

Reporting behaviour change interventions and techniques

Susan Michie & Caroline E Wood

In this chapter we outline the need for behavioural science to develop and implement an agreed, shared standard and method for the reporting of complex behaviour change interventions. We discuss the use of behaviour change techniques (BCTs) as a reliable methodology for the specification of interventions and illustrate this with examples from current research and practice.

Preventable behaviours, such as smoking, physical inactivity, eating unhealthy diets and excessive alcohol consumption have been identified as the leading causes of morbidity and mortality (Lozano et al., 2012; Mokdad, Marks, Stroup, & Gerberding, 2004; Murray et al., 2013; NICE, 2007). Progress in tackling major health problems such as these requires behaviour change in those who are at risk from ill health, those with a chronic or acute illness, and health professionals and others responsible for delivering effective, evidence-based public health and healthcare. Interventions to change behaviour are therefore fundamental to promoting the uptake of healthy behaviours and the implementation of effective clinical practice (NICE, 2014). ‘Behaviour change interventions’ refer to coordinated sets of activities designed to change specified behaviour patterns, such as prescribing behaviours, adherence behaviours and screening attendance (Michie, Churchill, & West, 2011).

Behaviour change interventions are typically complex and comprise several potentially interacting active components (Craig et al., 2008). This complexity can make them challenging to accurately replicate in research, to synthesise across studies in evidence reviews and to translate into practice. Thus, to inform the development of more effective health behaviour change interventions and to enhance the understanding of their mechanisms of action, it is crucial that researchers report interventions with clarity and detail. We require a reporting

method that would enable us to have a clearer understanding of what was delivered in the intervention (i.e. the ‘active ingredients’) and how it was delivered, that is who delivered, to whom, how often, for how long, in what format, and in what context (Davidson et al., 2003; Hoffmann, Erueti, & Glasziou, 2013; Michie, Fixsen, Grimshaw, & Eccles, 2009). This clarity is also needed to advance behavioural science, as evidence accumulation about behaviour change can only occur if scientists know exactly what was delivered in a particular intervention (Michie & Johnston, 2012, 2013; Rothman, 2004). Studies of published trials reports show that poor descriptions render 40-89% of interventions non-replicable. Thus, precise and reliable description of intervention content is an important step in reducing the waste that is evident in the current research process (Glasziou et al., 2014; Macleod et al., 2014). There are at least three potential benefits of implementing a more rigorous approach for specifying intervention content:

1. To promote the accurate replication of interventions and control conditions in comparative effectiveness research.

Replicating interventions is a key activity in accumulating scientific knowledge and investigating generalisability across behaviours, populations and settings. However, published descriptions of both behavioural and biomedical interventions frequently omit essential information; one analysis found that 67% of drug intervention descriptions were adequate compared with only 29% of non-pharmacological interventions (Glasziou, Meats, Heneghan, & Shepperd, 2008). When secondary data analyses take place to identify types of interventions that are effective, many are too poorly specified to be included (Michie, Abraham, Whittington, McAteer, & Gupta, 2009). This leads to confusion and uncertainty amongst researchers and practitioners and may result in low confidence in their abilities to accurately replicate interventions (Michie, Hardeman, et al., 2008).

To address this problem, a guide for reporting the essential minimum data for interventions was developed, drawing on existing checklists and relevant literature evaluated and synthesised in a consensus exercise involving 90 international experts from many disciplines (Hoffmann et al., 2014). The result is TIDieR (Template for Intervention Description and Replication), a 12-items checklist covering intervention name, why (rationale), what (materials), what (procedure), who provided, how, where, when and how much, tailoring, modifications, how well (planned), how well (actual). The guide contains a brief explanation and cross-disciplinary examples for each item and can be used to guide the writing of intervention reports and may also be of value to journal editors and reviewers.

TIDieR is a significant step forward in reporting interventions. To complement this, a more fine-grained method is required to specify and report the content or ‘active ingredients’ of interventions. These are the techniques with potential, in the right circumstances, to bring about changes to behaviour. In both intervention protocols and published reports, these active ingredients’ are often described in partial or vague terms. This is illustrated in a study of 152 Cochrane review trials of behavioural support for smoking cessation which found that only 44% of the techniques specified in the treatment manuals were specified in the published reports (Lorenzatto, West, Stavri, & Michie, 2012).

2. To specify intervention content to facilitate faithful implementation of (a) intervention protocols in research and (b) interventions found to be effective.

An under-specified intervention cannot be delivered with fidelity (i.e. as documented in the research protocol). This limits both the replication of interventions in the effort to accumulate evidence, and the implementation of effective interventions. Poor fidelity to intervention protocols when practitioners try to implement the intervention in clinical practice has been documented in many areas (Borrelli, 2011). On average, fewer than half the techniques specified in treatment manuals were found to be delivered in a study of behavioural support for

smoking cessation (Lorenatto, West, Bruguera, & Michie, 2013) and in a study of interventions to increase physical activity amongst a sedentary population with a family history of type 2 diabetes (Hardeman et al., 2007); the percentages were 41% and 42% respectively.

3. To extract and synthesise information about intervention content in systematic reviews.

Evidence about behaviour change intervention effectiveness is accumulating slowly (NICE, 2007, 2014). Systematic reviews have been conducted across a wide range of behaviours and populations, as can be found in the Cochrane Collaboration library (<http://www.thecochranelibrary.com/>) and guidance provided by the National Institute for Health and Care Excellence (NICE) (<http://guidance.nice.org.uk/>) and serve as a useful guide for health providers seeking the most effective interventions to bring about behaviour change. These reviews tend to report modest effects from very heterogeneous interventions and evaluation methods. This has limited the extent to which there are clear patterns of results and indications that one specific method or technique should be favoured over another. The essential elements of behaviour change interventions are frequently omitted from intervention descriptions. Titles and abstracts of published interventions have been found to mention the active components of the intervention in only 56% of published descriptions compared with over 90% in pharmacological interventions (McCleary, Duncan, Stewart, & Francis, 2013). This creates difficulties for evidence synthesis.

To date, we do not have a full understanding of what accounts for variability in effectiveness across interventions. Lack of a methodology for unpacking the “black box” of intervention content has limited progress in developing more effective interventions and reliably implementing effective ones (Craig et al., 2008; NICE, 2014). The absence of an agreed methodology also means that systematic reviewers develop their own systems for classifying content and synthesising intervention outcomes (Albarraçín et al., 2005; Hardeman

et al., 2007; Mischel, 2012; West, Walia, Hyder, Shahab, & Michie, 2010). This does not enhance evidence accumulation.

Guidance for reporting interventions

In the last decade, several guidance documents have clarified best practice in reporting intervention construction, content and delivery. For example, CONSORT (Moher, Schulz, & Altman, 2003) advises researchers to report the ‘precise details’ of the intervention as ‘actually administered’, and the TREND statement (Des Jarlais, Lyles, & Crepaz, 2004) emphasises the reporting of the theories used and full description of comparison and intervention conditions. The CONSORT statement has since been updated and extended to enable application to different study designs, interventions and data (e.g. (Boutron, Moher, Altman, Schulz, & Ravaud, 2008; Campbell, Piaggio, Elbourne, & Altman, 2012). More recently, the TIDieR checklist has been developed by incorporating guidance from statements such as CONSORT and TREND, to guide the writing of intervention reports (Hoffmann et al., 2014).

The existing guidance has been pivotal to improving the clarity and structure of intervention reporting and as such, have been endorsed by many journals. The WIDER (**W**orkgroup for **I**ntervention **D**evelopment and **E**valuation **R**esearch) group has had some success in encouraging journal editors to ensure that transparent and accessible intervention descriptions are available before publication of intervention outcomes (Albrecht, Archibald, Arseneau, & Scott, 2013). However, descriptions of intervention content (i.e. the active ingredients) often still lack sufficient detail to allow replication.

The UK Medical Research Council’s (MRC) guidance for developing and evaluating complex interventions called for the specification of the active ingredients as a necessary step for investigating how interventions exert their effect and therefore for designing more effective interventions and applying them appropriately across group and setting (Craig et al., 2008).

The detailed specification of interventions is important for both basic and applied behaviour science (Davidson et al., 2003; Hoffmann et al., 2013; Moher et al., 2003; Proctor, Powell, & McMillen, 2013). Further, a well-specified intervention is essential before evaluation of effectiveness is worth undertaking. Progress has been made in improving how intervention content is reported. However, if descriptions are to be communicated effectively and successfully replicated, a shared and standardised method of classifying intervention content is needed (Michie, Abraham, et al., 2011). In the absence of such a methodology, the same techniques may be reported with different labels (e.g. ‘self-monitoring may be labelled ‘daily diaries’), or the same labels may be applied to different techniques (e.g. ‘behavioural counselling’ may involve ‘educating patients’ or ‘feedback, self-monitoring and reinforcement’ (Michie, Johnston, Francis, Hardeman, & Eccles, 2008).

Behaviour Change Technique (BCT) Taxonomies

One approach taken by researchers to develop a standardised method for reporting the content of interventions to change behaviour has been to specify the potentially active ingredients in terms of behaviour change techniques (BCTs) (Abraham & Michie, 2008; Albarracín et al., 2005; Hardeman, Griffin, Johnston, Kinmonth, & Wareham, 2000). By BCT, we mean an observable, replicable and irreducible component of an intervention designed to alter or redirect causal processes that regulate behaviour (e.g., feedback, self-monitoring, reinforcement) (Michie, Abraham, et al., 2011; Michie & Johnston, 2013). BCTs can be used alone or in combination and in a variety of formats. BCTs have been presented in structured lists, or ‘taxonomies’ (Stavri & Michie, 2012). The BCTs have standardised labels, clear definitions and examples to specify the active content of interventions so that any given BCT will always be described by the same label and that label will always be used to describe the same BCT.

The first cross-domain BCT taxonomy was developed by Abraham and Michie (2008) and comprised 26 BCTs. Abraham and Michie's 26-item taxonomy showed good inter-coder reliability (i.e. the extent to which coders agreed on the presence/absence of BCTs) in identifying 22 BCTs and 4 BCT packages across 221 intervention descriptions in papers and manuals. More specifically, this work demonstrated the feasibility of specifying intervention content according to BCTs and provided a model by which researchers and practitioners could begin to ascertain which techniques, or combination of techniques, are associated with effective behaviour change.

The taxonomy has been widely used internationally to report interventions, synthesise evidence (Dombrowski et al., 2010; Dusseldorp, van Genugten, van Buuren, Verheijden, & van Empelen, 2013; Michie, Abraham, et al., 2009; Michie, Jochelson, Markham, & Bridle, 2009; Quinn, Unpublished doctoral dissertation) and design interventions (Araujo-Soares, McIntyre, MacLennan, & Sniehotta, 2009; Cahill, 2008; Michie, Hardeman, et al., 2008). Additionally, it has been used to assess the extent to which published reports reflect intervention protocols (Lorenatto et al., 2012) and to assess fidelity of delivery (Lorenatto et al., 2013). Abraham and Michie's taxonomy has also enabled the specification of professional competences for delivering BCTs (Dixon & Johnston, 2012; Michie, Churchill, et al., 2011) and has formed the basis for a national training program (West & Michie, 2013) (see www.ncsct.co.uk). Guidance has also been developed for incorporating BCTs in text-based interventions (Abraham, 2012).

Taxonomies of BCTs have since been developed to enable specification of BCTs across a number of different behavioural domains. For example, physical activity and healthy eating (Dombrowski et al., 2010; Michie, Abraham, et al., 2009), smoking cessation (Michie, Churchill, et al., 2011; West, Evans, & Michie, 2011; West et al., 2010), excessive alcohol consumption (Michie et al., 2012), sexually transmitted infections (Abraham, Good, Huedo-

Medina, Warren, & Johnson, 2012; Albarracín et al., 2005) and changing professional behaviour (Ivers et al., 2012).

The development of BCT taxonomies has been accompanied by a progressive increase in comprehensiveness and clarity; however this work has been conducted by only a few research groups. For the BCT methodology to maximise scientific advance, there is a need for collaborative work to develop agreed labels and definitions and reliable procedures for their identification across behaviours, disciplines and countries. Given the number of BCTs that have been identified, it is also necessary to start exploring ways in which we can group BCTs to make the taxonomy more memorable and useable (Stavri & Michie, 2012). Previously, taxonomies have existed either in the form of an unstructured list or were linked to, or structured, according to categories judged to be the most appropriate by the authors (e.g., theory (Abraham & Michie, 2008; Albarracín et al., 2005) and theoretical mechanism (Dixon & Johnston, 2012)). Science and practice will be served by an agreed method for identifying BCTs and grouping them to make the method easier to use and more reliable.

The Behaviour Change Technique Taxonomy v1 (BCTTv1)

With these factors in mind, a three year project, funded by UK's Medical Research Council, developed such a method. It engaged the input from a total of 400 researchers, practitioners and policymakers all of whom were active in investigating, reviewing, designing or delivering behavioural interventions. The result is a comprehensive, cross-domain, hierarchically structured list of clearly defined BCTs: Behaviour Change Technique Taxonomy v1 (BCTTv1) (Michie, Abraham, et al., 2011; Michie et al., 2013). The project involved seven studies that developed and tested BCTTv1 as an appropriate and acceptable tool for improving specification of complex behaviour change interventions. In this next section, we summarise the findings from each study.

Developing a comprehensive list of BCTs. The aim of this study was to develop an extensive, agreed list of BCTs used in behaviour change interventions. First, a list of distinct BCT labels and definitions was systematically developed using Delphi methods, building on a preliminary list of six published taxonomies (Abraham et al., 2012; Abraham & Michie, 2008; Dixon & Johnston, 2012; Michie, Abraham, et al., 2009; Michie, Hyder, Walia, & West, 2011; Michie et al., 2012). The list was then refined following feedback from the study's multi-disciplinary International Advisory Board of 30 behaviour change experts (see <http://www.ucl.ac.uk/health-psychology/BCTtaxonomy/collaborators.php>). BCTs were added, divided and removed and their labels and definitions refined to capture the smallest components compatible with retaining the proposed active ingredients with the minimum of overlap. This resulted in 93 distinct BCTs, BCT Taxonomy v1 (BCTTv1) (Michie et al., 2013). Development of BCTTv1 comprised a series of consensus exercises involving 35 experts in delivering and/or designing behaviour change interventions. These experts were drawn from a variety of disciplines including psychology, behavioural medicine and health promotion and from seven countries. The resulting BCTs therefore have relevance among experts from varied behavioural domains, disciplines and countries and potential relevance to the populations from which they were drawn.

Exploring the structure of BCTTv1. The 93-item taxonomy poses problems for the easy recall of, and ready access to, the BCTs and thus its speed and accuracy of use. This study therefore aimed to provide a structure for the list to increase its ease of use, and to compare a pragmatic 'bottom-up' method with a theoretical 'top-down' method for generating this structure. Its objectives were to: (i) develop a hierarchical structure within BCTTv1 using an open-sort task ('bottom-up' method), (ii) identify whether BCTs could reliably be linked to theoretical domains using a closed-sort task ('top-down' method) and, (iii) identify any overlap between the 'bottom-up' and 'top-down' groupings.

Participants created an average of 15.11 groups ($SD = 6.11$; range 5-24 groups). BCTs relating to 'Reward and Punishment' and 'Cues and Cue Responses' were perceived as markedly different to other BCTs. Fifty-nine of the BCTs were reliably allocated to 12 of the 14 theoretical domains; 47 were significant and 12 were of borderline significance. There was a significant association between the 16 'bottom-up' groupings and the 13 'top-down' groupings, $\chi^2 = 437.80$, $p < .001$. Thirty-six of the 208 'bottom-up' x 'top-down' pairings (i.e. 16 x 13) showed greater overlap than expected by chance. However, only six combinations achieved satisfactory evidence of similarity. The 'bottom-up' method, resulting in 16 groupings had some overlap with the theory-driven groupings. The moderate overlap between the groupings indicates some tendency to implicitly conceptualise BCTs in terms of the same theoretical domains. Further research into understanding the nature of this overlap will aid the conceptualisation of BCTs in terms of theory and application.

Training to code intervention descriptions using BCTTv1. Satisfactory inter-coder reliability has been demonstrated in using BCT taxonomies for shorter, specific behaviour categories amongst coders with varying amounts of training (Abraham et al., 2012; Abraham & Michie, 2008; Michie, Ashford, et al., 2011; Michie, Hyder, et al., 2011; Michie et al., 2012). For a BCT taxonomy to be reliably applied, it needs to have intrinsic clarity and structure *and* to be used by those with adequate skills.

The process of coding intervention descriptions into BCTs is a highly skilled task requiring familiarity with the BCT labels and definitions and the ability to make a series of complex interpretative judgments. This requires an effective program of coder training to ensure a sufficient level of skills to demonstrate reliability and validity of identifying BCTs. Reliability can be measured by the extent to which coders agree with each other on the presence and absence of BCTs in intervention descriptions ('inter-coder' agreement) and validity can be measured by the extent to which coders agree with expert judgement about BCTs present and

absent. In this study, two programmes of user training were developed, one-day workshops and distance group-tutorials. Effectiveness was evaluated in terms of whether training enhanced coding reliability, validity, confidence in identifying BCTs and the proportion of trainees reaching the accepted standard of competence. Both methods of training improved coding competence, trainee agreement with experts (i.e. validity) (both $p < .001$) and trainee confidence in identifying the BCTs (workshops: $p < .001$ and tutorials: $p < .05$). Training did not improve agreement between trainees about which BCTs were present and absent in the descriptions. Training was evaluated positively by trainees.

Assessing the reliability and validity of BCTTv1. The aim of this study was to investigate the reliability and validity of BCTTv1. Reliability was assessed by inter-coder and test-retest reliability (measured at two time points one month apart) in coding intervention descriptions into BCTs, and validity was assessed by the extent to which this coding agreed with experts (consensus reached by the BCTTv1 study team as to which BCTs were present). We calculated PABAK (Prevalence and Bias Adjusted Kappa (Byrt, Bishop, & Carlin, 1993)) to assess agreement between coders. In addition, we also calculated the AC1 statistic (Gwet, 2012) and tested whether the two statistics gave different measurements of inter-coder agreement. Finally, we investigated trained coders' confidence in identifying BCTs in intervention descriptions and whether descriptions varied in the ease with which BCTs could be identified.

Eighty of 93 defined BCTs were identified by at least one trained coder and 22 BCTs were identified in 16 or more of 40 descriptions. Thus coders made extensive use of BCTTv1, justifying the large number of BCTs included. Good inter-coder reliability was observed across 80 BCTs; 64 (80%) achieved mean PABAK scores of 0.70 or greater and 59 (74%) achieved mean scores of 0.80 or greater. There was good within-coder agreement between time 1 and time 2 thus demonstrating good test re-test reliability. Good validity was demonstrated for the

15 BCTs identified by experts; trained coder agreement with expert coding was good (i.e. PABAK > 0.70) for 14 of the 15 BCTs. Coders' confidence in their BCT identifications varied across BCTs and increased from time 1 to time 2.

Inter-coder reliability was good across all of the intervention descriptions ($M = .87$; $SD = .05$). Only 4 of 40 descriptions had PABAK scores below 0.80 (mean PABAK for the four descriptions = .76, $SD = .04$). All four intervention descriptions were from protocols published in 2010 by BMC Public Health. Results showed that the PABAK and AC1 statistics generated very similar assessment of inter-coder reliability for the majority of BCTs; they only differed for the most frequently occurring BCTs with PABAK generating lower scores than AC1.

Since its development, BCTTv1 has been widely applied by researchers and practitioners to specify, evaluate and synthesise behaviour change interventions targeting a range of behaviours, for example, to increase young adults condom use intentions and behaviour (Newby, French, Brown, & Lecky, 2013), to reduce decline of physical activity during pregnancy (Currie et al., 2013), to evaluate a national sexual health and relationships education package (Dale, Raftery, & Locke, 2014) and to improve oral hygiene behaviours (Schwarzer, Antoniuk, & Gholami, 2014). The final group of studies sought to explore whether BCTTv1 can improve the quality of behaviour change intervention reporting.

Using BCTTv1 to report behaviour change interventions. In three different study designs, 166 participants ('writers') watched videos of behaviour change interventions and wrote descriptions of the active content delivered, with and without BCTTv1 provision and with and without training. The first two studies (both RCTs) examined provision of BCTTv1 without training, and the effects of training plus provision of BCTTv1 compared with a control group receiving neither the taxonomy nor training. A within-person design was used to assess change in the quality of descriptions before and after training. Writers provided with BCTTv1 for the task evaluated usability and acceptability of using BCTTv1 to write descriptions.

Twelve ‘raters’ (untrained in BCTTv1) assessed description quality in terms of clarity and replicability, and 12 ‘coders’ (trained in BCTTv1) coded the descriptions for BCTs.

Provision of the taxonomy alone did not improve quality. Training writers resulted in descriptions that were rated to be of poorer quality in one study but training improved description quality in the within-person study. The taxonomy improved agreement between coders on the presence of BCTs. More work is being undertaken to develop guidance for using BCTTv1 to describe the content of behaviour change interventions in written reports

Future developments

The work discussed in this chapter is a step toward the objective of developing agreed methods that permit and facilitate the aims of CONSORT and UK MRC guidance of precise reporting of complex behavioural interventions. BCT taxonomies lay the foundation for the reliable and systematic specification of behaviour change interventions. Their use significantly increases the possibilities of identifying the active ingredients within intervention components, the conditions under which they are effective and the possibilities of replicating and implementing effective interventions. The Behaviour Change Technique Taxonomy v1 (BCTTv1) (Michie, Abraham, et al., 2011; Michie et al., 2013) is foundational for long-term goals of developing a comprehensive, hierarchical, reliable and generalisable BCT taxonomy that can be applied, and possibly extended, to many different types of intervention, including organisational and community interventions.

We recommend that coders already trained in the use of BCTTv1 regularly review training materials and check their own reliability. To give coders further practice and experience in applying relevant learning principles to coding BCTs, and in order to train new coders using BCTTv1, we have developed an interactive online training course which can be accessed via the BCT Taxonomy project website (<http://www.ucl.ac.uk/health-psychology/BCTtaxonomy/>). The course trains coders on frequently-used BCTs from the

taxonomy over a number of tutorial sessions and practice coding tasks. This allows trainees to apply newly acquired knowledge and skills. They also have access to a social support network to foster continued and effective learning. To further increase usability of the taxonomy, a digital version of BCTTv1 available as a smartphone and tablet application has been developed. Users can download this version via a link on the website.

It is anticipated that further refinement and development of BCTTv1 will occur as a result of its use and feedback from trainees, primary researchers, systematic reviewers and practitioners. A system has already been set up on the website to receive this feedback and a multidisciplinary, international team is being established to guide the development of BCTTv2.

BCTTv1 is a methodological tool for specifying intervention content and does not, itself, make links with theory. Further research is needed to link BCTs to theories of behaviour change, for both designing and evaluating theory-based interventions. Publications have suggested links between BCTs and domains of theoretical constructs (Abraham, 2012; Michie, Johnston, Francis, & Hardeman, 2005). A methodology for linking BCTs to theoretical constructs is currently being developed and evaluated in a multi-disciplinary and internationally supported project led by Michie and funded by the Medical Research Council (MRC) Methodology Board. Details of this project are available on the BCT Taxonomy project website. This project will begin to develop a Behaviour Change Ontology, linking BCTs, theoretical mechanisms of action, modes of delivery and context. This will allow the investigation of and building of an evidence base of interactions within this ontology and of their impact on outcomes. This will be a step change in advancing behavioural science research.

Meanwhile, a guide to developing behaviour change interventions has been published. This guide provides a systematic method for selecting BCTs on the basis of a theoretical analysis of the target behaviour in context, using the Theoretical Domains Framework (Cane, O'Connor, & Michie, 2012; Michie, Johnston, Abraham, et al., 2005) and/or the Behaviour

Change Wheel (Michie, van Stralen, & West, 2011). This book is aimed at researchers, practitioners, policymakers, organisational change consultants and systems scientists and all those involved in designing behaviour change interventions (Michie, Atkins, & West, 2014). The Behaviour Change Wheel Guide will be available via the website of University College London's Centre for Behaviour Change (<http://www.ucl.ac.uk/behaviour-change>).

Conclusion

Behaviour Change Technique (BCT) taxonomies can be used to reliably specify the active content of complex behaviour change interventions in standard terms that can be understood across discipline and country. Behaviour Change Technique Taxonomy v1 (BCTTv1) is an extensive, hierarchically-organised taxonomy of 93 distinct BCTs (with clear definitions and examples) that offers a reliable and useable method for specifying the active content of interventions. The process of building a shareable consensus methodology is likely to be an ongoing, iterative process, involving collaborative input from international advisors and networks. The increasing standardisation and communication of methods, and wide collaborations and networks to achieve this, are steps forward in advancing the science of behaviour change.

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Keywords:

Behaviour change, behaviour change techniques, taxonomy, reporting, describing, evaluation, replication, behaviour change interventions, guidelines, reporting quality, active content, specifying intervention content, Behaviour change technique taxonomy, training, methodology