

## **Enhancing Behavior Change Technique Coding Methods: Identifying Behavioral Targets and Delivery Styles in Smoking Cessation Trials**

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## Abstract

1  
2 Background. The behavior change technique (BCT) taxonomy v1 is often used in systematic  
3 reviews for identifying active components of interventions. Its utility could be enhanced by  
4 linking BCTs to specific target behaviors and qualifying BCT delivery style. Purpose. To  
5 determine whether behavioral targets and delivery styles of BCTs can be coded reliably, and  
6 to determine the utility of coding these characteristics. Methods. As part of a large systematic  
7 review of 142 smoking cessation trials, two researchers independently coded publicly and  
8 privately held intervention and comparator group materials, specifying the behavioral target  
9 (quitting, abstinence, medication adherence, or treatment engagement) and delivery style  
10 (tailored vs. not tailored; active participation vs. passive receipt) of each BCT. Results.  
11 Researchers coded 3843 BCTs, which were reliably attributed to behavioral targets ( $AC_1 =$   
12  $0.92$ , PABAK =  $0.91$ ). Tailoring ( $AC_1 = 0.80$ , PABAK =  $0.74$ ) and participation ( $AC_1 = 0.71$ ,  
13 PABAK =  $0.64$ ) were also coded reliably. There was considerable variability between groups  
14 in quitting and abstinence BCTs (ranges: 0-41; 0-18) and in tailoring and participation  
15 (ranges: 0-20; 0-32), but less variability for medication adherence and treatment engagement  
16 (ranges: 0-6; 0-7). Conclusions. Behavioral targets and delivery styles of BCTs can be  
17 reliably identified and occur with sufficient frequency in smoking cessation trials for  
18 inclusion in quantitative syntheses (e.g., meta-regression analyses). Systematic reviewers  
19 could consider adopting these methods to evaluate the impact of intervention components  
20 targeting different behaviors, as well as the benefits of different BCT delivery styles.  
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46 Key words: *behavior change technique, smoking cessation, reliability, systematic review,*  
47 *delivery style, tailoring*  
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## Enhancing Behavior Change Technique Coding Methods:

### Identifying Behavioral Targets and Delivery Styles in Smoking Cessation Trials

Health risk behaviors such as tobacco smoking are important causes of disease and disability (1), health care expenditure (2), and societal costs related to loss of labor (3).

Numerous behavioral interventions have been, and continue to be, developed, evaluated, and published; however, suboptimal reporting of these interventions limits their implementation, replication, and synthesis. The behavior change technique taxonomy v1 (BCTTv1) was developed to introduce a shared language for reporting the content of behavioral interventions (4). It has also been widely adopted by both primary researchers, and by systematic reviewers as a tool for coding the behavior change techniques (BCTs) delivered in interventions and for identifying potentially effective BCTs via meta-regression analyses (e.g., 5-8). The current study examined whether the utility of the BCTTv1 as a coding tool can be extended by identifying factors that might influence the capacity of interventions to modify behavior; namely, the behavioral target and delivery style of each BCT (9).

Intervention development frameworks systematically build these features into interventions. For example, the widely used Intervention Mapping framework starts by specifying the desired behavioral outcome and the specific preparatory and supportive behaviors leading to that outcome (10). Behavioral interventions for smoking cessation—the focus of the present study—require that a person first quits smoking (behavior 1) and then remains abstinent (behavior 2; the behavioral outcome). Theoretical accounts of behavior change initiation and maintenance suggest that different factors, and thus different BCTs, will affect success in quitting compared to abstinence (11, 12). Further, smoking cessation interventions are often supplemented with pharmacotherapy, which is most likely to work if the person adheres to its recommended use (behavior 3). Similarly, for people to experience optimal benefits from the smoking cessation program in which they are participating, their

1 engagement in the program (behavior 4) is important. Different BCTs may be effective in  
2 influencing these four different behaviors. Additionally, the impact of BCTs on the  
3 behavioral outcome (e.g., smoking cessation at 12 months) may vary depending on the  
4 relevance of the specific behavior targeted by these BCTs (i.e., quitting, abstinence,  
5 adherence, engagement). Accordingly, to understand the active content of these interventions,  
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7 it is important to examine which BCTs target which behaviors.  
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14 Intervention Mapping further specifies that how a BCT is applied will influence its  
15 effectiveness in changing behavior (10). For example, the Elaboration Likelihood Model  
16 asserts that the degree of effect of interventions on attitudes and behaviors varies along a  
17 continuum and depends on characteristics of the intervention and the participant (13).  
18 Specifically, interventions that involve participant-relevant content and that require effortful  
19 elaboration from the participant should lead to larger changes in attitudes and behaviors than  
20 those that are less relevant and require little effort to process. From this it follows that  
21 interventions that actively engage participants and are tailored to participant characteristics  
22 should produce larger changes in behavior. Indeed, results from meta-analyses support these  
23 claims (14-17). Many BCTs in the BCTTv1 are defined in such a way that they may or may  
24 not be tailored or require active participant engagement. For example, BCT 5.1 ‘information  
25 about health consequences’ may include personalized information based on the participant’s  
26 assessed health status (tailored), general health consequences (not tailored), be delivered via  
27 collaborative discussion (active), or be delivered via a leaflet (passive). These delivery styles  
28 were included in an earlier BCT taxonomy for medication adherence (18, 19) but have not yet  
29 been applied to BCTs used in smoking cessation trials. Identifying these two styles of BCT  
30 delivery (tailoring and participation) is an important step in fully specifying the active content  
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58 Enhancing investigation of BCT effects by considering BCT coding in relation to  
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1 coding of behavioral targets and style of BCT delivery could benefit both evidence syntheses  
2 and intervention development and delivery. Those synthesizing evidence on interventions  
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4 could not only identify the associations between BCTs and intervention effectiveness, but  
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6 also identify which BCTs are effective in promoting behavior initiation versus behavior  
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8 maintenance, whether intervention components targeting auxiliary behaviors such as  
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10 medication adherence and treatment engagement result in better outcomes, and whether the  
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12 effectiveness of BCTs varies depending on the delivery style. Those developing and  
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14 delivering interventions could use these systematic reviews to gain a clearer picture of the  
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16 content of effective interventions than would be offered by systematic reviews that only  
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18 specify the BCTs used. This is likely to increase the replicability of effective interventions  
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20 and their active components.  
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27 There is general consensus that it is important to achieve adequate inter-coder  
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29 reliability on BCTs extracted from published intervention descriptions, and this has been  
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31 demonstrated for the majority of BCTs included in the BCTTv1 (20). In this study we will  
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33 examine whether (1) BCTs can be reliably attributed to specific target behaviors and whether  
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35 the BCT delivery styles can be reliably identified, and (2) these behaviors and delivery styles  
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37 are occurring with sufficient frequency to make this additional data extraction work useful for  
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39 enhancing intervention replicability and meta-analyses.  
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## 43 Method

### 44 Design

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46 This study is part of a larger, ongoing review of smoking cessation trials (IC-  
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48 SMOKE; PROSPERO registration number CRD42015025251; 21). Full details, including the  
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50 data, of all outputs from the IC-SMOKE project will be available on the project's Open  
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52 Science Framework page (<https://osf.io/23hfv/>) upon publication.  
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58 The Cochrane Tobacco Addiction Group Specialized Register was searched for  
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1 randomized controlled trials (RCTs) assessing the impact of behavioral interventions (with or  
2 without pharmacological support) on biochemically verified smoking cessation at six months  
3 or longer. Trials were excluded if they were published before 1996 or after November 1<sup>st</sup>  
4 2015 (the search date), were not reported in English or in peer-reviewed journals, or if the  
5 participants were aged under 18 years (21).  
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### 11 **Data Extraction**

12 Data were first collected from the *publicly available materials* (e.g., the primary trial  
13 articles and appendices, but also protocols and additional publications such as intervention  
14 development papers). Additionally, a comprehensive procedure was used for contacting  
15 authors of all included trials to request additional materials describing their experimental and  
16 comparator interventions in order to obtain *privately held materials* (e.g., intervention  
17 manuals, practitioner training materials, websites, self-help materials; 21). While not  
18 pertinent to the current study as it does not allow for calculating reliability or identifying  
19 tailoring and participation, it should be noted that authors were also asked to complete a brief  
20 checklist detailing the active content delivered to the comparator group in their trial  
21 (discussed further in the discussion). Publicly available materials—besides the primary  
22 article, which was retrieved for all groups—were retrieved for 59% of groups (intervention:  
23 61%; comparator: 56%) and privately held materials were retrieved for 45% of groups  
24 (intervention: 51%; comparator: 37%). When checklist responses are included, privately held  
25 materials/information were retrieved for 64% of groups (intervention: 63%; comparator:  
26 65%). The procedure for retrieving additional materials took approximately eight months,  
27 with one final response received at eleven months.  
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52 Identifying BCTs, their behavioral targets, and delivery styles in these materials  
53 involved two steps: independent coding and discussion to resolve disagreements. First, two  
54 independent researchers coded materials for the presence of each of the 93 BCTs in the  
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BCTTv1 (4). Minor adaptations to the taxonomy were made prior to coding, including the removal of BCT 8.5 (overcorrection), as it was unclear how this would be used in this context, the addition of a BCT 4.5 (tell to act, defined as ‘tell the person to perform the target behavior’), and the inclusion of smoking cessation examples for each BCT, to enhance validity and inter-coder reliability. For efficiency, the BCT coding sheet was designed such that the additional properties could be coded without additional note taking (see definitions of these properties in Table 1 and a simplified illustration of the coding sheet in Figure 1). Researchers read the materials and each time a new BCT was identified, the BCT code and source quote were entered into the first two columns. It was possible for a single quote to contain multiple BCTs. This was followed by columns for tailoring and participation for BCTs targeting each behavior. Researchers entered a T or A into the tailoring and participation columns of the targeted behavior if the BCT was tailored or actively delivered, respectively. Smoking cessation interventions often define a formal quit date. To manage workload, coders were instructed to code a BCT no more than once for each behavior before the quit date and no more than once after the quit date (even if it occurred more frequently). Hence, a total possible  $93 \text{ (BCTs)} \times 4 \text{ (behaviors)} \times 2 \text{ (before/after quit date)} = 744 \text{ BCTs}$  could be coded per (intervention or comparator) group. Researchers were also asked to identify any BCTs that were particularly difficult to code, to inform potential sensitivity analyses. In the second step, researchers used discussion to resolve discrepancies in BCT codes. The BCT coding took approximately ten weeks, including discussion time.

[TABLE 1 AND FIGURE 1 NEAR HERE]

### Data Analysis

To examine whether the behavioral targets and delivery style of BCTs could be reliably identified, two indicators of inter-rater reliability were used: Gwet’s AC1 (22), and prevalence- and bias-adjusted kappa (PABAK; 23). AC<sub>1</sub> and PABAK were chosen because



1 they are more stable indicators of inter-rater reliability than is the widely used Cohen's kappa  
2 (24, 25). Results were interpreted using Altman's guidelines:  $\leq 0.20$  poor, 0.21-0.40 fair,  
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4 0.41-0.60 moderate, 0.61-0.80 good, and 0.81-1.00 very good reliability (26). These analyses  
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6 were conducted on BCTs independently identified by both coders prior to resolving  
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8 discrepancies in BCT coding. Analyses were conducted separately for each group type  
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10 (intervention or comparator) as well as overall. This was in order to pick up any potential  
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12 differences in coding ability of the content provided for the intervention and comparator  
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19 To evaluate the utility of coding behavioral targets and delivery style of BCTs, we  
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21 examined whether these properties occurred with sufficient frequency for inclusion in  
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23 quantitative meta-regression analyses. Utility was judged according to whether researchers  
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25 would be able to examine questions such as 'Does using BCTs to target behavior X (i.e.,  
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27 cessation, abstinence, adherence, engagement) improve outcomes (e.g., smoking cessation  
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29 rates, quit attempts, medication adherence, attrition)?', 'Does tailoring intervention content  
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31 improve outcomes?', and 'Does active client participation improve outcomes?'. To answer  
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33 these questions, histograms were inspected to determine whether there was sufficient spread  
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35 across groups in (a) the number of BCTs used to target each of quitting, abstinence, treatment  
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37 engagement, and, amongst those groups who received medication, medication adherence, (b)  
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39 the number of BCTs that were tailored, and (c) the number of BCTs that involved active  
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41 client engagement. Variables with little spread would not be useful as predictor variables in  
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43 meta-regression analyses. Histograms are presented separately by group type (intervention or  
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45 comparator), as it was expected that intervention groups would tend to contain more BCTs,  
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47 more tailored BCTs, and more actively delivered BCTs. Since only about half of the studies  
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49 reported a quit date, for consistency between trials, quit date was removed from the dataset  
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51 for this analysis, thus allowing each group to provide one BCT per target behavior (for a  
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possible total of 93 BCTs \* 4 behaviors = 372 BCTs per group).

## Results

### Descriptives

One hundred and forty-two studies reporting 204 intervention and 142 comparator groups were included. Included studies are listed in the supplemental materials. Through coding the publicly available and privately held materials, there were 3843 BCTs (intervention: 2860; control: 983) that were identified by both of the researchers, 725 BCTs were identified by one of the researchers but not the other (388/725 identified by researcher one but not two; 337/725 identified by researcher two but not one; this constitutes 0.3% [725/(744 BCTs \* 346 groups)] of the total number of judgements that were made by each researcher), and 4128 BCTs after discrepancies were reconciled and quit date was removed from the dataset (for reasons mentioned above). The 3843 BCTs were used for the reliability analyses and the 4128 BCTs for the utility analyses.

Table 2 presents the mean number of BCTs agreed present by both researchers, by treatment arm and targeted behavior. An average of 14.82 BCTs per intervention group and 7.78 per comparator group were coded.

[TABLE 2 NEAR HERE]

### Reliability of linking BCTs to behaviors and delivery style

As seen in Table 3a, reliability of attributing BCTs to one of four behaviors was very good (0.91-0.94). Reliability was good to very good for identifying tailoring of BCTs (0.73-0.84) and good for identifying participation in the delivery of BCTs (0.64-0.74).

During BCT coding, the two researchers identified particular difficulties with identifying the delivery style of one BCT: BCT 3.1 Social support (unspecified). When this BCT was removed ( $n = 420$  instances) from the reliability analyses, reliability for coding tailoring (0.73-0.88) and participation (0.75-0.85) improved, whereas reliability of coding the

behavioral targets remained the same (0.91-0.94; see Table 3b).

[TABLE 3 NEAR HERE]

### **Utility of coding targeted behaviors and delivery style of BCTs**

The degree of variability between different intervention and comparator groups in the use of BCTs is displayed in Table 2 and the histograms in Figures 2 and 3. As seen in Figure 2, between intervention groups, there was considerable variability in BCTs targeting quitting and abstinence, but minimal variability in BCTs targeting medication adherence and treatment engagement. Between comparator groups, there was considerable variability in BCTs targeting quitting, but minimal variability in BCTs targeting abstinence, medication adherence, and treatment engagement. As seen in Figure 3, there was considerable variability in tailored and active BCTs between intervention groups, but more limited variability between comparator groups.

[FIGURES 2 AND 3 NEAR HERE]

### **Discussion**

This study examined the reliability and utility of a BCT coding scheme that extends beyond extracting exclusively the presence or absence of a BCT in intervention descriptions. For a sample of 142 smoking cessation trials (346 intervention and comparator groups) we examined published materials and additional materials obtained from study authors. Behavioral targets and BCT delivery style could be identified with good to very good reliability. The utility of extracting these data for use in meta-regression analyses was evident for quitting and abstinence in relation to the target behaviors, and for tailoring and participation in relation to delivery styles, but less so for medication adherence and treatment engagement. Hence, this study demonstrated that extending BCT coding to include specific behavioral targets and styles of BCT delivery is feasible and adds substantial information to the coding of BCT occurrence only, which is currently the most common practice.

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It appears useful to collect information on the style of BCT delivery and on BCTs targeting quitting and abstinence delivered to intervention groups, but less so for BCTs targeting medication adherence and treatment engagement. It might be that these techniques are infrequently used, infrequently reported, or both. If they are used but infrequently reported, this limits the ability to replicate published interventions and to synthesize evidence on effective intervention techniques. If they are infrequently used, this highlights two areas of trial and intervention development in need of improvement. Fewer than half (46%) of the intervention groups who received medication received any behavioral support to help them adhere to its intended use. Given that medication adherence remains a challenge (27), trial developers in the field of smoking cessation should consider the use of appropriate BCTs to promote adherence. Similarly, low treatment engagement leads to attrition, which can contribute to incomplete delivery of intervention content and biased estimates of intervention effectiveness (28). Trial developers should thus also consider how BCTs could be used to retain participants in the intervention and trial. Alternatively, it might be that the use of BCTs to promote treatment engagement is reactive; treatment providers might utilize BCTs only when they observe that a participant is becoming disengaged. In this case authors should capture such information in published trial reports.

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Usual practice when conducting meta-regressions using BCTs has been to code the presence of each BCT targeting any of a cluster of final health behaviors (e.g., dietary behaviors), without identifying the delivery styles of each BCT, or disentangling which of the final health behaviors (e.g., vegetable intake, fat intake) or preparatory behaviors (e.g., buying food, preparing food) is being targeted (e.g., 7, 8). Current findings suggest that only limited additional information would be gained if reviewers were to widely adopt the coding of behavioral targets such as medication adherence and treatment engagement (though, this could be due to poor reporting in existing trials). Comparatively, coding the use of BCTs

1 targeting behavior change (e.g., quitting) and behavior change maintenance (e.g., abstinence)  
2 could be a useful addition to reviews of smoking cessation trials—and reviews of interventions  
3 for other health behaviors, such as substance use, diet, and physical activity. Theoretical  
4 accounts of behavior would suggest that BCTs that shift the relative cost-benefit analysis in  
5 favor of the new behavior should promote behavior change initiation (e.g., promoting the  
6 perceived benefits and/or reducing the perceived costs should promote behavior change; 11,  
7 12). Comparatively, behavior change maintenance could be promoted through BCTs that  
8 promote habit, resource availability and utilization, positive maintenance motives, supportive  
9 environments, and self-regulation to monitor behavior and overcome barriers (29). The  
10 coding scheme presented in the current study would allow systematic reviewers to assess (a)  
11 whether authors use theoretically supported BCTs at each stage of behavior change, and (b)  
12 whether these BCTs are effective.

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Comparator groups received noticeably fewer BCTs than did intervention groups. This finding will partially reflect reality, in that intervention group support can be expected to be more intensive than comparator group support. It is plausible that this finding will also partially reflect differing reporting qualities for intervention and comparator group support. Comparator group support tends to be poorly reported and, in the case of usual care comparator groups, not manualized (18, 19). For these reasons, we have also developed a checklist based on previous work (18, 19) for collecting information from authors on the support provided to comparator groups and will be reporting on the data collected using this method elsewhere. Such information was not relevant to the current paper, as it does not allow for calculating the reliability of coding behavioral targets and delivery styles of BCTs, nor for the assessment of the delivery styles of BCTs. Nonetheless it is worth briefly mentioning that the apparent number of BCTs delivered to comparator groups increases considerably when data from this checklist are included.

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Strengths of this study are the rigorous systematic review methodology applied and the use of a considerable number of unpublished intervention materials that were obtained through contacting authors. Materials from 142 trials and 346 intervention and comparator groups were coded independently by two researchers, and bias- and prevalence-corrected reliability calculations were used given the skewed distributions. Limitations of this study are that BCT coding was conducted by two trained researchers and the degree to which other teams are able to reliably extract these data has yet to be examined. Further, a single behavioral domain (smoking cessation) was examined; it may be that extracting behaviors and delivery styles in other domains is more or less difficult. Nonetheless, our findings suggest that exploring whether different behavioral targets and delivery styles can be reliably and usefully identified in other behavioral domains is warranted. Finally only the first instance (before and after quit date) was coded for each BCT. This procedure is also likely to have resulted in an underestimation of the utility of the methods described, given that fewer BCTs were coded overall. Future researchers could avoid this problem by coding for repeated delivery of BCTs, when this occurs. Despite these limitations, it is important to note that much more BCT data was collected than is the case in most systematic reviews using the taxonomy. Further, to the authors' knowledge, the data presented here provide the most comprehensive representation to date of the active content of behavioral smoking cessation interventions.

To our knowledge, this study represents the first attempt at moving the coding of BCTs delivered to intervention and comparator groups beyond presence or absence of BCTs. It presented and tested an enhanced coding scheme for characterizing this active content of behavioral interventions. The proposed extensions can be coded reliably and, on the whole, these extensions are likely to be useful to both those attempting to replicate effective interventions and those trying to synthesize the evidence on behavior change interventions.

Table 1

*Elements of the Enhanced Behavior Change Technique Coding Scheme*

Characteristic		Coding
Behavior	Quitting	BCTs used to increase the likelihood of the participant ceasing tobacco smoking (initiating a quit attempt)
	Abstinence	BCTs used to increase the likelihood of the participant maintaining their non-(tobacco-)smoker state
	Medication Adherence	BCTs used to increase the likelihood of the participant using their smoking cessation medication in appropriate dosages at appropriate times
	Treatment Engagement	BCTs used to increase the likelihood of the participant engaging with, and completing components of, the smoking cessation treatment
Tailoring	Tailored	The BCT was modified based on characteristics of the recipient
Participation	Active	The delivery of the BCT required the participant to actively participate

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Table 2

*Mean (SD) Number of BCTs Coded by Targeted Behavior and Group*

	Quitting	Abstinence	Medication Adherence	Treatment Engagement	Total
Intervention	11.28 (8.35)	2.40 (3.84)	0.70 (1.26)	0.44 (1.18)	14.82 (10.85)
Comparator	6.61 (7.60)	0.64 (1.72)	0.41 (0.95)	0.12 (0.61)	7.78 (8.93)

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Table 3

*Inter-Rater Reliability for Coding Targeted Behavior, Tailoring, and Participation of Behavior Change Techniques*

	Intervention		Comparator		Total	
	AC <sub>1</sub>	PABAK	AC <sub>1</sub>	PABAK	AC <sub>1</sub>	PABAK
<b>a. All BCTs</b>						
Behavior	0.92	0.91	0.94	0.93	0.92	0.91
Tailoring	0.78	0.73	0.84	0.78	0.80	0.74
Participation	0.69	0.64	0.74	0.66	0.71	0.64
<b>b. All BCTs except 3.1</b>						
Behavior	0.92	0.91	0.94	0.93	0.92	0.91
Tailoring	0.80	0.73	0.88	0.81	0.82	0.75
Participation	0.80	0.75	0.85	0.80	0.81	0.76

*Note.*  $N = 3843$  for 3a,  $N = 3423$  for 3b.

**Abbreviations**

1		
2	BCT:	Behavior change technique
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4	BCTTv1:	Behavior change technique taxonomy v1
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7	PABAK:	Prevalence- and bias-adjusted kappa
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10	RCT:	Randomized controlled trial
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## Figure Captions

*Figure 1.* Simplified illustration of the coding sheet used to identify behavior change techniques, their targeted behavior, and their delivery style.

*Note.* i. Code from BCTTv1 taxonomy. ii. 1 = primary article, 2 = other publicly available material, 3 = privately held material. iii. A = active versus P = passive participant. iv. T = tailored versus N = not tailored.

*Figure 2.* Histograms showing the degree of between-group variability in use of behavior change techniques, by group type and behavioral target.

*Figure 3.* Histograms showing the degree of between-group variability in use of tailored and active behavior change techniques, by group type.

BCT <sup>i</sup>	Quote Illustrating BCT Application	Source <sup>ii</sup>	Targeted Behavior	Active <sup>iii</sup>	Tailored <sup>iv</sup>
1.1	“Counsellors worked with each participant to set a target quit date on a day that would work for that participant”	1	Quitting	A	T
10.4	“Participants who were smoke-free were congratulated and encouraged to remain smoke-free”	2	Abstinence	P	N
6.1	“Participants were shown how to correctly apply the nicotine patch”	3	Medication Adherence	P	N
1.9	“It is important that you make a commitment to review the sessions and complete the homework tasks each week”	3	Treatment Engagement	P	N

*Figure 1*





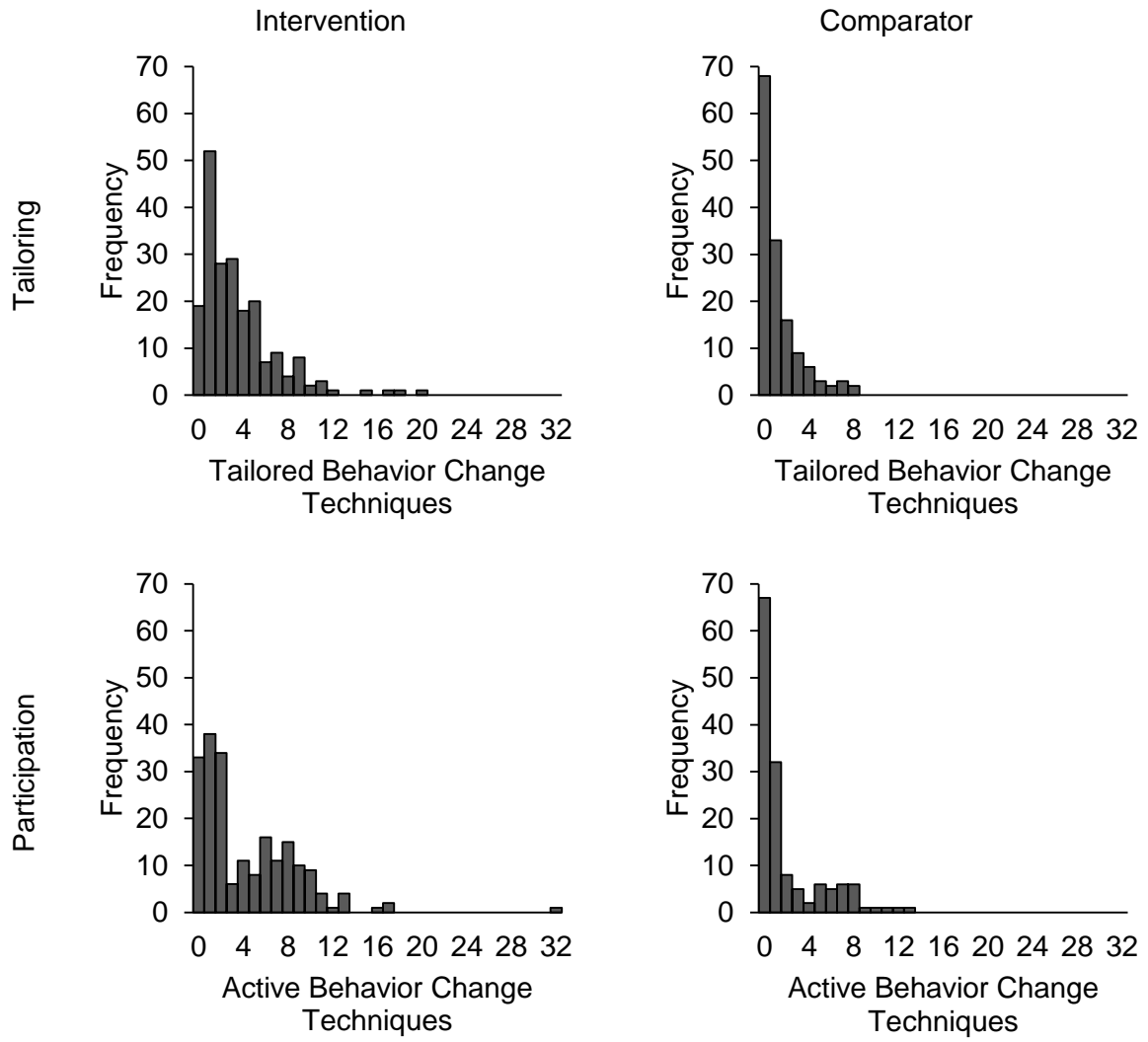


Figure 3

### Supplemental Materials

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