



Investigating theoretical explanations for behaviour change: The case study of *ProActive*

Susan Michie, Wendy Hardeman, Tom Fanshawe, A. Toby Prevost, Lyndsay Taylor & Ann Louise Kinmonth

To cite this article: Susan Michie, Wendy Hardeman, Tom Fanshawe, A. Toby Prevost, Lyndsay Taylor & Ann Louise Kinmonth (2008) Investigating theoretical explanations for behaviour change: **The case study of *ProActive***, *Psychology and Health*, 23:1, 25-39, DOI: [10.1080/08870440701670588](https://doi.org/10.1080/08870440701670588)

To link to this article: <https://doi.org/10.1080/08870440701670588>



Published online: 14 Dec 2007.



Submit your article to this journal [↗](#)



Article views: 1343



View related articles [↗](#)

Investigating theoretical explanations for behaviour change: The case study of ProActive

SUSAN MICHIE¹, WENDY HARDEMAN², TOM FANSHAW³,
A. TOBY PREVOST², LYND SAY TAYLOR¹, &
ANN LOUISE KINMONTH²

¹*Department of Psychology, University College London, 1-19 Torrington Place, London WC1E 7HB, UK,* ²*University of Cambridge, Public Health and Primary Care, Institute of Public Health, Robinson Way, Cambridge CB2 0SR, UK,* and ³*Department of Mathematics and Statistics, Lancaster University, Lancaster LA1 4YF, UK*

(Received 26 June 2007; in final form 7 September 2007)

Abstract

Developing more effective behavioural interventions requires an understanding of the mechanisms of behaviour change, and methods to rigorously test their theoretical basis. The delivery and theoretical basis of an intervention protocol were assessed in *ProActive*, a UK trial of an intervention to increase the physical activity of those at risk of Type 2 diabetes ($N=365$). In 108 intervention sessions, behaviours of facilitators were mapped to four theories that informed intervention development and behaviours of participants were mapped to 17 theoretical components of these four theories. The theory base of the intervention specified by the protocol was different than that delivered by facilitators, and that received by participants. Of the intervention techniques delivered, 25% were associated with theory of planned behaviour (TPB), 42% with self-regulation theory (SRT), 24% with operant learning theory (OLT) and 9% with relapse prevention theory (RPT). The theoretical classification of participant talk showed a different pattern, with twice the proportion associated with OLT (48%), 21% associated with TPB, 31% with SRT and no talk associated with RPT. This study demonstrates one approach to assessing the extent to which the theories used to guide intervention development account for any changes observed.

Keywords: *Theory, behaviour change, process evaluation, behavioural interventions, physical activity*

Correspondence: Susan Michie, Department of Psychology, University College London, 1-19 Torrington Place, London, WC1E 7HB, UK. Tel: +44(0)20 7679 5930. E-mail: s.michie@ucl.ac.uk

There is widespread recognition that behaviour change is key to improving health (UK Department of Health, 2004; US Department of Health and Human Services, 2000; WHO, 2002). In the United States, half of all deaths are estimated to be due to modifiable behaviours including smoking, physical inactivity, unhealthy eating and excessive alcohol use (Mokdad, Marks, Stroup, & Gerberding, 2004). There is good evidence that behavioural interventions can reduce or delay the incidence of disease (Gillies et al., 2007).

Until recently, few health behaviour change interventions were developed on the basis of theory, limiting the evaluation of mechanisms of change and their usefulness in developing more effective interventions (Kok, Schaalma, Ruiter, Van Empelen, & Brug, 2004; Noar & Zimmerman, 2005; Ory, Jordan, & Bazzarre, 2002). Evaluation of theory-based interventions offers the potential for generalising effective, and avoiding ineffective, interventions (Albaraccin et al., 2005; Trifiletti, Gielen, Sleet, & Hopkins, 2005). However, demonstrating the effectiveness of a theory-based intervention does not provide evidence for the explanatory value of the theory; change may occur due to factors other than those specified by the theory. Theory is rarely applied or tested with sufficient precision to allow theoretical conclusions to be drawn to inform future intervention development, even in well-designed interventions. There is a need for more rigorous work to define, operationalise and test the “theory-base” of interventions (Michie & Abraham, 2004; Noar & Zimmerman, 2005; Rothman, 2004).

To evaluate the extent to which theories used to guide intervention development explain observed changes in behavioural outcomes, the relationship between intervention techniques and theories of behaviour change should be elucidated. Further, intervention delivery should be protocol-based and protocol adherence should be assessed (Bellg et al., 2004; Borrelli et al., 2005) so that the extent to which interventions are delivered and received as planned is known. This requires detailed and precise descriptions of intervention techniques; regrettably, this is rare (Hardeman, Griffin, Johnston, Kinmonth, & Wareham, 2000; Michie & Abraham, 2004). A review of 287 evaluations of behaviour change interventions found that only 30% incorporated a mechanism to assess protocol adherence (Borrelli et al., 2005). Finally, evaluations should measure change along the hypothesised causal pathway from theoretical determinants of behaviour change to behaviour, allowing mediation analysis. This pathway comprises five steps (Figure 1).

First, theories of behaviour provide the determinants that are targeted by the behaviour-change techniques specified in the second step, the intervention protocol. Third is the delivery of the techniques as planned (protocol implementation). Fourth is the response of participants which gives an indication of the extent to which the intervention has been understood, processed and acted on by participants. The final step is the behavioural outcome of the intervention (or “enactment of treatment skills”, Bellg et al., 2004).

We use this framework to develop a method to assess theoretically the implementation and receipt of a theory- and evidence-based intervention (*ProActive*) to increase physical activity in adults at risk of Type 2 diabetes

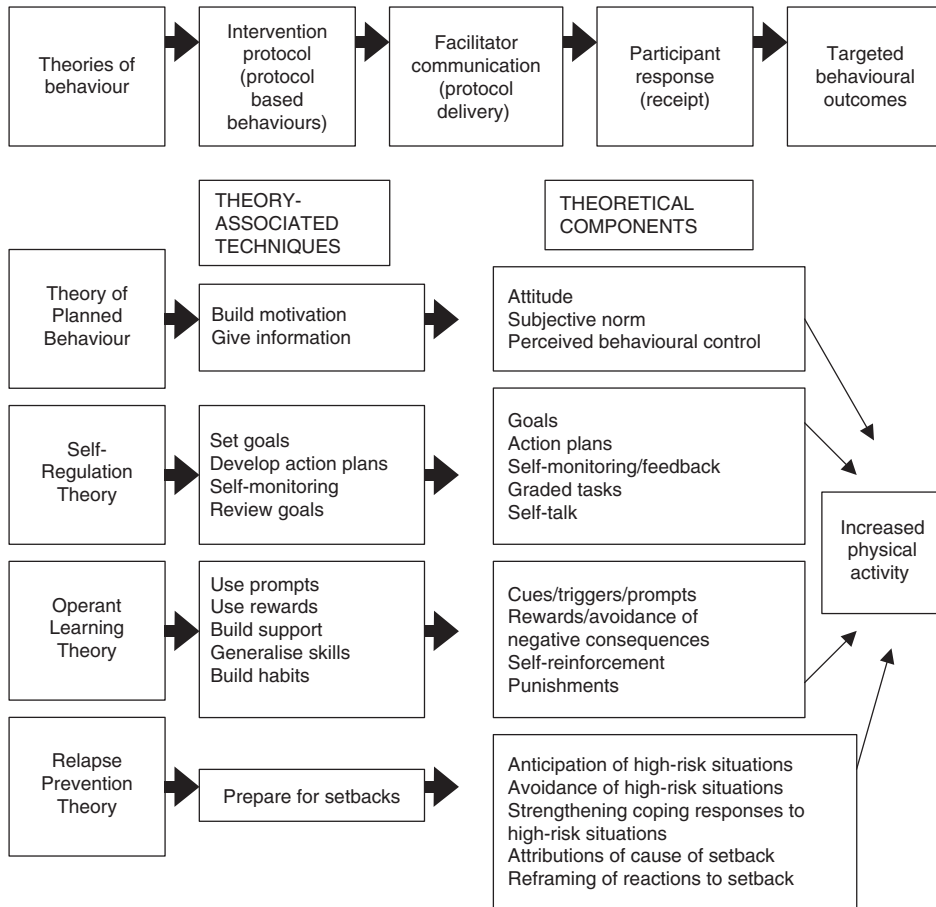


Figure 1. Mediating links between theories of behaviour and behavioural outcomes.

(Hardeman et al., 2005; Kinmonth et al., 2006; Williams et al., 2004). The work complements a study investigating the fidelity of intervention delivery (Hardeman et al., in this issue).

The theoretical model of behavioural determinants was the theory of planned behaviour (TPB; Ajzen, 1991). The behaviour change techniques were selected on the basis of published evidence of effectiveness (Hardeman et al., 2005). Many of these techniques can be considered within the frameworks of self-regulation theory (SRT; Bandura, 2000; Carver & Scheier, 1981, 1999), operant learning theory (OLT; Skinner, 1953) and relapse prevention theory (RPT; Marlatt & George, 1998) (Michie, Hardeman, & Abraham, 2005).

The TPB states that the main predictor of behaviour is intention to act, which, in turn, is predicted by the attitude towards the behaviour, subjective norm in relation to the behaviour and perceived behavioural control. Behaviour changes in response to persuasion and information aimed at changing these cognitive determinants. SRT postulates that behaviour is goal directed and

controlled by feedback loops resulting from systematic processes of monitoring behaviour, evaluating discrepancies between performance and desired goal and implementing strategies to reduce this discrepancy within a changing environment. Behaviour is changed by appropriate goal-setting, self-monitoring and action plans. According to OLT, behaviour is learnt as a result of contingencies between behaviour and consequent events (external or internal), with these contingencies signalled by antecedent events or situations (external or internal). The frequency of behaviour is changed by changing antecedents (e.g. cues, reminders) and consequences (e.g. rewards, punishments). RPT posits that behavioural change is maintained by identifying situations in which relapse is likely and taking steps to prevent or minimise relapse (e.g. avoiding the situation, or using appropriate coping skills within it), and by rehearsing and generalising behaviours. Behavioural maintenance is therefore facilitated by correct identification of “risky” situations and development of effective strategies to avoid or manage them.

The mediating links between these behaviour change theories and behavioural outcomes are shown in Figure 1. The intervention techniques and theoretical constructs associated with them are also shown. The aims of the current study were to develop methods to evaluate:

1. The theoretical basis of the delivered intervention.
2. Theoretical explanations of behaviour change.

Methods

Sample

A sub-sample of 27 participants of the *ProActive* trial provided audiotapes of four key intervention sessions (see Hardeman et al. in this issue for details).

Procedure

Ethical approval was granted [1]. Participants gave consent for the audiotape recording of their sessions.

Development of reliable coding frames to assess theoretical basis of protocols, delivery and receipt

Facilitator communication. Four raters (the first two authors, a health psychologist and a clinical psychologist) independently categorised 14 techniques into one or more of the four behavioural theories (Figure 1). For example, the facilitator behaviour “ask where and when the participant will do their activity” was classified under the technique “action planning”, and this technique was classified under SRT. Five techniques were categorised under more than one theory. To simplify the analysis, the theory mentioned by the highest number of raters was chosen. There was complete consensus for categorisation according to theory for eight techniques (57%) [2].

Participant response. All instances of participants talking about change or maintenance of physical activity were independently categorised into one or more of the four theories and 17 component constructs by the first and fifth authors. The constructs, identified from relevant literature were: attitude towards the target behaviour, perceived control over the behaviour, subjective norm (TPB); goals, action plans, self-monitoring/feedback, graded tasks and self-talk (SRT); cues/triggers/prompts, external rewards/avoidance of negative consequences, self-reinforcement, punishments (OLT); anticipation of high-risk situations, avoidance of high-risk situations, strengthening coping responses to high-risk situations, attributions of cause of setback, reframing of reactions to setback (RPT). Examples of categorised behaviours are “thinking about benefits of activity e.g. losing weight” (attitudes); “wife will be proud” (subjective norm); “parking car further away so has to walk further (action plans); “You can do this It’s only half an hour . . .” (self-talk); “asking partner to remind him” (cues to action) and “buying new clothes after” (reward). Discrepancies were discussed and coding guidelines refined accordingly, until more than 70% agreement was achieved [3]. Inter-rater agreement for coding participant responses into theoretical constructs increased from 24 to 54 to 94% over three rounds (one transcript per round), giving a mean of 60% (116 agreements/194 observations). Agreement on coding of participant responses into theories was 90% (62 agreements/69 observations) on the first round.

Outcome measures

Physical activity was measured objectively (dayPAR) and by questionnaire (see Hardeman et al in this issue for details). Although the study was not powered for a definitive analysis, we report an exploratory analysis of the associations between behaviours categorised according to theory and outcomes to illustrate the approach (Table IV).

Analysis of theoretical basis of the intervention and explanations for behaviour change. The intervention was analysed theoretically, using different denominators, to address the research questions:

1. What is the theoretical basis of delivery? This was determined by calculating (a) the number of protocol specified behaviours that were associated with each theory, and (b) the proportion of these behaviours that were delivered by facilitators.
2. To what extent do the theories explain behaviour change? This was determined by calculating (a) the proportions of facilitator behaviours assigned to each theory (the denominator being the total number of delivered facilitator behaviours) and the proportions of participants’ responses assigned to each theory, and (b) the association between theoretical category of participant response and physical activity outcome.

Frequencies and proportions of facilitator behaviours and participant responses were calculated for each participant separately, and mean frequencies/proportions

and 95% confidence intervals calculated by averaging over the 27 participants. Analysis was carried out using SPSS v12.0.

Results

Aim 1: Theoretical basis of intervention protocol and delivery

Theoretical basis of protocol. Protocol-specified facilitator behaviours were categorised according to technique and theory. The percentages of protocol-specified behaviours according to theory were TPB 19%, SRT 32%, OLT 24%, RPT 15% and “other” 10% [“other” refers to behaviours in two techniques (summarising messages and eliciting questions) not categorised into any theory].

Theoretical basis of intervention delivery. The facilitators delivered an average of 45% of protocol-specified behaviours. This varied across theory (Table I), with 51% of behaviours associated with TPB delivered on average, 50% for SRT, 41% for OLT, 26% for RPT and 61% for “other”. The percentages and confidence intervals in Table I suggest that the proportion of RPT-associated behaviours delivered was lower than for the other theories.

Table I. Theoretical basis of protocol delivery by facilitators.

Technique	Percentage of protocol-specified behaviours delivered (averaged across participants)	Total percentage for theory (95% CI)
Build motivation	51 ^a	TPB:
Give information	50	51 (43–58)
Set goals	62	SRT:
Develop action plans	50	50 (44–55)
Self-monitoring	50	
Review goals	43	
Use prompts	34	OLT:
Use rewards	54	41% (35–47)
Build support	43	
Generalise skills	25	
Build habits	36	
Prepare for setbacks	26	RPT:
Summarise message	66	26 (19–33)
Elicit questions	51	“Other” ^b :
All Theories	45	61 (51–70)

Notes: ^aThis does not always equal the ratio of the mean delivered to the number specified by the protocol as for some participants the number specified was reduced by a small number because of missing data due to coding errors.

^bThese are categorised as “other” for the current analysis; however, these techniques could be considered in relation to communication theory in another context.

Aim 2: Theoretical explanation of behaviour change

Theoretical basis of facilitator behaviours. Intervention delivery was assessed using as the denominator the total number of facilitator behaviours delivered to each participant across the four sessions (not the number of behaviours specified in the protocol). Of the facilitator behaviours delivered, on average 25% were associated with TPB, 42% with SRT, 24% with OLT and 9% with RPT (Table II).

Theoretical basis of participant response. The frequencies of participant responses (their relevant talk during sessions) according to the 12 theoretical constructs coded are shown in Table II (there were no responses relevant to the five components of RPT). Over a third of participants' responses were coded as "rewards" (an average of eight responses per participant per session), with the next most frequent category being "attitude" – mainly perceived benefits of physical activity (an average of four responses per participant per session). Cues and self-monitoring each had an average of two responses per participant per session, with less than this for all other component-coded responses. Averaged across the 27 participants, participants' talk about behaviour change was consistent with TPB on 21% of occasions, SRT on 31% of occasions and OLT on 48% of occasions, with no talk relevant to RPT.

Comparison of facilitator behaviours and participant response. The percentages and frequencies of facilitator behaviours and participant responses according to theory are shown in Table II. The proportions of participants' responses assigned to TPB, SRT and RPT were less than the proportions of facilitator behaviours, but the proportion of participants' responses assigned to OLT was twice as great as the proportion of facilitator behaviours. For 6 of the 14 techniques (Figure 1), it was possible to indirectly compare facilitators' delivery with participants' responses; the matching theoretical constructs are shown in Table III. These data show that participants talk more about rewards relative to facilitators, and less about all other intervention components.

Associations between theoretical basis and physical outcomes. In the 25/27 participants who had complete dayPAR follow-up, the average change over 12 months was +0.08 (SD = 0.49, range = -1.07–1.04), similar to the change in the intervention arms of the trial. There were no significant associations between theoretical categorisations of facilitator/participants behaviours and change in physical activity over the year of the study in this small sample (Table IV).

Discussion

This study reports an innovative approach to developing theoretical explanations for behaviour change following interventions. It examines the delivery of an intervention, as well as its receipt, by reliably categorising talk between facilitators and participants within sessions into theoretical categories. It compares the

Table II. Percentage and frequency of facilitator behaviours and participant responses according to theory and theoretical component.

Theory	Facilitator behaviours		Participant responses			
	Percentage total mean (SD) ^a	Total frequency ^b	Percentage total mean (SD) ^a	Total frequency ^b	Frequency of theoretical component among participants	
TPB	25.27 (3.38)	522	21.31 (11.11)	125	Attitude Subjective norm	110
SRT	41.61 (6.43)	846	30.65 (14.76)	184	Goals Action Plans	3 10
OLT	24.22 (3.85)	507	48.04 (16.15)	293	Self-monitoring/feedback Cues/triggers/prompts Rewards/avoidance of negative consequences	56 55 219
RPT	8.89 (4.18)	208	0	0		
Total	100	2083	100	602		

Notes: ^a“% Total” column was derived by calculating % for each of the 27 participants, then averaging across participants. ^b Aggregated over participants.

Table III. Comparison between frequency of participant responses according to theoretical component, and the associated facilitator behaviours.

Theoretical component in participant talk	Technique used by facilitator	Frequency of participant responses ^a	Frequency of facilitator behaviours ^a	Ratio of participant responses to facilitator behaviours
Attitude (inc. outcome expectancy), subjective norm, perceived behavioural control, graded tasks Action plans	Build motivation	138	495	0.28
Goals	Develop action plans	52	188	0.28
Cues/triggers/prompts	Set goals and review goals	10	502	0.02
Self-monitoring/feedback	Use prompts	55	86	0.64
Rewards/avoidance of negative consequences, actively organised reward	Self-monitoring Use rewards	56 237	156 194	0.36 1.22

Note: ^aAcross all 27 participants.

Table IV. Association between proportions of facilitator delivery and participant response assigned to theories and change in physical activity between baseline and 12 months (Spearman's correlations with 95% confidence interval).

Theory	Facilitator delivery		Participant response	
	Change in dayPAR	Change in self-reported physical activity	Change in dayPAR ^a	Change in self-reported physical activity
TPB	0.02 (-0.38 to 0.41)	0.26 (-0.14 to 0.60)	0.24 (-0.17 to 0.58)	-0.16 (-0.52 to 0.25)
SRT	0.002 (-0.39 to 0.40)	0.37 (-0.03 to 0.67)	0.003 (-0.39 to 0.40)	0.34 (-0.06 to 0.65)
OLT	-0.12 (-0.49 to 0.29)	0.31 (-0.09 to 0.63)	-0.20 (-0.55 to 0.21)	-0.11 (-0.48 to 0.29)
RPT	-0.02 (-0.41 to 0.38)	0.12 (-0.29 to 0.49)	- (-0.55 to 0.21)	- (-0.48 to 0.29)

Note: ^a $n=25$; two participants had missing 12-month day PAR data.

theoretical underpinning of the intervention protocol, delivery in practice and intervention receipt. Detailed analyses of the component techniques delivered in the intervention showed that fidelity to protocol varied by technique and theoretical category of technique. About half of the protocol components were delivered, but the theoretical basis of the delivered intervention largely reflected that of the protocol.

Comparison of facilitator communication and participant response showed a clear theoretical difference between intervention delivery and receipt. Receipt was lower than delivery, as assessed by frequency of relevant utterances, for all theoretical categories apart from operant theory. The proportion of participants' responses assigned to operant theory was twice as great for participants as for facilitators; this difference reflects participants' tendency to talk more about rewards, rather than to talk more about cues.

The significance of this study lies in conceptualising, and attempting to assess, behaviour change interventions as a causal sequence rather than an input–output association. This is especially important if conclusions are to be drawn about theoretical mechanism of change, as well as efficacy. Conclusions about the explanatory power of theory cannot be drawn from efficacy results of theoretically based interventions unless detailed assessment of protocol content and delivery and participant response is conducted, and unless the links between theory and intervention techniques are established. In our study, these links, illustrated in Figure 1, were established by consensus methods. This study produced a substantive finding worthy of further research: that participants talk about behaviour change in ways consistent with OLT more frequently than do facilitators. This finding points to increasing the role of operant techniques in interventions to change physical activity.

However, the main significance of this study is conceptual, rather than substantive, due to limitations in inference and power. Interpretation of delivery is limited by the assumption that the more frequently a technique is delivered, the greater impact on behaviour change it will have. It may be that one technique within a theoretical cluster is particularly powerful or well delivered, thereby accounting for more change than another technique that is delivered more frequently. Interpretation of receipt is limited by the assumption that the extent to which people talk about the targeted behaviour (in this case, physical activity) in terms of a particular theoretical construct reflects the extent to which this construct explains behaviour change in their everyday life. These assumptions need to be tested empirically. We know that people are not always accurate in their direct reporting of their cognitive processes (Nisbett & Wilson, 1977), and that behaviour may be determined by automatic, non-conscious processes (Bargh & Ferguson, 2000). However, in our study, people were not asked about influences on their behaviour or to report on their cognitive processes. Instead, their general discourse about the targeted behaviour was analysed according to theoretical determinant.

A key question is “Is the theoretical basis of the intervention associated with outcome?” Because of the intensive nature of coding facilitator and participant

behaviours, such coding was conducted for only 27 of the total 224 participants. Thus, the study is not sufficiently powered to investigate the association between the theoretical basis of techniques used and behavioural outcomes.

In conclusion, this study highlights key issues. The first is that one cannot assume that the theoretical basis of an intervention as planned is reflected in delivery or receipt in practice. Inferences about the mechanisms by which an intervention has affected outcome should be informed by knowledge of its delivery and receipt by participants. In this study, assessment of delivery was more straightforward than assessment of receipt. We took participants' verbal behaviour as an indication of constructs that influence behaviour change: Research to assess the reliability of this method and to develop more sophisticated methods is required.

Increasing attention is being paid to the fidelity of intervention delivery (Bellg et al., 2004; Borrelli et al., 2005; Hardeman et al., in this issue), and this study adds two dimensions. It links intervention delivery with theoretical explanation, and it documents participant responses as a further contribution to understanding mechanisms of change. There are three areas of research indicated by this study. The first is to investigate these associations to elucidate mechanisms of behaviour change in sufficiently well-resourced trials powered to detect differences in outcome measures. Such a trial could also investigate whether the degree of concordance between the theoretical basis of techniques used by intervention providers and theoretical basis of participants' responses is associated with outcome (over and above facilitator delivery and participant response on their own).

A second research area is a detailed assessment of protocol delivery and receipt for the control group. This would reveal what the intervention group added over and above the control group, and whether the experience of being in the control group may have itself facilitated behaviour change. Such an analysis of control, as well as intervention, participants would inform the conclusions drawn from trials of behavioural interventions.

Third, the development of a reliable taxonomy of behaviour change techniques for describing the intervention protocol and delivery would facilitate the scientific investigation of behavioural interventions. This would allow replication, both for intervention evaluations and for the application of effective interventions. A further refinement would be to develop a method for linking techniques to particular theories of behaviour change. For theory to effectively inform intervention development, and for intervention evaluation to effectively inform theory development, links between intervention techniques and theoretical components and theories need to be clear. The links between techniques and theories/theoretical components for this study were made by four clinical and health psychologists. A firmer basis for technique–theory links is required. Research is currently being conducted to develop a reliable taxonomy of techniques and reliable links between techniques and theories, using a range of consensus methods and a group of theoreticians and practitioners (Abraham & Michie, in press; Francis, Michie, Johnston, Hardeman, & Eccles, 2005).

This study explores a method for identifying theoretical mechanisms in interventions to change behaviour related to health. In doing so, it points to innovations as well as limitations of the approach. These limitations point to a research agenda for developing the science of behaviour change, especially the need for a reliable taxonomy of behaviour change techniques and a method for linking these to theory on one hand, and to behavioural outcomes on the other.

Acknowledgements

We are grateful to Diabetes UK (RG35259) who funded the *ProActive* fidelity study; and to the UK Medical Research Council, National Health Service R&D and Royal College of General Practitioners Scientific Foundation who funded the development and execution of the *ProActive* Trial (isrctn 61323766). We thank study participants, facilitators and the practice teams for their collaboration and work in helping with recruitment. We greatly acknowledge the contribution of the *ProActive* research team: Kate Williams and Julie Grant (study coordinator and recruitment leads); Ulf Ekelund and Emanuella De Lucia-Rolfe (measurement leads); and Toby Prevost and Tom Fanshawe (statisticians). Principal investigators are Ann Louise Kinmonth, Nick Wareham, Stephen Sutton, Wendy Hardeman, David Spiegelhalter and Simon Griffin. We are grateful to Theresa Marteau, Paschal Sheeran, Stephen Sutton and Falko Sniehotta for comments on earlier drafts, and to two anonymous, very helpful reviewers.

Notes

- [1] Ethical approval for the *ProActive* trial was granted by the UK Eastern MREC (02/5/53) and the Cambridge (00/446), West Suffolk (00/046), Huntingdon (H01/734) and West Essex (1442-0302) Local Research Ethics Committees. Approval was sought from the relevant Primary Care Trusts.
- [2] Details available from first author.
- [3] Coding guidelines available from second author.

References

- Abraham, C., & Michie, S. (in press). Specifying behavior change techniques used in interventions: A preliminary taxonomy. *Health Psychology*.
- Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Decision Making Processes*, 50, 179–211.
- Albarracin, D., Gillette, J.C., Earl, A.N., Glasman, L.R., Durantini, M.R., & Ho, M.-H. (2005). Test of major assumptions about behavior change: A comprehensive look at the effects of passive and active HIV-prevention interventions since the beginning of the epidemic. *Psychological Bulletin*, 131, 856–897.
- Bandura, A. (2000). Health promotion from the perspective of social cognitive theory. In P. Norman, C. Abraham & M. Conner (Eds), *Understanding and changing health behavior*. The Netherlands: Harwood Academic Publishers.
- Bargh, J.A., & Ferguson, M.J. (2000). Beyond behaviorism: On the automaticity of higher mental processes. *Psychological Bulletin*, 126, 925–945.

- Bellg, A., Borrelli, B., Resnick, B., Hecht, J., Minicucci, D.S., Ory, M., et al. (2004). Enhancing treatment fidelity in health behavior change studies: Best practice and recommendations from the NIH behavior change consortium. *Health Psychology*, 23(Suppl 1), 443–451.
- Borrelli, B., Sepinwall, D., Ernst, D., Bellg, A.J., Czajkowski, S., Breger, R., et al. (2005). Assessment of treatment fidelity. *Journal of Consulting and Clinical Psychology*, 73, 852–860.
- Carver, C.S., & Scheier, M.F. (1981). *Attention and self-regulation: A control-theory approach to human behavior*. New York: Springer-Verlag.
- Carver, C.S., & Scheier, M.F. (1999). Themes and issues in the self-regulation of behavior. In R.S. Wyer Jr (Ed.), *Perspectives on behavioral self-regulation. Advances in Social Cognition*. New Jersey: Lawrence Erlbaum Associates.
- Francis, J., Michie, S., Johnston, M., Hardeman, W., & Eccles, M. (2005). How do behavior change techniques map on to psychological constructs? Results of a consensus process. *Conference proceedings. Psychology and Health*, 20, 83–84.
- Gillies, C.L., Abrams, K.R., Lambert, P.C., Cooper, N.J., Sutton, A.J., Hsu, R.T., et al. (2007). Pharmacological and lifestyle interventions to prevent or delay type 2 diabetes in people with impaired glucose tolerance: Systematic review and meta-analysis. *British Medical Journal*, 334, 299–308.
- 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 behavior change methods. *International Journal of Obesity and Related Metabolic Disorders*, 24, 131–143.
- Hardeman, W., Michie, S., Prevost, A.T., Fanshawe, T., McLoughlin, K., & Kinmonth, A.L. (2008). Fidelity of delivery of a physical activity intervention: Predictors and consequences. *Psychology and Health*, 23, 11–24.
- Hardeman, W., Sutton, S., Griffin, S., Johnston, M., White, A., Wareham, N., et al. (2005). A causal modelling approach to the development of theory-based behavior change programmes for trial evaluation. *Health Education Research*, 20, 676–687.
- Kinmonth, A.L., Hardeman, W., Sutton, S., Prevost, T., Fanshawe, T., Williams, K., et al. (2006). The ProActive Trial: Impact of a theory-based behavioral intervention on physical activity, social function and psychological predictors. *Annals of Behavioral Medicine*, 31, S018.
- Kok, G., Schaalma, H., Ruiter, R.A.C., Van Empelen, P., & Brug, J. (2004). Intervention mapping: A protocol for applying health psychology theory to prevention programmes. *Journal of Health Psychology*, 9, 85–98.
- Marlatt, G.A., & George, W.H. (1998). Relapse prevention and the maintenance of optimal health. In S.A. Shumaker & E.B. Schron (Eds), *The handbook of health behavior change* (pp. 35–58). New York, USA: Springer Publishing Co Inc.
- Michie, S., & Abraham, C. (2004). Identifying techniques that promote health behavior change: Evidence based or evidence inspired? *Psychology and Health*, 19, 29–49.
- Michie, S., Hardeman, W., & Abraham, C. (2005). Identifying effective techniques: The example of physical activity. *Psychology and Health*, 20(Suppl 1), 173.
- Mokdad, A.H., Marks, J.S., Stroup, D.F., & Gerberding, J.L. (2004). Actual causes of death in the United States. *Journal of the American Medical Association*, 291, 1238–1245.
- Nisbett, R.E., & Wilson, T.D. (1977). Telling more than we can know: Verbal reports on mental processes. *Psychological Review*, 84, 231–259.
- Noar, S.M., & Zimmerman, R.S. (2005). Health behavior theory and cumulative knowledge regarding health behaviors: Are we moving in the right direction? *Health Education Research*, 20, 275–290.
- Ory, M.G., Jordan, P.J., & Bazarre, T. (2002). The behavior change consortium: Setting the stage for a new century of health behavior-change research. *Health Education Research*, 17, 500–511.
- Rothman, A.J. (2004). Is there nothing more practical than a good theory? Why, innovations and advances in health behavior change will arise if interventions are used to test and refine theory. *International Journal of Behavioral Nutrition and Physical Activity*, 1. Retrieved October 2007. Available at: <http://www.ijbnpa.org/content/1/1/11>.
- Skinner, B.F. (1953). *Science and human behavior*. New York: Free Press.

- Trifiletti, L.B., Gielen, A.C., Sleet, D.A., & Hopkins, K. (2005). Behavioral and social sciences theories and models: are they used in unintentional injury prevention research? *Health Education Research*, 20, 298–307.
- UK Department of Health (2004). *Choosing health? Making healthy choices easier*. London: Department of Health.
- US Department of Health and Human Services (2000). *Healthy people 2010: Understanding and improving health conference*. Washington, DC: Government Printing Office.
- Williams, K., Prevost, A.T., Griffin, S., Hardeman, W., Hollingworth, W., Spiegelhalter, D., et al. (2004). The *ProActive* trial protocol – a randomized controlled trial of the efficacy of a family-based, domiciliary intervention programme to increase physical activity amongst individuals at high risk of diabetes. *BMC Public Health*, 4, 48–84.
- World Health Organization. (2002). *WHO mega country health promotion network: Behavioral risk factor surveillance guide*. Geneva: World Health Organization.
- Zimmerman, R.S., & Noar, S.M. (2005). Health behavior theory and cumulative knowledge regarding health behaviors: Are we moving in the right direction? *Health Education Research: Theory & Practice*, 20, 275–290.