Title: **From theory to intervention: mapping theoretically derived**

behavioural determinants to behaviour change techniques

Short title: From theory to intervention

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ABSTRACT

Theory provides a helpful basis for designing interventions to change behaviour but offers little guidance on how to do this. This paper aims to illustrate methods for developing an extensive list of behaviour change techniques (with definitions) and for linking techniques to theoretical constructs. A list of techniques and definitions was generated from techniques published in two systematic reviews, supplemented by 'brainstorming' and a systematic search of nine textbooks used in training applied psychologists. Inter-rater reliability of extracting the techniques and definitions from the textbooks was assessed. Four experts judged which techniques would be effective in changing 11 theoretical constructs associated with behaviour change. Thirty-five techniques identified in the reviews were extended to 53 by brainstorming and to 137 by consulting textbooks. Agreement for the 53 definitions was 74.7% (15.4% cells completed and 59.3% cells empty for both raters). Agreement about the link between the 35 techniques and theoretical constructs was 71% of 385 judgments (12.2% agreement that effective and 59.5% agreement that not effective). This preliminary work demonstrates the possibility of developing a comprehensive, reliable taxonomy of techniques linked to theory. Further refinement is needed to eliminate redundancies, resolve uncertainties and complete technique definitions.

Keywords: Behaviour change, theory, intervention techniques, behavioural

interventions, intervention development; health psychology; UK

From theory to intervention: mapping theoretically derived behavioural determinants to behaviour change techniques

There is increasing recognition that interventions to change behaviour should draw on theories of behaviour and behaviour change in their development. For example, in the UK, the Medical Research Council has published a strategy for developing and evaluating complex interventions, which starts with a 'theory' phase before progressing to 'modelling' and then experimental phases (exploratory trial and randomised controlled trial (RCT)) (Medical Research Council, 2000; Campbell, Murray, Darbyshire, Emery, Farmer, & Griffiths 2007). In the theory phase, evidence is accumulated and a theoretical basis for intervention is developed which is modelled in the next phase. Modelling involves hypothesising and testing both *what* to target (behavioural determinants) and *how* to do this (techniques to change these determinants). The process of designing and implementing an intervention was seen as challenging: "Problems often arise in the evaluation of complex interventions because researchers have not fully defined and developed the intervention" (Campbell, Fitzpatrick, Haines, Kinmonth, Sandercock, Spiegelhalter et al., p. 694).

There are three main reasons for advocating the use of theory in designing interventions. First, interventions are likely to be more effective if they target causal determinants of behaviour and behaviour change; this requires understanding these causal determinants, i.e., theoretical mechanisms of change. Second, theory can be tested and developed by evaluations of interventions only if those interventions and evaluations are

theoretically informed. Third, theory-based interventions facilitate an understanding of what works and thus a basis for developing better theory across different contexts, populations and behaviours.

Theory represents an integrated summary of the hypothesised causal processes involved in behaviour change. Unlike 'theory-inspired' interventions, theory-based interventions use an explicit causal pathway (Michie & Abraham, 2004) and enable the intervention developer to avoid implicit causal assumptions which may lack evidence or even have been invalidated (Johnston, 1995). Causal processes that underlie a behavioural intervention can be tested within randomised controlled trials examining the effectiveness of the intervention (The Improved Clinical Effectiveness through Behaviour Research Group (ICEBeRG), 2006; Francis, Grimshaw, Zwarenstein, Eccles, Garfinkel, Godin, et al., in press) thereby strengthening the evidence base for intervention design. Without a theoretical basis, even a large literature on behaviour change interventions may offer no guidance on how to design an intervention for a new situation (Foy, Eccles, Jamtvedt, Young, Grimshaw, & Baker, 2005). In trials of interventions to enhance the implementation of evidence-based practice by health professionals, evidence from over 235 RCTs showed modest success; however the authors of the systematic review concluded that they had no basis on which to design a new intervention as very few of the trials had used any theoretical foundation and it was therefore impossible to find an integrating framework that could signal the basis of effective interventions (Grimshaw, Thomas, MacLennan, Fraser, Ramsay, et al., 2007).

Nevertheless, even with a theoretical framework, there is little information about how to develop theory-based interventions. A notable exception is Social Cognitive Theory (Bandura, 1997) which specifies how to change the main causal determinant of behaviour, namely self-efficacy, using four techniques: mastery experiences, modelling or vicarious experience, persuasion and giving physiologically compatible experiences. By contrast, a systematic review of the use of the Theory of Planned Behaviour (Ajzen, 1991) in interventions concluded that the theory was rarely used to *design* the intervention and was more frequently used as a background to understand the behaviour and to develop measures (Hardeman, Johnston, Johnston, Bonetti, Wareham, & Kinmonth, 2002). Even when people use theory, they tend to use it to explain behaviour but not to *change* behaviour.   For example, Ajzen proposes that the first stage in developing behaviour change interventions is to identify what predicts the behaviour and then to change the predictors but leaves open the question as to *how* to change these targets. This is evident in his advice, "Once it has been decided which beliefs the intervention will attempt to change, an effective intervention method must be developed. This is where the investigator's experience and creativity comes into play" (Ajzen, 2006, p. 2). Hardeman, Sutton, Griffin, Johnston, White, Wareham, et al. (2005) attempt to make the process explicit, but comment that there was no simple link between theory and the choice of intervention techniques.

Thus there is little guidance on how to progress through the early phases of the MRC framework for complex interventions. In considering the key tasks in optimising an intervention, Campbell et al. (2007) do not even refer

to the theory-base identified in conceptualising the target problem. Hardeman et al. (2005) have proposed a causal modelling approach (see Box 1). Each arrow represents a causal process and interventions are targeted at changing these causal processes. Within this framework, behaviour change is achieved by targeting the determinants of behaviour.

Behavioural determinants (s*tep 1*) can be identified from theories of behaviour. So for example, the Theory of Planned Behaviour (Ajzen, 1991), Social Cognitive Theory (Bandura, 1997), Operant Learning Theory (Skinner, 1963) all propose, and have evidence from cross-sectional and longitudinal studies to support, a range of constructs which affect behaviour (Walker, Grimshaw, Johnston, Pitts, Steen, & Eccles, 2003) including: intention, perceived behavioural control, self-efficacy, outcome expectancy, response-reinforcement contingencies and discriminative stimuli. Evidence-based behaviour change techniques can be directed at these identified behavioural determinants, and evidence for their role in behaviour change investigated (Michie, Hardeman, Fanshawe, Prevost, Taylor, & Kinmonth, 2007). However, effective mapping of theoretical constructs to behaviour change techniques also requires work to: (1) address the problem of the wide range of theoretical frameworks available; (2) specify the range of techniques available to change the determinants of behaviour; (3) develop a basis for selecting relevant techniques to map on to differing determinants of behaviour.

Box 1. Proposed framework for causal modelling approaches (Hardeman et al., 2005): *Adding behaviour change techniques to the causal modelling schema*

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┌──────────────────────────────────────────────────────────────────────────┐
│                                                                            │
│  ┌───────────┐      ┌───────────┐    ┌──────────┐  ┌──────────────┐  ┌──────────┐ │
│  │ Behaviour │  ⇨   │Behavioural│ ⇨  │ Behaviour│⇨ │Physiological │⇨│ Disease  │ │
│  │ change    │      │determinants│   │          │  │& biochemical │  │ outcomes │ │
│  │ techniques│      │           │    │          │  │ processes    │  │          │ │
│  └───────────┘      └───────────┘    └──────────┘  └──────────────┘  └──────────┘ │
│        ↑                 ↑      ↑                                           │
│        │                 │      │    step 1                                 │
│        │                 │      │     identifies                           │
│        │                 │      │     behavioural                          │
│        │                 │      │     determinants                         │
│    step 2                │                                                 │
│     identifies           │                                                 │
│     behaviour     step 3                                                   │
│     change         identifies link between                                 │
│     techniques     behaviour change techniques and behavioural determinants │
│                                                                            │
└──────────────────────────────────────────────────────────────────────────┘
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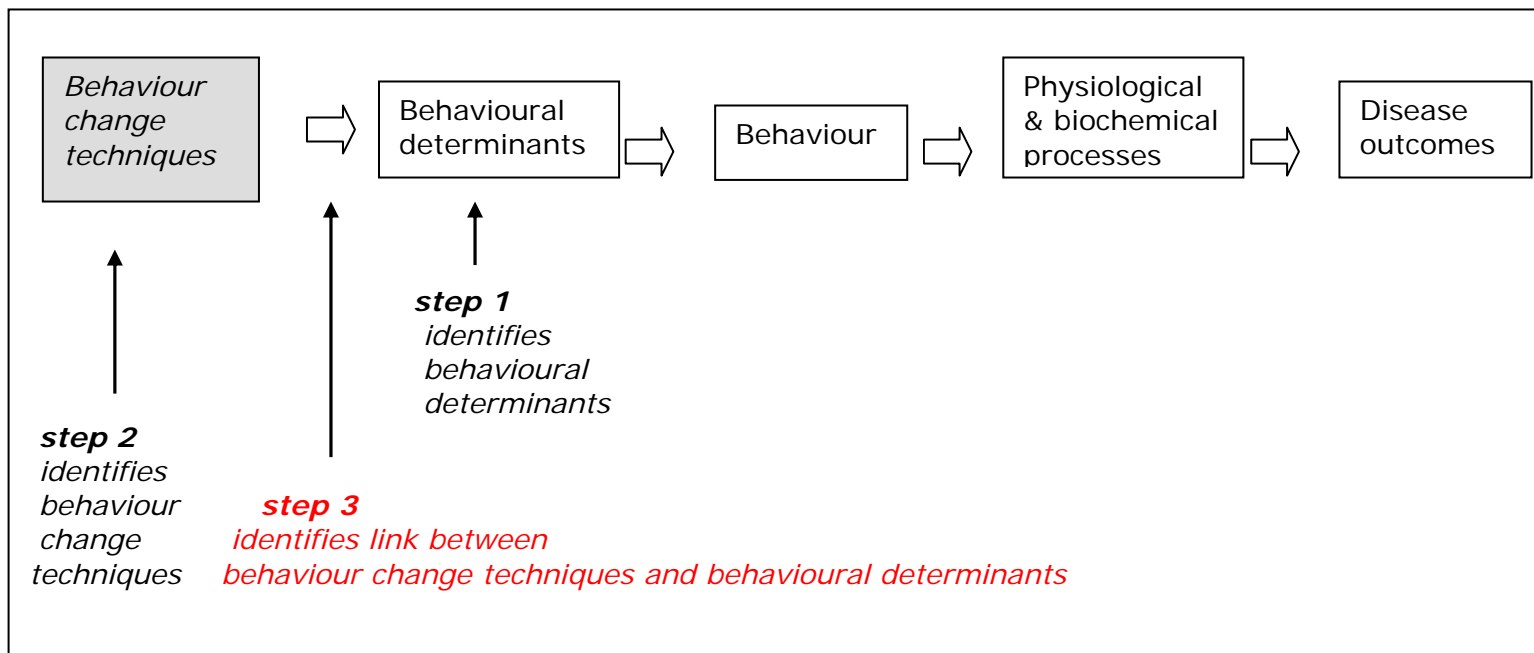
Ideally, researchers designing interventions would choose a small number of the theoretical frameworks based on empirical evidence of their predictive and intervention value, i.e., there should be evidence that the theory can predict the behaviour and that interventions which change these determinants achieve change in behaviour. However, where that is lacking, it would be valuable to find a systematic way to simplify these potential determinants. Two independent attempts at simplification, based on expert consensus, have been published (Fishbein, Triandis, Kanfer, Becker, Middlestadt, Eichler, et al., 2001; Michie, Johnston, Abraham, Lawton, Parker, & Walker, 2005a) and show good agreement about the key behavioural determinants (see Table 1).

However, there is still the need to identify techniques to change these behavioural determinants, as illustrated in Box 1. The work reported in this paper relates to the development of methods to clarify the list of behaviour change techniques (*step 2*) and to identify links between the behaviour change techniques and behavioural determinants (*step 3*).

There is a wide range of techniques available to change behavioural determinants. These techniques are described in texts largely used by applied psychologists and mental health practitioners. However, they tend to be integrated with other techniques designed to change mental states rather than behaviour and are presented as practical tools without reference to their evidence base or clear indication of which theoretical constructs they might target. There is currently no comprehensive and accessible list of techniques; it would be extremely difficult for someone new to the field of behaviour change to extract these techniques from the literature and to find the detail that would be necessary to use them in a complex intervention. In addition, their appropriate application depends on mapping these techniques on to the proposed behavioural determinants.

Thus this paper reports the development of a procedure for selecting relevant techniques to map on to each of the behavioural determinants. It seems obvious that different techniques will address different behavioural determinants. For example, it might be appropriate to rehearse practical skills where the determinant is lack of skill, but not where there is lack of motivation to perform the skill. This mapping process is essential if we are to optimise the benefits of theory-based interventions. Other approaches to

intervention development have not done this work e.g. MRC framework, Intervention Mapping (Kok, Schaalma, Ruiter, Van Empelen, & Brug, 2004).

This paper describes two pieces of preliminary work addressing steps 2 and 3 (Box 1 above). The first was to develop an extensive list of behaviour change techniques and definitions; the second identified links between these techniques and the theory-based behavioural determinants identified through step 1 and specified in Table 1. This paper describes a first iteration of this process and provides a basis for the further elaboration of this work (dealing with issues such as the further identification of techniques, completing technique definitions and the elimination of overlap between techniques). Our aim is to contribute to a process of constructing an evolving taxonomy of behaviour change techniques to be used for developing theory-based behaviour change interventions.

<div align="center">Methods</div>

Stage 1   Generating a list of techniques and definitions

The list of techniques and definitions was developed incrementally by brainstorming and consulting textbooks. The reliability of definition extraction was then tested. *Brainstorming:* 35 techniques identified from two published systematic reviews (Hardeman, Griffin, Johnston, Kinmonth, & Wareham, 2000; Abraham & Michie, in press) were expanded by "brainstorming" by four health and clinical psychologists (SM, MJ, JF, WH) with expertise in developing and implementing behaviour change interventions. Definitions were also agreed at this stage (see Appendix A).

Textbooks: Two researchers (Authors JF, WH) expanded this list by systematically extracting techniques from textbooks in current use in training applied psychologists in behaviour change techniques. The textbooks were identified by correspondence with clinical psychology course leaders. The nine textbooks (asterisked in the References) (3,182 pages) were consulted according to year of publication, starting with the most recently published books. They covered a range of therapies and approaches (e.g., operant conditioning, behaviour therapy, self-management interventions). Systematic extraction consisted of reading the Contents, Glossaries (where present) and full text to identify (1) specific reference to each of the 53 techniques; (2) technique definitions, if present; (3) additional techniques and their definitions.

Testing the reliability of extracting definitions: While extracting the data, JF and WH independently created a matrix of techniques by textbooks. If a technique was reported, the researchers recorded verbatim the description of the technique and the page number. The cell was left blank if the technique was not reported. Reliability between the two researchers in extraction of techniques and definitions was assessed by a third, independent researcher who assessed the proportion of occasions that: there was agreement that *no definition* was offered; extracted definitions were *identical* or almost identical; there was *disagreement* in definitions; there was a definition from *only one* researcher.

Stage 2. Mapping techniques onto behavioural determinants

Stage 2 was conducted concurrently with Stage 1 and so the experts used the initial set of 35 behaviour change techniques, without definitions.

Four researchers (SM, MJ, JF, WH) answered the question, "Which techniques would you use as part of an intervention to change [each determinant]?" (where Blank=no; 1=possibly, 2=probably, 3 =definitely). The researchers thus independently rated the applicability of each technique to changing each of the 11 behavioural determinants in Table 1, Column 2. Data relating to 35 techniques x 11 behavioural determinants (giving 385 ratings per rater) were categorised to examine agreement. Categories were: (1) *Agreed use:* agreement that they would use the technique (at least three raters reported 2 or 3); (2) *Agreed non-use:* agreement that they would not use the technique (all blank **or** only one rating of 2 **or** only 2 ratings of 1); (3) *Disagreement* (as for (2) but containing a 3); and (4) *Uncertain* (all the remaining cells in the matrix).

<div align="center">Results</div>

Generating a list of techniques and definitions

The 53 definitions agreed by the four experts during the brainstorming exercise are shown in Appendix A. Extraction of definitions, and assessment of its reliability, will be established for the additional 83 techniques identified in textbooks in a future study.

Testing the reliability of extracting definitions

In identifying definitions for the 53 techniques in nine textbooks, the two researchers agreed on 74.7% (363) of the 486 cells (including agreement that the book presented no definition in 288 cells and identification of almost identical definitions in 75 cells). Of the remaining 123 cells, 19 recorded different definitions; 101 recorded a definition by only one rater,

indicating possible omissions; and 3 cells contained both agreement and disagreement (i.e. more than one definition recorded, with only partial inter-rater agreement).

Mapping techniques onto behavioural determinants

The matrix of results is shown at Appendix B. Overall there was 71% agreement, with agreement that a technique was useful in 47 of 385 cells (12.2%), that a technique was not useful in 229 (59.5%) cells and disagreement in 32 (8.3%) cells. Of the 385 cells, 77 (20%) were classified as 'uncertain'. The number of techniques agreed to be useful for each behavioural determinant is shown in Figure 1. Raters agreed on one technique that would change Social/professional role and identity; Knowledge; and Environmental context/resources. They agreed on two techniques that would change Social influences and Emotion; three techniques that would change Memory, attention, decision processes; four techniques that would change Beliefs about consequences; five techniques that would change Action planning; nine techniques that would change Beliefs about capabilities and Motivation and goals; and ten techniques that would change Skills. Conversely, raters agreed on one technique (Self-monitoring) that would likely be effective in changing four constructs and on five techniques (Goal/target specified; Graded task; Increasing skills; Social processes; Information regarding behaviour and outcome) that would likely be effective in changing three constructs. The mapped techniques and constructs can be identified in Appendix B.

Discussion

The procedures and results reported are early stages in a programme of work aimed at developing a comprehensive taxonomy of behaviour change techniques, linked to theoretically-derived behavioural determinants. In the context of a complex series of tasks, we have demonstrated that we can reach reasonable agreement (75%) about the identification of separate techniques and their definitions, and in mapping the techniques onto behavioural determinants informed by psychological theory (71%). However it is also clear that this is a cumulative process and that the list generated will continue to have additions. For the list to be cumulative, the definitions need to be clear and agreed. We need to establish not only that a technique has a clear definition, but also that it does not duplicate existing techniques. Readers can evaluate for themselves the extent of our success to date by examining Appendix A.

This list was generated in the context of developing theory-based interventions, but it clearly has wider applicability. It can be used to develop and describe interventions without an explicit theoretical basis as long as there is evidence of behavioural determinants that fit with the 11 domains described by Michie, et al. (2005a).

The list of behaviour change techniques can also be used to describe published interventions in systematic reviews and meta-analyses. Complex interventions usually involve a combination of the techniques described in this preliminary list. The current status of reporting complex behaviour change interventions does not achieve scientific standards of replicability, even when extended protocols are reported. For example, experienced researchers in psychology, primary care, public health, epidemiology and

health services research rated their confidence in replicating even a very high standard protocol (US Diabetes Prevention Program, 2001) to be 1.7 (on a scale of 1 to 5) (Michie et al., 2005a; Michie, Johnston, Francis, & Hardeman, 2005b). The definitions generated in Appendix A are likely to prove useful in the reporting of complex interventions.

The results of mapping the techniques to the behaviour determinants also showed a reasonable level of agreement, despite the subjective difficulty of the task, and the fact that the task was completed without definitions. Any lack of familiarity with the techniques would be reflected in disagreement or uncertainty. Nevertheless, the pattern of results shows that a substantial amount of the agreement is in agreeing that a technique is not appropriate for changing specific determinants. This finding alone could be used to avoid wasting research resources on interventions that are extremely unlikely to be successful. Furthermore, there is substantial agreement about how to change some of the determinants. There is clear agreement about techniques for changing each of the 11 theoretical domains. However, the distribution of techniques across the causal determinants was not even. This means that, for example, to change skills, researchers could select from the 10 possible techniques identified for this determinant. In contrast, these results indicate that, for other determinants, there will be fewer options for selecting change techniques or that we are unaware of relevant literature. Conversely, some techniques appear to be relevant to changing more constructs than do others so for example, self-monitoring is judged to be appropriate for changing four constructs whilst self-talk is judged to be appropriate for only one. The

selection of techniques is likely to be guided by the particular application: it may be more feasible to operationalise some of these techniques than others, given situational constraints. Future work is likely to identify more techniques for each causal determinant.

The agreement observed in Appendix B represents opinion, not evidence of actual effectiveness of the techniques. Opinions are likely to be influenced by people's experiences and knowledge. It is possible that the experts making the judgments in Appendix B (see Figure 1) had greater expertise, for example, in changing skills and capabilities than in changing emotional and environmental influences on behaviour. In addition, this work is only an illustration of what could be achieved using a larger sample of experts. Nevertheless, we see this consensus work of identifying likely candidate techniques for changing each behavioural determinant as necessary for building an evidence base of technique effectiveness.

The 385 cells of Appendix B will be increased substantially by identifying more techniques; it would be virtually impossible to undertake effectiveness work without reducing this number. By selecting candidate techniques for changing each behavioural determinant, we are laying the basis for undertaking systematic reviews and conducting experimental studies, including intervention modelling experiments (Eccles, Grimshaw, Walker, Johnston, & Pitts, 2005; Bonetti, Eccles, Johnston, Steen, Grimshaw, & Baker 2005) to identify the most effective techniques.

In conclusion, we have shown that we can reach reasonable agreement about the identification of techniques and their definitions, and in mapping the techniques onto theoretical constructs. Further work on the taxonomy

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will involve generation of additional techniques, expert review of the definitions of the already identified 137 techniques, consensus work on selecting candidate techniques and the collection of evidence of effectiveness through experimental studies and systematic reviews. As indicated in the introduction, we see the process of achieving truly theory-based rather than theory-inspired behaviour change interventions as difficult, but desirable, if we are to achieve a sound scientific basis for the development and reporting of such interventions. The work we have described in this paper, while a substantial body of work, is a first iteration of the process and is being further developed. However, we wish to place it in the public domain and invite comment and feedback.

References

Abraham, C., & Michie, S. (2007). Categorizing the content of behavior change interventions. (in press).

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

Ajzen, I. (2006). (http://www.people.umass.edu/aizen/pdf/tpb.intervention.pdf

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: Freeman.

*Bergin, A. E., & Garfield, S. L. (1994). *Handbook of psychotherapy and behavior change.* New York: Wiley.

Bonetti, D., Eccles, M., Johnston, M., Steen, N., Grimshaw, J., Baker, R., et al. (2005). Guiding the design and selection of interventions to influence the implementation of evidence-based practice: An experimental simulation of a complex intervention trial. *Social Science & Medicine, 60,* 2135-2147.

Campbell, M., Fitzpatrick, R., Haines, A., Kinmonth, A. L., Sandercock, P., Spiegelhalter, D., et al. (2000). Framework for design and evaluation of complex interventions to improve health. *British Medical Journal, 321,* 694-696.

Campbell, N. C., Murray, E., Darbyshire, J., Emery, J., Farmer, A., Griffiths F., et al. (2007). Designing and evaluation complex interventions to improve health care. *British Medical Journal, 334,* 445-459.

Eccles, M., Grimshaw, J., Walker, A., Johnston, M., & Pitts, N. (2005). Changing the behaviour of healthcare professionals: The use of theory in promoting the uptake of research findings. *Clinical Epidemiology, 58,* 107-112.

Fishbein, M., Triandis, H. C., Kanfer, F. H., Becker, M., Middlestadt, S. E., & Eichler, A. (2001). Factors influencing behaviour and behaviour change. In

A. Baum, T. A. Revenson, & J. E. Singer (Eds.), *Handbook of Health Psychology* (pp. 3-17). Mahwah, N J: Lawrence Erlbaum Associates.

Foy. R., Eccles. M., Jamtvedt, G., Young, J., Grimshaw, J., & Baker, R. (2005). What do we know about how to do audit and feedback? Pitfalls in applying evidence from a systematic review. *MBC Health Services Research, 5,* 50.

Francis, J.J., Grimshaw, J.M., Zwarenstein, M., Eccles, M.P., Shiller, S., Godin, G., Johnston, M., O'Rourke, K., Presseau, J., & Tetroe, J. Testing a TheoRY-inspired MEssage ('TRY-ME'): A sub-trial within the Ontario Printed Educational Message (OPEM) trial [Registration number ISRCTN72772651] *Implementation Science* (in press).

*Gambrill, E. D. (1977). *Behavior modification: A handbook of assessment, intervention, and evaluation*. San Francisco: Jossey-Bass.

Grimshaw, J. M., Thomas, R. E., MacLennan, G., Fraser, C., Ramsay, C. R., et al. (2007). Effectiveness and efficiency of guideline dissemination and implementation strategies. *Health Technology Assessment, 204,* 6.

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

Hardeman, W., Johnston, M., Johnston, D. W., Bonetti, D., Wareham, N. J., & Kinmonth, A. L. (2002). Application of the Theory of Planned Behaviour in Behaviour Change Interventions: A systematic review. *Psychology & Health, 17,* 123-158.

Hardeman, W., Sutton, S., Griffin, S., Johnston, M., White, A. J., Wareham, N. J., & Kinmonth, A. L. (2005). A causal modelling approach to the development of theory-based behaviour change programmes for trial evaluation. *Health Education Research, 20,* 676-687.

Johnston, M. (1995). Health Related Behaviour Change. In I. Sharpe (Ed.), *Cardiovascular Prevention in Primary Care: The Way Forward. National Forum for Coronary Disease Prevention* (pp. 37-47). London: King's Fund.

*Kazdin, A. E. (2001). *Behavior modification in applied settings*, 6th ed. Belmont CA, USA: Wadsworth/Thomson.

*Kanfer, F. H., & Goldstein, A. P. (Eds). (1986). *Helping people change: A textbook of methods*, 3rd ed. New York: Pergamon.

Kok, G., Schaalma, H., Ruiter, R. A .C., Van Empelen, P., & Brug, J. (2004). Intervention Mapping: Protocol for applying health psychology theory to prevention programmes. *Journal of Health Psychology, 9,* 85-98.

*Leslie, J. C. (2002). *Essential behavior analysis*. London: Arnold.

*Leslie, J. C., & O'Reilly, M. F. (1999). *Behavior analysis: Foundations and applications to psychology*. Amsterdam: Harwood.

Medical Research Council, (2000). A framework for the development and evaluation of RCTs for complex interventions to improve health. London: Medical Research Council.

Michie, S., & Abraham, C. (2004). Identifying techniques that promote health behaviour change: Evidence based or evidence inspired? *Psychology & Health, 19,* 29-49.

Michie, S., Hardeman, W., Fanshawe, T., Prevost, A. T., Taylor, L., & Kinmonth, A. L. (2007). Investigating theoretical explanations for behaviour change: The case study of *ProActive. Psychology & Health,* (in press).

Michie, S., Johnston, M., Abraham, C., Lawton, R., Parker, D., & Walker, A. (2005a). Making psychological theory useful for implementing evidence based practice: A consensus approach. *Quality & Safety in Health Care, 14,* 26-33.

Michie, S., Johnston, M., Francis, J., & Hardeman, W. (2005b). Behaviour change interventions: Developing a classification system. Workshop presented at the 1st annual conference of the UK Society for Behavioural Medicine, London.

*Sarafino, E. P. (2001). *Behavior modification: Principles of behaviour change*, 2nd ed. Boston: McGraw Hill.

Skinner, B. F. (1963). Operant Behaviour. *American Psychologist, 18,* 503-515.

*Sherman, W. M. (1990). *Behavior modification.* New York: Harper.

*Stern, R. (1978). *Behavioural techniques.* London: Academic Press.

The Improved Clinical Effectiveness through Behavioural Research Group (ICEBeRG). (2006). Designing theoretically-informed implementation interventions. *Implementation Science*, *1*, 4.

US Diabetes Prevention Program (2001). Protocol of the US Diabetes Prevention Program. Version 4.4. http://www.bsc.gwu.edu/dpp/prot4407.pdf [accessed 10/04/2007] [On-line].

Walker, A., Grimshaw, J., Johnston, M., Pitts, N., Steen, N., & Eccles, M. (2003). PRIME; PRocess modelling in ImpleMEntation research: Selecting a theoretical basis for interventions to change clinical practice. *BMC Health Services Research, 3.*

Table 1. Key determinants of behaviour change from (Fishbein et al., 2001; Michie et al., 2004). See original publications for definitions.

Fishbein, Triandis, Kanfer et al., 2001	Michie, Johnston, Abraham, et al., 2004
Self-standards	Social/professional role and identity
	Knowledge
Skills	Skills
Self-efficacy	Beliefs about capabilities
Anticipated outcomes / Attitude	Beliefs about consequences
Intention	Motivation and goals
	Memory, attention and decision processes
Environmental constraints	Environmental context and resources
Norms	Social influences
	Emotion
	Action planning

Appendix A. Behaviour change techniques and labels identified in three stages: (a) reviews; (b) brainstorming; (c) textbook consultation. Definitions for the first 53 techniques.[1]

Stage	Technique Number	Technique Label and Definition
(a) Review identified techniques	1.	**Goal**: set behavioural goal
	2.	**Standard**: decide target standard of behaviour (specified and observable)
	3.	**Monitoring**: record specified behaviour (person has access to recorded data of behavioural performance e.g. from diary)
	4.	**Record antecedents and consequences of behaviour** (social and environmental situations and events, emotions, cognitions)
	5.	**Feedback**: of monitored (inc. self-monitored) behaviour
	6.	**Comparison**: provide comparative data (cf standard, person's own past behaviour, others' behaviour)
	7.	**Social comparison**: provide opportunities for social comparison e.g. contests and group learning
	8.	**Discrepancy assessment**: highlight nature of discrepancy (direction, amount) between standard, own or others' behaviour (goes beyond simple self-monitoring)
	9.	**Contract**: of agreed performance of target behaviour with at least one other, written and signed
	10.	**Planning**: identify component parts of behaviour and make plan to execute each one *or* consider when and/or where a behaviour will be performed i.e. schedule behaviours (not including coping planning – see. 11)
	11.	**Coping planning**: identify and plan ways of overcoming barriers (note, this must include identification of specific barriers e.g. "problem solving how to fit into weekly schedule" would not count)
	12.	**Goal review**: assess extent to which the goal/target behaviour is achieved, identify the factors influencing this and amend goal if appropriate
	13.	**Discriminative (learned) cue**: environmental stimulus that has been repeatedly associated with contingent reward for specified behaviour
	14.	**Prompt**: stimulus that elicits behaviour (inc. telephone calls or postal reminders designed to prompt the behaviour)
	15.	**Reward**: contingent valued consequence i.e. if and only if behaviour is performed (inc. social approval, exc. general non-contingent encouragement or approval)
	16.	**Punishment**: contingent aversive consequence i.e. if and only if behaviour is not performed
	17.	**Omission**: contingent removal of valued consequence i.e. if and only if behaviour is not performed
	18.	**Negative reinforcement**: contingent removal of aversive consequence i.e. if & only if behaviour is performed
	19.	**Threat**: offer future punishment or removal of reward contingent on performance
	20.	**Fear arousal**: induce aversive emotional state associated with the behaviour
	21.	**Anticipated regret**: induce expectations of future regret about non-performance of behaviour
	22.	**Graded tasks**: set easy tasks to perform, making them increasingly difficult until target behaviour performed
	23.	**Instruction**: teach new behaviour required for performance of target behaviour (not as part of graded hierarchy or as part of modelling) e.g. give clear instructions.

[1] This Appendix presents work in progress. Further work is needed to agree the final definitions for the techniques.

Stage	Technique Number	Technique Label and Definition
	24.	**Shaping**: build up behaviour by initially reinforcing behaviour closest to required behaviour and systematically altering behaviour required to achieve contingent reinforcement
	25.	**Chaining**: build up behaviour by starting with final component; gradually add components earlier in sequence
	26.	**Behavioural rehearsal**: perform behaviour (repeatedly)
	27.	**Mental rehearsal**: imagine performing the behaviour repeatedly
	28.	**Habit formation**: perform same behaviour in same context
	29.	**Role play**: perform behaviour in simulated situation
	30.	**Behavioural experiments**: testing hypotheses about the behaviour, its causes and consequences, by collecting and interpreting data
	31.	**Modelling**: observe the behaviour of others
	32.	**Vicarious reinforcement**: observe the consequences of others' behaviour
	33.	**Self talk**: planned self-statements (aloud or silent) to implement behaviour change techniques
	34.	**Imagery**: use planned images (visual, motor, sensory) to implement behaviour change techniques (inc. mental rehearsal)
	35.	**Cognitive restructuring**: changing cognitions about causes and consequences of behaviour
(b) Brainstormed techniques	36.	**Relapse prevention**: identify situations that increase the likelihood of the behaviour not being performed and apply coping strategies to those situations
	37.	**Behavioural information**: provide information about antecedents or consequences of the behaviour, or connections between them, or behaviour change techniques
	38.	**Personalised message**: tailor techniques or messages from others to individual's resources and context (includes stages of change based information; doesn't include personal plans and feedback)
	39.	**Verbal persuasion/persuasive communication**: credible source presents arguments in favour of the behaviour. Note, there must be evidence of presentation of arguments; general pro-behaviour communication does not count.
	40.	**Social support (instrumental)**: others perform component tasks of behaviour or tasks that would compete with behaviour e.g. offering childcare
	41.	**Social support (emotional)**: others listen, provide empathy and give generalised positive feedback
	42.	**Decision-making**: generate alternative courses of action, and pros and cons of each, and weigh them up.
	43.	**Coping strategies**: behaviours undertaken to avoid or reduce stressors
	44.	**Stress management**: behaviours undertaken to reduce stressors or impact of stressors
	45.	**Relaxation**: systematic instruction in physical and cognitive strategies to reduce sympathetic arousal, and to increase muscle relaxation and a feeling of calm

Stage	Technique Number	Technique Label and Definition		
	46.	**Desensitisation**: exposure to threatening experiences		
	47.	**Systematic desensitisation**: graded exposure to increasingly threatening experiences		
	48.	**Time management**: action planning applied to the perceived problem of shortage of time		
	49.	**Motivational interviewing**: elicit self-motivating statements&evaluation of own behaviour to reduce resistance to change		
	50.	**Environmental change**: change the environment in order to facilitate the target behaviour (other than prompts, rewards and punishments e.g. choice of food provided)		
	51.	**Set homework tasks**		
	52.	**Non-specific social support** (only if additional to 40 and 41)		
	53.	**General information** about the behaviour and behaviour change (other than 37)		
	54.	**General problem-solving**		

Stage	Technique Number	Technique Label	Technique Number	Technique Label
(c) Textbook identified techniques	55.	Anti-depression skills training	77.	Response cost
	56.	Biofeedback	78.	Response priming
	57.	Differential reinforcement	79.	Satiation
	58.	Escape	80.	Screening
	59.	Extinction	81.	Social skills training
	60.	Flooding	82.	Stress inoculation program
	61.	Group contingencies	83.	Symbolic desensitization
	62.	Implosive therapy	84.	Thought stopping
	63.	Avoidance	85.	Time out
	64.	Counter-conditioning	86.	Token economy
	65.	Distraction	87.	Activity scheduling
	66.	Exposure	88.	Adventitious reinforcement / superstitious conditioning
	67.	Fading; thinning	89.	Altering antecedent chains
	68.	Flooding in imagination	90.	Anger control training
	69.	Habit reversal	91.	Assertion training
	70.	Negative punishment	92.	Buddy system
	71.	Non contingent delivery of reinforcing stimuli	93.	Clarification (supportive therapy)
	72.	Overcorrection	94.	Classical conditioning
	73.	Peer-administered contingencies	95.	Community reinforcement
	74.	Problem identification	96.	Covert conditioning
	75.	Rational emotive therapy	97.	Covert sensitisation
	76.	Reinforcer sampling	98.	Deflection techniques

Stage	Technique Number	Technique Label	Technique Number	Technique Label
(c) Textbook identified techniques	99.	Discrimination training	119.	Positive scanning
	100.	Emetic therapy	120.	Premackian reinforcers
	101.	Encounter (existential analysis)	121.	Rate reduction
	102.	Fishbowl	122.	Reassurance (supportive therapy)
	103.	Fogging	123.	Recapitulation
	104.	Functional communication training	124.	Reframing
	105.	Functional family therapy	125.	Reinforcer displacement
	106.	Identification (psychoanalysis)	126.	Response priming
	107.	Instigation	127.	Restitution
	108.	Interpretation (psychoanalysis)	128.	Rule release
	109.	Least-to-most prompting	129.	Self-exploration
	110.	Lottery	130.	Self-help
	111.	Most to least prompt sequences	131.	Small group exercises
	112.	Motivational techniques	132.	Stimulus generalisation
	113.	Multiple exemplar training (generalisation)	133.	Stimulus narrowing
	114.	Natural maintaining contingencies (generalisation)	134.	Systematic rational conditioning
	115.	Negotiation training	135.	Thinning
	116.	Paradoxical instructions	136.	Turtle technique
	117.	Paradoxical intention (behaviour therapy)	137.	Vicarious punishment
	118.	Positive reinforcement		

APPENDIX B. Data from consensus process for linking behaviour change techniques with determinants of behaviour

Technique for behaviour change	Techniques judged to be effective in changing each construct domain										
	1	2	3	4	5	6	7	8	9	10	11
Goal/target specified: behaviour or outcome											
Monitoring											
Self-monitoring											
Contract											
Rewards; incentives (inc self-evaluation)											
Graded task, starting with easy tasks											
Increasing skills: problem solving, decision making, goal setting											
Stress management											
Coping skills											
Rehearsal of relevant skills											
Role-play											
Planning, implementation											
Prompts, triggers, cues											
Environmental changes (eg, objects to facilitate behaviour)											
Social processes of encouragement, pressure, support											
Persuasive communication											
Information regarding behaviour, outcome											
Personalised message											
Modelling /demonstration of behaviour by others											
Homework											
Personal experiments, data collection (other than self-monitoring of behaviour)											
Experiential: tasks to gain experiences to change motivation											
Feedback											
Self talk											
Use of imagery											
Perform behaviour in different settings											
Shaping of behaviour											
Motivational interviewing											
Relapse prevention											
Cognitive restructuring											
Relaxation											

	1	2	3	4	5	6	7	8	9	10	11
Desensitisation											
Problem solving											
Time management											
Identify/ prepare for difficult situation/ problems											

KEY:

	Agreed use
	Uncertain
	Disagreement
	Agreed non-use

Techniques judged to be effective in changing each construct domain

1   Social/ Professional role & identity
2   Knowledge
3   Skills
4   Beliefs about capabilities
5   Beliefs about consequences
6   Motivation and goals
7   Memory, attention, decision processes
8   Environmental context and resources
9   Social influences
10   Emotion
11   Action planning

Figure 1: Number of techniques which raters agreed to be useful in changing each behavioural determinant (from Appendix B)