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Please note Stefanie Ashford has subsequently changed her name to Stefanie Williams.

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**A refined taxonomy of behaviour change techniques to help people change their
physical activity and healthy eating behaviours – The CALO-RE taxonomy**

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Abstract

Background

Current reporting of intervention content in published research articles and protocols is generally poor, with great diversity of terminology, resulting in low replicability. This study aimed to extend the scope and improve the reliability of a 26-item taxonomy of behaviour change techniques developed by Abraham and Michie (2008) in order to optimize the reporting and scientific study of behaviour change interventions.

Methods

Three UK study centres collaborated in applying this existing taxonomy to two systematic reviews of interventions to increase physical activity and healthy eating. The taxonomy was refined in iterative steps of (a) coding intervention descriptions, and assessing inter-rater reliability, (b) identifying gaps and problems across study centres, and (c) refining the labels and definitions based on consensus discussions.

Results

Labels and definitions were improved for all techniques, conceptual overlap between categories was resolved, some categories were split and 14 techniques were added, resulting in a 40-item taxonomy. Inter-rater reliability, assessed on 50 published intervention descriptions, was good ($\kappa = 0.79$).

Conclusions

This taxonomy can be used to improve the specification of interventions in published reports, thus improving replication, implementation and evidence syntheses. This will strengthen the scientific study of behaviour change and intervention development.

Background

In order to improve the effectiveness of interventions to change behaviour, such as physical activity and healthy eating, it is necessary to replicate and accumulate evidence across empirical studies. This is not straightforward, as interventions to change health-related behaviours are usually complex, comprising many, often interacting components (Craig et al., 2008). Systematic reviews of the effects of physical activity and healthy eating interventions on behaviour or health outcomes often conclude that both the interventions as well as the effect sizes are extremely heterogeneous (Avenell et al., 2004; Lemmens, Oenema, Klepp, Henriksen, & Brug, 2008; Ogilvie et al., 2007). While some interventions are indeed highly effective in changing behaviour and relevant health outcomes, others fail to achieve such effects. Replication, accumulation and application of evidence depend on the ability to reliably specify the details of intervention content both for primary research and for secondary evidence syntheses.

Current reporting of interventions in published evaluations falls short of the detail required for reliably identifying intervention content (Dombrowski, Sniehotta, Avenell, & Coyne, 2007; Glasziou, Meats, Heneghan, & Shepperd, 2008; Michie, Fixen, Grimshaw, & Eccles, 2009) and hence limits the possibility of identifying the effective ingredients within interventions (Michie, Abraham, Wittington, McAteer, & Gupta, 2009). Reporting of intervention content is often brief and imprecise with interventions being broadly characterized as, for example, “behavioural counselling”, “Cognitive Behavioural Therapy” or “motivational strategies”. In some cases reporting does not mention content but, instead, describes mode of intervention delivery such as “face to face” or “nurse delivered” or in terms of number of intervention sessions.

Where detail of intervention content is provided, such as in published intervention protocols, terminology is variable across intervention descriptions; the same label may be applied to different behaviour change techniques (BCTs) or different labels applied to the same technique. An example of the former is ‘behavioural counseling’ described both as “educating patients about the benefits of lifestyle change, encouraging them, and suggesting what changes could be made” (Steptoe, Kerry, Rink, & Hilton, 2001, p.266) and “feedback on self-monitoring record, reinforcement, recommendations for change, answers to questions, and general support” (Tate, Jackvony, & Wing, 2003, p.1834). Similarly, interventions reporting the use of ‘goal setting’ for dietary and physical activity behaviour change interventions differ substantially from each other (Shilts, Horowitz, & Townsend, 2004) and ‘barrier identification’ has been described as “motivational messages” that highlight “perceived benefits of exercise while addressing perceived barriers and strategies to overcome those barriers” (Richardson et al., 2007) or “practical strategies” used to increase “the uptake of dietary and physical activity recommendations, given that people are concurrently managing family, work and study; may have limited finances;...” (Pettman et al., 2008).

Standardized definitions of techniques are required to put the study of behaviour change onto a more scientific footing for at least four reasons:

First, they are required to allow identification of which techniques contribute to intervention effectiveness. Accumulating evidence of what works is a necessary part of developing more effective and parsimonious complex interventions. Standardized definitions are invaluable for evidence synthesis in systematic literature reviews; without them, it is unclear how intervention content should be categorized in meta-analyses

across studies (Gardner, Whittington, McAteer, Eccles, & Michie, 2010). Second, they allow authors of interventions to accurately describe interventions in a way that faithfully represents the implemented BCTs, thereby allowing accurate appraisal of the scientific evidence produced (e.g. Araújo-Soares, McIntyre, MacLennan, & Sniehotta, 2009). Third, standardization is necessary for reliably linking BCTs to mechanisms of action, and therefore understanding how interventions work (Michie, 2008). This allows intervention effectiveness to be optimized by providing knowledge about how techniques may be effectively combined together and how intervention effects are likely to generalize across situations. Moreover, such information is fundamental to theoretical development (Sniehotta, 2009b) and requires linking intervention techniques with theoretical constructs (e.g. Ashford, Edmunds, & French, 2010) and theories of behaviour change (e.g. Michie, Johnston, Francis, Hardeman, & Eccles, 2008). Without a reliable method of specifying techniques, such mapping is impossible. Lastly, standard technique definitions are required for effective implementation of interventions from research protocols to practice 'in the field'. By ensuring that effective intervention techniques are in fact delivered as intended such definitions facilitate implementation of evidence-based practice across different health care contexts.

Attention has increasingly been paid to the standardised reporting of intervention content and their component BCTs (Abraham & Michie, 2008; **Workgroup for Intervention Development and Evaluation Research (WIDER, 2008)** at <http://interventiondesign.co.uk>), with the aim of improving reporting of behaviour change interventions and thereby advancing the science of behaviour change (Michie, Rothman, & Sheeran, 2007). To identify specific BCTs contributing to intervention

effectiveness, a standardized 26 item taxonomy to classify BCTs in physical activity and healthy eating interventions has been developed (Abraham & Michie, 2008). This taxonomy demonstrated reliability in judging the presence or absence of 26 techniques in three systematic reviews mainly of interventions aimed at changing physical activity and dietary behaviours. The taxonomy has had immediate impact on the field.

To date, the Abraham and Michie (2008) taxonomy has been used in systematic reviews (de Bruin, Viechtbauer, Hoppers, Schaalma, & Kok, 2009; Jacobs-van der Bruggen et al., 2009; Michie, Abraham et al., 2009; Renz & Newton, 2009), reports of intervention development and study protocols (Biran et al., 2009; Sanchez et al., 2009), empirical reports; (Albada, Van Dulmen, Otten, Bensing, & Ausems, 2009; Araújo-Soares et al., 2009; Gardner et al., 2010; Hanbury, Wallace, & Clark, 2009) and several editorials and position papers (Hagger, 2009; Marks, 2009; Michie, Fixsen et al., 2009). This work has contributed to the advancement of behavioural science and clarified the evidence base about behaviour change. For example, Michie, Jochelson, Markham, & Bridle, 2009 reviewed the effectiveness of interventions to reduce smoking or increase physical activity and/or healthy eating practices in low income groups and found that effective interventions tended to use fewer BCTs. Two large-scale systematic reviews using the taxonomy and conducting meta-regression showed that interventions prompting participants to self-monitor their behaviour were more effective in achieving behaviour change. In line with this, both reviews found that interventions using more techniques associated with Control Theory (Carver & Scheier, 1998) achieved larger effects (Dombrowski, Sniehotta, Avenell, MacLennan, & Araújo-Soares, in press; Michie, Abraham et al., 2009). These examples show how the availability of a standardised and

reliable taxonomy of behaviour change may help towards the identification of ‘active ingredients’ through reviews of the literature, and facilitate comparisons between reviews.

Despite this successful uptake, a descriptive taxonomy of BCTs is not written in stone. Additional iterations are needed to optimize reliability, comprehensiveness, theoretical coherence and relevance based on applications to different studies in different research centres (Abraham & Michie, 2008). Whilst the Abraham and Michie (2008) taxonomy marks a significant step forward in specifying intervention content, researchers have identified opportunities for further improvement. For example, the systematic review of interventions targeting low income groups mentioned above (Michie, Jochelson et al., 2009) identified two additional BCTs: prompt use of imagery, and environmental restructuring. The present research was a collaboration of three study centres arising from two independent research projects applying this taxonomy to systematically review interventions to increase physical activity and healthy eating. The collaboration aimed to extend the existing taxonomy to improve its comprehensiveness, ease of use and reliability, by clarifying definitions and labels and identifying and adding additional techniques. Similar issues arose in the two reviews, suggesting that findings generalise beyond the studies included in these reviews.

Methods

The research teams engaged in an iterative process of taxonomy refinement based on (a) identifying problems (within teams), (b) revising taxonomy (within and across teams), (c) using a revised and extended version and calculating inter-rater reliability (within teams) and repeating the cycle until the taxonomy categories were conceptually clear and

unambiguous and reliability was good. There were four iterations of this cycle that included coding one or two papers, calculating kappas and revising the taxonomy following group discussion of the three research teams. These refinements, such as revising existing technique labels and descriptions and adding extra ones that had been identified in the reviews, were agreed using an expert consensus approach, i.e., final definitions were agreed by all lead researchers in all three centres, based on the previous iteration and behaviour change theory.

The Abraham and Michie (2008) taxonomy was used as a starting point to code behaviour change intervention descriptions reported in systematic reviews conducted by two separate UK research groups. The interventions in these reviews targeted, respectively, (1) increasing physical activity and healthy eating in obese adults with additional risk factors for morbidity (Dombrowski, Sniehotta, Avenell, MacLennon, & Araújo-Soares, in press) and (2) increasing self-efficacy to promote lifestyle and recreational physical activity (Ashford et al., 2010; Ashford & French, in submission). These reviews comprised a total of 72 studies (n=44, ranging from 1-16 techniques and n=28, ranging from 1-12 techniques respectively) and ranged across a variety of populations, behaviours and settings.

Both research teams used the Abraham & Michie (2008) 26 item BCT taxonomy to code the content of the interventions included in the systematic reviews they conducted. For full details of the application of the taxonomy in each of these reviews, see cited references above. The researchers identified and recorded problems with the use of the 26 item taxonomy, including a lack of clarity for certain techniques and their definitions, overlap between categories and missing categories. The method used by the

study teams are outlined below. Four criteria were used to identify areas for possible improvement.

1. Each time a discrepancy between coders emerged, the reasons for this were identified and possible solutions outlined.
2. Each time relevant intervention content was identified which was not covered by the 2008 taxonomy the inclusion of an additional BCT was considered
3. Each time intervention content coded as the same BCT showing variability in terms of behaviour change strategy and/or the assumed process of change, the definition of separate BCTs or sub-classifications was considered
4. The definitions for all BCTs with unsatisfactory inter-rater agreement in either the original 2008 paper, the Ashford et al. (2010) paper or the Dombrowski et al. (in press) paper were reviewed for improvements.

A solution was agreed on only when all teams considered it offered acceptable clarity and was sufficiently unambiguous to allow reliable coding.

Aberdeen team

Coding was based on the most comprehensive published intervention descriptions or freely available published protocols and full manuals. All coding was made independently by two researchers, Dombrowski (SUD) & Araújo-Soares (VAS). Initially, a selection of eight papers excluded from the review was coded for training purposes and results were discussed between SUD, VAS and Sniehotta (FFS). In addition, the Aberdeen team used the 26-item taxonomy to describe a complex intervention for physical activity changes in an original report (Araújo-Soares et al., 2009). Based on

these experiences and subsequent team discussions, a list of questions that remained unresolved based on the published taxonomy and coding manual was further discussed with Charles Abraham and Susan Michie. Based on these iterations, modifications and additional specifications, a slightly revised 26-item taxonomy was used to code the Dombrowski et al. (in press) review.

Coventry team

Three researchers, Ashford (SA), Edmunds (JE) and French (DPF) independently coded a selection of five intervention descriptions using the original 26-item taxonomy. Subsequent discussions of this coding by the researchers resulted in a list of problems and unresolved issues which, along with a list of unresolved questions from the Aberdeen team, was the basis for the first stage of revision.

All study teams discussed and resolved the issues that arose from the use of the taxonomy in Aberdeen and Coventry as described earlier. Following this, a first revised version of the taxonomy was developed with additional BCTs and revised definitions. Further iterations of the taxonomy were produced, based on email correspondence between the three study teams, culminating in a 39 item version of the taxonomy.

The penultimate version of the taxonomy (39 items) was tested for reliability by one of the study teams (Coventry). Two independent raters (SA and Bishop [AB]) underwent four cycles of an iterative process of independent coding, calculation of kappas, and discussion of differences and further refinement of the taxonomy descriptions, using 10 intervention descriptions. Once good agreement was reached, SA and AB coded the intervention and control groups of the remaining 18 studies in the Ashford et al (2010) review, followed by re-coding the 10 studies previously coded.

Despite achieving good inter-rater reliability, this version was slightly revised based on the problems encountered following completion of the coding for the Ashford et al review.

Results

Aberdeen findings

The Aberdeen team found several difficulties. Table 1 lists these by BCT, as well as the solutions found based on discussions within the Aberdeen team and with the authors of the initial taxonomy. It was agreed not to code the presence of a BCT unless the description was clear and did not require inference, which helped resolve several disagreements.

< Table 1 >

This work resulted in a slightly revised 26-item taxonomy with further agreed specification and a list of additional changes for future iterations of the taxonomy. The resultant inter-rater agreement was ‘good’ (Altman, 1991) with kappas ranging from .59-.78 (Dombrowski et al., in press).

Coventry findings

The Coventry team identified similar problems as the Aberdeen team (Table 1) The inter-rater reliability when using the original Abraham & Michie (2008) taxonomy was $\kappa = 0.45$ to 0.69 across pairs of raters, with a mean of 0.57 . This taxonomy was revised, based on problems encountered in both Aberdeen and Coventry, and a 39-item taxonomy was produced, and used to code all intervention descriptions.

Examples of additional problems found during the final iteration of coding of 28 intervention studies using the revised 39-item taxonomy, and the solutions to these problems, are shown in Table 2.

< Table 2 >

Coding of the intervention descriptions using later versions of the taxonomy yielded better inter-rater reliability than those found using the original version, reaching a mean kappa of 0.79. Despite this good inter-rater reliability, further use identified further aspects to improve. The final version of 40 BCTs, with improved labels and definitions of existing BCTs, and one additional BCTs, is shown in Table 3.

< Table 3 >

Discussion

A collaboration of three study centres applying a 26-item taxonomy of BCTs (Abraham & Michie, 2008) to intervention descriptions in two systematic reviews of interventions to increase physical activity and healthy eating (Ashford et al., 2010; Dombrowski et al., in press) has produced a more comprehensive, well specified and more clearly labelled taxonomy of 40 items, with good reliability: the ‘Coventry, Aberdeen & London – Refined’ (CALO-RE) taxonomy. The 2008 taxonomy was seen as a first step towards establishing a common language for intervention designers, reviewers and practitioners to specify the content of behaviour change interventions across two behavioural domains (Abraham & Michie, 2008). Although the 2008 taxonomy was a step forward in defining intervention content, and a necessary tool in advancing the science of behaviour change, the current work shows the importance of further systematic and rigorous development of

this work. The CALO-RE taxonomy is more comprehensive, with fewer conceptual problems and less overlap between items, as well as clearer labels and definitions.

We recommend that primary and secondary researchers and those translating research evidence into practice use the CALO-RE taxonomy to specify behaviour change interventions aimed at increasing physical activity and healthy eating. Where necessary, authors may need to extend this taxonomy for their purposes and provide detailed definition clarifying the changes made. We also recommend that they take a similar approach to its development to that described here if the CALO-RE taxonomy is found wanting, and consider extending it to other behavioural domains. The extent to which CALO-RE will generalise without adaptation to other investigations of physical activity and healthy eating is an empirical question.

Drawing on this work, a similarly specified taxonomy of 43 BCTs has been developed for smoking cessation interventions (Michie, Hyder, Walia, & West, 2009), which is informing a national training program of smoking cessation specialists in England (<http://www.ncsct.co.uk>). The BCTs within the smoking taxonomy have been reliably grouped into theoretically based functions of behaviour change, as a step towards linking BCTs with mechanisms of action (Michie, Churchill, & West, in press). This taxonomy has also been used in empirical research to analyse the protocols of the English NHS Stop Smoking Services and investigate the association between the inclusion of specific BCTs and 4-week smoking cessation outcomes, using data collected by the Department of Health (West, Walia, Hyder, Shahab, & Michie, 2010). Nine of the BCTs were significantly associated with both self-reported and CO-verified 4-week quit rates (e.g. strengthen ex-smoker identity, provide rewards contingent on abstinence, advise on

medication, measure CO) and a further five were associated with CO-verified 4-week quit rates but not self-reported quit rates (e.g. facilitate/advise on use of social support, provide reassurance). The development of a taxonomy of BCTs for interventions aimed at reducing excessive alcohol intake is underway, part of a larger program of work to develop a cross-domain architecture of BCTs and a more comprehensive and sophisticated taxonomy. Whilst the majority of BCTs are interchangeable between behaviours, there are some that are domain specific e.g. “assess withdrawal symptoms” is appropriate only for addictive behaviours and “advise on stop-smoking medication” and “measure CO” are smoking-specific. Five BCTs were identified in relation to physical activity and healthy eating which were not used for smoking cessation or brief alcohol interventions. These reflect the fact that interventions for physical activity and healthy eating are primarily about initiating behaviour whereas the others are primarily about stopping behaviour. They were: “prompt focus on past success”, “provide information on where and when to perform the behaviour”, “provide instruction on how to perform the behaviour”, “teach to use prompts and cues” and “shaping”. The examination of BCTs across behavioural domains does allow the possible identification of BCTs found to be effective in one domain to be considered for use in others. For example, “behavioural substitution” occurred in brief alcohol interventions but not for the other behaviours, and could be potentially effective in interventions to reduce unhealthy snacking or in smoking cessation interventions.

Taxonomies of BCTs are work in progress in developing useful methodological tools for behavioural science. For example, researchers addressing other issues may identify additional BCTs (e.g. feedback on progress toward achieving a behavioural goal)

or subdivisions within current BCTs (e.g. different types of feedback on performance, such as behavioural, normative or comparative). As taxonomies of behaviour change techniques become more comprehensive, there will be a trade-off between precision and statistical power, particularly when using the taxonomy for meta-regression analyses in systematic reviews. Using 40 items in a meta-regression would require considerable power, certainly more than most reviews of behaviour change techniques have had to date. A possible solution for this problem is analyzing clusters of conceptually coherent BCTs or the collapsing of similar techniques according to research question or application (see Michie, Abraham et al, 2009).

Part of our future programme of work is to develop and apply a methodology for linking BCTs to mechanisms of action (theory). Whilst we have not attempted this for the current taxonomy, this is essential to facilitate experimental tests of theory and theory development based on intervention research (Abraham & Michie, 2008). Establishing such links is not a trivial task. Many theories of behaviour hypothesise causal antecedents of behaviour (social, cognitive and/or environmental), but do not specify BCTs to change these antecedents (Sniehotta, 2009a). Some theories such as the Social Cognitive Theory (Bandura, 1989) do suggest techniques for changing central theoretical constructs, but evidence shows that BCTs other than those hypothesised to effect change might be more effective (Ashford et al., 2010; Michie et al., 2008). A recent expert rating exercise to link BCTs to theoretical construct domains showed that experts agreed in about 75% of the cases whether or not a BCT would be effective to modify a theoretical construct (Michie et al., 2008). However, there is considerable uncertainty about how exactly to

match BCTs onto theoretical constructs; more research is needed and the developing taxonomies need to reflect this ongoing research.

The current CALO-RE taxonomy not only provides a reliable and improved means of reporting, evaluating and implementing evidence, but also offers the prospect of further integrating the means and the mechanisms of action. The CALO-RE taxonomy lays the basis for improving the reliable and systematic application of evidence and theory for physical activity and healthy eating interventions and the extension of this approach to other behavioural domains. It allows the possibility of specific links between BCTs and theoretical constructs, a helpful step for refining theory on the basis of intervention evaluations. This is a major undertaking that requires collaborative, systematic work using a comprehensive, parsimonious and reliable taxonomy of BCTs.

Authors' information

All authors contributed to the analysis and interpretation of data, and read and approved the final manuscript.

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Table 1. Behaviour Change Technique Definitions

1. Provide information on consequences of behaviour in general

Information about the relationship between the behaviour and its possible or likely consequences **in the general case**, usually based on epidemiological data, and not personalised for the individual (contrast with technique 2).

2. Provide information on consequences of behaviour to the individual

Information about the *benefits and costs* of action or inaction to the individual or tailored to a relevant group based on that individual's characteristics (i.e. demographics, clinical, behavioural or psychological information). This can include any costs/ benefits and not necessarily those related to health, e.g. feelings.

3. Provide information about others' approval

Involves information about what other people think about the target person's behaviour. It clarifies whether others will like, approve or disapprove of what the person is doing or will do. **NB** Check that any instance does not also involve techniques 1 (Provide information on consequences of behaviour in general) or 2 (Provide information on consequences of behaviour to the individual) or 4 (Provide normative information about others' behaviour).

4. Provide normative information about others' behaviour

Involves providing information about what other people are doing i.e., indicates that a particular behaviour or sequence of behaviours is common or uncommon amongst the population or amongst a specified group – presentation of case studies of a few others is not normative information. **NB** this concerns other people's actions and is distinct from the provision of information about others' approval (technique 3 [Provide information about others' approval]).

5. Goal setting (behaviour)

The person is encouraged to make a behavioural resolution (e.g. take more exercise next week). This is directed towards encouraging people to decide to change or maintain change. **NB** This is distinguished from technique 6 (Goal setting - outcome) and 7 (Action planning) as it does not involve planning exactly how the behaviour will be done and either when or where the behaviour or action sequence will be performed. Where the text only states that goal setting was used without specifying the detail of action planning involved then this would be an example of this technique (not technique 7 [Action planning]). If the text states that 'goal setting' was used if it is not clear from the report if the goal setting was related to behaviour or to other outcomes, technique 6 should be coded. This includes sub-goals or preparatory behaviours and/or specific contexts in which the behaviour will be performed. The behaviour in this technique will be directly related to or be a necessary condition for the target behaviour (e.g. shopping for healthy eating; buying equipment for physical activity). **NB** check if techniques applied to preparatory behaviours should also be coded as instances of technique 9 (Set graded tasks).

6. Goal setting (outcome)

The person is encouraged to set a general goal that can be achieved by behavioural means but is not defined in terms of behaviour (e.g. to reduce blood pressure or lose/maintain weight), as opposed to a goal based on changing behaviour as such. The goal may be an expected consequence of one or more behaviours, but is not a behaviour per se (see also techniques 5 [Goal setting - behaviour] and 7 [Action planning]). This technique may co-occur with technique 5 if goals for both behaviour and other outcomes are set.

7. Action planning

Involves detailed planning of what the person will do including, as a minimum, when, in which situation and/or where to act. “When” may describe frequency (such as how many times a day/week or duration (e.g., for how long). The exact content of action plans may or may not be described, in this case code as this technique if it is stated that the behaviour is planned contingent to a specific situation or set of situations even if exact details are not present **NB** The terms “goal setting” or “action plan” are not enough to ensure inclusion of this technique unless it is clear that plans involve linking behavioural responses to specific situational cues, when only described as “goal setting” or “action plan” without the above detail it should be regarded as applications of technique 5 and 6.

8. Barrier identification/Problem solving

This presumes having formed an initial plan to change behaviour. The person is prompted to think about potential barriers and identify ways of overcoming them. Barriers may

include competing goals in specified situations. This may be described as “problem solving”. If it is problem solving in relation to the performance of a behaviour, then it counts as an instance of this technique. Examples of barriers may include behavioural, cognitive, emotional, environmental, social and/ or physical barriers. **NB** Closely related to techniques 7 (Action planning) and 9 (Set graded task) but involves a focus on specific obstacles to performance. It contrasts with technique 35 (Relapse prevention/ Coping planning) which is about maintaining behaviour that has already been changed.

9. Set graded tasks

Breaking down the target behaviour into smaller easier to achieve tasks and enabling the person to build on small successes to achieve target behaviour. This may include increments towards a target behaviour, or incremental increases from baseline behaviour.

NB The key difference to technique 7 (Action planning) lies in planning to perform a sequence of preparatory actions (e.g. remembering to take gym kit to work), task components or target behaviours which are in a logical sequence or *increase in difficulty over time* - as opposed to planning “**if-then**” contingencies when/where to perform behaviours. General references to *increasing* physical activity as intervention goal are not instances of this technique.

10. Prompt review of behavioural goals

Involves a review or analysis of the extent to which previously set behavioural goals (e.g. take more exercise next week) were achieved. In most cases this will follow previous goal setting (see technique 5, ‘goal setting-behaviour’) and an attempt to act on those

goals, followed by a revision or readjustment of goals, and/ or means to attain them. **NB** Check if any instance also involves techniques 6 (goal setting - behaviour), 8 (Barrier identification/Problem solving), 9 (Set graded tasks) or 11 (Prompt review of outcome goals).

11. Prompt review of outcome goals

Involves a review or analysis of the extent to which previously set outcome goals (e.g. to reduce blood pressure or lose/maintain weight) were achieved. In most cases this will follow previous goal setting (see technique 6, goal setting-outcome') and an attempt to act on those goals, followed by a revision of goals, and/ or means to attain them. **NB** Check that any instance does not also involve techniques 5 (goal setting - outcome), 8 (Barrier identification/Problem solving), 9 (Set graded tasks) or 10 (Prompt review of behavioural goals).

12. Prompt rewards contingent on effort or progress towards behaviour

Involves the person using praise or rewards **for attempts** at achieving a behavioural goal. This might include efforts made towards achieving the behaviour, or progress made in preparatory steps towards the behaviour, but not merely participation in intervention. This can include self-reward. **NB** This technique is not reinforcement for performing the target behaviour itself, which is an instance of technique 13 (Provide rewards contingent on successful behaviour).

13. Provide rewards contingent on successful behaviour

Reinforcing successful performance of the specific target behaviour. This can include praise and encouragement as well as material rewards but the reward/ incentive must be explicitly linked to the achievement of the specific target behaviour i.e. the person receives the reward if they perform the specified behaviour but not if they do not perform the behaviour. This can include self-reward. Provision of rewards for completing intervention components or materials are not instances of this technique. References to provision of incentives for being more physically active are not instances of this technique unless information about contingency to the performance of the target behaviour is provided. **NB** Check the distinction between this and techniques 7 (Action planning) and 17 (Prompt self-monitoring of behavioural outcome) and 19 (Provide feedback on performance).

14. Shaping

Contingent rewards are first provided for any approximation to the target behaviour e.g., for any increase in physical activity. Then, later, only a more demanding performance, e.g., brisk walking for 10 minutes on three days a week would be rewarded. Thus, this is graded use of contingent rewards over time.

15. Prompting generalization of a target behaviour

Once a behaviour is performed in a particular situation, the person is encouraged or helped to try it in another situation. The idea is to ensure that the behaviour is not tied to one situation but becomes a more integrated part of the person's life that can be performed at a variety of different times and in a variety of contexts.

16. Prompt self-monitoring of behaviour

The person is asked to keep a record of specified behaviour/s as a method for changing behaviour. This should be an explicitly stated intervention component, as opposed to occurring as part of completing measures for research purposes. This could e.g., take the form of a diary or completing a questionnaire about their behaviour, in terms of type, frequency, duration and/or intensity. Check the distinction between this and techniques 17 (Prompt self-monitoring of behavioural outcome).

17. Prompt self-monitoring of behavioural outcome

The person is asked to keep a record of specified measures expected to be influenced by the behaviour change, e.g. blood pressure, blood glucose, weight loss, physical fitness. **NB** It must be reported as part of the intervention, rather than only as an outcome measure. Check the distinction between this and techniques 16 (Prompt self-monitoring of behaviour).

18. Prompting focus on past success

Involves instructing the person to think about or list previous successes in performing the behaviour (or parts of it). **NB** This is not just encouragement but a clear focus on the person's past behaviour. It is also not feedback because it refers to behaviour preceded the intervention.

19. Provide feedback on performance

This involves providing the participant with data about their own recorded behaviour (e.g., following technique 16 [Prompt self-monitoring of behaviour]) or commenting on a person's behavioural performance (e.g., identifying a discrepancy with between behavioural performance and a set goal – see techniques 5 [Goal setting - behaviour] and 7 [Action planning] – or a discrepancy between one's own performance in relation to others' – note this could also involve technique 28 [Facilitate social comparison]).

20. Provide information on where and when to perform the behaviour

Involves telling the person about when and where they might be able to perform the behaviour this e.g. tips on places and times participants can access local exercise classes. This can be in either verbal or written form. **NB** Check whether there are also instances of technique 21 (Provide instruction on how to perform the behaviour).

21. Provide instruction on how to perform the behaviour

Involves *telling* the person *how* to perform a behaviour or preparatory behaviours, either verbally or in written form. Examples of instructions include; how to use gym equipment (without getting on and showing the participant), instruction on suitable clothing, and tips on how to take action *Showing* a person how to perform a behaviour without verbal instruction would be an instance of technique 22 only. **NB** Check whether there are also instances of techniques 5, 7, 8, 9, 22. Instructions to follow a specific diet or programme of exercise without instructions how to perform the behaviours are not included in this definition. Cooking and exercise classes as well as personal trainers and recipes should

always be coded as this technique, but may also be coded as 22 (Model/ Demonstrate the behaviour).

22. Model/ Demonstrate the behaviour

Involves *showing* the person how to perform a behaviour e.g., through physical or visual demonstrations of behavioural performance, in person or remotely. **NB** This is distinct from just providing instruction (technique 21) because in “demonstration” the person is able to *observe* the behaviour being enacted. This technique and techniques 21 (Provide instruction on how to perform the behaviour) and may be used separately or together. Instructing parents or peers to perform the target behaviour is not an instance of this technique as fidelity would be uncertain.

23. Teach to use prompts/ cues

The person is taught to identify environmental prompts which can be used to **remind** them to perform the behaviour (or to perform an alternative, incompatible behaviour in the case of behaviours to be reduced). Cues could include times of day, particular contexts or technologies such as mobile phone alerts which prompt them to perform the target behaviour. **NB** This technique could be used independently or in conjunction with techniques 5 (goal setting - behaviour) and 7 (Action planning) (see also 24 [Environmental restructuring]).

24. Environmental restructuring

The person is prompted to alter the environment in ways so that it is more **supportive** of the target behaviour e.g. altering cues or reinforcers. For example they might be asked to lock up or throw away or their high calorie snacks, or take their running shoes to work. Interventions in which the interveners directly modify environmental variables (e.g. the way food is displayed in shops, provision of sports facilities) are not covered by this taxonomy and should be coded independently.

25. Agree behavioural contract

Must involve written agreement on the performance of an explicitly specified behaviour so that there is a written record of the person's resolution witnessed by another.

26. Prompt practice

Prompt the person to rehearse and repeat the behaviour or preparatory behaviours numerous times. Note this will also include parts of the behaviour e.g., refusal skills in relation to unhealthy snacks. This could be described as “building habits or routines” but is still practice so long as the person is prompted to try the behaviour (or parts of it) during the intervention or practice between intervention sessions, e.g. as “homework”.

27. Use of follow up prompts

Intervention components are gradually reduced in intensity, duration and frequency over time, e.g. letters or telephone calls instead of face to face and/or provided at longer time intervals.

28. Facilitate social comparison

Involves explicitly drawing attention to others' performance to elicit comparisons. **NB**

The fact the intervention takes place in a group setting, or have been placed in groups on the basis of shared characteristics, does not necessarily mean social comparison is actually taking place. Social support may also be encouraged in such settings and this would then involve technique 29 (Plan social support/ social change). Group classes may also involve instruction (technique 21 [Provide instruction on how to perform the behaviour]) demonstration (technique 22 [Model/ Demonstrate the behaviour]) and practice (technique 26 [Prompt practice]).

29. Plan social support/ social change

Involves prompting the person to plan how to elicit social support from other people to help him/ her achieve their target behaviour/ outcome. This will include support during interventions e.g., setting up a “buddy” system or other forms of support and following the intervention including support provided by the individuals delivering the intervention, partner, friends, family.

30. Prompt identification as role model/ position advocate

Involves focusing on how the person may be an example to others and affect their behaviour e.g., being a good example to children. Also includes providing opportunities for participants to persuade others of the importance of adopting/ changing the behaviour, for example, giving a talk or running a peer-led session.

31. Prompt anticipated regret

Involves inducing expectations of future regret about the performance or non-performance of a behaviour. This includes focusing on how the person will *feel* in the future and specifically whether they will feel regret or feel sorry that they did or did not take a different course of action. Do not also code instances of this technique as the more generic providing information on consequences (techniques 1 [Provide information on consequences of behaviour in general] and 2 [Provide information on consequences of behaviour to the individual]).

32. Fear Arousal

Involves presentation of risk and/or mortality information relevant to the behaviour as emotive images designed to evoke a fearful response (e.g, “smoking kills!” or images of the grim reaper). Do not also code instances of this technique as the more generic providing information on consequences (techniques 1 [Provide information on consequences of behaviour in general] and 2 [Provide information on consequences of behaviour to the individual]).

33. Prompt Self talk

Encourage the person to use talk to themselves (aloud or silently) before and during planned behaviours to encourage, support and maintain action.

34. Prompt use of imagery

Teach the person to imagine successfully performing the behaviour or to imagine finding it easy to perform the behaviour, including component or easy versions of the behaviour. Distinct from recalling instances of previous success without imagery (technique 18 [Prompting focus on past success])

35. Relapse prevention/ Coping planning

This relates to planning how to maintain behaviour that has been changed. The person is prompted to identify in advance situations in which the changed behaviour may not be maintained and develop strategies to avoid or manage those situations. Contrast with techniques 7 (Action planning) and 8 (Barrier identification/ Problem solving) which are about initiating behaviour change.

36. Stress management/Emotional control training

This is a set of specific techniques (e.g., progressive relaxation) which do not target the behaviour directly but seek to reduce anxiety and stress to facilitate the performance of the behaviour. It might also include techniques designed to reduce negative emotions or control mood or feelings that may interfere with performance of the behaviour, and/ or to increase positive emotions that might help with the performance of the behaviour. **NB** Check whether there are any instances of technique 8 (Barrier identification/ Problem solving), which includes identifying emotional barriers to performance, in contrast to the current technique, which addresses stress and emotions, whether they have been identified as barriers or not.

37. Motivational interviewing

This is a clinical method including a specific set of techniques involving prompting the person to engage in change talk in order to minimize resistance and resolve ambivalence to change (includes motivational counselling). **NB** Only rate this technique if explicitly referred to by name, not if one identifies specific elements of it, this may happen if you have prior experience with this technique.

38. Time management

This includes any technique designed to teach a person how to manage their time in order to make time for the behaviour. These techniques are not directed towards performance of target behaviour but rather seek to facilitate it by freeing up times when it could be performed. **NB** Only rate this technique if explicitly referred to by name, not if one identifies specific elements of it, this may happen if you have prior experience with this technique.

39. General communication skills training

This includes any technique directed at general communication skills but not directed towards a particular behaviour change. Often this may include role play and group work focusing on listening skills or assertive skills. **NB** Practicing a particular behaviour-specific interpersonal negotiation e.g., refusal skills in relation to cigarettes or alcohol would not be an instance of this technique.

40. Stimulate anticipation of future rewards

Create anticipation of future rewards without necessarily reinforcing behaviour throughout the active period of the intervention. Code this technique when participants are told at the onset that they will be rewarded based on behavioural achievement.