML, Cook GN, Merikle EP, Castellini SM, Otte PS. OTC nicotine patch:


Appendix: Black et al., Variability and effectiveness of comparator...

**Exploratory and Sensitivity Analyses**

*Interactions Effects by Time and BCT Target on Smoking Cessation Rates*

There was no significant interaction effect between time and BCTs on cessation rates either when the total smoking cessation BCTs were considered ($B = -0.006, p = .396$), or when personalised ($B = -0.039, p = .084$) and non-personalised ($B = 0.001, p = .944$) smoking cessation BCTs were considered separately. When the cluster robust re-estimation was used, there was evidence of a declining effect of personalised BCTs over time ($p = .013$), whereas results for the total number and non-personalised BCTs remained largely unchanged ($p = .387, .937$, respectively).

When examining the separate effects of quitting and abstinence BCTs within the same model, only the abstinence BCTs predicted smoking cessation rates (quitting: $B = 0.003, p = .789$; abstinence: $B = 0.069, p = .025$). As noted in the analysis plan, these two variables were highly correlated (Pearson’s $r = .77, p < .001$). When these were considered in separate models, both quitting ($B = 0.024, p = .002$) and abstinence ($B = 0.075, p < .001$) BCTs predicted smoking cessation rates. Finally, there was no evidence that quitting and abstinence BCTs interacted in their effect on smoking cessation rates (interaction term $B = -0.002, p = .370$).
Predicting Smoking Cessation while including all $p < .1$ Predictors

As described in the analysis plan, a sensitivity analysis adding all predictors demonstrating $p < .1$ into one model was pre-specified (pp. 9-10, https://osf.io/24pzj/). Results of this analysis are presented in Supplemental Table S1, below.

Supplemental Table B1

Results of Sensitivity Analysis Including all Predictors Demonstrating $p < .1$ [B (SE)]

<table>
<thead>
<tr>
<th></th>
<th>B (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Received medication (1 = yes, 0 = no)</td>
<td>0.213 (0.159)</td>
</tr>
<tr>
<td>Personalised smoking cessation BCTs</td>
<td>-0.126 (0.060) *</td>
</tr>
<tr>
<td>Non-personalised smoking cessation BCTs</td>
<td>0.007 (0.009)</td>
</tr>
<tr>
<td>Mode of delivery (1 = person-delivered, 0 = written)</td>
<td>-0.425 (0.306)</td>
</tr>
<tr>
<td>Personalised smoking cessation BCTs × mode of delivery</td>
<td>0.165 (0.063) **</td>
</tr>
<tr>
<td>Treatment engagement BCTs</td>
<td>0.161 (0.076) *</td>
</tr>
</tbody>
</table>

Note. BCT = behaviour change technique. Model was controlled for mean age, mean Fagerström Test for Nicotine Dependence, length of follow-up, cotinine verification, and point prevalence vs. sustained abstinence. Variables that formed part of interaction terms were not mean-centred. The ‘main’ effects of these variables should be interpreted as the effect of that variable when the other from the interaction term = 0. E.g., the ‘main’ effect of personalised BCTs is the simple effect when mode of delivery is written (mode of delivery = 0) and the ‘main’ effect of mode of delivery is the simple effect when no personalised BCTs were delivered (Personalised BCTs = 0). *** $p < .001$, ** $p < .01$, * $p < .05$, † $p < .1$. 
Appendix: Black et al., Variability and effectiveness of comparator...

Predicting Smoking Cessation while including All\textsuperscript{a} Studies and Controlling for Attrition

As described in the analysis plan, sensitivity analyses including all\textsuperscript{a} studies (not just the well-described ones) and including attrition were pre-specified (p. 10, [https://osf.io/24pzj/](https://osf.io/24pzj)). Results of these sensitivity analyses are presented in Supplemental Table S2, below.

Supplemental Table B2

Results of Sensitivity Analyses Including All Studies and Including Attrition as a Covariate [B (SE)]

<table>
<thead>
<tr>
<th>Model 1</th>
<th>Primary Model</th>
<th>With All\textsuperscript{a} Studies Included</th>
<th>With Attrition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Received medication (1 = yes, 0 = no)</td>
<td>0.334 (0.155) *</td>
<td>0.301 (0.149) *</td>
<td>0.264 (0.149) †</td>
</tr>
<tr>
<td>Total smoking cessation BCTs</td>
<td>0.020 (0.006) ***</td>
<td>0.016 (0.006) *</td>
<td>0.124 (0.067) †</td>
</tr>
<tr>
<td>Description quality</td>
<td>-0.009 (0.084)</td>
<td>0.085 (0.101)</td>
<td></td>
</tr>
<tr>
<td>Total smoking cessation BCTs × description quality\textsuperscript{b}</td>
<td></td>
<td>-0.036 (0.022)</td>
<td></td>
</tr>
<tr>
<td>Attrition</td>
<td></td>
<td></td>
<td>-1.353 (0.405) ***</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model 2</th>
<th>Primary Model</th>
<th>With All\textsuperscript{a} Studies Included</th>
<th>With Attrition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Received medication (1 = yes, 0 = no)</td>
<td>0.346 (0.156) *</td>
<td>0.316 (0.149) *</td>
<td>0.274 (0.149) †</td>
</tr>
<tr>
<td>Personalised smoking cessation BCTs</td>
<td>0.038 (0.022) †</td>
<td>0.041 (0.023) †</td>
<td>0.511 (0.227) *</td>
</tr>
<tr>
<td>Non-personalised smoking cessation BCTs</td>
<td>0.016 (0.008) *</td>
<td>0.010 (0.008)</td>
<td>0.065 (0.074)</td>
</tr>
<tr>
<td>Description quality</td>
<td>-0.009 (0.084)</td>
<td>0.098 (0.101)</td>
<td></td>
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<tr>
<td>Personalised smoking cessation BCTs × description quality\textsuperscript{b}</td>
<td></td>
<td>-0.160 0.077 *</td>
<td></td>
</tr>
<tr>
<td>Non-personalised smoking cessation BCTs × description quality\textsuperscript{b}</td>
<td></td>
<td>-0.018 0.025</td>
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</tr>
<tr>
<td>Attrition</td>
<td></td>
<td></td>
<td>-1.357 (0.404) ***</td>
</tr>
</tbody>
</table>
### Appendix: Black et al., Variability and effectiveness of comparator...

<table>
<thead>
<tr>
<th>Model 3</th>
<th>Primary Model</th>
<th>With All Studies Included</th>
<th>With Attrition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Received medication (1 = yes, 0 = no)</td>
<td>0.266 (0.166)</td>
<td>0.228 (0.162)</td>
<td>0.188 (0.162)</td>
</tr>
<tr>
<td>Total smoking cessation BCTs</td>
<td>-0.020 (0.027)</td>
<td>-0.020 (0.023)</td>
<td>0.085 (0.072)</td>
</tr>
<tr>
<td>Mode of delivery (1 = person-delivered, 0 = written)</td>
<td>-0.605 (0.546)</td>
<td>-0.422 (0.421)</td>
<td>-0.418 (0.416)</td>
</tr>
<tr>
<td>Total smoking cessation BCTs × mode of deliveryb</td>
<td>0.042 (0.028)</td>
<td>0.035 (0.024)</td>
<td>0.035 (0.024)</td>
</tr>
<tr>
<td>Description quality</td>
<td>0.020 (0.095)</td>
<td>0.122</td>
<td>0.115</td>
</tr>
<tr>
<td>Total smoking cessation BCTs × description qualityb</td>
<td>-0.035</td>
<td>0.023</td>
<td></td>
</tr>
<tr>
<td>Attrition</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model 4</th>
<th>Primary Model</th>
<th>With All Studies Included</th>
<th>With Attrition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Received medication (1 = yes, 0 = no)</td>
<td>0.231 (0.164)</td>
<td>0.213 (0.161)</td>
<td>0.182 (0.161)</td>
</tr>
<tr>
<td>Personalised smoking cessation BCTs</td>
<td>-0.131 (0.068) †</td>
<td>-0.123 (0.076)</td>
<td>0.345 (0.242)</td>
</tr>
<tr>
<td>Non-personalised smoking cessation BCTs</td>
<td>0.031 (0.038)</td>
<td>0.019 (0.035)</td>
<td>0.064 (0.083)</td>
</tr>
<tr>
<td>Mode of delivery (1 = person-delivered, 0 = written)</td>
<td>-0.235 (0.564)</td>
<td>-0.243 (0.436)</td>
<td>-0.367 (0.435)</td>
</tr>
<tr>
<td>Personalised smoking cessation BCTs × mode of deliveryb</td>
<td>0.186 (0.071) **</td>
<td>0.177 (0.079) *</td>
<td>0.173 (0.078) *</td>
</tr>
<tr>
<td>Non-personalised smoking cessation BCTs × mode of deliveryb</td>
<td>-0.016 (0.039)</td>
<td>-0.012 (0.036)</td>
<td>-0.004 (0.036)</td>
</tr>
<tr>
<td>Description quality</td>
<td>0.013 (0.093)</td>
<td>0.125 (0.112)</td>
<td></td>
</tr>
<tr>
<td>Personalised smoking cessation BCTs × description qualityb</td>
<td>-0.157 (0.077) *</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-personalised smoking cessation BCTs × description qualityb</td>
<td>-0.017 (0.025)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attrition</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model 5</th>
<th>Primary Model</th>
<th>With All Studies Included</th>
<th>With Attrition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Received medication (1 = yes, 0 = no)</td>
<td>0.429 (0.251) †</td>
<td>0.350 (0.222)</td>
<td>0.254 (0.226)</td>
</tr>
<tr>
<td>Total smoking cessation BCTs</td>
<td>0.010 (0.008)</td>
<td>0.005 (0.009)</td>
<td>0.128 (0.067) †</td>
</tr>
<tr>
<td>Description</td>
<td>Coefficient</td>
<td>Standard Error</td>
<td>Coefficient</td>
</tr>
<tr>
<td>-------------</td>
<td>-------------</td>
<td>----------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Treatment engagement BCTs</td>
<td>0.176 (0.079) *</td>
<td>0.181 (0.086) *</td>
<td>0.196 (0.086) *</td>
</tr>
<tr>
<td>Medication adherence BCTs</td>
<td>0.044 (0.078)</td>
<td>0.043 (0.084)</td>
<td>0.042 (0.083)</td>
</tr>
<tr>
<td>Medication adherence BCTs × received medication&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-0.067 (0.089)</td>
<td>-0.054 (0.092)</td>
<td>-0.035 (0.092)</td>
</tr>
<tr>
<td>Description quality</td>
<td>-0.012 (0.083)</td>
<td>0.095 (0.100)</td>
<td></td>
</tr>
<tr>
<td>Total smoking cessation BCTs × description quality&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-0.042 (0.023) †</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attrition</td>
<td>-1.312 (0.398) ***</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Model 6

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Primary Model</th>
<th>With All&lt;sup&gt;a&lt;/sup&gt; Studies Included</th>
<th>With Attrition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Received medication (1 = yes, 0 = no)</td>
<td>0.399 (0.260)</td>
<td>0.309 (0.227)</td>
<td>0.224 (0.230)</td>
</tr>
<tr>
<td>Personalised smoking cessation BCTs</td>
<td>0.021 (0.023)</td>
<td>0.026 (0.025)</td>
<td>0.525 (0.224) *</td>
</tr>
<tr>
<td>Non-personalised smoking cessation BCTs</td>
<td>0.007 (0.011)</td>
<td>-0.001 (0.011)</td>
<td>0.069 (0.074)</td>
</tr>
<tr>
<td>Treatment engagement BCTs</td>
<td>0.171 (0.080) *</td>
<td>0.171 (0.087) *</td>
<td>0.191 (0.086) *</td>
</tr>
<tr>
<td>Medication adherence BCTs</td>
<td>0.046 (0.078)</td>
<td>0.048 (0.085)</td>
<td>0.048 (0.083)</td>
</tr>
<tr>
<td>Medication adherence BCTs × received medication&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-0.057 (0.092)</td>
<td>-0.039 (0.094)</td>
<td>-0.026 (0.093)</td>
</tr>
<tr>
<td>Description quality</td>
<td>-0.013 (0.083)</td>
<td>0.108 (0.100)</td>
<td></td>
</tr>
<tr>
<td>Personalised smoking cessation BCTs × description quality&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-0.169 (0.076) *</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-personalised smoking cessation BCTs × description quality&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-0.023 (0.025)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attrition</td>
<td>-1.319 (0.400) ***</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note.** BCT = behaviour change technique. All models were controlled for mean age, mean Fagerström Test for Nicotine Dependence, length of follow-up, cotinine verification, and point prevalence vs. sustained abstinence. *** p < .001, ** p < .01, * p < .05, † p < .1.

<sup>a</sup> All comparator groups were included regardless of the quality of their BCT descriptions; however, seven groups still had to be excluded due to missing data on the control variables.

<sup>b</sup> Variables that formed part of interaction terms were not mean-centred. The ‘main’ effects of these variables should be interpreted as the effect of that variable when the other from the interaction term = 0. E.g., in Model 3, the ‘main’ effect of BCTs is the simple effect when mode of delivery is written (mode of delivery = 0) and the ‘main’ effect of mode of delivery is the simple effect when no BCTs were delivered (BCTs = 0).
Interactions Effects by Smoking Cessation BCTs and Receipt of Medication on Smoking Cessation Rates

During the peer review process, one reviewer raised the interesting suggestion of whether the impacts of smoking cessation BCTs and medication on smoking cessation can be considered independently, or whether they interact with one another to influence smoking cessation. To investigate this, we conducted unplanned exploratory analyses to test these interactions. We found no evidence that receipt of medication interacted with the total number of smoking cessation BCTs ($B = 0.000, p = .981$), the number of personalised smoking cessation BCTs ($B = 0.009, p = .839$), or the number of non-personalised smoking cessation BCTs ($B = -0.001, p = .942$).