1
2
3 **The compendium of self-enactable techniques to change and self-manage motivation and**
4 **behaviour (v1.0)**
5
6
7
8 Keegan Knittle, Matti Heino, Marta M. Marques, Minna Stenius, Marguerite Beattie,
9 Franziska Ehbrecht, Martin S. Hagger, Wendy Hardeman, Nelli Hankonen
10
11
12
13
14
15
16
17
18

19   **ABSTRACT**
20   Behaviour change techniques describe the content of behaviour change interventions, but do not
21   adequately account for the actions that individuals must themselves undertake to successfully
22   change or self-manage motivation or behaviour. This compendium of 123 self-enactable techniques
23   fills this gap by combining behaviour- and motivation-regulation techniques across six existing
24   classifications of behaviour change techniques and three scoping reviews, converting each into a
25   self-enactable form with instructive examples to facilitate self-enactment. Qualitative feedback was
26   gathered from intervention developers and the general public to improve the utility, congruence,
27   and ease of self-enactability of technique definitions and instructive examples. This integrative index
28   of self-enactable techniques can help intervention developers and individuals select appropriate self-
29   directed techniques to self-manage motivation and behaviour. Future research with this
30   compendium will expand on the number of behaviours covered by the instructive examples and link
31   techniques with their potential impacts on theoretical determinants of behaviours.
32
33
34
35
36   **Supplementary Files** (available from https://osf.io/pqfjz/):

1	Simplified list version of the compendium (.pdf)
2	Instructions and glossary for the general public (.pdf)
3	Full tabular version of the compendium (.xlsx)
4	Work scoping review (.pdf)
5	Sport scoping review (.pdf)
6	Education scoping review (.pdf)
7	Preliminary compendium v0.3 – Tested in expert review (.xlsx)
8	Verbatim methods of expert review exercise (.pdf)
9	Full results of expert review (.xlsx)
10	Notes of discussion after expert review (.pdf)
11	Full methods and results of qualitative interviews (.pdf)

37

38   To be effective, many behaviour change interventions require that individuals take active
39 roles in changing their own behaviour, by adopting and using appropriate strategies and methods
40 (e.g., weighing pros and cons of changing, setting goals) to do so. This entails that individuals need to
41 be equipped with the necessary skills, abilities, tools and techniques to effectively change their own
42 behaviour, a process collectively referred to as self-management or self-regulation. While behaviour
43 change interventions undoubtedly take place within complex systems involving many parts, there is
44 evidence that individual-level interventions can change health-related (and other) behaviours[1] and
45 outcomes[2], and these interventions are increasingly being used to reduce costs in healthcare
46 systems across Western societies[3]. As such, the keys to improving health and well-being, as well as
47 other issues which arise from the behaviour of individuals[4], lie in the capabilities that individuals
48 have at their disposal to successfully self-manage their own motivation and behaviour.
49   Behaviour change interventions often draw from behavioural theories, and target changes in
50 important determinants of a behaviour to change the behaviour itself[5]. Historically, the descriptions
51 of such interventions have lacked specificity, as broad treatment labels such as "cognitive therapy"
52 or "lifestyle counselling" do not immediately reveal an intervention's component parts[6]. For
53 example, two interventions with the same overarching label might contain different techniques,
54 while, at the same time, two interventions with identical component techniques might receive
55 different overarching treatment labels. This lack of granularity in intervention descriptions has led to
56 a 'black box' problem in intervention research[7], and has limited the scientific understanding of which
57 'active ingredients' effectively change behaviour within interventions.
58   Behaviour change techniques are the active components of behaviour change
59 interventions[8], and have been enumerated in several recently-developed taxonomies of behaviour
60 change techniques. These include the 93-item behaviour change techniques taxonomy v1 (BCTTv1)[9];
61 the 99-item intervention mapping (IM) taxonomy[10], which arranges behaviour change techniques (or
62 'methods,' in IM terminology) by the theoretical determinants that each is presumed to target as a
63 precursor to behaviour change; and the 38-item motivational interviewing (MI) taxonomy[11], which
64 specifies the content-based and relational techniques present within MI counselling approaches[12].
65 Taken together, these taxonomies[9–11] offer researchers and practitioners an elaborated classification
66 of the many methods available to change behaviours and some common language with which they
67 can describe the content of behaviour change interventions. This has led to improved consistency in
68 the description of behaviour change interventions, allowing for greater replicability of interventions,
69 and offers those aiming to synthesize evidence across intervention studies means to adequately
70 compare and classify intervention content. Across taxonomies, however, several shortcomings
71 remain, including a lack of focus on individuals and technique enactment, limited scope, and
72 insufficient examples of use.
73
74 **Shortcomings of existing taxonomies**
75   The most important outstanding issue is what the recipients of behaviour change
76 interventions (i.e. individuals in the target population whose behaviour needs to change) can do *on*
77 *their own* to facilitate behavioural change and maintenance. While some existing taxonomies
78 indicate that techniques may be self-delivered[9], the definitions and examples they provide focus
79 largely on the actions that intervention providers (e.g., nurses, community workers, designers of
80 public health campaigns) would take when delivering a technique to individuals (e.g., *prompting*
81 behavioural goal setting, *demonstrating* the target behaviour, or *providing* information). This leaves
82 some doubt about whether individuals can "self-deploy"[13] techniques to change behaviour, and if so,

83   how that should occur[14]. For example, within the BCTTv1, technique 11.2 (reduce negative
84   emotions) states that intervention providers should "advise on ways of reducing negative emotions"
85   to facilitate behavioural performance, but does not elucidate the actions that recipients of that
86   technique would need to take in order to bring about change. In other words, how should an
87   individual go about reducing their own negative emotions? Furthermore, some techniques from
88   existing taxonomies do not lend themselves to self-enactment at all. This includes techniques from
89   the IM taxonomy[10] and TIPPME intervention typology[15], which apply only to actors at other
90   environmental levels (e.g., public policy or organizational change methods), and relational
91   techniques from MI[12], which are only applicable to those delivering MI in one-on-one practitioner-
92   client sessions. While one existing taxonomy (the Oxford Food and Activity Behaviours taxonomy –
93   OxFAB)[16] has focused on self-enacted behaviour change and self-management, its techniques were
94   drawn exclusively from weight management protocols, and have unknown applicability to other
95   behavioural domains. The present study aims to compile a new domain-general list of techniques
96   which focuses specifically on agentic and self-enactable behaviour change methods, which will offer
97   intervention developers and the general public a clearer overview of the available options and
98   specific actions which contribute to the successful self-management of behaviours related to health,
99   environmental protection, and other outcomes.
100   Furthermore, by focusing primarily on behaviour change techniques that are delivered
101   within interventions, existing taxonomies also do not specifically address the issue of technique
102   *enactment,* which is imperative when investigating the behaviour change of individuals within
103   complex systems[17,18]. For an intervention to have effects, providers must successfully deliver
104   techniques, individuals must successfully receive the techniques, and individuals must then also
105   successfully act on the techniques[19]. A growing body of evidence suggests that sustained behaviour
106   change following interventions depends on the extent to which individuals self-enact or utilise
107   behaviour change techniques themselves[20–22], but existing taxonomies do not indicate what
108   successful self-enactment should look like, or which techniques require enactment beyond delivery.
109   This may limit the extent to which intervention developers can take the individual perspective into
110   account when trying to optimize enactment. This work will therefore also promote intervention
111   designs which more coherently address enactment, and which bridge the gap between intervention
112   receipt and the adoption and maintenance of new behaviours.
113   Second, existing technique classifications do not capture all possible techniques that might
114   be used to change or regulate behaviour or behavioural determinants (e.g., motivation), so drawing
115   techniques from a wider range of behavioural domains could reveal additional techniques. For
116   example, within work and occupational psychology, the idea that individuals can themselves alter
117   working patterns to increase their own motivation ('job craft') has attracted much attention. The job
118   crafting research to date indicates that various positive outcomes follow when employees
119   themselves make changes to their work patterns and relationships[23]. Within sport psychology a
120   number of studies have linked cognitive self-management strategies, such as self-talk, imagery, and
121   attentional focus with positive outcomes[24,25]. Attentional focus is also prevalent as a self-
122   management technique within educational psychology. This work will therefore explore self-
123   management and behaviour change strategies in various applied domains, which could unearth new
124   techniques to supplement existing taxonomies and make them more complete.
125   Finally, while existing taxonomies offer some examples of how techniques might be applied
126   in practice, these are generally limited in scope and described using technical terminology. This
127   makes the meaning and operationalisation of individual techniques less accessible and

comprehensible to practitioners who may lack expertise in behavioural science. It also means that, while techniques from existing taxonomies might potentially be self-enactable, self-enactment would not likely occur successfully in practice. The current work aims to increase the likelihood of successful self-enactment, by writing self-enactable techniques in plain, accessible language and by including adequate instructions and examples to facilitate ease of use by the general public.

The Present Study

The present study aimed to develop an integrative compendium of self-enactable techniques to change or self-manage motivation and behaviour, with a focus on techniques which require conscious participation and initiation on the part of the individual. Specifically, this research will (a) identify, assess, and integrate techniques across existing taxonomies and other domains of psychological research (sport, education and work); (b) identify how individuals can take an active role in enacting the identified techniques to change or manage motivation and behaviour; and (c) compile a comprehensive list of self-enactable behaviour change techniques that intervention developers can adopt to incorporate into interventions aimed at changing motivation and behaviour. To achieve this, our group undertook an iterative development process that involved searching and content-analysing existing research on behaviour change interventions and extant taxonomies; discussions within the research team and an advisory group comprising behaviour change experts; feedback from experienced intervention developers; and qualitative interviews with members of the public. This process involved: identifying relevant techniques; outlining how the techniques could be self-enacted and developing appropriate definitions, descriptions, and self-enactable formats; producing instructive examples; and identifying information about dependencies between techniques. Table 1 outlines the steps taken during this research, and further details are available in the methods section.

<div align="center">

Results

</div>

Developing the compendium of self-enactable behaviour changes involved three distinct phases: Initial development work (Phase 1); external expert reviews (Phase 2); and the refinement of the compendium into its final form (Phase 3). The Methods section provides further detail on the processes undertaken during the three phases (and seven individual steps) shown in Table 1.

Phase 1: Initial development

In step one, the 230 techniques from the three primary source taxonomies[9–11] were consolidated in a spreadsheet, leading to a provisional listing (v0.1) containing 125 techniques. This provisional listing was then supplemented with the 13 additional techniques shown in Table 2, which were derived from three scoping reviews (in the areas of work, sport and education psychology (Step 2; Supplementary Files 4, 5 and 6), and three additional classifications of behaviour change techniques[16,26,27] (Step 3). Steps two and three resulted in an expanded provisional listing of 138 techniques (v0.2). Finally, in step four, the text of each technique in v0.2 was re-written into a self-enactable form and supplemented with a plain-language instructive example of how to self-enact it. This resulted in a first draft of the compendium (v0.3) which contained 123 techniques. Figure 1 shows the flow of techniques from original sources through to the final compendium, and specifies reasons for removal of techniques.
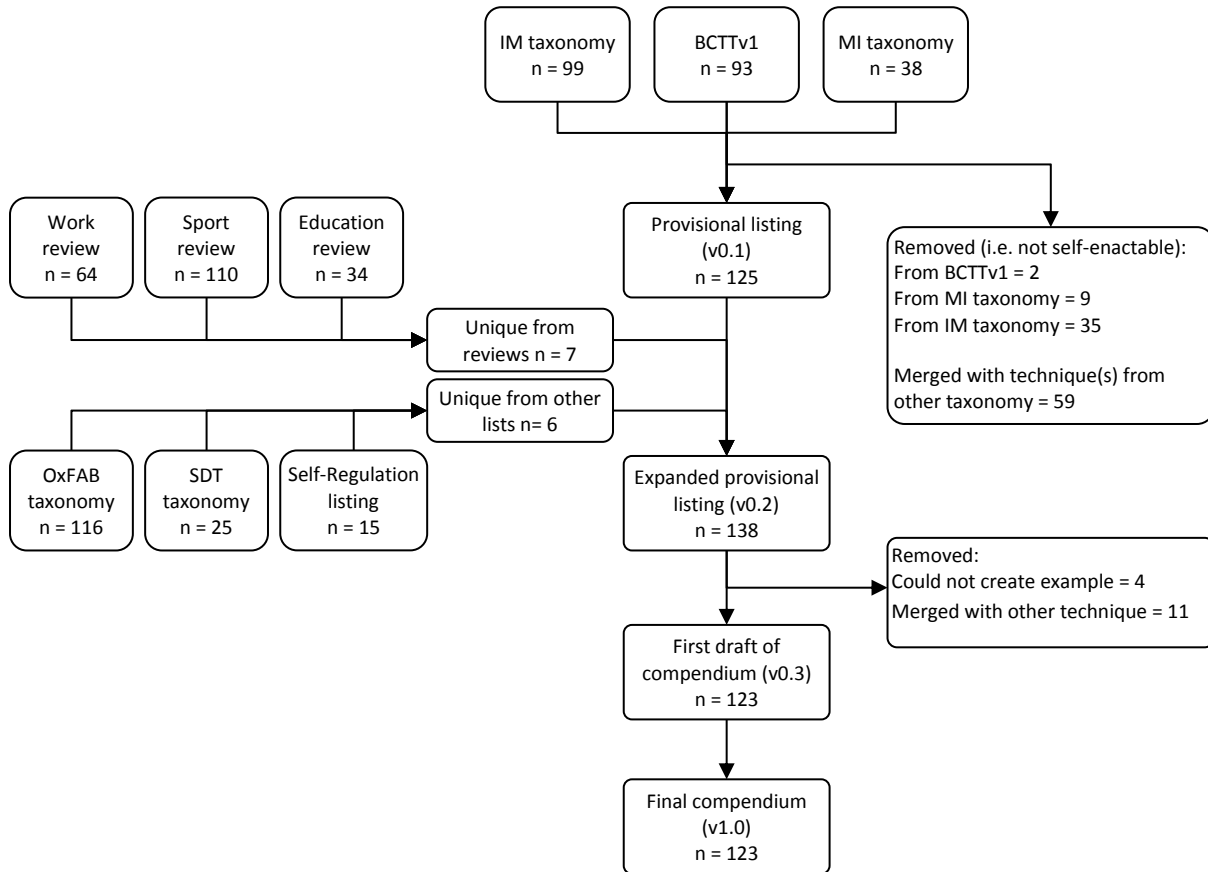
Phase 2: External reviews by end users and experts

In step five, we conducted qualitative interviews with members of the general public (i.e., one group of potential end users of the compendium) to examine the acceptability of a subset of the techniques from version 0.3. These interviews revealed several issues with the definitions and examples of some techniques, which limited their potential acceptability as part of self-enacted behaviour change interventions. The interviews identified the presence of technical language which interviewees had difficulty understanding. Some interviewees expressed doubts about the personal relevance of some techniques (e.g., "I could see how this might be good for *someone else,* but not me"). Some interviewees found it difficult to identify ways to implement the techniques beyond what was explicitly mentioned in the technique definitions or examples.

Table 1. Outline of the steps taken in developing the compendium of self-enactable techniques.

| Phase	Step	Methods	Outputs
1. Initial development	1. Integrating three existing global taxonomies of behaviour change techniques/methods	Group discussions within research team; consultations with authors of previous technique classifications	A provisional list of technique definitions (v0.1; n = 125)
	2. Identifying techniques from applied psychology literature	Three scoping reviews of self-management in the sport, education and work psychology domains	Additional self-enactable techniques for potential inclusion.
	3. Adding in content from scoping reviews and other previous (domain-specific) classifications of behaviour change techniques	Group discussions within research team; consultations with authors of previous technique classifications	An expanded provisional list of technique definitions (v0.2; n = 138)
	4. Creating instructive examples to improve ease of self-enactability	Group discussions within research team; consultations with authors of previous technique classifications and other behaviour change experts	A draft list of technique definitions and examples (v0.3; n = 123)
2. External reviews	5. Assessing acceptability of a subset of techniques	Qualitative interviews with members of the public (n = 20)	Possible improvements of the definitions and examples in v0.3
	6. Assessing utility, congruence and ease of self-enactability of technique definitions and examples	Online survey of external experts in intervention development (n = 17)	Possible improvements of the definitions and examples in v0.3
3.Refinement and finalising	7. Improving technique definitions, examples, and overall usability	Group discussions within research team to reach consensus on final wording of technique definitions and examples	The final compendium (v1.0; n = 123), which includes introductory text and a glossary

188 Figure 1. Sources of identified techniques and the flow of techniques into the final compendium.

| IM taxonomy n = 99 | BCTTv1 n = 93 | MI taxonomy n = 38 |

Work review n = 64 | Sport review n = 110 | Education review n = 34

Unique from reviews n = 7

Provisional listing (v0.1) n = 125

Removed (i.e. not self-enactable):
From BCTTv1 = 2
From MI taxonomy = 9
From IM taxonomy = 35

Merged with technique(s) from other taxonomy = 59

Unique from other lists n= 6

OxFAB taxonomy n = 116 | SDT taxonomy n = 25 | Self-Regulation listing n = 15

Expanded provisional listing (v0.2) n = 138

Removed:
Could not create example = 4
Merged with other technique = 11

First draft of compendium (v0.3) n = 123

Final compendium (v1.0) n = 123

189
190

191   In step six, external experts in intervention development (n = 20), another group of potential
192 end users of the compendium, used an online system to rate the labels, definitions, and examples of
193 included techniques on three dimensions: utility, congruence, and ease of self-enactability. Experts
194 also provided comments about how each technique, and the draft compendium as a whole, could be
195 improved. Rates of agreement across experts ranged from 70.5% for utility, to 64.9% for
196 congruence, to 53.7% for ease of self-enactability. We did not calculate Fleiss' kappa for multiple
197 raters, as the review exercise aimed to identify possible problems with the techniques as written and
198 did not aim to achieve a consensus or final agreed-on rating for each technique[28]. A breakdown of
199 quantitative responses from the review exercise is presented in Figure 2. In total, results of the
200 expert review indicated that the utility of 28 techniques, the congruence of 34 techniques, and the
201 ease of self-enactability of 62 techniques required improvements to the definitions and examples.
202 Fifty-five techniques did not require improvement in any of these three dimensions, 28 needed
203 improvement in one dimension, 24 needed improvement in two dimensions, and 16 needed
204 improvement in all three dimensions. The results of Phase 2 indicated several concrete ways to
205 improve the definitions and examples in Phase 3.
206
207
208
209
210
211

Figure 2. Percentages of expert responses (n = 492) to questions of utility, congruence and ease of self-enactability for the definitions and examples in the draft compendium (v0.3). Definitions and examples of problematic techniques were then revised, resulting in the final compendium (v1.0).
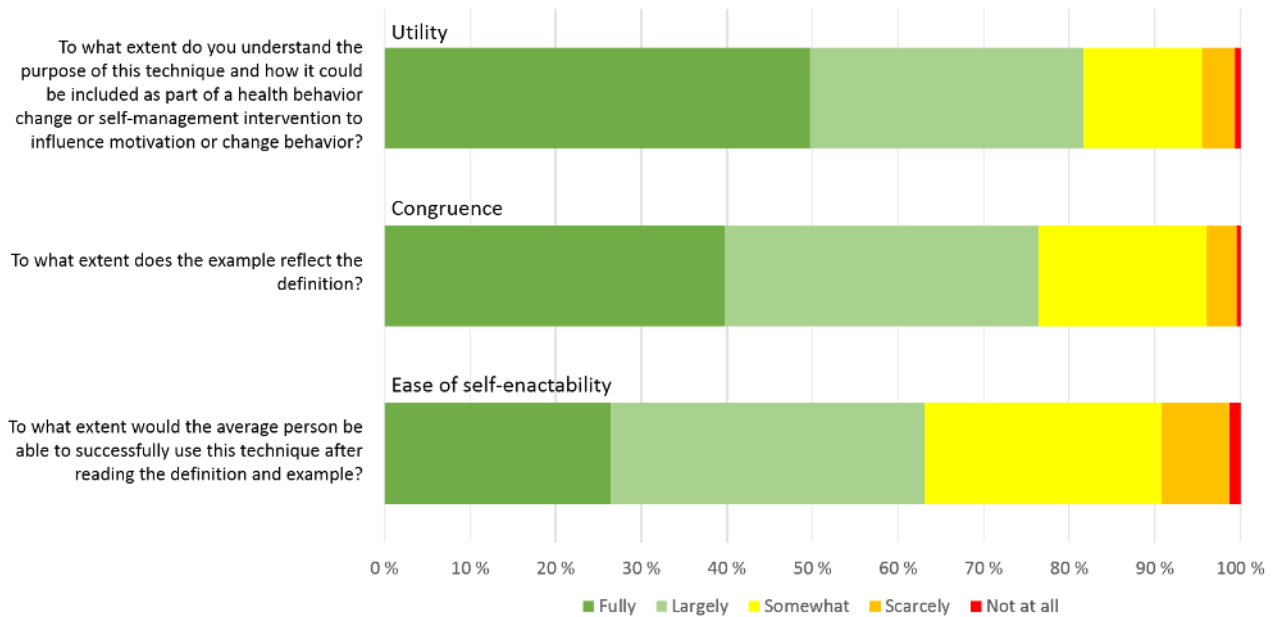
Phase 3: Refinements and finalizing

The results of Phase 2 informed the final Phase of development, wherein we used qualitative feedback from intervention development experts and the general public to adapt the compendium into its final revised form. This involved rewriting definitions and instructive examples of problematic techniques to improve utility, congruence and ease of self-enactability. In addition, based on suggestions from the expert review, each technique was supplemented with information about possible unintended adverse effects, and information to distinguish between techniques that would likely require instruction on delivery, and those that are more readily and independently self-enactable based on the provided definitions and instructive examples alone. Finally, based on suggestions in the qualitative data, a primer and glossary were added to summarize the purposes of the compendium, to offer guidance on how to use it, and to define key terms from the technique definitions and examples. This resulted in the final compendium (v1.0; supplementary file 3).

Discussion

Taxonomies of behaviour change techniques provide a common set of terms for describing the unique components of behaviour change interventions, and improve the uniformity of descriptions to facilitate replicability and evidence synthesis. This integrative compendium of self-enactable techniques builds on existing taxonomies in three key ways: by reconceptualising techniques as actions that individuals can themselves undertake to change or self-manage motivation or behaviour; by combining techniques across existing taxonomies and from applied psychological research in the areas of work, sport, and education; and by including instructive examples, information about adverse effects and dependencies between techniques, and a guide to facilitate self-directed use of the techniques. These advances offer researchers and intervention developers a comprehensive resource for optimally accounting for the participant perspective when building behaviour change interventions, and have the potential to facilitate self-enactment of these

242   techniques among the general public. This compendium is a first step in this direction (v1.0), and it
243   will be further developed, expanded and updated as additional evidence comes to light.

244   The agentic approach taken within this work draws attention to the importance of fidelity of
245   receipt and enactment within behaviour change interventions[19]. Many existing interventions are not
246   delivered or enacted as intended, which can reduce the effectiveness of these interventions. By
247   conceptualising techniques not only in terms of what is delivered, but also in terms of the concrete
248   actions that individuals receiving an intervention must themselves take to bring about change, this
249   work will help intervention developers to carefully consider and plan ways to increase fidelity of
250   receipt and enactment. Further extensions to this compendium may include questionnaire items to
251   assess enactment of techniques in a way that accounts for these actions[16].

252   Behaviour change researchers may also find this compendium useful for coding the content
253   of self-delivered interventions (e.g., self-help). Despite the known under-reporting problems
254   associated with retrospective taxonomy-based coding of intervention content from published
255   intervention descriptions[29], this method is consistently used in meta-analyses across behavioural
256   domains. While taking a self-enactment approach when coding published intervention descriptions
257   will not solve the problem of under-reporting, it could help to identify subtle variations in the
258   delivery of certain techniques, which may contribute to a technique's effectiveness across studies.
259   Furthermore, if applied to the coding of individual interactions between intervention providers and
260   recipients, an agentic approach could help to identify differences in technique enactment across
261   participants within studies, by examining the extent to which providers bring up and discuss specific
262   agentic actions participants took outside of sessions[30].

263   The detailed instructive examples which accompany the techniques in this compendium will
264   help to facilitate self-enactment. Each instructive example offers a rationale for using the technique,
265   and lists concrete actions an individual should take to enact the technique to self-manage or change
266   behaviour or motivation. While not a guarantee of successful self-enactment, these brief and
267   informative instructive examples capture the essence of each technique, and have been reviewed
268   and refined based on the inputs of intervention developers and members of the general public alike.
269   This means that they meet a minimal threshold of prospective acceptability[31], and could be used as
270   off the shelf options in face-to-face or technology-assisted self-management or behaviour change
271   interventions. However, this work does not yet provide evidence for the concurrent acceptability or
272   efficacy of any techniques, and future testing is needed to examine how well individuals can self-
273   enact these techniques based on these definitions and examples alone. With further refinements
274   based on the results of such testing, the techniques could open new possibilities for self-delivered
275   interventions. This is an important contribution, as effective self-delivered or technology-assisted
276   interventions have great potential to reduce the costs associated with primary prevention and
277   medical management of chronic disease[32], and in improving other outcomes.

278   In addition to their utility for researchers and intervention developers, the instructive
279   examples offer members of the public direct access to self-enactable techniques that they could use
280   to self-manage or change their behaviour. This includes techniques that are best used before (e.g.,
281   obtaining information, mental rehearsal), during (e.g., action control, distraction), or after (e.g.,
282   reviewing behavioural goals, self-reward) engaging in a target behaviour. It also includes techniques
283   that would be expected to change behaviour or motivation via reflective and deliberative processes
284   (e.g., goal setting, graded tasks), and those that target automatic or impulsive response (e.g., habit
285   formation, training executive function). As this work focused solely on agentic actions, we excluded
286   behaviour change techniques target the environment and operate (largely) outside of an individual's

287 awareness (e.g., choice architecture or nudging), as well as techniques which could not be
288 reasonably self-initiated (e.g., policy-level interventions). We did, however, include techniques which
289 might (potentially) require external inputs (e.g., from other people, the internet or healthcare
290 professionals), but which individuals could nevertheless self-deploy (e.g., obtain social support); and
291 techniques by which an individual might automatize their behavioural patterns (e.g. habit
292 formation). The final listing distinguishes between techniques that might require external inputs and
293 those which do not, and provides additional information about prerequisite techniques, to avoid
294 self-enactment of techniques for which the necessary preconditions have not been met. The
295 information accompanying each technique will be expanded in the future to include further
296 information about each technique's parameters of effectiveness.

297   Based on our expert review and interviews with potential end users, we also added an
298 introductory text to the compendium, which outlines how it can be used and defines several key
299 terms from the behaviour change literature. While this accessibility and user-friendliness goes
300 beyond that offered by existing taxonomies, which provide no such guidance to members of the
301 public looking change their health behaviours on their own, it stops short of being a fully self-guided
302 intervention platform. Rather, in its present form, the listing offers the general public a list of ideas
303 for how to go about changing or managing their own lifestyle behaviours or motivation.

304   As the compendium at this point lacks the capability to fully guide individuals through the
305 process of behaviour change, several areas of concern for misuse and unintended consequences of
306 techniques require highlighting. During the expert review phase, several techniques were flagged as
307 potentially having adverse effects when used incorrectly[33], or when applied to a different behaviour
308 than the ones included in the instructive examples. As an example, when the technique *satiation*
309 (#69) is targeted toward physical activity (i.e., sitting for an extended period until physical activity
310 feels like a nice change from sitting), no immediate adverse events would be expected. However,
311 when applied to reducing unhealthy snack intake, the technique could lead to unhealthy binge
312 eating behaviours and potentially contribute to the development of eating disorders[34]. Although
313 most potentially adverse effects from technique misuse were mild (e.g., frustration at not achieving
314 a goal, placing a burden on friends), we found it important to proactively identify and clearly indicate
315 these to individuals wishing to self-manage their behaviour, and have added such designations
316 where applicable. While this is currently sufficient, future development of this compendium into a
317 standalone system for self-delivered behaviour change interventions would necessitate a more
318 complete plotting of worst-case scenarios and implementation of more rigorous safeguards to
319 protect individuals who might unknowingly misapply these self-enactable techniques.

320   In developing this compendium, our research team followed a systematic and stepwise
321 process that was informed by past experiences with taxonomy development[11,35,36]. This included
322 extensive in-depth discussions and consensus-reaching procedures, scoping reviews, input from a
323 panel of expert intervention developers, and input from authors of published taxonomies and other
324 topic-area experts. The development process also included the novel aspect of qualitative interviews
325 with the public to assess and improve the comprehensibility of a subset of techniques.

326   Despite these strengths, several limitations of this work related to both the final product and
327 the development process bear mentioning. First, the instructive examples currently relate to only
328 one or two health-related behaviours (e.g. physical activity, healthy eating, smoking cessation) per
329 technique. During the expert review phase, several experts called for an extension of the examples
330 to cover a wider range of health and environmental protection behaviours. This is important, as
331 some techniques are better suited to changing some behaviours than they are others (e.g.

332 differences between "stop" and "start" behaviours, behaviours with addictive elements). Given the
333 wide range of behaviours that interventions might target, it was not feasible to extend the
334 compendium beyond its current form within the current project. To expand this work in the future,
335 our group has set up a crowdsourcing platform[37], through which researchers and others can
336 contribute their own examples of how each technique could be used to target health behaviours not
337 currently covered. While facilitating this crowdsourcing approach presents quality control and
338 logistical challenges, which themselves require resources to overcome, expanding on this work via a
339 collaborative effort of the scientific community is an exciting possibility. We welcome submissions
340 for new examples via the online form at http://bit.do/SubmitAnExample.
341   Second, while most of these techniques have been included as part of previous behaviour
342 change interventions, this was rarely done in a specifically self-enactable form. There is therefore
343 little evidence about the efficacy of these techniques when self-enacted. Instead of making claims
344 about technique efficacy, this compendium of self-enactable techniques supports the development
345 of self-enactable intervention components, the efficacy of which would need to be tested
346 separately. Relatedly, this listing also does not include comprehensive information about how each
347 technique relates to motivational constructs and other behavioural determinants. Other research
348 groups are currently working to establish an evidence-base for the linkages between behaviour
349 change techniques and behavioural determinants (i.e. an ontology of behaviour change)[38,39], which
350 may be tied into this work in the future.
351   Finally, interviews with members of the public about the perceived acceptability and utility
352 of techniques only covered a subset of the techniques included here. While these interviews led to
353 several improvements in these 20 techniques, we were unable to conduct interviews for all included
354 techniques. Work is underway to expand upon the qualitative findings presented here, and any
355 resultant improvements to technique definitions or instructive examples will be integrated into the
356 compendium in due course (https://osf.io/pqfjz/). We would therefore like to echo previous calls for
357 further research into uptake and enactment of behaviour change techniques[40].
358
359   In taking this work further, one could envision an online system to offer members of the
360 public guided, individualised access to these techniques. By utilising principles of computer
361 tailoring[41,42] and ongoing ontological work to improve the evidential links between behaviour change
362 techniques and behavioural determinants[38,39], such a system could account for individuals' current
363 states and offer choices of the best techniques they could self-enact to change or manage their
364 behaviour in real time. Paucity of research on some behaviour change techniques, especially when
365 used in a self-enactable way, means that fully realising this type of evidence-based system would
366 require substantial advances in the breadth and depth of the evidence base. However, such a system
367 could also work to expand the evidence base on its own.
368   This compendium could also be used to develop measures of self-enactment processes for
369 assessing fidelity within interventions. Measuring enactment of behaviour change techniques
370 requires short technique definitions that can be readily utilised as questionnaire items. Hartmann-
371 Boyce and colleagues have previously created a questionnaire based on their OxFAB taxonomy
372 work[16], and a similar process could be undertaken utilising the self-enactable techniques presented
373 here. Developing adequate measures is key to improving scientific understanding of what individuals
374 themselves do to change and manage their behaviour.
375   In conclusion, this integrative compendium of self-enactable techniques to change and self-
376 manage motivation and behaviour builds upon existing taxonomies of behaviour change techniques,

377 and clarifies the agentic actions needed for successful self-enactment. It also extends previous
378 taxonomies by pulling together their component techniques into a single listing, and by including
379 clear instructions for how to use each technique in practice. In its present form, researchers can use
380 this list to develop behaviour change interventions that optimally account for enactment by
381 intervention recipients. This also offers members of the public access to definitions and instructive
382 examples of self-enactable techniques that they could themselves use to change or manage their
383 behaviour. With further refinements and contributions from theory and evidence, these intervention
384 delivery and self-enactment perspectives could be brought together into a generalised, self-guided
385 behaviour change system tailored to the needs of individuals.
386
387   **Methods**
388
389 **Step 1: Integrating existing primary taxonomies**
390   In creating this compendium of self-enactable techniques for motivation and behaviour change, the
391 intervention mapping taxonomy[10], the BCTTv1[9], and the motivational interviewing taxonomy[11] were chosen as
392 primary sources, as they each identify and describe behaviour change techniques that are applicable across
393 multiple behavioural domains. Efforts were then made to map these taxonomies onto one another (i.e., to
394 combine them while accounting for overlaps). The mapping exercise was initiated by a single researcher (MB),
395 who first placed the 93 techniques from the BCTTv1 into a spreadsheet. The BCTTv1 was used as the starting
396 point, as it is extensively used within behaviour change intervention research. Then, each subsequent
397 technique from the other two taxonomies was examined individually in relation to the techniques present in
398 the BCTTv1. If a subsequent technique was judged to overlap (or partially overlap) with a technique present in
399 the spreadsheet, then these techniques were mapped on to one another by placing the label of this new
400 technique in the cell adjacent to the one containing the existing technique. If no match or overlap with the
401 existing list was perceived, then a new row containing this new technique was added to the spreadsheet. In
402 case of any uncertainty regarding the overlap of techniques from new sources, notes were made for later
403 discussion with other members of the research team. The result of this mapping exercise and any uncertainties
404 encountered were fully reviewed and discussed in detail until consensus on the mapping was reached within
405 the study group (MB, NH, MH, KK, MS). Where consensus was not reached during discussions within this
406 group, the study advisory group (MSH, WH, MMM), the authors of source taxonomies and additional topic
407 experts were consulted via email, skype or in person for clarity on how they would differentiate between
408 techniques from different taxonomies. These opinions informed further discussions within the study group to
409 reach consensus.
410   After this initial mapping exercise, all techniques from the combined post-mapping list were
411 evaluated for potential conversion into a self-enactable technique by a study group member (MH or KK).
412 Techniques which were adjudged to have limited possibility of self-enactability were maintained and discussed
413 with the rest of the research team. After these discussions, techniques were only removed due to lack of self-
414 enactability when all members of the study group agreed the technique was not self-enactable.
415   In the next step, MB, NH, MH, KK and MS (with inputs from MMM and WH) worked collaboratively to
416 rewrite each technique definition in a self-enactable way, using three pre-specified criteria: First, each
417 technique had to contain at least one verb (e.g., seek out, obtain, arrange, reflect on) that refers to the action
418 an individual would need to take to self-enact the technique. Second, each rewritten technique had to refer to
419 either the performance of, and/or motivation for, a specific target behaviour. This could include engaging in a
420 wanted behaviour and/or refraining from engaging in an unwanted behaviour. Definitions were worded to
421 accommodate both possibilities where applicable. Finally, all techniques were written under the assumption
422 that an individual has already identified a specific target behaviour that they are considering changing or
423 already desire to change. One technique (#1 - Agenda mapping) was an exception to this rule however, as it
424 involved choosing a behavioural domain. In writing the definitions, wordings present in the BCTTv1 were used

425 as a guide, and these were supplemented or altered where necessary to accommodate self-enactment and to
426 include operationalisations of techniques from other sources.
427
428 **Step 2: Scoping reviews to identify additional techniques**
429 Three scoping reviews were undertaken by MB and MS to identify potential additional techniques
430 from the domains of sport, education, and work psychology. These scoping reviews included examining topic-
431 related reviews, interventions, theories and questionnaire items from each of these three domains. The full
432 methods and findings of the scoping reviews in the work, sport, and education domains are reported in
433 supplementary files 4, 5 and 6 respectively, which are available on the project's open science framework page
434 (https://osf.io/pqfjz/).
435
436 Table 2. Final forms of techniques added during Phase 1, Step 3 of the development process.

Number	Label	Definition	Source
29	Task crafting (enjoyment)	Restructure the target behaviour to make performing it more enjoyable	OxFAB taxonomy; Work scoping review
30	Task crafting (skills and ability)	Introduce new approaches to the target behaviour that are congruent with current skills and ability	Work scoping review
31	Add challenge	Add challenges to the target behaviour.	Work scoping review
32	Goal integration	Modify (or choose ways of doing) the behaviour such that it allows for simultaneously engaging in other valued behaviours and/or pursuing valued outcomes	Work scoping review; Group discussion
52	Support others	Provide support to others in relation to the target behaviour	OxFAB taxonomy; Work scoping review
57	Remind of outcome goal content	Remind yourself of your outcome goal(s).	Work scoping review; Group discussion
58	Action control (keep goals in mind)	Make efforts to consciously keep the target behaviour and your goals in mind	Self-regulation listing; Sport scoping review
59	Action control (maximize effort)	Maximise effort toward undertaking the target behaviour	Self-regulation listing; Sport scoping review; Education scoping review
103	Critically assess beliefs	Evaluate and challenge the accuracy of your own beliefs	Work scoping review
109	Focus on enjoyment (pleasant aspects) of behaviour	Focus thinking on pleasant rather than unpleasant aspects of the target behaviour.	Work scoping review
120	Identify sources of pressure for behaviour	Identify sources of pressure (external or internal) and expectations to perform the target behaviour	SDT taxonomy
121	Identify ways of dealing with pressure	Take steps to manage or limit the effects of pressure (external or internal) to perform the target behaviour	SDT taxonomy
123	Prayer	Appeal to a higher power for changes in motivation or behaviour	Education scoping review

437

Step 3: Integrating techniques from scoping reviews and additional taxonomies

One member of the study team (KK) examined all techniques identified in the scoping reviews, and made notes on their possible overlaps with those already present in the merged taxonomy. These notes were then reviewed by additional members of the study team (NH, MH, MMM), and non-overlapping techniques were added to the existing list. Similarly, each technique from three additional classifications of behaviour change techniques[16,26,36] was reviewed by at least one researcher (MB, NH, MH, KK, MMM). Techniques identified as potentially unique were then discussed by NH, MH, KK, and MMM until consensus was reached on uniqueness or overlap with existing techniques in the listing. Authors of two secondary sources[16,26] were contacted for additional information where consensus could not immediately be reached within the study group. Techniques added to the listing during Step 3 were reworded into a self-enactable form following the same procedures as in Step 1, after consensus had been reached on their inclusion (See Table 2).

Step 4: Creating instructive examples

Each technique from the expanded provisional listing (v0.2) was then supplemented by an instructive example which could allow the average person to self-enact the technique to change or self-manage a behaviour. While the techniques could, strictly speaking, be used to self-manage any behaviour, we elected to focus the contents of initial examples on health-related behaviours. To create the examples, five techniques from v0.2 were selected at random, and members of the study group (FE, NH, MH, KK, MMM) worked independently to create instructive examples for each of these same five techniques. The group then met to collaboratively discuss the positive and negative aspects of each of these independently-created instructive examples, and co-wrote instructive examples that best represented the five techniques in question. The characteristics of the resulting instructive examples, as well as the positives and negatives of the independently-created instructive examples were then worked into guidelines for the creation of subsequent instructive examples. The guidelines stated that each instructive example should: (1) be consistent with the technique's definition; (2) be written in an instructive way that would enable a lay person reading it to implement the technique on their own; and (3) refer to a specific health behaviour (e.g., physical activity, diet, smoking). Additionally, examples were required to follow a uniform structure: An introduction sentence; 2-3 concrete examples written in complete sentences with one sentence per example the standard; and an optional additional sentence with information on the best ways of doing the technique and/or its relation to other techniques. Furthermore, the created examples should not contain instructions that could constitute another technique, include any unnecessary verbs that are not put into action in the example (e.g., "Think about doing..." should simply be "do..."), or contain unnecessary linking words that might have unintended meanings (e.g., alternatively, conversely).

In the next step, a draft example was created for each technique by a randomly selected member of the study group (FE, MH, KK, or MMM) according to the guidelines above. All created examples were then checked by a second researcher (FE, NH, MH, KK, or MMM) to ensure adherence to the guidelines. In instances where the created example did not fulfil the guidelines, the second researcher made edits to ensure that it did. Any edits to the examples were then checked by the researcher who had created the initial example, and if he or she agreed with the new wording, this was accepted as is. If there was disagreement with the new version, then the example was discussed and revised within the group (FE, NH, MH, KK, MMM) until consensus was reached. These consensus-based examples coupled with the self-enactable definitions created in Step 3 made up the draft version of the compendium (v0.3) in supplementary file 7.

Step 5: Qualitative interviews to assess acceptability of techniques

To examine the prospective acceptability of a subset of 20 techniques among potential end users, qualitative interviews were conducted with individuals recruited via social media. These 20 techniques were selected based on the results of a rating exercise, in which nine experts in self-determination theory rated the likelihood of each technique to impact upon autonomous and controlled forms of motivation[43]. The 20 techniques rated as having the greatest likelihood to increase autonomous forms of motivation and decrease

487 controlled forms of motivation were selected for the interviews. Within the interviews, each participant
488 sequentially reviewed a random selection of 12 techniques, including its label, definition and instructive
489 example from v0.3. Following a pilot-tested interview protocol, and after obtaining informed consent, one
490 researcher (FE) asked participants whether the technique definitions and instructive examples were
491 understood as intended, whether participants utilised the techniques themselves, and how they might be able
492 to implement the techniques in their own lives (e.g. to increase physical activity levels). Information on how to
493 improve each technique was also gathered. Interview sessions lasted approximately 75 minutes per
494 participant, and acceptability was assessed using the Theoretical Framework of Acceptability[31]. The University
495 of Helsinki Ethical Review Board in the Humanities and Social and Behavioural Sciences provided a favourable
496 assessment for this work. All portions of this work which involved human participants complied with all
497 relevant ethical regulations. For further description of the methods see supplementary file 11.

499 **Step 6: Review of technique listing and instructive examples by experienced intervention developers**
500 After compiling the preliminary draft version of the compendium (v0.3), 20 external experts in the
501 development of health behaviour change interventions and/or in the use of taxonomies of behaviour change
502 techniques for coding intervention descriptions were recruited to review it. The expert review aimed to
503 examine: (a) the extent to which each technique was clearly understood from an intervention development
504 standpoint (utility); (b) the extent to which each technique's instructive example was congruent with its
505 definition (congruence); and (c) the extent to which members of the general public would be able to
506 successfully enact each technique based on reading the definition and example (ease of self-enactability). In
507 achieving these aims, we also gathered the experts' qualitative assessments of how each of these aspects
508 could be improved.
509 A list of 37 potential expert reviewers was identified by the study team, and experts were approached
510 via email to participate. The first 20 who agreed to participate received a link to an online form which allowed
511 them to review of a random selection of 28 to 40 BCTs per participating expert. Each of the BCT definitions and
512 instructive examples to be reviewed was presented on its own page, along with the following three items
513 measuring the (a) utility, (b) congruence, and (c) ease of self-enactability of each technique: (a) "Based on your
514 reading of the definition and example, to what extent do you understand the purpose of this technique and
515 how it could be included as part of a health behaviour change or self-management intervention to influence
516 motivation or change behaviour?", (b) "To what extent does the example reflect the definition?"; and (c) "To
517 what extent would the average layperson be able to successfully use this technique after reading the definition
518 and example?". Experts responded to each item on a 5-point Likert scale with options of 'fully,' 'largely,'
519 'somewhat,' 'scarcely,' and 'not at all'. If an expert gave a rating of 'somewhat,' 'scarcely,' or 'not at all,' the
520 system prompted him or her to complete follow-up free response items to elicit their opinions on ways in
521 which the utility, congruence, or ease of self-enactability might be improved. Space was also provided for the
522 experts to provide opinions about each technique and the listing as a whole. See supplementary file 8 for
523 verbatim methods of this step.

525 **Step 7: Finalising the classification**
526 Study team members (NH, MH, KK, MMM) convened to review all techniques for which the expert
527 review had revealed potential problems with utility, congruence, or ease of self-enactability. All techniques
528 which at least one expert had rated as 'scarcely' or 'not at all,' or which two or more experts had rated as
529 'somewhat,' in any domain were reviewed. The team reviewed the qualitative responses given during the
530 expert review for each problematic domain of a technique, came to a decision about whether a change to the
531 definition or example was required, and collaboratively brainstormed ways in which utility, congruence, or
532 ease of self-enactability of the technique definition and example could be improved in line with the reviewers'
533 comments. This included re-wording techniques' labels, definitions or examples to improve clarity or precision,
534 defining key terms that are necessary in explaining a definition or example, or adding additional information
535 about the intended or appropriate uses of a technique. In some cases, no action could be taken on the expert's

536 qualitative responses, as it would have pushed the work beyond its pre-defined boundaries. Changes made
537 during this phase were logged and are presented in supplementary file 10. After these refinements, techniques
538 were re-numbered to group similar techniques and support a logical flow within the listing, resulting in the
539 final compendium (v1.0; supplementary files 1 and 3). Finally, a primer and glossary were written to spell out
540 the purposes of the compendium and to define key terms (supplementary file 2).
541

545

546 **Data availability statement**
547 All data generated or analysed during this study are included in this published article (and its
548 supplementary information files).
549

550 **Competing interests statement**
551 MSH, WH and MMM are co-authors of existing taxonomies of behaviour change techniques which
552 have informed this work. The authors declare no other competing interests.
553
554

References

1. Sheeran, P. *et al.* The impact of changing attitudes, norms, and self-efficacy on health-related intentions and behavior: A meta-analysis. *Health Psychol.* **35**, 1178–1188 (2016).

2. Marcolino, M. S. *et al.* The Impact of mHealth Interventions: Systematic Review of Systematic Reviews. in *JMIR mHealth and uHealth* (2018). doi:10.2196/mhealth.8873

3. Ahn, S., Smith, M. L., Altpeter, M., Post, L. & Ory, M. G. Healthcare Cost Savings Estimator Tool for Chronic Disease Self-Management Program: A New Tool for Program Administrators and Decision Makers. *Front. Public Health* **3**, (2015).

4. Riegel Barbara *et al.* Self-Care for the Prevention and Management of Cardiovascular Disease and Stroke. *J. Am. Heart Assoc.* **6**, e006997

5. Michie, S. *et al.* From Theory-Inspired to Theory-Based Interventions: A Protocol for Developing and Testing a Methodology for Linking Behaviour Change Techniques to Theoretical Mechanisms of Action. *Ann. Behav. Med.* **52**, 501–512 (2018).

6. Abraham, C. & Michie, S. A Taxonomy of Behavior Change Techniques Used in Interventions. *Health Psychol.* **27**, 379–387 (2008).

7. Michie, S., Fixsen, D., Grimshaw, J. M. & Eccles, M. P. Specifying and reporting complex behaviour change interventions: the need for a scientific method. *Implement. Sci.* **4**, 40 (2009).

8. Michie, S., Johnston, M. & Carey, R. Behavior Change Techniques. *Encycl. Behav. Med.* 1–8 (2016). doi:10.1007/978-1-4614-6439-6_1661-2

9. Michie, S. *et al.* The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: Building an international consensus for the reporting of behavior change interventions. *Ann. Behav. Med.* **46**, 81–95 (2013).

10. Kok, G. *et al.* A taxonomy of behaviour change methods: an Intervention Mapping approach. *Health Psychol. Rev.* **10**, 297–312 (2016).

11. Hardcastle, S. J., Fortier, M., Blake, N. & Hagger, M. S. Identifying content-based and relational techniques to change behaviour in motivational interviewing. *Health Psychol. Rev.* **11**, 1–16 (2017).

12. William, M. R. & Rollnick, S. *Motivational Interviewing, Third Edition: Helping People Change*. (Guilford Press, 2012).

13. Duckworth, A. L., Milkman, K. L. & Laibson, D. Beyond Willpower: Strategies for Reducing Failures of Self-Control. *Psychol. Sci. Public Interest* **19**, 102–129 (2018).

14. Hankonen, N. Participants' enactment of behavior change techniques: A call for increased focus on what people do to manage their motivation and behaviour. (2018). doi:10.31234/osf.io/pa4wg

590   15. Hollands, G. J. *et al.* The TIPPME intervention typology for changing environments to change
591   behaviour. *Nat. Hum. Behav.* **1**, 0140 (2017).

592   16. Hartmann-Boyce, J., Aveyard, P., Koshiaris, C. & Jebb, S. A. Development of tools to study
593   personal weight control strategies: OxFAB taxonomy. *Obesity* **24**, 314–320 (2016).

594   17. Richardson, M. J., Dale, R. & Marsh, K. L. Complex dynamical systems in social and personality
595   psychology: Theory, modeling, and analysis. in *Handbook of research methods in social and*
596   *personality psychology, 2nd ed* 253–282 (Cambridge University Press, 2014).

597   18. Shiell, A., Hawe, P. & Gold, L. Complex interventions or complex systems? Implications for
598   health economic evaluation. *BMJ* **336**, 1281–1283 (2008).

599   19. Bellg, A. J. *et al.* Enhancing treatment fidelity in health behavior change studies: best practices
600   and recommendations from the NIH Behavior Change Consortium. *Health Psychol. Off. J. Div.*
601   *Health Psychol. Am. Psychol. Assoc.* **23**, 443–451 (2004).

602   20. Knittle, K., De Gucht, V., Hurkmans, E., Vlieland, T. V. & Maes, S. Explaining Physical Activity
603   Maintenance after a Theory-Based Intervention among Patients with Rheumatoid Arthritis:
604   Process Evaluation of a Randomized Controlled Trial. *Arthritis Care Res.* **68**, (2016).

605   21. Hankonen, N. *et al.* Which Behavior Change Techniques are Associated with Changes in Physical
606   Activity, Diet and Body Mass Index in People with Recently Diagnosed Diabetes? *Ann. Behav.*
607   *Med.* **49**, 7–17 (2015).

608   22. Burke, L. E., Wang, J. & Sevick, M. A. Self-Monitoring in Weight Loss: A Systematic Review of the
609   Literature. *J. Am. Diet. Assoc.* **111**, 92–102 (2011).

610   23. Tims, M., Bakker, A. B. & Derks, D. The impact of job crafting on job demands, job resources,
611   and well-being. *J. Occup. Health Psychol.* **18**, 230–240 (2013).

612   24. Brick, N., MacIntyre, T. & Campbell, M. Attentional focus in endurance activity: new paradigms
613   and future directions. *Int. Rev. Sport Exerc. Psychol.* **7**, 106–134 (2014).

614   25. Van Raalte, J. L., Vincent, A. & Brewer, B. W. Self-talk: Review and sport-specific model. *Psychol.*
615   *Sport Exerc.* **22**, 139–148 (2016).

616   26. Maes, S. & Karoly, P. Self-regulation assessment and intervention in physical health and illness:
617   A review. *Appl. Psychol.* **54**, 267–299 (2005).

618   27. Teixeira, P. J. *et al.* Classification of Techniques Used in Self-Determination Theory-Based
619   Interventions in Health Contexts: An Expert Consensus Study. (2018).

620   28. Fleiss, J. L. Measuring nominal scale agreement among many raters. *Psychol. Bull.* **76**, 378–382
621   (1971).

622 29. Black, N. *et al.* Enhancing Behavior Change Technique Coding Methods: Identifying Behavioral
623   Targets and Delivery Styles in Smoking Cessation Trials. *Ann. Behav. Med.*
624   doi:10.1093/abm/kay068

625 30. Lorencatto, F., West, R., Bruguera, C., Brose, L. S. & Michie, S. Assessing the Quality of Goal
626   Setting in Behavioural Support for Smoking Cessation and its Association with Outcomes. *Ann.*
627   *Behav. Med.* **50**, 310–318 (2016).

628 31. Sekhon, M., Cartwright, M. & Francis, J. J. Acceptability of healthcare interventions: an overview
629   of reviews and development of a theoretical framework. *BMC Health Serv. Res.* **17**, 88 (2017).

630 32. Urrea, B. *et al.* Mobile Health Initiatives to Improve Outcomes in Primary Prevention of
631   Cardiovascular Disease. *Curr. Treat. Options Cardiovasc. Med.* **17**, 59 (2015).

632 33. Schroeder, J. & Fishbach, A. How to motivate yourself and others? Intended and unintended
633   consequences. *Res. Organ. Behav.* **35**, 123–141 (2015).

634 34. Guerdjikova, A. I., Mori, N., Casuto, L. S. & McElroy, S. L. Binge Eating Disorder. *Psychiatr. Clin.*
635   **40**, 255–266 (2017).

636 35. Michie, S. *et al.* A refined taxonomy of behaviour change techniques to help people change
637   their physical activity and healthy eating behaviours: the CALO-RE taxonomy. *Psychol. Health*
638   37–41 (2011). doi:10.1080/08870446.2010.540664

639 36. Marques, M. & Hagger, M. S. Identifying the Active Components of Self-Determination Theory-
640   Based Health Behavior Change Interventions: An Expert Consensus Study. (2018). doi:None

641 37. Brabham, D. C. Crowdsourcing as a Model for Problem Solving: An Introduction and Cases.
642   *Convergence* **14**, 75–90 (2008).

643 38. Carey, R. N. *et al.* Behavior Change Techniques and Their Mechanisms of Action: A Synthesis of
644   Links Described in Published Intervention Literature. *Ann. Behav. Med.* (2018).

645 39. Johnston, M. *et al.* Linking behavior change techniques and mechanisms of action: Triangulation
646   of findings from literature synthesis and expert consensus. (2018). doi:10.31234/osf.io/ur6kz

647 40. Greaves, C. J. Uptake of Behavior Change Techniques – a Key Focus for Process Analysis and for
648   Intervention Delivery: a Comment on Hankonen et al. *Ann. Behav. Med.* **49**, 1–2 (2015).

649 41. Bradbury, K., Watts, S., Arden-Close, E., Yardley, L. & Lewith, G. Developing Digital
650   Interventions: A Methodological Guide. *Evidence-Based Complementary and Alternative*
651   *Medicine* (2014). doi:10.1155/2014/561320

652 42. de Vries, H. & Brug, J. Computer-tailored interventions motivating people to adopt health
653   promoting behaviours: introduction to a new approach. *Patient Educ. Couns.* **36**, 99–105 (1999).

654 43. Deci, E. L. & Ryan, R. M. The 'what' and 'why' of goal pursuits: Human needs and the self-
655   determination of behavior. *Psychol. Inq.* **11**, 227–268 (2000).