Intervention delivery fidelity assessment of a counselling based intervention for promoting smoking reduction and increasing physical activity.

Thompson, T. P.[1]*, Lambert, J. D.[2], Greaves, C. J.[2], & Taylor, A. H.[1].

Corresponding author: tom.thompson@plymouth.ac.uk

[1] Plymouth University Peninsula School of Medicine and Dentistry, Plymouth UK

[2] University of Exeter Medical School, Exeter, UK

Abstract

Objective: The aim of this study was to (1) develop an approach to assess the fidelity of delivery of a complex intervention designed to simultaneously increase physical activity and reduce smoking; and (2) to use this approach to assess the variation of fidelity across the delivery of different intervention components of the intervention.

Methods: 90 audio recorded and transcribed sessions involving 30 participants and 3 health trainers delivering a one to one intervention within in a pilot trial were purposefully sampled across HT and stage of treatment (early, middle, and late). The Dreyfus system for skill acquisition informed a scoring system based on twelve intervention processes (e.g. set goals to reduce smoking) and applied by three experts in health behaviour change. Scores ranges from $0 – 2$ (poor quality), $3 – 4$ (reasonable quality) and $5 – 6$ (expert level quality). Scores were averaged across coders and presented in relation to both fidelity of HT and intervention component.

Results: Average scores for each item by each coder differed by up to $+0.7$ to $– 0.9$ points indicating reasonable agreement. Mean scores for the three HT's were 2.9, 2.2 and 2.4, across all 12 intervention processes. The delivery of all intervention components for physical activity was scored lower (< 3) than their respective counterparts for smoking reduction (> 3) ($P < 0.001$).

Conclusions: Delivery fidelity was deemed to be of reasonable quality but was higher for smoking related intervention components over physical activity ones. Possible reasons for this may include participant motivation to change smoking behaviour rather than physical activity as a priority which dictated session content or HTs were more skilled and confident at promoting change in smoking behaviour. This study is the first

to attempt to identify how key components in an intervention were delivered with

respect to changing multiple health behaviours.

Key Words

Background

Individuals who engage in multiple risky health behaviours (smoking, alcohol consumption, physical inactivity, and poor diet) are at greater risk of chronic disease, disability, and premature death (Doll, Peto, Boreham, & Sutherland, 2004; Khaw et al., 2008; Kvaavik, Batty, Ursin, Huxley, & Gale, 2010; Mokdad, Marks, Stroup, & Gerberding, 2004), with the risk proportionate to the number of behaviours. In the UK, around 25% of adults engage in at least three of these risky behaviours (Poortinga, 2007), with the proportion increasing in disadvantaged communities (Berrigan, Dodd, Troiano, Krebs-Smith, & Barbash, 2003; Chiolero, Wietlisbach, Ruffieux, Paccaud, & Cornuz, 2006; Laaksonen, Prättälä, & Lahelma, 2003; Poortinga, 2007; Schuit, van Loon, Tijhuis, & Ocké, 2002; Shankar, McMunn, & Steptoe, 2010). Multiple health behaviour change (MHBC) research has therefore gained increased attention in recent years (Prochaska, 2008; Yin et al., 2013).

Understanding of the optimal formatting and content of MHBC interventions, of relevance for implementation remains undeveloped (Mc Sharry, Olander, & French, 2014; Nigg & Long, 2012; Prochaska et al., 2008). For example, there are mixed views on whether change in multiple behaviours should be encouraged or supported simultaneously or sequentially, separately or integrated, and over what time period (Hyman, Pavlik, Taylor, Goodrick, & Moye, 2007; King et al., 2013; Kodl, Fu, & Joseph, 2006; McEwen, Hajek, McRobbie, & West, 2006; Prochaska, 2008; Schulz et al., 2014; Spring et al., 2004; Vandelanotte, De Bourdeaudhuij, & Brug, 2007; Vandelanotte, Reeves, Brug, & De Bourdeaudhuij, 2008).

With increased interest in mapping health behaviour change techniques and theory linked intervention components the focus has been on interventions targeted at changing

single health behaviours rather than MHBC with only a few exceptions (eg, McSharry et al., 2014). So there is little understanding of how to assess what goes on and how to design interventions that target MHBC. As an example, practitioners may be unclear how to minimise weight gain, or fear of weight gain for smokers wishing to reduce or quit. Physical activity has been shown to reduce weight gain following cessation though dietary interventions have been less effective (Aubin, Farley, Lycett, Lahmek, & Aveyard, 2012). One view is that trying to change other behaviours while quitting smoking can lead to a greater risk of failure in all behaviours (McEwen et al., 2006), but in contrast others advocate an integrated MHBC approach to preventing weight gain (Marcus et al., 1999). Nevertheless, there is little or no evidence that may help to assess what takes place in such interventions (eg, the emphasis on changing one or both behaviours over multiple intervention sessions with different behaviour change techniques) or guidance for designing integrated MHBC interventions.

Training practitioners to faithfully deliver complex interventions is a major challenge. While studies have examined the effects of complex behaviour change interventions (Hyman et al., 2007; King et al., 2013; Kodl et al., 2006; Schulz et al., 2014; Spring et al., 2004; Vandelanotte et al., 2007, 2008) few studies have sought to rigorously assess how well practitioners are able to deliver multiple behaviour change within a counselling intervention. Everson and colleagues (Everson, Taylor, Ussher, & Faulkner, 2010) interviewed smoking cessation advisors (who promoted physical activity) to explore how they tackled MHBC, and found they adopted a dynamic approach in which practitioners tried to appropriately respond to the readiness of clients to take on one or more changes. This reflected real-world practice rather than enhancing our understanding of what practitioners do when trained to support MHBC.

Intervention fidelity is the extent to which a behavioral intervention was delivered as intended (Bellg et al., 2004; Borrelli et al., 2005). This is important as interventions may fail because they are not effective, or because they were not well-delivered. Furthermore, without fidelity assessment, a successful outcome could be mistakenly attributed to the intervention when it is actually the result of a non-specific therapist effect (e.g. empathy). In a meta-analysis the therapist effect accounted for 8.6% of the outcome variance (Crits-Christoph et al., 1991). A comprehensive treatment fidelity framework developed by the behaviour change consortium (BCC) for tailored health behaviour interventions exists, covering five domains: Study Design, Provider Training, Treatment Delivery, Treatment Receipt, and Treatment Enactment (Bellg et al., 2004; Borrelli et al., 2005). Treatment delivery is considered the 'heart of fidelity assessment in behavioral interventions (Gearing et al., 2011) but has historically been insufficiently considered (Miller & Rollnick, 2014). More specifically, previous interventions targeting smoking and physical activity behaviors have not reported BCTs or assessed fidelity (Bernard et al., 2015; Maddison et al., 2014; Ussher et al., 2015) . Due to the inherent difficulty in attempting to change two behaviors simultaneously (i.e. smoking and physical activity)assessing fidelity becomes even more important to have confidence in treatment effects and the active processes that produce high quality interventions. Despite these recommendations, a recent systemic review found that there was considerable heterogeneity in the quality of measurement of delivery fidelity in interventions promoting physical activity (Lambert et al., 2017).

This research examines the delivery fidelity of a novel multiple behaviour change intervention (targeting both physical activity and smoking reduction). It develops and evaluates the methods used making recommendations for assessing intervention fidelity

in future research, and also presents the findings relating to the fidelity of delivery of several identified processes within an intervention aimed at reducing smoking and increasing physical activity.

The aim of this study was to (1) develop an approach to assess the fidelity of delivery of a complex intervention designed to simultaneously increase physical activity and reduce smoking; and (2) to use this approach to assess the variation of fidelity across the delivery of different intervention components of the intervention.

Methods

The current study was conducted in parallel to a pilot randomised controlled trial, the Exercise Assisted Reduction to Stop smoking (EARS) trial: full details of the intervention are reported elsewhere (Taylor et al., 2014; Thompson et al., 2015; Thompson et al., 2016; Thompson et al., 2015).

Participants

Ethical approval for the EARS study was granted by the NHS National Research Ethics Service Committee South West, in the UK. Recruitment took place in the neighborhoods of Devonport and Stonehouse (Plymouth) which are among the top 3% of most deprived areas in the UK(Department of Communities and Local Government, 2011). The sample size calculations, recruitment methods, and baseline characteristics of the sample, have been reported elsewhere (Taylor et al., 2014). In summary, 99 adults who smoke moderately to heavily, who wanted to reduce smoking (without NRT) but who reported no plans to quit in the next month, were recruited by either a mailed invitation from their general practitioner or from NHS Stop Smoking Services (SSS), with follow-up telephone calls, or through other community based approaches.

Sampling frame

Within the intervention group of the EARS study, all consultation sessions were audio-recorded subject to informed consent. A sample of 30 participants split between the three HTs (90 audio recorded and transcribed sessions in total) were purposively sampled from those available to provide examples from early, in the middle of and at the end of the study period (in an attempt to smooth out any health trainer practice effects). For each participant, three consultations were selected for coding to provide examples of intervention techniques from early to later engagement for each participant where possible.

Intervention development and training the Health Trainers

The intervention aimed to provide support for a behaviour change techniques that were mapped against specific processes and theoretical domains. HT training using the Health Trainer Manual (Michie et al., 2008) was first delivered to ensure the HTs had a basic level of understanding of behaviour change techniques, followed by training in behaviour change techniques specific to EARS (see *Appendix 1*). The EARS training covered physical activity and smoking reduction counselling to achieve the objectives in *Table 1*. *Table 2* shows a list of behaviour change techniques (BCTs) (Michie, Ashford, et al., 2011; Michie, Hyder, Walia, & West, 2011) that the HTs were trained to use which are linked to the main theoretical constructs that underpinned the intervention (*Table1*). A full description of the intervention development and training of the HTs has been published elsewhere (Taylor et al., 2014).

INSERT TABLE 1 ABOUT HERE

INSERT TABLE 2 ABOUT HERE

Procedures

To assess intervention delivery fidelity (and at the same time quantify delivery in terms of predefined manualised elements), the Dreyfus system for assessing skill acquisition (Dreyfus, 1989) (*Figure 1*) was used to score recorded consultations with respect to the HTs' skill in delivering each of the twelve pre-defined intervention processes detailed in Table 1. . A scoring checklist and instructions were developed (*Appendix2*). The gold standard for assessing whether interventions are delivered as specified is considered to be the use of audio or videotapes for objective verification of delivery, evaluated against criteria that have been developed a priori (Borrelli, 2011). The checklist was applied initially by three researchers with expertise in behaviour change (AHT, CGvs, and TT) to a sample of six consultations from two participants. Scores were compared and reasons for any discrepancies were discussed to produce a consensus about how to apply the scoring system. A similar procedure was adopted at a later stage between TT and another researcher (JDL) to expand the number of sessions scored for fidelity.

INSERT FIGURE 1 ABOUT HERE

In total, between three researchers (TT, CGVS, JDL) consultation data from 30 participants across the three HTs (using three consultations per participant) were scored to produce an overall intervention fidelity rating for each checklist item (each component of the intervention) and for each health trainer (see *Table 3*). This was done by listening to the set of (3) recorded consultations for each participant and reading the transcripts of the same consultations, then rating the fidelity for each item on the checklist. The coding for each health trainer was split between the three researchers, so that each researcher coded at least two participants for each HT. The average score for the HT is therefore the average of the scores given by three coders.

Due to the clear descriptions associated with each score (see checklist scoring instructions in *Appendix 2*) and the steps taken to establish a consensus between coders on the approach to scoring, interpretation of scores is relatively straightforward: Scores of 0 or 1 represented poor delivery (or no delivery) of the intended process. A score of 3 or more was considered to represent a reasonable quality of intervention delivery. Scores of 5 or 6 represented very high (expert level) quality. Item 12 (referral to smoking cessation services) was scored as either 0 or 1 (yes or no) and so is not reported in *Table 3*.

Statistical analysis

A series of linear regression models were run (using Stata v14) on a the mean fidelity scores for each of the 30 participants assessed, to determine whether there was a statistically significant mean difference between intervention elements relating to smoking and physical activity and whether this was affected by the HT.

Results

Table 3 shows the intervention fidelity scores for each item on the checklist (excluding binary item 12), broken down by HT and by coder.

The mean scores for each fidelity item (figure 2) ranged from 1.3 (SD = 1.0) to 3.7 (0.8) with IF1 (Active participant Involvement) scoring the highest and IF10 and IF11 (Manage social influences) scoring the lowest.

Coder agreement

The average scores for each item as scored by each coder differed by up to +0.7 to -0.9 points (out of a possible 6) with overall mean scores by coder differing by no more 0.2. Hence, there

seemed to be a reasonable level of agreement between coders about the quality of

intervention delivery across all processes.

Overall Health Trainer Quality

The mean overall scores across the eleven checklist items for HT1, HT2, and HT3 were 2.9,

2.2, and 2.4 respectively suggesting no large differences in overall fidelity scores. HT1

demonstrated a better performance across all fidelity scales than the other two HTs.

INSERT TABLE 3 ABOUT HERE

An additional twelfth item (referral to smoking cessation services) was scored as being

delivered appropriately to 29 out of the 30 participants assessed. A positive score represented

the discussion and offer of referral to smoking cessation services as appropriate, not the

actual acceptance of a referral by the participant. There was only one reported case of

potential referral being missed where the participant talked of a possible desire to make a quit

attempt, but this was not followed up by the HT.

The delivery of checklist items related to promoting physical activity (IF3, IF5, IF7 and IF11)

were all significantly lower than their respective counterpart elements related to promoting

smoking reduction (IF2, IF4, IF6 and IF10). Linear regression revealed that mean score for

IF2 was significantly lower IF3 (Mean Diff: 0.4, 95% CI: 0.1 to 0.7, $p = 0.005$, $d = 1.0$), the

mean score for IF4 was significantly lower than IF5 (Mean Diff: 0.5, 95% CI: 0.2 to 0.8, $p = 0.004$, $d = 0.9$), the mean score for IF6 was almost significantly lower than IF7 (Mean Diff: 0.3, 95% CI: 0.0 to 0.6, $p = 0.051$, $d = 1.4$), and the mean score for IF10 was significantly

lower than IF11 (Mean Diff: 0.7, 95% CI: 0.5 to 1.0, $p = 0.000$, $d = 0.6$). No significant effects were found when health trainer was added into the model as a covariate.

All smoking related items scoring above the criterion of 3 or more indicating 'competent performance' on the Dreyfus scale, and all physical activity items scoring less (*Figure 2*). The exception to this was IF items 10 and 11 which both scored under 2 (despite smoking related items scoring higher).

INSERT FIGURE 2 ABOUT HERE

IF10 (managing social influences on smoking) and IF11 (managing social influences on physical activity) were considerably lower than expected, scoring well below what was considered to represent competent practice (a score of 3 or more).

The score for IF9 (reinforce health-identity shifts) met the lower criterion for acceptable delivery for this item of 1.5.

Discussion

Development of an approach to assess intervention delivery fidelity

Overall, the application of the developed methods for assessing intervention delivery fidelity were deemed acceptable. The intervention delivery fidelity was found to be approaching an acceptable level for this novel pilot intervention, and the application of the methods for assessing fidelity was successful from a sample of 90 recorded sessions. This study outlines a novel approach for assessing the fidelity of delivery of a multiple health behavior change intervention.

Whilst the rigorous approach taken here to assessing intervention delivery fidelity had its strengths, it contained potential problems in its application. The effectiveness of complex interventions may be dependent on the skills of those delivering them (Cross & West, 2011). 'Skills' has been characterised by the separate but related constructs of 'adherence' and 'competence' (Mars et al., 2013), where adherence represents the extent to which practitioners deliver what they were trained to do and was outlined by the intervention designers, and competence refers to the ability of the practitioner to deliver the predetermined intervention with a particular focus on their ability to respond to a variety of resistance and situational cues. These two behaviours of adherence to treatment components and competence to deliver the treatment in the manner specified have been shown to have low correlations (Miller & Binder, 2002; Perepletchikova & Kazdin, 2006) and should be assessed separately (Borrelli, 2011). The methods for assessing the 11 items within this research did not allow for a distinction between these two constructs. The attempt to integrate both aspects into the Dreyfus scoring system worked reasonably well, although this research could be strengthened by the addition or separation of adherence and competence scores for each of the processes, as has been successfully implemented elsewhere (Barber, Mercer, Krakauer, & Calvo, 1996; Mars et al., 2013).

The sampling of the sessions to be analysed did not allow for a robust examination of fidelity changes across time as the HTs potentially became more proficient in delivery with increased experience due to a relatively limited sample available. This potential limitation should be addressed in future application through a more robust sampling strategy,

More detailed assessment of non-specific factors (e.g. empathy-building, individual tailoring, communication style), rather than combining these as "active patient involvement", could also be considered for future research (Borrelli, 2011). Although useful in gaining an overall

picture of the HTs communication style. It is possible that one HT was more versed in one aspect of communication (e.g. empathy building) than another (individual tailoring). Future research could consider adapting an existing validated scale for capturing different dimensions of communication style, such as the motivational interviewing treatment integrity scale (MITI) (Moyers, Rowell, Manuel, Ernst, & Houck, 2016).

Within this study, characteristics and personal traits of the HTs were not assessed with regards to the role they may play in the delivery of the intervention. Therapists' personal characteristics may be associated with variation in quality and effectiveness of treatment delivery (Campbell et al., 2013), and of particular importance to the current study is evidence to suggest practitioners with higher levels of physical activity may be associated with higher physical activity promoting practices (Fie, Norman, & While, 2013). Future studies (with a larger number of practitioners) should incorporate this information into their analyses as a potential moderating factor.

Findings from the application of the methods

HTs were able to use multiple behaviour change techniques to address multiple health behaviours within the same intervention, although to varying degrees across the processes targeted. The processes relating to smoking reduction and behaviour were delivered more proficiently than those relating to increasing physical activity behaviour. This may be due to several reasons: (1) the primary target of EARS was smoking reduction which created inherent difficulties in introducing physical activity. As was shown in related qualitative work (Taylor et al., 2014) the main motivating factor for participant involvement was to address smoking behaviour and not physical activity; (2) Participants were more motivated to engage in discussions around smoking than physical activity; (3) The HTs found it difficult to

convince some participants of the value of PA as a smoking reduction technique, and therefore felt this element was difficult to deliver and were less inclined to focus on PA; (4) Participants often experienced early success in terms of smoking reduction, so later sessions focused on reinforcing this with less time and need to focus on PA; (5) The sample was already moderately active, completing more moderate PA per week (e.g. walking) than expected. This may have created uncertainty for the health trainers on how to best address PA behaviour; (6) None of the HTs had any prior experience of promoting either behaviour, and the satisfaction of seeing early successes in smoking reduction may have built their confidence to focus on this rather than PA; (7) Adequate training may not have been provided to promote PA relative to smoking. For example, the four schematic approaches to smoking reduction were easier and more appealing to use than more complex methods for increasing PA. If a participant is not willing to engage in considering changes in physical activity, appropriate responses might include a) focusing on reducing smoking initially (as this is the primary aim of the intervention), then bringing in ideas about PA later (e.g. as a possible strategy to help manage cravings) b) acknowledging the desire to focus on smoking reduction alone and "leaving the door open" for future discussions on PA if the participant wishes. People who are already moderately active may or may not wish to do more, but the benefits of specific activities designed to reduce cravings and the timing of activities may still be useful.

The poorer relative delivery of the processes related to physical activity compared to smoking reduction, may in part explain the main findings which demonstrated positive trends for changes in smoking behaviour but not necessarily in physical activity levels (Thompson et al., 2015)..

Scores for IF10 and IF11 relating to managing social influences on smoking and physical activity behaviour, respectively, both scored lower than expected. It was evident to a certain degree that participants saw their goals and targets for behaviour change as personal and individual experiences. However, the lack of attention on the part of the HTs to exploring social influences on the two behaviours meant that one of the key aspects of Self Determination Theory underpinning the intervention went largely unaddressed (that of relatedness or companionship (Deci & Ryan, 2000; Deci & Ryan, 1985)). This lack of developing social support may have resulted in reduced intervention effects, so this seems a key focus for refinement of the intervention training course.

All three HTs scored highly on active participant involvement. This may be due to all three having a depth of experience in working with patients in other clinical settings as well as a strong focus in the training and ongoing supervision on motivational interviewing principles and self-determined behavior which places the client at the centre of the decision making process.

Scores for IF9 (reinforce health-identity shifts) scored lower than would be desirable demonstrating room for improvement. This item and related process was an implicit part of the intervention in that the encouragement of greater physical activity sought to foster a more positive health identity. But there appears to be an opportunity in future intervention training to make this a more explicit focus.

The examination of intervention fidelity was facilitated by the development of a clear process model (*Table 1*) and was useful in highlighting specific areas where the intervention training could be improved. A valid and reliable measure of intervention fidelity would be very useful for both training and quality assurance purposes. A subsequent definitive trial has been

funded and begun in the early part of 2017 (Trial of physical Activity and Reduction of Smoking [TARS] funded by the NIHR Health Technology Assessment programme (NIHR HTA: 15/111/01)) which aims to recruit 900 participants across four cities in the UK (London, Nottingham, Oxford, and Plymouth). This work will inform the training and intervention delivery, as well as providing a refined framework for further assessing delivery fidelity of a multiple behavior change intervention.

One of the key benefits of rigorous treatment fidelity assessment is to allow for the early detection of errors to prevent protocol deviations from becoming widespread and long lasting which has the potential to influence a study's findings (Borrelli, 2011). The processes and their assessment outlined here as a result of this pilot work will be implemented as part of the definitive trial.

Recommendations for future research

Methodological considerations for assessing intervention fidelity in complex behaviour change interventions should consider: (1) Assessing fidelity relating to intervention receipt and enactment by participants to strengthen understanding relating to the use /uptake of the intervention techniques in practice; (2) The development of a way to assess adherence and competence separately; (3) A more structured sampling frame capturing a greater number of session from the later stages of the intervention to assess fidelity over time.

Future implementation of the EARS intervention as part of the definitive trial should consider the following: (1) Additional training to address physical activity behaviour (particularly amongst those who may already be physically active); (2) A stronger emphasis on training and feedback on exploring and managing social influences on behaviour; (3) Assessment of previous experience of the HTs in working with such a population to create a more

individual-tailored training programme; (4) Additional training and development to aid the HTs in reinforcing positive identity shifts; (5) assessment of both HT and participant characteristics as potential moderators of delivery quality; (6) the relationship between treatment fidelity and treatment outcome should be examined (7) within the pilot trial the fidelity framework was not explicitly shared with the HTs (although the processes were implicit in the training manual), but for the definitive trial the framework will be explicitly shared with the HTs to enable a more conscious focus on delivery of the assessed processes within the framework.

Conclusion

Intervention fidelity was examined and deemed to be acceptable overall in the EARS pilot study, with several recommendations for future training and fidelity assessment. The methods for assessing intervention fidelity were found to be acceptable and reliable, suggesting this approach could be modified and implemented in future research. This is the first study to examine a framework for assessing delivery fidelity of a multiple health behaviour change intervention. .

Declarations, acknowledgements etc. to be added depending on journal

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Table 1 Processes targeted (objectives) and related content for the EARS intervention

Intervention process /objective	Intervention strategy	Behaviour Change Techniques (See Table 2 for description)	Theoretical Domains
1. Active participant involvement. Develop rapport, building trust, and shared respect and empower the participant to be the primary agent of change.	Use MI principles and communication skills. Exhibit empathy using Open questions, Affirmation. Reflections, Summaries (OARS). Individual tailoring of techniques and responses to the individual participant's existing knowledge, skills, needs or preferences.	RC1, RC2, RC4, RC7, RC8, RC9, RC10 RD1, RD2	Knowledge; Skills; Identity (e.g. social identity); Capability beliefs; Beliefs about consequences; Reinforcement; Intentions; Goals; Memory or attention; Context /resources; Social influences; Emotion; Behavioural regulation.
2. Explore initial beliefs about *cutting down* (importance and confidence, triggers for smoking). Build /enhance motivation and confidence for *cutting down.* Desire to quit may also be discussed.	Use OARS (as above) to explore current and past smoking behaviour, the pros and cons of cutting down. 0-10 questions to explore importance and confidence. Use OARS to develop discrepancies (e.g. by exploring possible futures). Identify strengths and barriers (e.g. by exploring past experiences of success and failure or asking 'what might stop you?'). Identify possible solutions to barriers. Exchange information on pros and cons of cutting down and barrier-solutions using the elicit-provide-elicit (Ask-Tell-Discuss) technique.	RI1, RI2, BM3, BM9 RC6, RI3, RI4, A2, BM2, BS2 RC2, A2, BM2, BS2	Knowledge; Capability beliefs; Beliefs about consequences; Intentions; Context /resources; Social influences; Emotion

Intervention process /objective	Intervention strategy	Behaviour Change Techniques (See Table 2 for description)	Theoretical Domains
3. Explore initial beliefs about *Physical Activity* and using it as an aid to cutting down (importance and confidence, barriers to PA). Build /enhance motivation and confidence for *Physical Activity*.	Use OARS (as above) to explore pros and cons. Decisional balance tool, 0-10 questions to explore importance and confidence about introducing additional physical activities. Use OARS to develop discrepancies. Identify strengths and barriers (e.g. by exploring past experiences of success and failure or asking 'what might stop you?). Identify possible solutions to barriers. Exchange information on pros and cons of PA and on barriers /solutions using the elicit-provide-elicit (Ask-Tell-Discuss) technique.	C37 C18, C37 C8, C31, C37	Knowledge; Capability beliefs; Beliefs about consequences; Intentions; Context /resources; Social influences; Emotion
4. Set goals and discuss strategies *to reduce smoking*.	Set SMART goals with smoker to reduce smoking. Discuss /offer a choice of specific strategies. Negotiate strategy and rate of smoking reduction (over following 1 and 4 weeks). Encourage self-monitoring of daily smoking.	BS3, BS4, BS6, BS7, BS8, BS9 C12, C23 BS6	Intentions; Goals; Behavioural regulation.

Intervention process /objective	Intervention strategy	Behaviour Change Techniques (See Table 2 for description)	Theoretical Domains
5. Set goals and discuss strategies *for Physical Activity*	Set SMART goals with smoker to increase PA /introduce new physical activities. Discuss preferences and smoker to choose activities. Signpost to relevant PA/exercise opportunities. Encourage self-monitoring of daily or weekly physical activity (e.g. using a pedometer).	C5, C7, C9, C23, C26, C24 C16	Intentions; Goals; Behavioural regulation; Context /resources
6. Review and reflect on efforts *to cut down smoking* to build confidence gradually and perceptions of control and ability to self-regulate.	Smoker and HT review progress with smoking reduction. Any successes are reflected on and reinforced. Smoker and HT discuss any setbacks (reframing to normalise them, identifying social, environmental or other barriers and exploring ways to overcome them). Set new targets (perhaps to quit). Reflection on /reinforcement of the smoker's skills in avoiding or managing relapse. Re-assessment /checking of motivation /perceived benefits of reducing smoking and also of making an attempt to quit.	RC7, RC8, BM3, BS5 A2, RI4, RC6, BS1, BM5, BS8 BS3, BS4, BS5, BS6, BS7, BS9 BM2, BM3 BM2, BM9	Skills; Identity (e.g. social identity); Capability beliefs; Beliefs about consequences; Memory or attention; Context /resources; Social influences; Emotion; Behavioural regulation

Intervention process /objective	Intervention strategy	Behaviour Change Techniques (See Table 2 for description)	Theoretical Domains
7. Review and reflect on efforts *to increase Physical Activity* to build confidence gradually and perceptions of control and ability to self-regulate.	Smoker and HT review and reflect on successes in increasing PA /introducing new physical activities. Smoker and HT discuss any setbacks (reframing to normalise them, identifying social, environmental or other barriers and exploring ways to overcome them). Set new targets for PA. Re-assessment /checking of motivation /perceived benefits of physical activity in relation to smoking reduction, but also discussing other personal benefits.	C11 C8, C28, C29, C35 C10, C6, C7, C16 C37, C15	Skills; Identity (e.g. social identity); Capability beliefs; Beliefs about consequences; Memory or attention; Context /resources; Social influences; Emotion; Behavioural regulation
8. Integration of concepts: Building an association between PA and smoking reduction.	The HT introduces PA as a healthy behaviour and aid to cutting down and quitting. A clear rationale is presented for how PA might be relevant to reducing smoking (as a distraction, as a way to reduce withdrawal symptoms such as stress or cravings). The HT and smoker agree to experiment with using PA. The smoker reflects on use of PA and relates it to smoking urges and /or to number of cigarettes smoked.	RD1, RC2, RC8, R6 C6, C11	Beliefs about consequences; Emotion

Intervention process /objective	Intervention strategy	Behaviour Change Techniques (See Table 2 for description)	Theoretical Domains
9 and 10. Engage social support to facilitate behaviour change (both for reducing smoking and for physical activity)	Exploring the possible role of social influences as potential barriers to change and as potential facilitators of change is encouraged during the motivation, action-planning and review stages above. Social support is conceptualised as being either informational (e.g. helping to make plans) practical (e.g. providing transport), or emotional (e.g. encouraging)	A2 C29	Social Influences; Emotion
11. Identify and reinforce any identity shifts towards being a more 'healthy person' or 'healthy living'. This represents a generalisation of the specific desire to stop smoking or to be more active into a more general self-concept of being someone who is healthy.	Recognise and reinforce any identity change talk using reflective listening techniques.	RC2, RC7, RC8, C30 NB: Explicitly encouraging /reinforcing positive changes in social identity is not currently a recognised BCT	Identity (e.g. social identity); Emotion

Intervention process /objective	Intervention strategy	Behaviour Change Techniques (See Table 2 for description)	Theoretical Domains
12. Referral to NHS Stop Smoking Services if needed.	Ask if ready to quit and refer to NHS SSS if desired	RC2, RD1	Context /resources

BCT: Behaviour change technique; HT: Health Trainer; NHS: National Health Service; PA: Physical Activity; SMART: Specific, Measurable, Achievable, Realistic, Time bound; SSS: Stop Smoking Services

Table 2 Planned behaviour change techniques to be used in intervention sessions (authors' alterations to original text in italics)

Behaviour addressed	BCT (modified for the EARS protocol of delivery)
Smoking Reduction (Michie, Hyder, et al., 2011)	BM2 (boost motivation and self-efficacy)
	BM3 (*offer* feedback on current behaviour)
	BM5 (*offer* normative information about others' behaviour and experiences)
	BM9 (*elicit* reasons for wanting and not wanting to ~~stop smoking or~~ *cut down)*
	BM11 (measure CO)
	BS1 (facilitate barrier identification and problem solving)
	BS2 (facilitate relapse prevention and coping)
	BS3 (facilitate action planning/develop treatment plan)
	BS4 (facilitate goal setting)
	BS5 (prompt review of goals)
	BS6 (prompt self-recording)
	BS7 (*offer to provide support with techniques* for changing behaviour)
	BS8 (*prompt thoughts* on environmental restructuring)
	BS9 (*help* set graded tasks)
	A2 (advise on/facilitate use of social support
	RD1 (tailor interventions appropriately)
	RD2 (emphasise choice)
	RI1 (assess current and past smoking behaviour)
	RI2 (assess current readiness and ability to ~~quit~~ *cut down*)
	RI3 (assess past history of quit attempts)
	RI4 (assess withdrawal symptoms)
	RC1 (build general rapport)
	RC2 (elicit and answer questions)
	RC4 (explain expectations regarding treatment programme)
	RC6 (provide information *where appropriate* on withdrawal symptoms)
	RC7 (use reflective listening)
	RC8 (elicit client views)
	RC9 (summarise information/confirm client decisions)
	RC10 (provide reassurance)
	C5 (goal setting – behaviour)

Physical Activity (Michie, Ashford, et al., 2011)	C6 (goal setting – to achieve possible benefits from increasing physical activity)
	C7 (action planning)
	C8 (barrier identification/problem solving)
	C9 (set graded tasks)
	C10 (prompt review of behavioural goals)
	C11 (prompt review of achievement of benefits from PA)
	C12 (prompt rewards contingent on progress)
	C15 (prompting generalisation of a target behaviour)
	C16 (prompt self-monitoring of behaviour)
	C18 (prompting focus on past success)
	C23 (teach to use prompts/cues)
	C24 (environmental restructuring)
	C26 (prompt practice)
	C28 (facilitate social comparison)
	C29 (plan social support)
	C30 (prompt identification as role model)
	C31 (prompt anticipated regret from not changing current behaviour)
	C35 (relapse prevention/coping planning)
	C37 (motivational interviewing)

Note: The BCTs are utilised in a highly responsive and tailored manner to the individuals' needs and rate of change across sessions.

[a]Specific focus on behaviour and addressing motivation (BM), specific focus on behaviour and maximising self-regulatory capacity/skills (BS), promote adjuvant activities (A), general aspects of the interaction focusing on the delivery of the intervention (RD), general aspects of the interaction focusing on information gathering (RI), general aspects of the interaction focusing on general communication (RC).

[b]Lettered coding added here to aid identification in *Table 1*.

Table 3 Intervention fidelity scores for each process, with breakdown by trainer and by coder

	IF1	IF2	IF3	IF4	IF5	IF6	IF7	IF8	IF9	IF10	IF11	*Mean (SD)*
Mean score (SD)	**3.7 (0.8)**	**3.1 (1.0)**	**2.2 (0.9)**	**3.3 (0.7)**	**2.6 (0.8)**	**3.3 (0.6)**	**2.4 (0.7)**	**2.6 (1.0)**	**1.5 (1.1)**	**1.8 (1.0)**	**1.2 (1.0)**	*2.5 (0.8)*
HT1 mean (SD)	4.0 (0.7)	3.8 (0.6)	2.6 (0.6)	3.6 (0.5)	2.7 (0.6)	3.5 (0.6)	2.5 (0.6)	3.1 (0.6)	1.8 (1.1)	2.2 (1.4)	1.6 (1.1)	*2.9 (0.8)*
HT2 mean (SD)	3.8 (0.8)	2.7 (1.0)	1.9 (0.7)	2.8 (0.7)	2.6 (0.8)	3.1 (0.6)	2.2 (0.9)	1.9 (1.2)	0.8 (0.8)	1.4 (0.8)	1.0 (0.9)	*2.2 (0.9)*
HT3 mean (SD)	3.4 (0.9)	2.8 (0.9)	2.0 (1.0)	3.4 (0.7)	2.6 (1.0)	3.1 (0.5)	2.4 (0.8)	2.6 (0.9)	1.7 (1.1)	1.7 (0.5)	1.0 (1.0)	*2.4 (0.8)*
Coder 1 mean (SD)	3.8 (0.6)	3.2 (1.1)	2.3 (0.9)	3.2 (0.8)	2.7 (0.8)	3.0 (0.5)	2.3 (0.8)	2.7 (1.0)	2.0 (1.0)	1.9 (1.0)	1.3 (0.9)	*2.6 (0.7)*
Coder 2 mean (SD)	4.3 (0.8)	2.9 (0.7)	2.0 (0.7)	3.9 (0.5)	2.9 (0.7)	3.6 (0.7)	2.7 (0.4)	2.6 (1.0)	1.1 (1.0)	1.6 (1.1)	1.0 (1.0)	*2.6 (1.1)*
Coder 3 mean (SD)	3.2 (0.8)	3.1 (0.9)	2.1 (0.8)	3.1 (0.6)	2.3 (0.7)	3.5 (0.4)	2.3 (0.8)	2.4 (1.0)	1.1 (1.0)	1.8 (1.2)	1.3 (0.9)	*2.4 (0.8)*

Notes: IF1: Active participant involvement; IF2: Motivation-building (smoking); IF3: Motivation-building (physical activity); IF4: Set goals (smoking); IF5: Set goals (physical activity); IF6: Review/ problem-solving (smoking); IF7: Review/ problem-solving (physical activity); IF8: Integration of concepts; IF9: Reinforce health-identity shifts; IF10: Manage social influences (smoking); IF11: Manage social influences (PA).

HT1: scored on 11 participants (33 sessions); HT2: scored on 8 participants (24 sessions); HT3: scored on 11 participants (33 sessions).

Coder 1: Scored 17 participants (51 sessions); Coder 2: Scored 7 participants (21 sessions); Coder 2 scored 11 participants (33 sessions). NB Some participants scored by more than one coder.

Figure 1 The Dreyfus model of skill acquisition

Competence level	Scoring	Examples
Incompetent	0	Absence of feature and /or highly inappropriate performance
Novice	1	Minimal use of feature and /or inappropriate performance
Advanced beginner	2	Evidence of competence, but numerous problems
Competent	3	Competent, but some problems or inconsistencies
Proficient	4	Good features, but minor problems or inconsistencies
Expert	5	Very good features, minimal problems or inconsistencies
	6	Excellent performance

Figure 2 Overall fidelity scores by item
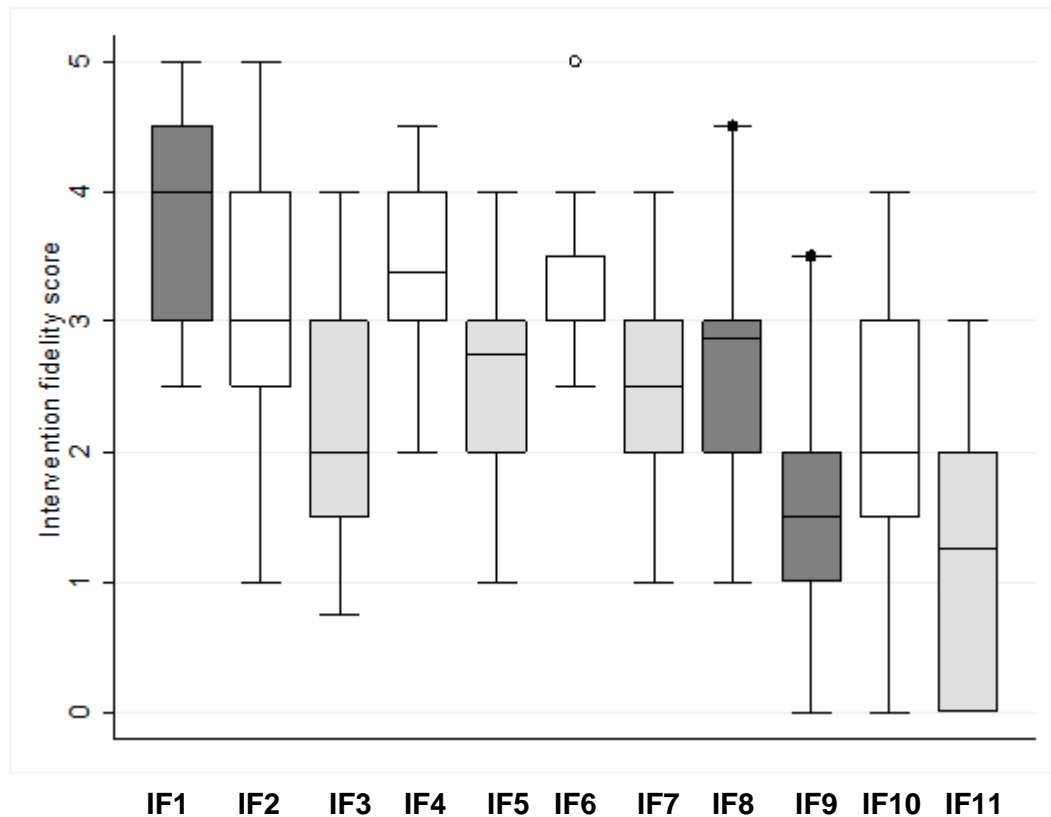
KEY
Dark grey = General
Light grey = PA
White = Smoking

Notes: IF1: Active participant involvement; IF2: Motivation-building (smoking); IF3: Motivation-building (physical activity); IF4: Set goals (smoking); IF5: Set goals (physical activity); IF6: Review/ problem-solving (smoking); IF7: Review/ problem-solving (physical activity); IF8: Integration of concepts; IF9: Reinforce health-identity shifts; IF10: Manage social influences (smoking); IF11: Manage social influences (physical activity).