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ARTICLE

Using the behaviour change wheel approach to optimize self-sampling packs for sexually transmitted infection and blood borne viruses

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Abstract

Purpose: This paper describes the process of optimizing a widely offered intervention—self-sampling packs for sexually transmitted infections (STIs) and blood borne viruses (BBVs). We drew upon the behaviour change wheel (BCW) approach, incorporating the theoretical domains framework (TDF) and the behaviour change technique taxonomy (BCTTv1) to systematically specify potential intervention components that may optimize the packs.

Methods: A BCW analysis built upon prior thematic analyses of qualitative data collected through focus groups and interviews with members of the public and people recruited from sexual health clinics in Glasgow and London ($n = 56$). Salient barriers and facilitators to specific sequential behavioural domains associated with the wider behavioural system of pack use were subjected to further analyses, coding them in relation to the TDF, the BCW's intervention functions, and finally specifying potential optimisation using behaviour change techniques (BCTs).

Results: Our TDF analysis suggested that across the overall behavioural system of pack use, the most important theoretical domains were 'beliefs about consequences' and 'memory, attention and decision-making'. BCW analysis on the overall pack suggested useful intervention functions

should focus on 'environmental restructuring', 'persuasion', 'enablement', 'education' and 'modelling'. Specific ways of optimizing the intervention were also described in relation to potentially useful BCTs.

Conclusions: Through a detailed behavioural analysis and the TDF and wider BCW approach built on earlier qualitative work, we provide a systematic approach to optimizing an existing intervention. The approach enabled the specification of highly specific, evidence-based, and theoretically informed recommendations for intervention optimization.

KEYWORDS

behaviour change taxonomy, behaviour change wheel, blood borne viruses, intervention optimisation, methodology, self-sampling, sexual health, sexually transmitted infections, theoretical domains framework

INTRODUCTION

Within this paper, we show how, within the context of a large multi-site trial, we sought to systematically optimize an existing widely offered public health intervention (self-sampling packs for sexually transmitted infections (STIs)). Building on our previous qualitative analyses (Flowers et al., 2020), here, we report on our use of the behaviour change wheel approach (BCW; Michie, van Stralen, & West, 2011) to systematically optimize self-sampling packs.

Globally, over one million STIs are acquired each day (World Health Organisation, 2021). In England, more than 460,000 new STI diagnoses were made in 2019, the highest number for a decade (Ratna et al., 2021). It is not possible to calculate the proportion of STI testing in the United Kingdom (UK) that is carried out using self-sampling postal kits as access and provision are variable between UK nations. However, in England, all Local Authorities offer some access to this service with 21% and 40% of all chlamydia tests in 15 to 24 years olds done through Internet self-sampling in 2019 and 2020, respectively. Rates of HIV in England have declined over the last 15 years from a peak of over 7000 in 2015 to 1990 in 2020. Forty-six per cent of all HIV tests in England in 2020 were conducted through Internet-based services (Martin et al., 2021). The proportion of tests for hepatitis B and C virus that are done through self-sampling in the United Kingdom is not reported. Whilst negative results from self-sampling are often sent by text directly to the patient by the laboratory provider, health care professionals within sexual health services contact patients with reactive results to arrange suitable follow-up including treatment and confirmatory testing if required.

The background to self-sampling packs

Across the United Kingdom, home-based self-sampling packs for STIs and blood borne viruses (BBVs) are widely offered (e.g., Barnard et al., 2018; Ogale et al., 2019). Typically, a person requests a pack online, has it delivered to their home address, takes their samples (urine, genital swab and finger prick blood sample) at home, repackages up the kit and posts it back to the laboratory for testing. Results are provided by SMS (text message), telephone or email by the sexual health clinic.

The provision of self-sampling packs chimes with wider cultural changes clustering around the home delivery of a range of commodities, including diverse health technologies (e.g., COVID-19

self-sampling packs, bowl screening packs or home-based genetic self-sampling kits). In the light of recent changes to the ways people live and work wrought by COVID-19, it is likely that more and more health care will be delivered remotely. In the UK context, the widespread provision of self-sampling for STIs and BBVs, sometimes to replace face-to-face options, has taken place at a time of austerity for many public services including sexual health. In some UK countries, it has also occurred at a time when the commissioning of sexual health services has been de-coupled from the National Health Service and repositioned within the remit of local authorities. In this paper, as part of a much larger sequential programme of work, we provide an example of how we used the BCW approach to optimize self-sampling packs for STIs to improve their use, enable their wider reach and increase sample return rate.

As an already widely available and widely used intervention, the problems with existing packs only prevent *some* people from using them effectively. In this way, their problematic aspects affect some people more than others. We know that pack users tend to be women, of white ethnicity and live in less deprived areas (Banerjee et al., 2018; Bracebridge et al., 2012; Manavi & Hodson, 2017). It is also likely that the pack in its current form may be amplifying long-standing inequalities, leading to the social stratification of sexual health screening and contributing to ongoing sexual health inequalities (e.g., Wayal et al., 2017). Our earlier analysis suggested that those who are likely to struggle to use the pack are more likely to be people who have vulnerabilities such as low literacy, low health literacy or low digital literacy (Middleton et al., 2021). Choices for sexual health care for these people may be reduced to only bricks and mortar clinics—and they may not be able to access them either given the social patterning of geographical and resource-related barriers for example. In this way, existing problems with the pack can negate the pack's role in reducing STI transmission because people cease engaging in sexual health self-care altogether, or drive them to attempt to use bricks and mortar sexual health services. Finally, because of challenges with attaining appointments, people can be delayed, or prevented, from accessing timely treatment and wider care altogether.

Our previous exploratory qualitative insights (Flowers et al., 2020) highlighted a range of problems with the existing self-sampling pack. Through thematic analyses with diverse members of the public and those attending sexual health services, we showed that the use of the pack overall was sometimes experienced as overwhelming, that pack-level instructions were challenging to many, and that the poor overall pack-usability was likely to reduce pack use. Our earlier analysis also provided a clear and user-led sense of direction for considering ways of optimizing existing packs. However, these suggestions were not systematic and did not capitalize on the prior expertise and learning embodied within health psychological, or broader interdisciplinary, behaviour change theory. Nor did they connect to systematic approaches to consider ways of specifying intervention content to optimize the intervention. The BCW offers just such a systematic approach drawing on previous work. When the BCW is combined with the theoretical domains framework (TDF; Atkins et al., 2017), it offers a means to systematically borrow and build upon decades of previous research. These meta-frameworks offer a particularly useful touchstone for studies which draw on qualitative research alone because they draw upon far wider theoretical generalisability than can be gleaned from small samples alone. As such, within this paper, we focus on reporting how we systematically used these tools to develop highly specific ways of optimizing self-sampling packs. Furthermore, we draw upon the behaviour change technique taxonomy (BCTTv1; Michie et al., 2013) for similar reasons. The BCTTv1 provides a common language to specify intervention content in terms of the indivisible techniques that can be harnessed to change behaviour; in this case, the correct and prompt use of the sampling pack, once ordered and received, and its prompt return by post.

Research questions

1. How can the barriers and facilitators to STI and BBV self-sampling pack use *be theorized* using the TDF?
2. What potentially useful *intervention functions* and potentially useful *behaviour change techniques* can be specified and operationalized using the BCW to optimize self-sampling packs for STI and BBV testing?

METHODS

Participants

Details of the participants that generated the initial data can be found elsewhere (Flowers et al., 2020). Briefly, eleven focus groups and seven interviews with young heterosexual individuals and men who have sex with men (MSM) were conducted in Glasgow and London in 2016 and 2017. In total, 56 participants took part in the study, of whom 25 were women and 31 were men. All were cisgender. Most participants were of a 'white British' or 'other white' ethnic group (n = 40, 71%) with others reporting themselves as Black African, Indian Pakistani and of mixed ethnicity, and were educated to University level (n = 39). Over half of the sample were heterosexual (n = 40), with the remaining participants self-identifying as MSM, gay or bisexual (n = 14). Around one third (n = 20, 36%) were recruited from sexual health services and had recently had a STI; the others were sampled from the wider community. One quarter of this wider community sample (n = 9, 25%) had previously had an STI.

Original data collection

The primary data were collected within focus groups and interviews using a topic guide and examples of a self-sampling pack (see Figure 1 below). As this study formed part of a programme of research into accelerated partner therapy (APT), the process of identifying, testing and treating sex partners of people with STIs (www.lustrum.org.uk), the pack also contained antibiotics. The topic guide was used to steer discussion across the full range of issues detailed. Where possible within the focus groups, discussion between participants was encouraged rather than between facilitators and participants. The pack used to assist with data collection contained self-sampling kits for genital swabbing, urine collection and taking finger prick blood samples. The pack included a variety of information sheets giving instructions on how to use the kits, a return envelope and a series of labels to adhere to completed samples.

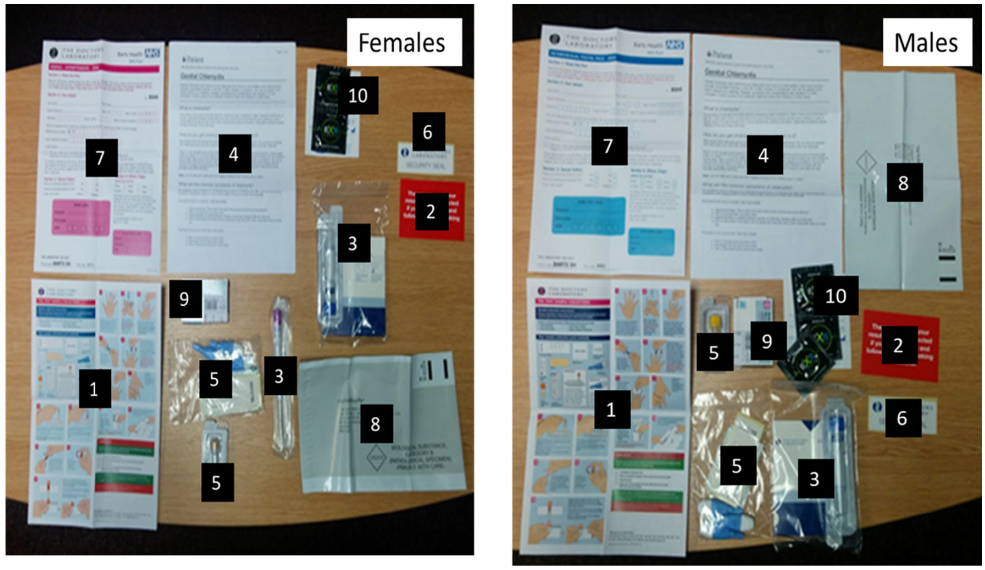

FIGURE 1 Images of the pack and its contents used within initial data collection

Data analysis

The original thematic analysis is reported elsewhere (see Flowers et al., 2020 for details).

In developing or optimizing behaviour change interventions, two key principles are important: the notion of parsimony and the idea of behavioural specificity. Parsimony is about offering the simplest and most elegant explanations of often complex phenomena. Behavioural specificity, on the other hand, highlights that the best insights into behavioural change occur when we can harmonize the highly specific nature of our understandings of antecedents to behaviours with an equally fine grained, highly specific, understanding of the behaviour that we seek to change (e.g., Presseau et al., 2019).

For us, as a pragmatic and applied interdisciplinary team, we sought to attain the best balance of both behavioural specificity and parsimony. Our inductive, participant-led thematic analysis (Flowers et al., 2020) detailed how our participants thought about the pack and what constituted pack use. From this work, we conceptualized self-sampling packs as a behavioural system structured by a series of interrelated and sequential behavioural domains. In turn, each behavioural domain was constituted from a series of smaller, highly related and interdependent-specific behaviours. Although we could have analysed each behavioural domain in even more specific behavioural terms, we felt it was very likely that the number of shared antecedents for these highly related specific behaviours would be high and that there could be a lot of effort for minimal reward. Equally, we could have tried to identify a single behaviour within the system—chosen because of its potential for wide ranging spillover effects. Again, because of the sequential nature of many of the behaviours and because the pack was already widely used, this did not seem to be the optimal approach.

Figure 2 illustrates how we conceptualized pack use; conceptualizing sequential elements as distinct behavioural domains within an overarching behavioural system. It is worth noting that effective pack use requires completion of all four behavioural domains within this behavioural system. However, the specificity of intervention optimization demands distinct behavioural analyses at the level of each domain. For the applied and pragmatic focus of the work reported here, and for the goals of this project, Figure 2 captures a *useful* degree of behavioural specificity to enable intervention optimisation.

In relation to finding a pragmatic, parsimonious approach to understanding the determinants of our behavioural domains we again deliberated on the level of detail the project required. On the one hand, the plethora of explanatory frameworks that theorize behaviour change within traditional health psychology models and theories are too fine-grained and suffer from considerable duplication of theoretical constructs. Yet, on the other hand, popular approaches such as the Capability, Opportunity and

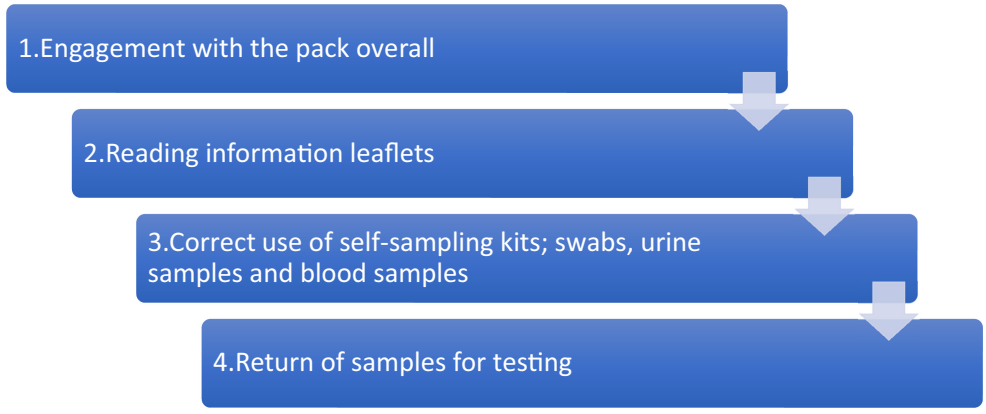

FIGURE 2 Balancing parsimony and behavioural specificity to illustrate the behavioural system of using self-sampling packs and associated behavioural domains

Motivation model of behaviour change (COM-B model; Michie, Atkins & West, 2011) categorize the antecedents of behaviour at too broad a level, only providing explanations of behaviour change within six very broad categories.

As such, for this project, hoping to make good use of health psychology expertise, we felt the TDF offered a suitable, mid-level, explanatory framework that enables a good level of specificity in relation to understanding the causal mechanisms underpinning behaviour change within the sequential behavioural domains that constitute the overall behavioural system of pack use. The TDF is a meta-theoretical framework that integrates 14 key theoretical domains known to be important in understanding behaviour change across a range of populations and settings and health arenas (Cane et al., 2012; Atkins et al., 2017). The TDF's domains provide a coherent and structured way of organizing explanations of why behaviours, such as those involved in the effective use of self- sampling packs, either *do,* or *do not* occur.

Figure 3 illustrates how the 14 domains of the TDF map and structure the causal mechanism shaping behaviour (the behaviour being changed is at the centre of the circle).

In relation to finding a pragmatic and parsimonious way of describing our optimized intervention content, we chose the BCW and the related BCTTv1 (Michie et al., 2013). These frameworks were both developed as a response to long-standing problems with the standardization of describing intervention content. The BCW, like the TDF, is an overarching meta-framework representing the synthesis of many other approaches to behaviour change. The BCW synthesizes 19 behaviour change frameworks all designed for the development and evaluation of behaviour change interventions (Michie et al., 2011). The BCW details nine intervention functions that represent broad categories by which interventions can change behaviour: 'Education'; 'Persuasion'; 'Incentivization'; 'Coercion'; 'Training'; 'Enablement'; 'Modelling'; 'Environmental Restructuring'; and 'Restrictions'. These intervention functions are useful in providing an overall sense of direction with suggested intervention content.

In contrast, the BCTTv1 is useful because of its particularly high level of specificity in describing behaviour change content. As part of the wider behaviour change wheel approach, Michie

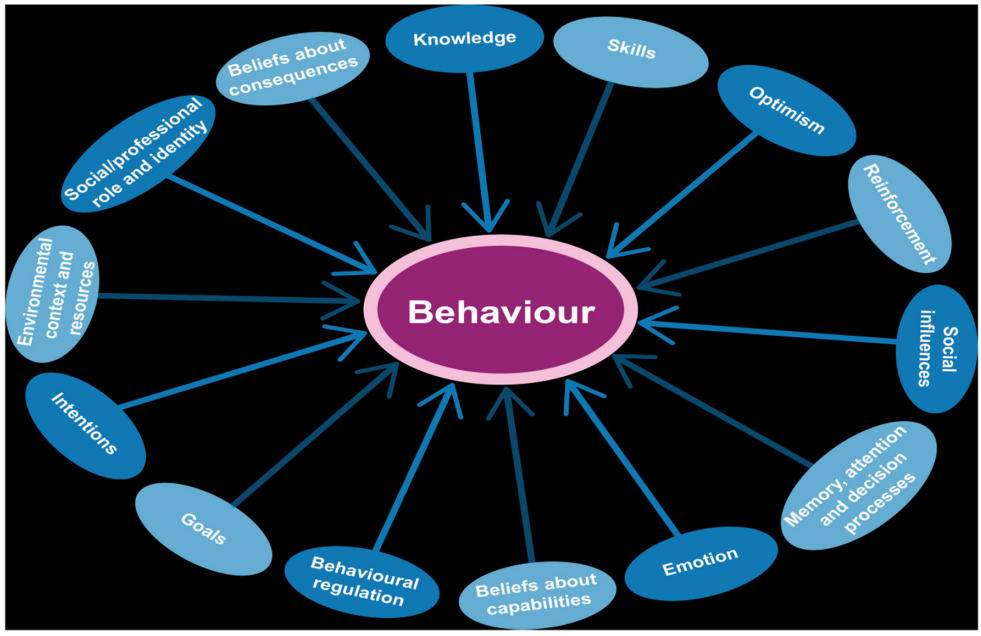

FIGURE 3 The theoretical domains framework mapping the causal mechanisms that can moderate any specific behaviour

et al. (2013) developed an extensive 93-item list of behavioural techniques, which was consensually agreed regarding impact and importance, and where every technique was clearly defined and exemplified.

In summary, we believe we have found a good balance of parsimony and specificity in relation to the process of behavioural diagnosis. This plays out at three levels: first, identifying the right *pitch* of our behavioural foci for intervention optimisation; second, in relation to theorizing the causal mechanisms that shape these behaviours at a useful level (i.e., the TDF rather than the COM-B) and third, it relates to the way we chose to describe our suggested intervention content (i.e., using the BCW and the BCTTv1).

How these tools were used within this paper

Our use of the behaviour change wheel approach to intervention optimisation centred on a three-step approach. These three steps were initially conducted by PF, an HCPC registered Health Psychologist and then audited by two other psychologists (GV, MP), all of whom are experts actively using the BCW approach, before discussing with the wider interdisciplinary team (medical clinicians, public health professionals, health service researchers and health economists). Throughout, we aimed to do justice to these conceptual tools by building on the wider team's synthesis of prior expertise and learning but also by drawing upon their subject-specific expertise, the context of the work and the data we had collected.

Step 1: For the current paper, our previous work identifying the barriers and facilitators to the range of behavioural foci within the overall system of using the self-sampling pack was further analysed, initially using the TDF (Cane et al., 2012). Each identified barrier or facilitator could be coded against multiple TDF domains. The relative frequency of particular TDF coding was assumed to be indicative of the relative importance of the causal mechanism it presents at the level of each behavioural domain but also in relation to considering the wider behavioural system. This measure of frequency, whilst pivotal in shaping the presentation and weighting of our findings, is more qualitative than quantitative, and did involve a degree of subjective interpretation on the part of the research team.

Step 2: The TDF domains were further analysed using the BCW approach (Michie et al., 2014). Here, TDF domains were matched prescriptively with appropriate intervention functions for each barrier and/or facilitator (see Appendix S1).

Step 3: The relevant intervention functions were further examined, and working iteratively with the previous qualitative analysis, BCTs were chosen and operationalized to this particular context, to specify useful optimized intervention content in reshaping optimal pack design.

RESULTS

Appendix S1 shows the results of the complete BCW analysis. It can be read both vertically and horizontally. Reading vertically from top to bottom illustrates the various sequential behavioural domains associated with the behavioural system of effective use of the pack (as shown in Figure 1). Reading horizontally, left to right, across the table, it is possible to see the target behaviour (pitched at the level of the behavioural domains) at the heart of the BCW analysis that is to be changed (left hand column). Second, we present the specific barriers and facilitators to changing that behaviour summarizing insights into our earlier qualitative work (Flowers et al., 2020). Third, we show how these barriers and facilitators (as causal influences on the enactment of each behavioural domain) were coded in relation to theoretical domains specified by the TDF. Fourth, we show how the TDF domains, when matched with the elements from the BCW, specify broad intervention functions that correspond to the underlying barrier or facilitator. Finally, at the far right, we show how these intervention functions can be expanded and detailed in relation to the specification of particular BCTs that should optimize the intervention.

The logic of the optimisation process is as follows: i) it is based on the evidence we collected through our earlier qualitative work; ii) it draws on decades of earlier theoretical work encompassed within the

TDF; iii) it uses the standardizing language of the intervention functions from the BCW approach and iv) it uses the specific and standardized language of the BCTTv1 and BCTs are tailored to the original context of study (e.g., the self-sampling pack). The interested reader should be able to gauge the logic of each row independently and see how we provide relatively granular solutions to the behaviour change problems identified by our participants within our previous qualitative work.

How can the barriers and facilitators to STI and BBV self-sampling pack use *be theorized* using the TDF?

In this section, the results of our TDF analysis are presented within a narrative format that should be read alongside Appendix S1. Table 1 shows the relative frequency of particular TDF domains for each of the four sequential behavioural steps. Each section is structured in a way that reflects the most frequent to the least frequent TDF domain.

Table 1 shows that for the broad behavioural domain of 1) '*Engagement with the pack overall',* the pack overall created a particular environmental stressor presenting significant anxiety and wider challenges to users' beliefs about their capabilities in using the pack. 'Environmental context and resource' was the most frequent TDF domain coded across both barriers and facilitators. Modifying

TABLE 1 Causal mechanisms relevant for each behavioural domain within pack use

TDF domain	Reported barrier	Reported facilitator
1. Engagement with the pack overall		
Environmental context and resources	xx	xxx
Memory, attention and decision processes	xx	x
Beliefs about capabilities	xx	x
Beliefs about consequences		xxx
Emotion	xx	
Knowledge		x
Skills		x
2. Reading the information leaflets		
Memory, attention and decision processes	xxxx	xxx
Beliefs about consequences		xx
3.Correct use of self-sampling kits; swabs, urine and blood samples		
Beliefs about consequences	xx	
Knowledge	xx	
Social influence	x	
Skills	x	
Beliefs about capabilities	x	
Emotion	x	
4. Return of samples for testing		
Beliefs about Consequences	xxxx	
Social Influences	xx	
Knowledge	xx	
Emotion	xx	
Behavioural regulation		x
Memory, attention and decision processes		x

x = Indicative of the frequency of particular TDF occurring in relation to the inductively derived barriers and facilitators.

the environment was seen as providing a potential solution to these barriers. This could include changing the pack itself or providing links to virtual sites that could support overall pack use. 'Memory, attention and decision-processes' was also frequently coded reflecting challenges to users' attention and the potential of cognitive overload. Similarly, 'beliefs about capability' were coded to barriers associated with perceptions of self-efficacy and/or personal life circumstances. It was felt that these could reduce overall pack use but that the inclusion of pack-level instructions could boost perceptions of self-efficacy. Overall, pack use was understood to be facilitated by the user's 'beliefs about the consequences' (i.e., relative ease) of using the pack (despite its complications) when compared to visiting a clinic and the negative sequelae of doing so (STI-related social stigma). 'Emotion' represented barriers to using the overall pack (stress relating to being concerned about a diagnosis) and as a result being able to maintain focus on using the pack. Enhancing procedural knowledge and skill acquisition concerning *how* to use the overall pack were suggested as simple facilitators to overall pack use.

For the behavioural domain of 2) '*Reading the information leaflets'*, the most frequently coded TDF domain was 'memory, attention and decision processes'. Here, barriers related to users' attention and ability to follow the specific instructions. These related to the formatting of leaflets and included too much text, an overload of information, in addition to particular attentional challenges associated with literacy, first language and issues of dyslexia or learning difficulties. The other important TDF domain that was identified was 'beliefs about consequences'. Our participants suggested the inclusion of information about the consequences of untreated infections at the start of the leaflets might increase attention whilst reading the leaflets. In turn, this might enable the user to continue reading the somewhat challenging level of information contained within the leaflets. Moreover, the inclusion of information about how long it might take to complete the task was also suggested as a means to enhancing reading the full leaflets through moderating 'beliefs about consequences'.

In relation to important causal mechanisms implicated in 3) '*Correct use of self-sampling kits; swabs, urine and blood samples'*, our coding highlighted the particular relative importance of 'beliefs about consequences' and 'knowledge'. These related primarily to erroneous beliefs about the potential for samples to degrade in the post minimizing the perceived positive consequences of collecting the samples; and an outdated and spurious understanding of HIV and the implications of a positive diagnosis (e.g., 'social influence'). Participants also highlighted poor procedural 'knowledge' and 'skills' deficits, and low perceived ability to use the kits properly themselves. 'Beliefs about capabilities' related to poor perceived self-efficacy in relation to collecting samples. No corresponding facilitators were recorded for this behavioural domain.

In relation to the behavioural domain 4) '*return of samples for testing'*, Table 1 shows an overview of the key causal domains that are important in explaining this behaviour. We coded 'beliefs about consequences' most often. These beliefs related to key concerns about the safety and efficacy of the postal system, potential damage to the return samples and the imagined social consequences of being seen to post a recognizable sample back. Herein, 'knowledge' of what the return envelope signified was important. This 'knowledge' and these social consequences were negative and related to issues of stigma (i.e., 'social influence') and ideas of shame (i.e., 'emotion'). Important facilitators were providing a range of alternative ways to return the pack ('memory, attention and decision-making' processes) and introducing a monitoring and feedback mechanism through which the pack user could receive a receipt notification (i.e., 'behavioural regulation').

What potentially useful intervention functions and potentially useful behaviour change techniques can be specified using the behaviour change wheel (BCW) to optimize self-sampling packs for STIs and BBVs?

Again, we draw the reader's attention to Appendix S1 within the supplementary file which shows the full matrix of our initial findings concerning the barriers and facilitators to completing each behavioural domain

within the overall behavioural system of pack use, the relevant TDF domains identified in the step above, and the corresponding intervention functions in addition to examples of how they could be operationalized as individual BCTs. That is, each row within Table A provides an auditable account of our use of these tools for the whole process of intervention optimisation. Within each row, there is a sense of how we have 'reverse engineered' potential intervention content in ways that are precisely tailored to the findings from our earlier qualitative work and the causal mechanisms identified through the use of the TDF. In this way, the suggested intervention content is both evidence-based and theoretically informed. Within this section, however, to address the research questions directly, we present a narrative account of our findings concerning intervention functions and then tabularize our suggestions for potentially useful BCTs.

Intervention functions

Overall, across the whole behavioural system, our analysis of potentially useful intervention functions shows that environmental restructuring (n = 16), persuasion (n = 14), enablement (n = 14), modelling (n = 9), education (n = 9) and training (n = 1) could all be important in optimizing the pack. In relation to considering optimization at the level of each of the four behavioural domains, a range of intervention functions were specified. As mentioned, intervention functions provide a clear sense of direction for future optimization but do not provide granular detail.

To address the behavioural domain of 1) '*engagement with the pack overall*', our analysis suggested intervention functions should focus on environmental restructuring by modifying the pack and providing online materials to enable pack use. Online materials should also model ideal pack use (for example, depicting pack use in a quiet location and how to organize and prepare pack content) and persuade the potential user that using the pack is a better way of testing than trying to get an appointment within a clinic, and that they can overcome perceived barriers to pack use.

For the behavioural domain of 2) '*reading information leaflets*', our analysis suggested that useful intervention functions should focus on environmental restructuring through changing the leaflets to improve accessibility and making sure the user is reading the leaflets within a quiet place. The leaflets should also be modified to persuade and educate the reader on the importance of reading the leaflet and following its instructions.

For the behavioural domain of 3) '*correct use of self-sampling kits; swabs, urine and blood samples*', intervention functions should focus on environmental restructuring and provide additional online support that educates, models, trains and persuades the viewer to use the sampling kits correctly. Barriers to kit use can be overcome through persuasion concerning the consequences of kit use and benchmarking normative behaviour around kit use.

Finally, for the behavioural domain of the user, 4) '*return of samples for testing*', useful intervention functions could use environmental restructuring through modifying the pack and specifically the return envelope. This is to ensure the envelope is not recognizable as an STI self-sampling pack from a distance, which was one of the key concerns among pack users. Furthermore, users can be educated and persuaded about the efficacy of the postal system and the laboratories in processing accurate results from samples through the modification of pack-level content, for example clearly detailing the safety and success of postal samples. Finally, intervention functions that *educate* and *enable* those returning samples about the receipt and results of their sampling may be useful modifications.

Behaviour change techniques

Table 2 illustrates the end product of our analyses and details the way BCTs could be operationalized to reflect intervention functions and specify evidence-based and theoretically informed ways of optimizing the intervention. We would recommend all the suggested changes to optimize the self-sampling packs.

TABLE 2 Suggested intervention functions and behaviour change techniques to optimizing behaviour change in relation to each behavioural domain within pack use

Behaviour change technique (numbers refer to the BCT numbers detail within the BCT taxonomy v1)	Operationalization
Using the overall pack	
12.5 Adding objects to the environment	The pack design must facilitate pack use rather than reduce it—it should include the compartmentalisation of pack components into bespoke packaging (individual tests or kits packaged and labelled), pack-level instructions as well as component level (i.e., kit-level) instructions.
15.4 Self-talk	Pack-level instructions or online support can prompt the user to articulate their prior successful experiences with using self-managed packs (e.g., Have you ever built Ikea ™ furniture?—Just keep telling yourself that).
12.1 Restructuring the physical environment	Online pack access or pack-level instructions should recommend the choice of a location in which to use the pack contents (e.g., in a quiet space at home).
9.2 Pros and Cons	Online pack access or pack-level instructions can encourage the user to identify and compare the pros and cons of using the pack vs visiting the clinic (e.g., waiting times and felt stigma).
5.3 Information about social and environmental consequences	Online pack access or pack-level instructions can stress the positive benefits of using the pack as opposed to visiting the clinic (e.g., time, resource, queues and potential feelings of exposure in the waiting room).
4.1 Instructions on how to perform a behaviour	Online support and links within the pack-level instructions should enable the user to access detailed real-time online support.
User reading the information leaflets	
12.1 Restructuring the physical environment	The leaflet, inserted within the pack, must be designed to be simple and engaging; it should include some visuals and have no large blocks of text.
11.3 Conserving mental resources	The leaflet can suggest that the user ensures a quiet environment to facilitate reading the leaflet (e.g., choose a time when you can focus on taking the samples undisturbed).
12.1 Restructuring the physical environment	The leaflet should be translated into a number of other languages.
5.1 Information about health consequences	The leaflet should provide information very early within its content that highlights the health consequences of testing for and effectively treating or not treating chlamydia.
5.2 Salience of consequences	Early on within the leaflet, the information about the consequences of untreated infection should be designed in such a way as to ensure that it is particularly memorable.
5.3 Information about social and environmental consequences	Provide information within the leaflet about the time needed for completion of the task.
Correct use of self-sampling kits; swabs, urine and blood samples	
5.3 Information about social and environmental consequences	Online pack access or pack-level instructions must explain the efficacy of the samples for diagnosis when they are distributed through the post.
15.1 Verbal persuasion about capability	Online pack access and pack-level instructions can boost user self-efficacy by telling users they can do the self-sampling tests; stating that they *will* succeed.

(Continues)

TABLE 2 (Continued)

Behaviour change technique (numbers refer to the BCT numbers detail within the BCT taxonomy v1)	Operationalization
6.1 Demonstration of the behaviour	Within the online materials, there should be a clear observable example of how to perform the self-samples, including the blood samples.
6.2 Social Comparison	Online pack access or pack-level instructions should draw attention to other user use of the entire pack (e.g., around 90% of users successfully return all the self-samples).
5.1 Information about health consequences	Online materials or pack-level instructions must explain the rationale for the HIV self-sampling kits and provide a clear articulation of the health consequences of not using it.
5.3 Information about social and environmental consequences	Online materials or pack-level instructions must explain the rationale for all the HIV self-sampling kits and a clear articulation of the wider consequences of not using it (e.g., the impact of undiagnosed HIV on others). Online materials or pack-level instructions should provide a sense of choice and partial uptake of the self-samples (HIV or Chlamydia).
Returning the sample	
12.5 Adding objects to the environment	The return envelope should look bland and not distinctive and the laboratory address should be easy to cover with one's hand.
12.5 Adding objects to the environment	Make sure there is a larger envelope available to mask the return envelope with the laboratory address.
5.1 Information about health consequences	Pack-level instructions and the site where packs can be accessed online should provide clear information concerning the viability of samples which are self-collected, and the viability of samples delivered to laboratories through the postal system.
6.2 Social Comparison	Pack-level instructions and the site where packs can be accessed online should draw the user's attention to the fact that other people return the samples and get accurate results all the time (e.g., 'this is routine care within London clinics').
12.5 Adding objects to the environment	Pack-level instructions and the site where packs can be accessed online should ensure that the user knows that there are safe and secure drop off boxes within sexual health clinics or pharmacies that represent alternatives to postal delivery.
2.2 Feedback on behaviour	Systems should be in place that acknowledge receipt of the pack to the user.
2.7 Feedback on outcomes of behaviour	Systems should be in place that provide feedback on the outcomes of the use of the self-sampling kits by giving results quickly and efficiently—including negative results.

Our analysis shows that different sequential behavioural domains that make up the overall behavioural system of pack use warrant distinct BCTs. However, in relation to describing the overall frequencies of recommended BCTs across the whole behavioural system, these related to the hierarchical clusters of BCT categories 'natural consequences' (n = 10), 'antecedents' (n = 9), 'comparison of behaviour' (n = 4), 'feedback and monitoring' (n = 2), 'comparison of outcomes' (n = 2), 'self-belief' (n = 2), 'shaping knowledge' (n = 1), and 'regulation' (n = 1).

DISCUSSION

To our knowledge, this paper is the first internationally to focus on the optimisation of self-sampling packs for infectious disease using tools from health psychology and the wider behavioural sciences. It presents the results of a BCW analysis of prior thematic analyses of qualitative data collected through focus groups and interviews (Flowers et al., 2020). It presents the step by step and eventual granular specification for changes that should optimize an existing intervention. Throughout, it uses common concepts and language connecting it to the wider behaviour change literature and decades of health psychology research; theoretical domains specified by the TDF, intervention functions from the BCW, and BCTs as listed within the BCTTv1. Uniquely, our analysis focussed upon ways to systematically optimize an existing intervention (a self-managed pack that contained several self-sampling kits, instructions and materials to enable the return of samples to lead to diagnosis). This existing intervention arose through necessity rather than through systematic behavioural science conducted in advance of intervention implementation. Across their careers, many health psychologists will find they are conducting similar work; bringing their skills and analytic acumen to well established, or considerably well-developed, interventions.

Our use of the behaviour change wheel may be interesting to other health psychologists in the way we sought to balance behavioural specificity with parsimony. The effectiveness of the BCW approach relies on rigorous examination and selection of the appropriate and typically specific behaviour(s). In our experience, this first step in the process of a 'behavioural diagnosis' is far more complex than published guidance and papers would suggest. Yet, it is central and indeed fundamental to the usefulness of the whole BCW approach. Michie et al. (2014), for example, highlight likely impact and spillover as well as ease of implementation and measurement as being central features of working out where in a complex behavioural system it makes most sense to intervene. However, for an existing intervention known to be less than optimal, the approach of searching for a single behavioural focus was deemed insufficient to enable the overall optimization that would lead to wider population reach and effective use. As such, we cast our behavioural lens across the whole behavioural system of pack use seeking to find a pragmatic level of behavioural detail to focus on. We spent a great deal of time considering how to conceptualize the diverse behaviours involved within effective pack use. We believe it is important to stress our belief in the centrality of this step in relation to using tools such as the BCW approach effectively. Within this study, we sought to conceptualize the overall use of the pack as a behavioural system. For us, a behavioural system is a series of interdependent behavioural domains, each domain in turn is constituted from a number of discrete behaviours. We made the decision to pitch our analysis at the level of the behavioural domain and not the overall behavioural system or indeed at the level of highly specific behaviours. This particular idea of conceptualizing a behavioural target in a multi-levelled way chimes with ideas from intervention mapping (Eldredge et al., 2016) wherein a target behaviour can comprise preparatory or sub-behaviours which are referred to as performance objectives (Kok, Peters & Ruiter, 2017).

Our findings show that there are important differences in the causal mechanisms (i.e., TDF domains) associated with each of the different behavioural domains and this resulted in us specifying different optimal intervention content for each sequential step. We believe that there is a need for further conceptual and methodological work in this area as many papers using these tools fail to provide clarity about this essential first step in the behavioural diagnosis. It may be that further focussed qualitative work is required to understand how we can develop methods that grasp the right balance between parsimony and behavioural specificity. A range of qualitative approaches may be useful in this regard; particularly those which share a commitment to inductive epistemology are likely to be useful. Ethnographic and/or observational studies focussing on describing how people engage with a complex behavioural system may be important. Complementing these, participant-led approaches such as interpretative phenomenological analysis (i.e., how do participants make sense of a given behaviour; Smith, Flowers & Larkin, 2021), or inductive thematic analysis (e.g., what is a behavioural system and how is it made from behavioural domains and specific behaviours; Braun & Clarke, 2006) may also prove invaluable.

It is beyond the scope of the current paper to detail how we used the recommendations outlined here within the trial of APT. Briefly, however, the analyses were used to inform a series on online support

videos. The process evaluation of APT highlighted some support for the optimized self-sampling packs, although we experienced difficulties in those using the self-sampling packs actually receiving links to the online supporting videos (Flowers et al., 2021). For the interested reader, the final videos are available on youtube (LUSTRUM, 2018). Furthermore, to date, the analyses have also helped to shape the UK guidance for the use of self-sampling for STIs and BBVs (BASH, 2021).

Strengths and limitations

Limitations of the current study included the potential for recruitment bias. Although we recruited participants from both clinical and community settings in Scotland and England, the participants that agreed to take part were largely well educated, health literate, confident and/or comfortable enough to share their views and opinions on self-sampling packs for sexually transmitted infections. In this way, our insights into optimizing self-sampling packs are based on the perspectives of participants who may not represent the people for whom optimisation may well be most important. In light of this, we also conducted similar research among people with mild learning difficulties to try to provide insights into more diverse populations (Middleton et al., 2021). Overall, we found similar barriers and facilitators to those reported in Flowers et al. (2020). Other limitations include our focus on qualitative data and analysis alone. If funding had permitted, sequential mixed methods assessing the population-level importance of key barriers and facilitators across the behavioural system would have strengthened the study.

Strengths of the current study are that the optimizations are all based on empirical qualitative work and have benefited from the use of behaviour change theory. Other strengths have included the use of interdisciplinary perspectives to strike a balance between behavioural specificity and parsimony. We have presented a clear account and auditable summary of our decision-making and the interpretation of results (Appendix S1). An additional strength relates to our attempt to report and visualize the findings of a BCW study in a way that does not solely rely on the reader pouring through the matrices of the analysis itself (Appendix S1).

CONCLUSION

Using tools from behavioural science and health psychology, we have shown how it is possible to systematically optimize STI and BBV self-sampling packs with the intent of increasing their reach and effective use. Whilst our analysis here focussed upon optimizing self-sampling packs for use within a wider trial of a particular form of APT, we believe our analysis offers several transferable insights into self-sampling packs for STIs and BBVs more generally, and for self-sampling packs for other infectious diseases such as COVID-19 in particular. The use of self-sampling packs is likely to be of increasing importance as remote and self-managed care becomes more and more normative.

AUTHOR CONTRIBUTIONS

Paul Flowers: Conceptualization; formal analysis; funding acquisition; methodology; supervision; writing – original draft; writing – review and editing. **Gabriele Vojt:** Formal analysis; validation; writing – review and editing. **Maria Pothoulaki:** Formal analysis; validation; writing – review and editing. **Fiona Mapp:** Writing – review and editing. **Melvina Woode Owusu:** Writing – review and editing. **Jackie Cassell:** Conceptualization; funding acquisition; writing – review and editing. **Claudia Estcourt:** Conceptualization; funding acquisition; writing – review and editing. **John Saunders:** Conceptualization; funding acquisition; writing – review and editing.

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CONFLICT OF INTEREST

All authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Due to the qualitative nature of this research, supporting data such as full interviews with participants are not available to the public.

ETHICAL APPROVAL

Ethical approval from Glasgow Caledonian University Research Ethics Committee (HLS/PSWAHS/A15/256) and NHS Ethics Approval (16/NI/0211) were obtained.

DISCLAIMER

The views expressed are those of the author(s) and not necessarily those of the NHS, the NIHR or the Department of Health. The funders had no role in study design, collection, management, analysis and interpretation of data; writing of the report and the decision to submit the report for publication.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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