A taxonomy of behavior change techniques used in interventions

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Authors' Note

We thank Paschal Sheeran for access to papers included in an intention/ behavior change intervention review and Blair T. Johnson for access to the HIV/ AIDS manuals and matching evaluations. We thank Eleanor Mann for coding papers from the intention/ behavior intervention review and the HIV/AIDS manuals and Elisa Sibley for coding the same manuals. We also thank Paschal Sheeran, Blair T. Johnston, Falko Sniehotta, Marijn de Bruin and two reviewers for helpful comments on earlier drafts.

Abstract

Objective*:* Without standardized definitions of the techniques included in behavior change interventions it is difficult to faithfully replicate effective interventions and challenging to identify techniques contributing to effectiveness across interventions. This research aimed to develop and test a theory-linked taxonomy of generally-applicable behavior change techniques (BCTs).

Design: Twenty six BCTs were defined. Two psychologists used a five-page coding manual to independently judge the presence or absence of each technique in published intervention descriptions and in intervention manuals.

Results: Three systematic reviews yielded 195 published descriptions. Across 78 reliability tests (i.e., 26 techniques applied to 3 reviews), the average Kappa per technique was 0.79 with 93% of judgments being agreements. Interventions were found to vary widely in the range and type of techniques employed, even when targeting the same behavior among similar participants. The average agreement for intervention manuals was 85% and a comparison of BCTs identified in 13 manuals and 13 published articles describing the same interventions generated a technique correspondence rate of 74% with most mismatches (73%) arising from identification of a technique in the manual but not in the article.

Conclusions: These findings demonstrate the feasibility of developing standardized definitions of BCTs included in behavioral interventions and highlight problematic variability in the reporting of intervention content.

Key words: behavior change, intervention, content, techniques, taxonomy, CONSORT

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Do differences in the content of behavior change interventions impact on effectiveness? If so, which techniques or combinations of techniques enhance effectiveness? Answers to these questions are crucial to designers of behavior change interventions. Researching these questions depends on identification of common and distinctive techniques across evaluated interventions. For example, a reviewer might observe that some interventions employ goal setting alone while others combine goal setting with self-monitoring and feedback (as might be suggested by control theory; Carver & Scheier, 1982). If the latter group were found to be consistently more effective than the former this would indicate that the combination of these three techniques (rather then goal setting alone) was critical to effectiveness. Unfortunately, categorization of intervention content is problematic because a standardized vocabulary which defines intervention components has not been developed. Consequently, different reviewers use different approaches to categorizing intervention content (cf. Albarracín, Gillete, Earl, Glasman & Durantini, 2005; Webb & Sheeran, 2006). This may mean that particular techniques or content characteristics which distinguish between interventions remain unidentified. If such "unseen" content differences are associated with effectiveness then researchers will remain unaware of how intervention content determines effectiveness, thereby impeding the design of optimally effective interventions.

Meta-analysis has demonstrated that inclusion of particular intervention techniques is associated with to effectiveness. For example, Albarracín et al. (2005) showed that 10 distinct techniques (e.g., provision of factual information, attitudinal arguments and normative arguments) could be reliably identified in published descriptions of interventions designed to promote condom use. These reviewers identified which techniques were associated with effectiveness and how technique effectiveness was moderated by the recipients. For example, provision of normative arguments was found to be associated with effectiveness for audiences under 21 but associated

with ineffectiveness for older audiences. The results generated recommendations for intervention designers and allowed theory testing. Theories such as the theory reasoned of action (Fishbein & Ajzen, 1975) were supported because inclusion of attitudinal arguments was associated with effectiveness as was inclusion of normative arguments (for young people). By contrast, theories advocating use of fear appeals were not supported because inclusion of threat-inducing arguments was not associated with effectiveness for any audience. Thus, characterizing interventions in terms of shared and distinctive techniques and relating such characterizations to effectiveness can rule out or support potential mediating (or change) processes, thereby distinguishing between competing theoretical accounts of behavior change. In the absence of such characterization the implications of intervention evaluations for theoretical development may remain unclear (Rothman, 2004).

Despite the importance of Albarracín et al.'s analyses, it seems unlikely that condom promotion interventions are generally composed of only 10 distinct techniques. Consequently, it is possible that associations between currently-identified techniques included in interventions and intervention effectiveness could be overshadowed by uncategorized content differences. The need for more comprehensive categorization systems is further emphasized by reviews from other behavioral domains (e.g., Webb & Sheeran, 2006). For example, Hillsdon, Foster, Cavill, Crombie and Naidoo (2005) conducted a review of systematic reviews of physical activity interventions and identified a series of techniques which were more frequently found in effective interventions (i.e., exploring beliefs about the costs and benefits of physical activity, bolstering confidence to engage in physical activity, prompting goal setting, encouraging self-monitoring and providing reinforcement of change). Thus a range of behavior change technique definitions is required to comprehensively relate effectiveness to intervention content across behavioral domains, so illuminating when and how content matters to effectiveness.

Considerable progress has been made in standardizing the description of intervention evaluations through acceptance by journal editors of the CONSORT (Moher, Schultz, & Altman, 2001) and TREND statements (Des Jarlais, Lyles & Crepaz, 2004) which specify information which should be included in published reports. Davidson et al., (2003) have augmented these guidelines by proposing that behavioral scientists should also report (1) the content or elements of the intervention, (2) characteristics of the those delivering the intervention, (3) characteristics of the recipients, (4) the setting (e.g., worksite), (5) the mode of delivery (e.g., face-to-face) (6) the intensity (e.g., contact time), (7) the duration (e.g., number sessions over a given period) and (8) adherence to delivery protocols. Such standardization combined with use of standard measures of behavior change (e.g., Semaan et al., 2002) should greatly accelerate the identification of factors associated with behavior change. Yet clarity concerning the "content or elements" of behavior change interventions remains problematic because, although CONSORT guidelines specify that evaluators should report "precise details of interventions [as] .. actually administered" (Moher et al., 2001, p. 1192), there is no standardized vocabulary with which to describe the techniques employed by designers of behavior change interventions. Consequently, unlike descriptions of reinforcement schedules in Skinner's (1938) experiments, intervention descriptions included in published evaluations of behavior change interventions are variable and subjective in both language and format.

Particular theory-based techniques and combinations of techniques have been clearly defined (e.g., motivational interviewing; Rollnick & Miller, 1995). In such cases, reviewers can reasonably assume that different research teams applying these techniques are using similar procedures and so likely to be eliciting the same underlying change processes. Moreover, some published evaluations of health behavior interventions clearly list the techniques employed in the intervention. For example, Inoue et al. (2003) note the intervention involved: "explaining the

benefits of physical activity", using a "decisional balance", encouraging "goal setting [and] self-monitoring", inviting participants to sign a "contract to maintain an active lifestyle" and "control[ing] reinforcers encouraging physical activity". This multi-component intervention also included advice to "to seek support of family and friends" and lessons on use of "positive self talk" and "relapse prevention" techniques (p.157-8). In this case, the content of the intervention is described in terms of discrete techniques which can be translated into practical delivery procedures and materials in an appropriate manual, thereby facilitating replication and adoption. Unfortunately, many published intervention descriptions focus primarily on modes of delivery and/or the type of person delivering the intervention component (Davidson et al., 2003) e.g., "counseling sessions", "classes", "discussion groups", "peer-led laboratories" etc. Such descriptions mask procedurally and theoretically distinct designs and so fail to highlight techniques that may be critical to effectiveness. Consequently, reviewers may be limited to relating effectiveness to the settings in which interventions occur (e.g., worksite interventions, Proper et al., 2003) rather than their content. Unsurprisingly, reviewers have continued to call for more precise, standardized descriptions of intervention content (e.g., Neumann et al., 2002; Semaan et al., 2002).

As well as promoting identification of intervention techniques associated with effectiveness and facilitating theory testing through meta analyses, standardized descriptions of intervention content would facilitate the fidelity of intervention operationalization in replication studies and applications. The present variability in intervention descriptions may inhibit faithful adoption of effective interventions (e.g., by health promotion agencies) thereby curtailing their contribution to evidence-based practice (Bellg et al., 2004; Michie & Abraham, 2004; Nation et al., 2003). This is especially likely if, as is often the case, detailed intervention manuals and assessments of adherence to protocols are not available. For example, if a technique associated with effectiveness is not identifiable in available intervention descriptions then adopting agencies are likely to omit

this technique. If the intervention is then found to be ineffective this may be wrongly attributed to delivery failures rather than (unnoticed) deviations from the original content.

Comparable challenges have been addressed in identifying and defining empirically-supported psychological treatments for psychological/ psychiatric conditions. For example, a Task Force established by Division 13 of the American Psychological Association sought to identify psychological treatments that had been found to be effective for particular conditions with a view to developing treatment manuals with which to train practitioners (Chambless & Ollendick, 2001). A foundational first step for such work is the definition and identification of commonly-used change techniques.

The present research

Having established the need for a common vocabulary in terms of which content components of behavior change interventions can be defined and described, we set ourselves two objectives. First, to develop and extend existing lists of content components into a set of distinct, theory-linked definitions of behavior change techniques (BCTs) and, second, to test whether these definitions could be used to reliably identify techniques included in interventions on the basis of intervention descriptions. If, such a reliable taxonomy was developed it could be used to identify specific techniques included in a range of behavior change interventions, thereby clarifying differences and similarities in intervention content (e.g., among those targeting similar behaviors in similar settings). This detailed characterization would facilitate exploration of the impact of content differences on effectiveness. In addition, a taxonomy of techniques would provide the foundation for standardized descriptions of intervention content in published articles and manuals which would enhance replication fidelity.

Method

Developing a theory-linked taxonomy of behavior change techniques

Researchers have categorized messages included in health promotion videos (e.g., Herek, Ganzales-Rivers, Fead & Welton, 2001) and leaflets (Abraham, Southby, Quandte, Krahé, & van der Sluijs, 2007), listed principles of social influence (Cialdini, 1965) and categorized techniques used to implement changes in professional practice (Leeman, Baernholdt & Sandelowski, 2007) but there are few available lists of discrete BCTs used in health behavior interventions. We identified three potentially useful lists. First, the transtheoretical model (Prochaska, DiClemente & Norcross, 1992) specified 10 processes of behavior change, namely, (1) consciousness raising, (2) self re-evaluation, (3) self-liberation, (4) counter conditioning, (5) stimulus control, (6) reinforcement, (7) helping relationships, (8) dramatic relief, (9) environmental re-evaluation and (10) social liberation. Second, in a review of interventions designed to prevent weight gain, Hardeman, Griffin, Johnston, Kinmonth and Warehman (2000) used 19 behavior change methods to describe intervention content, namely, (1) specifying a behavioral goal, (2) self-monitoring (3) agreeing a contract, (4) providing incentives contingent on behavior, (5) using graded tasks, (6) increasing skills, (7) rehearsal of skills, (8) stress management, (9) planning, (10) use of prompts or cues, (11) changing the environment, (12) social support or encouragement, (13) persuasive communication, (14) information about behavioral outcomes, (15) use of personalized messages (16) modeling or demonstrating a behavior, (17) setting homework (18) personal experiments to gather data and (19) experiential tasks to change motivation. Third, in a meta-analysis of interventions designed to increase physical activity, Conn, Valentine and Harris (2002) identified 20 separate intervention components. These were (1) behavioral modification, (2) cognitive modification, (3) prompting greater commitment, (4) use of rewards, (5) agreeing a contract, (6) considering advantages and disadvantages of a behavior, (7) providing a supervised class at a set time, (8) behavioral prescription, (9) providing feedback about performance, (10) fitness testing, (11) goal setting, (12) providing health education information, (13) providing health risk appraisals, (14) relapse

prevention training, (15) self management, (16) self monitoring, (17) providing opportunities to watch others performing the behavior, (18) social support, (19) stimulus control and (20) thought restructuring. These lists usefully identify specific BCTs which could be widely applied (e.g., use of rewards or self monitoring) and it is reassuring to note the considerable overlap in identification of BCTs used to promote physical activity and healthy eating. However, in these lists, specific techniques are mixed with general theoretical approaches (e.g. behavioral modification), modes of delivery (e.g. use of supervised classes) intervention settings (e.g. homework) and behavior-specific procedures (e.g. fitness testing must presumably affect behavior change through the mechanism of feedback) so cutting across the classes of characterization proposed by Davidson et al. (2003). We aimed to refine these lists into a set of theory-linked techniques that could be used to characterize intervention content across behavioral domains, separately from the other characteristics defined by Davidson et al. (2003).

A pilot study (Michie, Abraham & Jones, 2003) was conducted to identify techniques listed by Hardeman et al. (2000) which had been employed in interventions included in a Cochrane review of rigorously evaluated interventions to promote physical activity (Hillsdon Foster, Cavill, Crombie & Naidoo, 2005). A standard definition of each BCT was developed and intervention descriptions in primary studies were coded for inclusion or exclusion of defined BCTs. Discussion of this inductive process resulted in refinement of technique definitions and identification of additional techniques. Following conceptual and theoretical analyses of technique definitions, a five-page coding manual was written (which is available on request). This includes coding instructions on how to identify techniques in intervention descriptions and definitions of 26 behavior change techniques. This manual can be used to ascertain whether an intervention description refers to any or all of the 26 defined BCTs. Abbreviated definitions are provided in table 1. As well as individual change techniques, the list includes four commonly applied sets of

techniques namely, relapse prevention (23, e.g., Marlatt & Donovan, 2005), stress management (24), motivational interviewing (25) and time management (26).

Our 26 defined BCTs reflect a variety of theoretical accounts of behavior change. Theories which specify the same process of behavior change (or mediating mechanisms) imply the same BCTs. For example, providing information about the consequences of an action may affect attitudes towards a target behavior. Thus, technique 2 could be derived from theories such as the theory of reasoned action (TRA: Fishbein & Ajzen, 1975), the theory of planned behavior (TPB: Ajzen, 1991), social cognitive theory (SCogT; Bandura, 1997) and the Information-Motivation-Behavioral Skills model (IMB: Fisher & Fisher, 1992). Other theories represented by the 26 BCTs include, control theory (CT; Carver & Scheier, 1982) and related goal theories (e.g., Austin & Vancouver, 1996; Gollwitzer, 1999; Locke & Latham, 2002) as well as operant conditioning (OC; Skinner, 1974), theories of social comparison (SCompT, e.g., Festinger 1954), theoretical accounts of the impact of social support on health-related behaviors (cf. Berkman & Syme, 1979) and explanations of the importance of stress management and relapse prevention to behavior change. (e.g., Marlatt & Donovan, 2005). Further work on the translation of theories relevant to behavior change into specific change techniques would greatly facilitate theory testing and development (cf. Michie, Johnston, Francis, Hardeman & Eccles (under review).

Table 1 shows how we mapped defined BCTs onto these various theoretical frameworks and so illustrates how meta analyses of intervention content and effectiveness could be used to test a variety of behavior change theories. For example, if interventions including techniques 2-4 (provide information on consequences, provide information about others' approval and prompt intention formation) were found to be noticeably more effective in promoting a specified behavior than interventions that did not include these techniques this would support the theory of reasoned action (and related theories) but if such interventions were clearly ineffective this would imply that

the TRA did not provide a useful basis for designing interventions to change the targeted behavior. Similarly, if interventions including techniques 10 – 13 (specific goal setting, self- monitoring of behavior, review of goals, and provision of performance feedback) were found to be effective this would constitute an endorsement of control theory while ineffectiveness amongst such interventions would imply that CT was not a useful foundation for intervention design in that domain. Such analyses could identify important mediators of behavior change and highlight theories likely to be most useful to intervention designers (Bartholomew, Parcel, Kok & Gottlieb, 2006; Albarracín et al., 2005).

Three systematic reviews

In order to assess whether these 26 defined BCTs can be used to characterize core components of behavior change interventions, we conducted a series of content analyses (Boyatzis, 1998; Weber, 1990) of published intervention descriptions using articles from three systematic reviews. Two reviews undertaken by the authors employed similar search strategies to identify evaluations of interventions designed to increase physical activity (PA) and healthy eating (HE) among adults living in the community with no known mental or physical health problems. In both these reviews, interventions providing only information or targeting specialized populations (e.g., pregnant women, athletes or those engaged in slimming or fitness programs) were excluded and only evaluations employing experimental or quasi-experimental designs were included. Outcome measures were objective or validated self-report measures of behavior. A comprehensive search strategy was implemented, using Medline, Embase, PsychInfo, Cochrane library (Cochrane Central Controlled Trials Register and the Health Technology Assessment database), AMED (Allied and Complementary Medicine Database) and HMIC (Health Management Information Consortium) databases for papers in peer-reviewed journals from 1990 to 2005. For PA, 11,490 references were identified. After excluding duplicates, screening of abstracts and data extraction

checks 34 papers reporting 29 studies met the inclusion criteria. Nineteen (66%) of these were conducted in the US. For HE, 17,323 references were identified and 23 papers reporting 22 studies met the inclusion criteria, 13 (59%) of these were conducted in the US.

A third review was designed to assess whether changing cognitions specified by the theory of planned behavior (Ajzen, 1991) and social cognitive theory (Bandura, 1977) resulted in changes in intention and behavior (Sheeran, Armitage, Rivia & Webb, 2006). Experimental studies which met three criteria were included, namely random assignment of participants, significant change in cognition measures and comparison of post-intervention intention or behavior between at least two conditions. A comprehensive search strategy of databases including Web of Science, PsychInfo, UMI's and Dissertation Abstracts databases generated 24,475 references whose abstracts were evaluated for inclusion. In total, 214 independent intervention tests were identified, including 163 behavior change tests and 103 intention change tests. Of these, two thirds (N=144) were available for coding. Three quarters (74%) targeted health-related intentions and behavior, including, safer sex, diet, cancer screening, PA, smoking and medication adherence.

Sample of intervention manuals

A sample of 13 detailed manuals describing interventions designed to reduce HIV/AIDS risks were also coded. These manuals described how intervention designs were implemented in practice, often including illustrative materials. For example, we included “The ARIES Home Companion” (Gordon, Craver, Beadnell & Rabin, 1992) and the National Institute on Drug Abuse (NIDA) Counseling and Education Intervention Model (NIDA, 1993). Lists of all coded evaluations and manuals are available.

Applying the taxonomy of behavior change techniques to intervention descriptions

A total of 195 published intervention descriptions were generated by the three systematic reviews (29 PA, 22 HE and 144 intention/ behavior). Two psychologists independently used the

coding instructions and technique definitions to identify behavior change techniques in each descriptions. The PA and HE intervention descriptions were coded by the authors while the 144 intention/ behavior interventions were coding by the first author and a postdoctoral psychology researcher. This researcher learned to use the coding manual by independently coding 11 published intervention descriptions (not included here) and by discussing these with the first author who had also independently coded the same 11 evaluations. Coding of the intention/ behavior intervention descriptions served two purposes. It provided a test of how reliably the coding manual could be applied to a larger, more varied set of intervention descriptions and allowed assessment of how easily a psychologist not involved in the development of the taxonomy could learn to use the coding manual.

These tests were extended by applying the taxonomy to 13 detailed intervention manuals. The same trained postdoctoral researcher and a postgraduate psychologist coded the manuals independently. The new coder was trained by the first author in a similar manner to the first postdoctoral researcher (as described above). In this case, however, only four practice articles were used as well as discussion of BCT identification.

Finally, the 13 manuals were matched to 13 published evaluations of the same interventions. The trained postdoctoral researcher coded the articles first and the manuals two weeks later without access to the articles or their BCT coding when coding the manuals. Identifying text was removed from manuals prior to coding.

Results

Reliability of identification of 26 BCT definitions was tested. Disagreements occurred when one coder identified a technique in an intervention description while the other coder judged the technique to be absent. Agreements arose when both coders identified the same technique or

judged it to be absent. Cohen's (1960) Kappa statistic was used to assess inter-rater reliability for each of the 26 techniques for each of the three reviews, resulting in 78 reliability tests. These are presented in the first three columns of table 2 with the percentage of agreements recorded for each technique definition.

In 7 of 78 tests both coders agreed that there were no instances of a technique in any of the intervention descriptions included in one of the three reviews. Such judgments represent 100% agreement but prohibit calculation of Kappas. None of the HE interventions used techniques 9 (model or demonstrate the behavior), 17 (prompt practice), 21 (prompt identification as a role model) or 22 (prompt self talk). Technique 3 (providing information about others approval) was only used in intention/behavior interventions included in the third review and none of the interventions in this review employed technique 25 (motivational interviewing).

Among the other 71 tests, Kappas ranged from 0.1 to 1.0 with a mean and median value of 0.79 (*sd* = .17). Apart from two, all Kappas were significant at $p<.01$. The percentage of disagreements per technique, per review ranged from 0% to 38% with a mean of 7.3%, that is, an agreement rate of 93%. Landis and Koch (1977) suggested that Kappa values of 0.4 -0.59 indicate "moderate" inter-rater reliability, those of 0.6-0.79 indicate "substantial" reliability and those above 0.8 are "outstanding". However, by convention, 0.7 is often regarded as indicative of acceptable or good inter-rater reliability. Fifty one of the 71 tests (72%) produced Kappas of above 0.7 and only ten percent (*N*=7) fell below 0.6. Of these, two fell below 0.40. These results indicate that independent coders can use our coding manual to reliably identify the same defined techniques in published intervention descriptions.

Coding was found to be reliable for each review independently. Modal and mean Kappa values and average percentage disagreements were 0.79, 0.80 and 8.2% for the PA review, 0.81, 0.82 and 6.7% for the HE review and 0.75, 0.74 and 7.0% for the third, general intention/behavior

review. No significant differences between Kappa distributions were found across reviews or between review pairs (Mann Whitney *U*s = (PA versus HE) 245.00, p =0.70, (PA versus general) 262.00, p =0.33 (HE versus general) 202.50, p =0.18), suggesting that technique definitions can be equally well applied to interventions with different behavioral targets and by psychologists who had and had not been involved in developing the technique taxonomy.

Good reliability was not demonstrated for three of the 26 technique definitions. Technique 15 (provide general encouragement) generated two of the lowest Kappas (0.46 and 0.39). Technique 17 (teach to use prompts) was rarely observed and while the authors agreed that no instances were observed in the PA and HE reviews, poor reliability was observed between the first author and the postdoctoral coder in applying this definition to studies in the third review. Finally, Kappas for technique 3 (provide information on consequences) fell below 0.7 (i.e., .53, .68, .61) in all three reviews, indicating only moderate inter-coder reliability.

Only thirteen manuals were coded and missing data prohibited calculation of Kappas for many techniques so only percentage agreements are presented in column four of table 2. For each technique, one disagreement (out of 13) resulted in 92% agreement, 2 disagreements in 85% etc. Agreement rates ranged from 62% (5 disagreements) to 100% with a mean and mode of 85% agreement. Only 4 of 26 technique definitions resulted in greater than 2 disagreements, namely, prompt intention formation, use of follow-up prompts, prompt identification as a role model (69% agreement) and plan social support/ social change (62%).

Finally, comparisons of BCTs identified (by the same coder) in each of the thirteen manuals and a published evaluation of the same intervention generated a correspondence rate of 74%, ranging from 31% to 100% across techniques. Moreover, in the 73% of instances when inclusion/exclusion of a technique was judged differently when examining an article compared to the matching manual, this was due to identification of the technique in the manual but not in the

article. On average 9.07 techniques were identified in manuals but only 6.07 techniques in articles (paired t (25) = 2.4, p = .033, two tailed).

Discussion

The present research is the first systematic analysis that identifies potentially effective techniques included in behavior change interventions across behavioral domains. We have defined a set of theory-linked behavior change techniques that can be used to characterize and differentiate between intervention content and so facilitate communication between intervention designers, adopters and reviewers. We have shown that psychologists can reliably judge inclusion/exclusion of these techniques from published articles and intervention manuals and have illustrated how inclusion of these techniques can be linked to theory testing. This work demonstrates the feasibility of characterizing interventions in terms of common behavior change techniques and provides a model for standardizing published descriptions of intervention content in terms of defined techniques which can be linked to mediating processes implied by theory. Standard categorization of intervention content could facilitate theoretical development by clarifying (e.g., through meta analyses) which techniques, or combinations of techniques, are associated with effective behavior change within and across behavioral domains. Standardization would also facilitate the design of effective behavior change interventions and accurate replication of intervention content.

Reliability in identifying BCTs from 195 descriptions in published articles was good for 23 of the 26 defined techniques indicating that currently-available intervention descriptions can be readily and reliably profiled in terms of combinations of discrete techniques. Technique 6 (provide general encouragement) was included to describe the use of rewards and encouragement which were not contingent on behavioral performance. However, the definition appears to be too broad to allow identification of clearly equivalent behavior change procedures in interventions. Technique

15 (teach to use prompts) was rarely observed and showed poor reliability between the first author and an independent psychologist and requires further consideration or re-definition. Technique 2 (provide information on consequences) showed moderate inter-coder reliability and further clarification of this technique definition and re-test reliability is required. Thus 23 definitions represent discrete BCTs which psychologists can be easily trained to identify.

The same coding instructions were used by two psychologists not involved in development of the taxonomy to categorize BCTs in a small sample of detailed intervention manuals from a separate behavioral domain. Good reliability was observed (85%) suggesting that our instructions and definitions can be applied reliably to these much more detailed descriptions of intervention content after only brief training. Further testing will clarify whether elaboration of certain BCT definitions (e.g., plan social support/ social change) is required to fully adapt our coding instructions for use with intervention manuals.

All interventions included in the physical activity and healthy eating reviews were self-management interventions designed for adults living in the community without specialized histories in relation to the target behaviors. Yet these interventions varied markedly in their content. After resolving disagreements between coders through discussion of definitions, our categorization showed that the 29 physical activity interventions included between 1 and 14 of the 26 defined techniques (with a mean of 8 techniques per intervention), while the 22 healthy eating interventions included between 1 and 13 techniques (with a mean of 6). Some techniques were commonly included in both types of interventions. For example, technique (3) “provide information about consequences” was included in 19 physical activity interventions (65%) and 10 healthy eating interventions (45%). Other frequently included techniques were (4) prompt intention formation (18 PA = 62%, 16 HE = 73%) and (7) prompt barrier identification (15 PA = 52%, 10 HE = 45%). These data highlight the complexity of intervention designs and remind us

that even interventions designed to change the same behavior among very similar target populations can differ markedly in their content. This further emphasizes the need to precisely categorize intervention content and so unmask such content differences.

Only two thirds of the techniques identified in intervention manuals were also identified in descriptions of the same interventions in journal articles by a trained coder previously found to apply the technique definitions in a reliable manner. While larger samples are required to confirm this finding, the data indicate that pressure on journal space may curtail intervention descriptions in published articles. This may threaten replication fidelity because detailed manuals are not always accessible and are not presented in standardized formats. It also means that reviewers synthesizing findings on the basis of published evaluations may not be able to accurately and comprehensively identify intervention content.

The taxonomy presented here is not exhaustive. Other techniques with a range of application across behavioral domains could be defined e.g., use of fear appeals (Albarracín et al., 2005) and some BCTs may be especially important to one behavioral domain and not others. Nonetheless, this taxonomy provides a foundational first step towards standardization and accuracy of descriptions of behavior change intervention content, as called for by CONSORT. BCTs may be operationalized differently in different interventions and detailed procedures and materials should be available in manuals so that replication is possible. Intervention designers may also combine and modify techniques so that new definitions need to be established. However, identification of such variations and combinations depends on having initially established common definitions of techniques, just as the periodic table is critical to understanding molecular structure and chemical interactions.

In the longer term, the main implication of this research is not that existing intervention descriptions can be accurately characterized as distinct combinations of BCTs. Rather, by

developing taxonomies of defined theory-linked BCTs, future intervention descriptions can include lists of consensually-understood techniques, thereby establishing a common vocabulary in terms of which intervention designs can be understood and compared across interventions, behavioral domains and research teams. This would clarify links between inclusion of techniques and theory-specified change processes; links that are not always clear in published intervention descriptions at present (Bartholomew et al., 2006; Michie & Abraham, 2004). Detailed intervention manuals could then provide information on the operationalization of the BCTs listed in standardized published descriptions, including specific materials.

Audience characteristics are crucial to effectiveness (Albarracín et al., 2005; Durantini, Albarracín, Earl & Mitchell, 2006) and mode of delivery, type of materials, fidelity of implementation in relation to manual specifications and the extent to which interventions are tailored to individuals or groups are all potentially important determinants of effectiveness (Davidson et al., 2003). However, specification of content is also critical and, at present, inadequately specification leads to uncertainty regarding when, and in what respects, differences in content impact on effectiveness. This slows preparation of evidence-based guidelines for intervention designers and increases the risk that ineffective or unproven interventions may be adopted (cf. Nicassio, Meyerowitz & Kerms, 2004). Developing standardized theory-linked taxonomies of BCTs is foundational to resolving the current variability in intervention description.

In conclusion, the present work provides a crucial first step towards establishing a common language in terms of which intervention designers, reviewers and practitioners can clearly specify the content of behavior change interventions across domains and so clarify content differences between them. Adoption of such a taxonomy of behavior change techniques could also facilitate theory testing through meta-analytic review of intervention effectiveness. In combination with this work, three related steps could accelerate progress in the science of behavior change. First, a

supplement to the CONSORT and TREND statements could require authors to list behavior change techniques included in their interventions, specifying links between included techniques and theoretical framework/s used to conceptualize potential change mechanisms. Second, authors could be required to describe all intervention features listed by Davidson et al. (2003). Third, standardized intervention manuals should be prepared for all published intervention evaluations (e.g., to be posted on journal websites) so that researchers and practitioners can discover how techniques constituting the content design of interventions were operationalized in practice.

References

Abraham, C., Southby, L., Quandte, S., Krahé, B. & van der Sluijs, W (2007). Identifying research-based persuasive messages in health promotion texts: An analysis of widely available European alcohol-education leaflets. *Psychology and Health, 22,* 31-60.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50,* 179-211.

Albarracín, D., Gillete, J. C., Earl A. N., Glasman, L. R., & Durantini, M. R. (2005). A test of major assumptions about behavior change: A comprehensive look at the effects of passive and active HIV-prevention interventions since the beginning of the epidemic. *Psychological Bulletin, 131,* 856-897.

Austin, J., T., & Vancouver, J., B. (1996). Goal constructs in psychology: Structure, process, and content. *Psychological Review, 120,* 338-375.

Bandura, A. (1997). *Self-efficacy; the exercise of control*. NewYork: Freeman.

Bartholomew, L. K., Parcel, G. S., Kok, G., & Gottlieb, N. H. (2006). *Planning health promotion programs. An intervention mapping approach*. San Francisco, CA: Jossey-Bass.

Bellg, A., J., Borrelli, B., Resnick, B., Hecht, J., Mincucci, D., S. Orly, M. et al. (2004). Enhancing treatment fidelity on health behavior change studies: Best practices and recommendations from the NIH Behavior change Consortium. *Health Psychology, 23,* 443-451.

Berkman, L. F. & Syme, S. L. (1979). Social networks, host resistance and mortality: a nine year follow-up study of Alameda county residents. *American Journal of Epidemiology, 109,* 186-204.

Boyatzis, R., E. (1998). T*ransforming qualitative information: Thematic analysis and code development.* London: Sage.

Carver, C., S. & Scheier, M., F. (1982). Control theory: a useful conceptual framework for personality-social, clinical and health psychology. *Psychological Bulletin, 92,* 111-135.

Chambless, D. L. & Ollendick, T. H. (2001). Empirically supported psychological interventions: Controversies and evidence. *Annual Review of Psychology, 52,* 685-716.

Cialdini, R. B. (1995). Principles and Techniques of Social Influence. In A. Tesser (Ed.), *Advanced Social Psychology*. (pp. 257-281). New York: Mc-Graw Hill, Inc.

Cohen, J. (1960). A coefficient of agreement for nominal scales. *Educational and Psychological Measurement, 20,* 37-46.

Conn V., S., Valentine, J. C. & Cooper, H. M. (2002). Interventions to increase physical activity among aging adults: A meta analysis. *Annals of Behavioral Medicine, 24,* 190-200.

Davidson, K., W., Goldstein, M., Kaplan, R. M., Kaufmann, P., G., Knatterund, G., L., Orleans, C., T., Spring, B., Trudeau, K., J. & Whitlock, E. P. (2003). Evidence-based behavioral medicine: What is it and how do we achieve it? *Annals of Behavioral Medicine, 26*, 161-171.

Des Jarlais DC, Lyles C, Crepaz N. (2004). Improving the reporting quality of nonrandomized evaluations of behavioral and public health interventions: the TREND statement. *American Journal of Public Health, 94:*361–366.

Durantini, M. R., Albarracín, D., Earl, A., & Mitchell, A. L. (2006). Conceptualizing the influence of social agents of change: A meta-analysis of HIV prevention interventions across different genders, ethnicities, ages, and behaviorally-defined groups. *Psychological Bulletin, 132*, 212-248.

Festinger, L. (1954). A theory of social comparison processes. *Human Relations*, 7, 117-140.

Fisher, J. D. & Fisher W. A. (1992). Changing AIDS risk behavior. *Psychological Bulletin*, *111*, 455-74.

Fishbein, M. & Ajzen, I. (1975). *Belief, attitude, intention and behavior; An introduction to theory and research.* Reading, MA: Addison-Wesley.

Gollwitzer, P. M. (1999). Implementation intentions: Strong effects of simple plans. *American Psychologist, 54*, 493–503.

Gordon, J., Craver, J. Beadnell, B. & Rabin, C. (1992). *The ARIES Home Companion*. Washington: School of Social Work. University of Washington.

Hardeman, W., Griffin, S., Johnston, M., Kinmonth, A.L. and Warehman, N.J. (2000). Interventions to prevent weight gain: a systematic review of psychological models and behavior change methods. *International Journal of Obesity*, *24*, 131-143.

Herek, G., H., Ganzales-Rivers, M., Fead, F., & Welton, D. (2001). AIDS educational videos for gay and bisexual men: A content analysis. *Journal of the Gay and Lesbian Medical Association, 5*, 143-153.

Hillsdon, M., Foster, C., Cavill, N., Crombie, H. & Naidoo, B. (2005). *The effectiveness of public health interventions for increasing physical activity among adults: a review of reviews*. London: Health Development Agency (http://www.publichealth.nice.org.uk/page.aspx?o=505281).

Inoue, S., Odagiri, Y., Wakui, S., Katoh, R., Moriguchi, T., Ohya, Y. & Shimomitsu, T. (2003). Randomized controlled trial to evaluate the effect of a physical activity intervention program based on behavioral medicine. Journal of Tokyo Medical University, 61, 154-165.

Landis, J. & Koch, G. (1977). The measurement of observer agreement for categorical data. *Biometrics, 33*, 159-174.

Locke, E. A., & Latham, G. P. (2002). Building a practically useful theory of goal setting and task motivation. A 35-year odyssey. *American Psychologist, 57,* 705–717.

Leeman, J., Baernholdt, M. & Sandelowski, M. (2007). Developing a theory-based taxonomy of of methods of implementing change in practice. *Journal of Advanced Nursing, 58*, 191-200.

Levant R., F. (2005). *Report of the 2005 Presidential Task Force on Evidence-Based Practice*. American Psychological Association (http://www.apa.org/practice/ebpreport.pdf).

Marlatt, G., A. & Donovan, D., M. (Eds.). (2005). *Relapse Prevention: Maintenance Strategies in the Treatment of Addictive Behaviors.* New York, The Guildford Press.

Michie, S. & Abraham, C. (2004). Interventions to change health behaviors: Evidence-based or evidence inspired?, *Psychology & Health, 19,* 29-49.

Michie, S., Abraham, C. & Jones, C. (2003). *Achieving the "Fully Engaged Scenario": what works and why?* London: Department of Health, Division of Public Health.

Michie, S., Johnston, M., Francis, J., Hardeman, W. & Eccles, M. (under review). From theory to intervention: mapping theoretical constructs to behaviour change techniques.

Moher, D., Schultz, K. F., Altman, D. G. and the CONSORT Group (2001). The CONSORT statement: revised recommendations for improving the quality of reports of parallel-group randomized trials. *The Lancet*, *357*, 1191-1194.

Nation, M., Crusto, C., Wandersman, A., Kumpfer, K., L., Seybolt, D., Morrissey-Kane, E. & Davino, K. (2003). What works in prevention: Principles of effective prevention programs. *American Psychologist, 58*, 449-456.

National Institute on Drug Abuse (1993). *The NIDA Counseling and Education Intervention Model.* National Institutes of Health, US Department of Health and Human Services.

Nicassio, P., M., Meyerowitz, B. E. & Kerms, R. D. (2004). The future of health psychology interventions. *Health Psychology, 23*, 132-137.

Neumann, M.S., Johnson, W.D., Semaan, S., Flores,. S.A., Peersman, G., Hedges, L.V., &. Sogolow, E. (2002). Review and meta-analysis of HIV prevention intervention research for heterosexual adult populations in the United States. *Journal of acquired immune deficiency syndromes, 30*, S106-17

Prochaska, J. O., DiClemente, C.C. & Norcross, J. C. (1992). In search of how people change. *American Psychologist, 47,* 1102-1114.

Proper, K.I., Koning, M., van der Beek, A.J., Hildebrandt, V.H., Bosscher, R.J., and van Mechelen, W. (2003). The effectiveness of worksite physical activity programs on physical activity, physical fitness, and health. *Clinical Journal of Sport Medicine, 13*, 106-117.

Rollnick, S., & Miller, W.R. (1995). What is motivational interviewing? *Behavioural and Cognitive Psychotherapy*, *23*, 325-334.

Rothman, A. J. (2004). Is there nothing more practical than a good theory? Why, innovations and advances in health behavior change will arise if interventions are used to test and refine theory. *International Journal of Behavioral Nutrition and Physical Activity, 1*:11 (http://www.ijbnpa.org/content/1/1/11).

Semaan, S., Des Jarlais, D. C., Sogolow, E., Johnson W. D., Hedges, L.V., Ramirez G., Flores S. A., Norman, L., Sweat, M. D., Needle, R. (2002). A meta-analysis of the effect of HIV prevention interventions on the sex behaviors of drug users in the United States. *J Acquired Immune Deficiency Syndrome, 30,* (Suppl) S73-93.

Sheeran, P., Armitage, C. J., Rivia, A. & Webb, T. L. (2006). Does changing attitudes, norms and self-efficacy change intentions or behaviour? Unpublished Final Report to the Economic and Social Council. (RES-00-22-0847) Department of Psychology, University of Sheffield. UK.

Skinner B. F. (1938). The Behavior of Organisms. New York: Appleton-Century-Crofts.

Skinner, B F. (1974). *About Behaviorism.* New York, Knopf.

Webb, T. & Sheeran, P. (2006). Does changing behavioral intentions engender behavior change? A meta analysis of experimental evidence. *Psychological Bulletin, 132*, 249-268.

Weber, R., P. (1990). *Basic content analysis.* (2nd ed.). Newbury Park, CA: Sage.

Table 1.

Definitions of 26 behavior change techniques and illustrative theoretical frameworks

Technique (Theoretical Framework)	Definition
1. Provide information about behavior-health link. (IMB)	General information about behavioral risk, e.g., susceptibility to poor health outcomes or mortality risk in relation to the behavior.
2. Provide information on consequences (TRA, TPB, SCogT, IMB)	Information about the benefits and costs of action or inaction, focusing on what will happen if the person does/ does not perform the behaviour.
3 Provide information about others' approval (TRA, TPB, IMB)	Information about what others' think about the person's behavior and whether others will approve or disapprove of any proposed behavior change.
4. Prompt intention formation (TRA, TPB, SCogT, IMB)	Encouraging the person to decide to act or set a general goal e.g., to make a behavioral resolution such as "I will take more exercise next week".
5. Prompt barrier identification (SCogT)	Identify barriers to performing the behavior and plan ways of overcoming them.
6. Provide general encouragement (SCogT)	Praising or rewarding the person for effort or performance without this being contingent on specified behaviors or standards of performance.

7. Set graded tasks (SCogT)	Set easy tasks, and increase difficulty until target behavior is performed.
8. Provide instruction (SCogT)	Telling the person how to perform a behavior and/ or preparatory behaviors.
9. Model/ demonstrate the behavior (SCogT)	An expert shows the person how to correctly perform a behavior e.g., in class or on video.
10. Prompt specific goal setting (CT)	Involves detailed planning of what the person will do including a definition of the behavior specifying frequency, intensity or duration as well as specification of at least one context, i.e., where, when, how or with whom.
11. Prompt review of behavioral goals (CT)	Review and/or reconsideration of previously set goals or intentions.
12. Prompt self-monitoring of behavior (CT)	The person is asked to keep a record of specified behavior/s (e.g., in a diary).
13. Provide feedback on performance (CT)	Providing data about recorded behavior or evaluating performance in relation to a set standard or others' performance. Person received feedback.
14. Provide contingent rewards (OC)	Praise, encouragement or material rewards that are be explicitly linked to the achievement of specified behaviors.
15. Teach to use prompts/ cues (OC)	Teach the person to identify environmental cues which can be used to remind them to perform a behavior, including times of day, contexts or elements of contexts.
16. Agree behavioral contract (OC)	Agreement (e.g., signing) of a contract specifying behavior to be performed so that there is a written record of the person's resolution witnessed by another.

17. Prompt practice (OC)	Prompt the person to rehearse and repeat the behavior or preparatory behaviors.
18. Use follow up prompts	Contacting the person again after the main part of the intervention is complete.
19. Provide opportunities for social comparison (SCompT)	Facilitate observation of non-expert others' performance e.g., in a group class or using video or case study.
20. Plan social support/ social change (social support theories)	Prompting consideration of how others' could change their behavior to offer the person help or (instrumental) social support, including "buddy" systems – and/or providing social support.
21. Prompt identification as role model	Indicating how the person may be an example to others and influencing their behavior or providing an opportunity for the person to set a good example.
22. Prompt self talk	Encourage use self instruction and self encouragement (aloud or silently) to support action.
23. Relapse prevention (Relapse Prevention Therapy)	Following initial change, help identify situations likely to result in re-adopting risk behaviors or failure to maintain new behaviors and help the person plan to avoid or manage these situations.
24. Stress management (stress theories)	May involve a variety of specific techniques (e.g., progressive relaxation) which do not target the behavior but seek to reduce anxiety and stress.
25. Motivational interviewing	Prompting the person to provide self-motivating statements and evaluations of their own behavior to minimize resistance to change.
26. Time management	Helping the person make time for the behavior (e.g., to fit it into a daily schedule).

Table 2.

Reliability of technique identification in three reviews and one manual set; Kappa and percentage agreement per technique

Technique	Physical Activity	Healthy Eating	Intention/Behavior	HIV/ AIDS (% only)
1. Provide general information	.86 93	.90 96	.51 77	100
2. Provide information on consequences	.53 80	.68 96	.61 81	85
3. Provide information about others' approval	N/A 100	N/A 100	.64 95	77
4. Prompt intention formation	.72 86	.81 91	.59 82	69
5. Prompt barrier identification	.79 90	.91 96	.67 89	85
6. Provide general encouragement	.39 62	.62 82	.46 94	77
7. Set graded tasks	.66 90	.74 91	.92 99	85
8. Provide instruction	.73 96	.79 73	.62 88	100
9. Model/ demonstrate the behavior	.62 86	N/A 100	.84 95	85
10. Prompt specific goal setting	.79 89	.62 91	.62 91	92
11. Prompt review of behavioral goals	.90 96	1.0 100	1.0 100	100
12. Prompt self-monitoring of behavior	.93 96	.89 96	.87 97	85
13. Provide feedback on performance	.75 90	.79 91	.74 92	77

14. Provide contingent rewards	.79 93	.88 96	1.0 100	85
15. Teach to use prompts/ cues	1.0 100	1.0 100	0.1 ns 97	85
16. Agree behavioral contract	.84 96	.78 96	1.0 100	85
17. Prompt practice	.91 96	N/A 100	.85 93	77
18. Use follow up prompts	.86 93	.70 91	.83 97	69
19. Provide opportunities for social comparison	.78 90	.51 86	.75 88	92
20. Plan social support/ social change	.85 93	.77 91	.75 93	62
21. Prompt identification as role model	1.0 100	N/A 100	.59 97	69
22. Prompt self talk	.84 94	N/A 100	.91 99	92
23. Relapse prevention	.78 90	.88 96	.85 99	92
24. Stress management	1.0 100	1.0 100	.85 98	85
25. Motivational interviewing	1.0 100	1.0 100	N/A 100	100
26. Time management	.76 100	1.0 100	1.0 100	100

Notes: All Kappas significant at $p<.01$ unless specified, * = $p<.05$, ns = non significant.

k's = 29 (physical activity), 22 (healthy eating), 144 (intention/behavior) and 13 (HIV/AIDS manuals).