



Delft University of Technology

Finding what fits: Explorative self-experimentation for health behaviour change

Fedlmeier, A.; Bruijnes, M.; Bos-de Vos, M.; Lemke, M.; Kraal, J.J.

DOI

[10.1080/24735132.2022.2147336](https://doi.org/10.1080/24735132.2022.2147336)

Publication date

2022

Document Version

Final published version

Published in

Design for Health

Citation (APA)

Fedlmeier, A., Bruijnes, M., Bos-de Vos, M., Lemke, M., & Kraal, J. J. (2022). Finding what fits: Explorative self-experimentation for health behaviour change. *Design for Health*, 1-22.
<https://doi.org/10.1080/24735132.2022.2147336>

Important note

To cite this publication, please use the final published version (if applicable).
Please check the document version above.

Copyright

Other than for strictly personal use, it is not permitted to download, forward or distribute the text or part of it, without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license such as Creative Commons.

Takedown policy

Please contact us and provide details if you believe this document breaches copyrights.
We will remove access to the work immediately and investigate your claim.

Finding what fits: Explorative self-experimentation for health behaviour change

Antonia Fedlmeier, Merijn Bruijnes, Marina Bos-de Vos, Mailin Lemke & Jos J. Kraal

To cite this article: Antonia Fedlmeier, Merijn Bruijnes, Marina Bos-de Vos, Mailin Lemke & Jos J. Kraal (2022): Finding what fits: Explorative self-experimentation for health behaviour change, Design for Health, DOI: [10.1080/24735132.2022.2147336](https://doi.org/10.1080/24735132.2022.2147336)

To link to this article: <https://doi.org/10.1080/24735132.2022.2147336>



© 2022 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group.



[View supplementary material](#)



Published online: 29 Nov 2022.



[Submit your article to this journal](#)



[View related articles](#)



[View Crossmark data](#)

Finding what fits: Explorative self-experimentation for health behaviour change

Antonia Fedlmeier^a, Merijn Bruijnes^{b,c} , Marina Bos-de Vos^d ,
Mailin Lemke^a  and Jos J. Kraal^a 

^aDepartment of Human Centered Design, Faculty of Industrial Design Engineering, Delft University of Technology, Delft, The Netherlands; ^bFaculty of Electrical Engineering, Mathematics & Computer Science, Delft University of Technology, Delft, The Netherlands; ^cUtrecht School of Governance, Utrecht University, Utrecht, Netherlands; ^dDepartment of Design, Organisation and Strategy, Faculty of Industrial Design Engineering, Delft University of Technology, Delft, The Netherlands

ABSTRACT

Changing a specific health behaviour can be highly complex and is often influenced by many personal, social, and environmental factors. Therefore, interventions that aim at behaviour change cannot be one-size-fits-all solutions, and no behaviour change technique is effective for everyone. One potential solution could be to support individuals in finding interventions through self-experimentation. This research explored the requirements for an explorative self-experimentation intervention and developed tools that support users in the process, complementing developments in quantitative self-experimentation. Based on a research through design approach, we developed three different prototypes for supporting a change in health-related behaviour, which were used and evaluated by fourteen participants over a four-week period. A thematic analysis of interviews with participants led to seven themes, which can be used as a starting point when designing for explorative self-experimentation.

ARTICLE HISTORY



Received 18 January 2022
Accepted 27 October 2022

KEYWORDS

Behaviour change; self-experimentation; human-centred design; research through design

Introduction

Many people have the intention to follow a healthy lifestyle. However, offers that provide instant gratification and other more pressing day-to-day matters often undermine the initiation or maintenance of health-related behaviour. There is a clear gap between what individuals *intend* to do and what they

CONTACT Jos J. Kraal  j.j.kraal@tudelft.nl  Department of Human-Centered Design, Faculty of Industrial Design Engineering, Delft University of Technology (TU Delft), Landbergstraat 15, Delft 2628 CE, The Netherlands.

 Supplemental data for this article is available online at <https://doi.org/10.1080/24735132.2022.2147336>.

© 2022 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group.

This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives License (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited, and is not altered, transformed, or built upon in any way.

actually do (Sheeran 2002). Lifestyle interventions and behaviour change tools try to reduce this intention-action gap, but results are often limited (Hagger et al. 2020). Although health interventions can be effective for a larger population, individual factors are often not taken into account. Therefore, no one solution or intervention will be effective for everyone (Hekler, Burleson, and Lee 2013). Personalization is crucial, especially when considering that health behaviours need to be sustained over time to have a significant impact on someone's health. Interventions should fit a person's goal, their ever-changing lifestyle, and be enjoyable (Phatak 2019). Intervention approaches developed by designers and/or health professionals that do not take this into account, regardless of personalization, may not be optimal and are often disconnected from the context, needs, and preferences of the user.

An alternative approach is to give individuals the tools to develop their own behaviour change plan (Lee et al. 2017). Instead of predefining the goal and interventions, we suggest that individuals can be encouraged to explore which factors influence their behaviour and which interventions could work for them. Such self-designed interventions might evoke ownership of the problem and the solution, increasing adherence to the intervention (Thabrew et al. 2018). Such an approach overlaps with the quantified-self (QS) movement. 'Q-Selfers often described the process of seeking answers as *self-experimentation*. When used in an academic context, self-experimentation means participating in one's own experiments when recruiting other participants is not feasible. However, in QS, the goal of self-experimentation is *not* to find generalizable knowledge, but to find meaningful self-knowledge that matters to individuals' (Choe et al. 2014, 1149).

QS and other self-experimentation frameworks often require tools that facilitate this self-experimentation and balance requirements such as simplicity and expressiveness, scientific rigour and individual users' needs, as well as enable creativity to develop and implement a range of interventions (Karkar et al. 2017; Lee 2013; Phatak 2019). Although some tools for self-experimentation have been introduced to facilitate this process (Karkar et al. 2017; Lee 2013), these approaches show usability issues because they lack flexibility, primarily focus on quantitative data, require the formulation of a hypothesis, or rely on tracking devices that are impractical or uncomfortable (Daskalova et al. 2017, 2020; Karkar et al. 2016; Pantzar and Ruckenstein 2017). For instance, when relying on quantified data in self-experimentation, users face the difficulty of evaluating complicated behavioural data without expert guidance, limiting the perceived effect of experiments (Phatak et al. 2018). Furthermore, current tools for self-experimentation often do not provide support during the initial goal-setting process and do not facilitate re-evaluating the chosen goal and intervention as part of the process.

Providing tools and support during these phases, and empowering users to apply a more qualitative reflection on these phases, could facilitate health behaviour change positively. We believe health interventions that guide users through explorative self-experimentation will support them to identify a behaviour change plan that fits their personal needs, preferences and context. These explorative self-experimentation interventions should focus on empowering individuals with tools and support during the goal setting, experimenting and self-reflection in the behaviour change process.

The aim of this study is to explore the requirements for Explorative Self-Experimentation (ESE) interventions and develop tools that support end-users in the process of self-experimentation. Following a Research through Design (RtD) approach (Frayling 1993; Stappers and Giaccardi 2017), the development and testing of a series of prototypes with participants over four weeks led to the identification of seven themes of user needs that are crucial in the context of ESE. These themes can be used as a starting point when designing ESE-based interventions to facilitate behaviour change.

The remaining paper is structured as follows: we first describe our exploration of the context of health behaviour change and self-experimentation through workshops with health design experts and students. Second, we present the methodology of our study, followed by a description of the seven identified themes. We end with a discussion and reflection on our findings.

Background: context exploration

Through a context mapping exploration, we developed a deep understanding of the people who want to change their health behaviour and their environment, needs, wishes, and experiences (Visser et al. 2005). This served as a starting point for our design process. Three generative activities helped participants express their latent needs and experiences with changing health behaviour. First, we held a generative workshop (Sanders and Stappers 2012) with five health design experts on self-experimenting with health interventions. Second, we conducted a creative session with 20 university students to understand their personal experiences or failed attempts to change their health behaviour. And finally, five interviews were conducted with (home) office workers. In preparation for these interviews, the participants were given a sensitizing booklet with different prompts to encourage them to observe themselves and reflect on their experiences while changing their health behaviours. An example of the sensitizing booklet is provided in Appendix 1 in the [Supplemental material](#). After one week, a 40-minute semi-structured interview was held with each participant to discuss their current struggles, past experiences and future aspirations regarding their health

behaviour. More details on the context exploration can be found in the workbook, available as Appendix 2 in the [Supplemental material](#), which offers screenshots of the generated digital materials including guiding questions and research set-up. These context-mapping activities provided a rich overview of the (desired) characteristics of the process of self-experimenting for health behaviour change. They were clustered into four core insights, which formed the starting point for the subsequent design explorations.

First, we found that people navigated their health behaviour and assessed the effectiveness of health behaviour changes through intuition. Whether it was one's energy level, skin outbreaks, stomach problems or mental state, participants mentioned being able to tell whether their health intervention was effective with very little to no conscious monitoring. Second, participants determined whether or not an intervention worked for them in terms of achieving their goal (i.e. is effective), whether it fit with their life and personality (compatibility), and whether it was enjoyable, simply by trying it out. Third, we found that self-experimentation should not feel like work. If the experience is playful and enjoyable, it was far better received. Fourth, we uncovered that people who practice self-experimentation are not seeking to answer a hypothesis but want to find an intervention that works for them, explore different options and learn about themselves in the process.

With these four insights, we conclude that a purely quantitative data-driven approach towards self-experimentation does not suffice. A more promising way to develop successful health interventions is to realize an experience through guided introspection. This creates space for participants to follow their intuition when choosing and evaluating interventions and making health behaviour change decisions. We argue for a playful approach that leaves room for participants to explore and reflect on personal growth.

Method: research through design

Research through design

RtD is a research approach that employs methods and approaches from the field of design and uses it to generate knowledge (Dalsgaard 2016). By applying RtD, it is possible to gain an actionable understanding of the complex issue of health behaviour change, resulting in communicable insights and an artefact that addresses the problem (Stappers and Giaccardi 2017). In RtD, the generative process of designing an artefact leads to many insights, as abstract theories and models around behaviour change are placed into real-world scenarios.

The role of a prototype as a vehicle to explore a design space can differ, spanning from aspects relating to its 'role', 'look and feel', and 'implementation' (Houde and Hill 1997). In this study, we used the

prototypes to evaluate the 'role' (what can the prototype do for the user), as well as 'look and feel' (demonstrating concrete experiences and aesthetic qualities) characteristics. Our prototypes were also used as a 'means of inquiry' (Wensveen and Matthews 2014) to provoke reactions and insights in regard to explorative self-experimentation.

We followed an expansive experimentation process during which three different prototypes were developed and provided to participants. Expansive design experiments focus on the 'identification of an area as-yet uncovered with the ambition to reveal its qualities, a mode of investigation resembling the work of geographers or biologists mapping new areas' (Krogh, Markussen, and Bang 2015, 46). This way of developing and using prototypes differs from the so-called 'scientific method', which focuses on hypothesis testing and a detailed method description to allow replicability with the overall aim to develop generalizable results (Gaver 2014; Stolterman 2008).

Our design prototypes were not linked to one specific theory or conceptual framework. Instead, the development process included hundreds of design decisions ranging from functional aspects to cultural and emotional ones (Gaver 2014). The first author, a trained designer, led the design development process and kept a design workbook to capture design decisions and reflections (Gaver 2011; See [Supplemental material](#)). We chose to develop the prototypes out of paper to refine them iteratively and produce multiple copies for the evaluation process. The print files of the three prototypes are publicly available (See [Supplemental material](#)).

Data collection

In the period between April and December 2020, we collected data via the process of designing a number of ESE prototypes. As shown in [Figure 1](#), our RtD process entailed three phases in which participants tested an ESE prototype. Each phase lasted for four weeks. Feedback was collected and analysed to be included in the next iteration of the design (i.e. the next prototype).

Participants were asked to choose a personal health-related goal as a starting point to engage with the prototype. We captured participants' feedback through 28 interviews; one interview two weeks into the self-experimentation and another interview after the fourth week. During the interviews participants were asked to reflect on the overall experience, the interventions they came up with to address the self-chosen health-related goal, the self-experimentation experience and interaction with the prototype (See the semi-structured interview guide in the [Supplemental material](#)). They were also asked to send photos of their interactions with the prototype.

The first prototype consisted of five different cards. The first card asked participants to write down a goal, commitment and why they want to

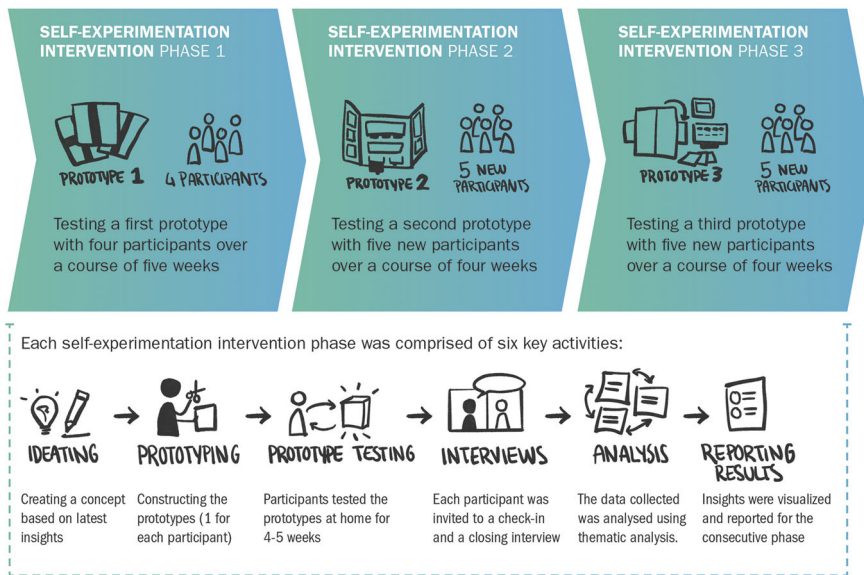


Figure 1. The study consisted of three research phases and six activities.

achieve this goal. The second card asked them to identify barriers, enablers and means they need to achieve the goal. Participants were asked to brainstorm some interventions to achieve the chosen goal on the third card. Card four focussed on determining a form of assessment to evaluate if the intervention was successful. The fifth card focussed on a baseline observation for one week before trying any interventions (Figure 2). Participants also received a package with five cards and one small notebook to capture the overall impression and observations regarding the chosen interventions and their effectiveness.

The second prototype was made as a folder of paper that participants could open (Figure 3). The prototype was split into three sections. On the left side, participants were asked to determine what they wanted to change, the middle section focussed on ‘tackling this’, and the third section on the right asked them what they learned. The prototype also provided three prompts in the first section focussing on the aspect people want to change. The first prompt concentrated on exploring the issue, the second focussed on defining a goal, and the third asked to reflect on barriers and enablers. Each prompt consisted of a small foldable element that participants could open up and read through. For example, the prompt focussing on a goal provided information about the difference between a behavioural and an outcome goal and then asked participants to write down the goal they wanted to focus on. The prototype also included four small ‘Tip’ sections that could be pulled out and provided further guidance and two ‘Inspiration’ pull-out elements. We also provided a separate A6 folded card, and we gave



Figure 2. The first prototype consisted of two packages containing paper flyers with instructions to plan, monitor and reflect on one's health intervention.

instructions to open it after two weeks. The card asked participants to reflect on the effectiveness of the chosen intervention and the barriers and enablers influencing the experience.

The third prototype introduced features to facilitate continued self-experimentation over time. The prototype included inspiration cards, a paper frame as a visual trigger, laser-cut foldable tracking cards for routine check-ins to track progress, and an 'infinity folding flyer' that contained the main instructions (Figure 4). The first page of the flyer focussed on defining what participants wanted to change. Five different prompts asked participants to explore the issue, define a goal, review the means needed to achieve the goal, and reflect on barriers and enablers. Participants could then open the flyer in the middle by folding the left and right sides down and start creating a plan to achieve the defined goal. The top and bottom sections could be



Figure 3. The second prototype presented a guide through a more structured process whilst introducing elements of playfulness in the interaction with paper.

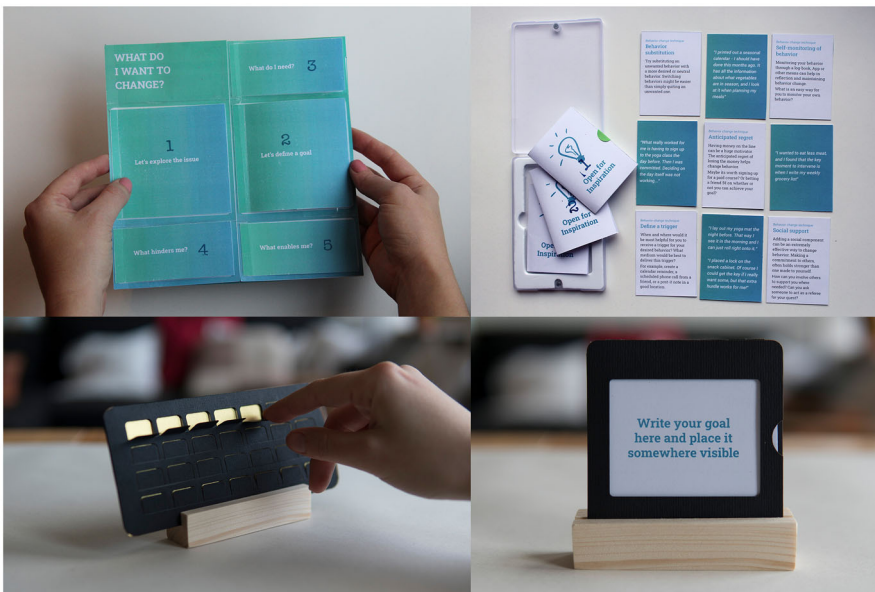


Figure 4. Prototype three consisted of a flyer with instructions, three sets of inspiration cards, a visual trigger, and a paper tool to track progress.

folded down in a consequential step and revealed a new flyer page that focussed on determining ways to track if the chosen intervention is effective. This section explained that the tracking tools provided as part of this prototype could be used as part of this step. The flyer could then be folded again, revealing the fourth page that asked participants to reflect on the experiment and personal learnings and next steps. The separate inspiration cards

aimed to help participants explore potential interventions. On one side of each card, a quote was shown as a form of personal inspiration, and the other side described a behaviour change technique (e.g. define a trigger).

Over the three phases, 14 participants took part in the study. Participants were (home) office workers between 25 and 50 years, who were recruited via the authors' various networks. Office workers that were pregnant or experiencing an urgent health issue (e.g. sickness) were excluded from our study. Due to Covid-19 restrictions, interviews were conducted online using Zoom and lasted 30–45 minutes. In the first iteration, interviews were conducted in a group setting. Due to logistical and privacy reasons, in phases two and three interviews were individual. We used the online whiteboard tool (www.miro.com) to capture comments and provide prompts during the interview. Interviews were conducted by the first author, digitally recorded and transcribed non-verbatim.

Data analysis

We used an inductive thematic analysis to systematically identify patterns of meaning across the qualitative data set. We followed the steps outlined by Braun and Clarke (2012). First, we familiarized ourselves with the data by reading the transcripts and reviewing the photos taken by participants multiple times. The first author then generated initial codes using digital post-its on an online Miro board. The generated codes were then clustered into themes, which were iteratively reviewed, refined and (re)named in discussions by the authors by going through corresponding quotes. Any disagreements between the coders were discussed until agreement was reached. In this process, we took a latent approach (Braun and Clarke 2012) looking past the explicit verbalized content into the subtext.

Results

Our analysis led to the identification of seven themes that can be seen as requirements for an ESE intervention: The need for (1) guidance; (2) incentives; (3) inspiration; (4) personal growth; (5) a resilient mindset; (6) flexibility; and (7) a personal feel (Figure 5). Next, we present each theme in detail giving illustrative examples from the data.

1. The need for guidance

Participants need a clear starting point and sufficient guidance during the goal-setting and experimental phase of ESE. Open questions such as 'What did I learn about myself?' or 'What are barriers to reaching my goal' were perceived as essential to the ESE process. Participants mentioned these questions guided them through the mental process, adding 'a qualitative feel'.

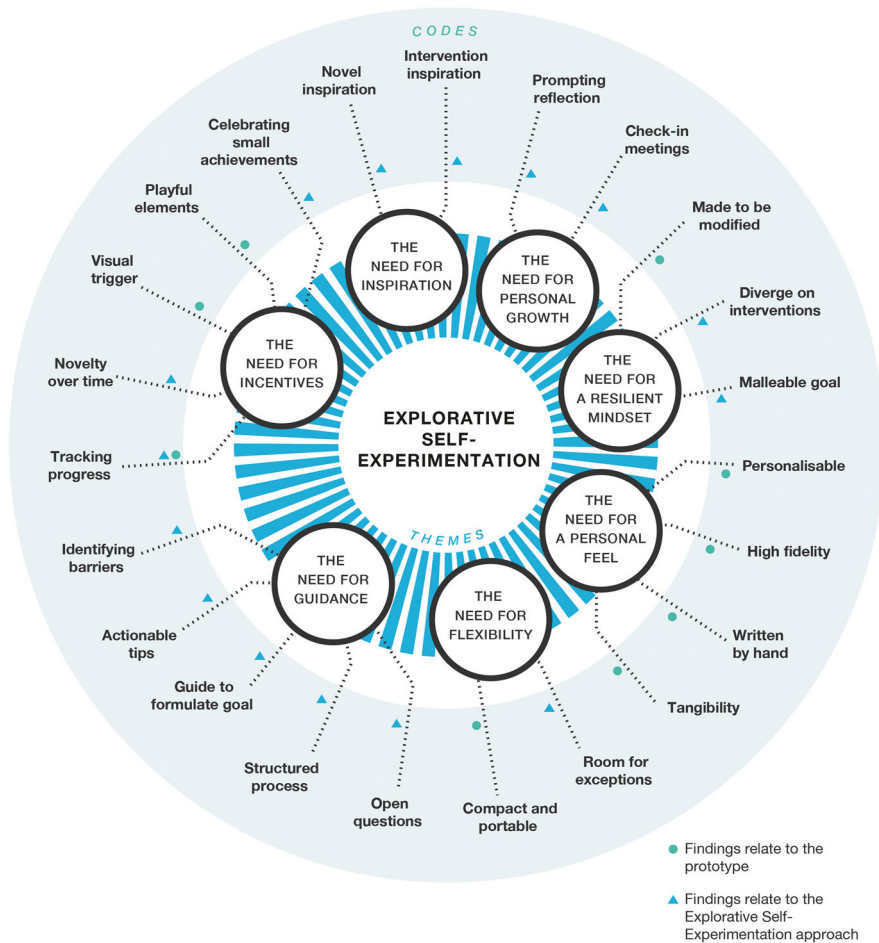


Figure 5. Overview of the seven main themes and associated codes.

Here, it was a bit more qualitative, so I could describe things with a bit more richness. So that was really nice, and kind of once again forced me to think about the barriers that were preventing me from reaching my goal.... P2, Phase 2

A structured process was seen as a helpful element to embark on as participants valued feeling guided and knowing what to do. Having a guide to formulate an initial goal, and writing the goal down somewhere was also essential to set up a successful ESE.

Writing down very like silly concrete things... and actually identifying like okay yeah it's actually that and not some big problem that I can't fix. P3, Phase 3

Participants greatly appreciated the tips provided on how to set up a behavioural goal. Once they defined a goal, an instrumental part was identifying barriers to achieving the set goal. Participants mentioned prompts provided as part of the prototypes to reflect on current barriers to be extremely

helpful. Such prompts had to be very concrete, actionable, and describe relevant interventions to circumvent barriers and provide sufficient guidance. The prompts reassured participants of their next steps, contributing significantly to the feeling of being guided.

Participants emphasized that any tips or guidance provided as part of the ESE tool should be actionable. They appreciated practical and relatable examples included in the prototypes and mentioned that they found general behaviour change theory too abstract to be of use.

[the tip] was a bit abstract... somehow I couldn't really relate to it. It felt a bit detached from the practical stuff that I was writing down. So, I wasn't sure what to do with it.. P5, Phase 2

2. *The need for incentives*

We also found that participants need incentives that support them when they struggle to stay motivated during the process. To track progress, participants need to define what constitutes a successful intervention. By providing a visual tool for tracking progress, participants automatically had to ask themselves how to define and measure their success. A tool component in the form of a physical tracking tool provided as part of the third prototype helped participants visually track when they completed their intervention/goal. This tool component was perceived as a great motivator, and participants interacted with it frequently. Visual progress tracking made participants feel productive and helped them quickly notice when something was not working.

I think visual tracking is very important so that you can actually see how it's going... It gives you an extra push to help you just reflect also to see if it's working or not, because if you don't do something for a while, clearly it isn't working P5, Phase 3

A visual trigger was provided as part of the prototypes to remind participants of their goal and, in extension, to do the intervention and maintain self-experimenting. This can be explicit such as presenting a written goal. It can also be implicit. For example, many participants mentioned being triggered by the prototype's envelope or seeing the instruction set on their table.

I put [the card with the goal written on it] in the bathroom so I could read it in the morning and in the evening when I was brushing my teeth. P2, Phase 3

Participants appreciated playful elements of the prototype that made the process fun, visual triggers that reminded them to stay on track, as well as components that helped visualize and celebrate progress – in short, anything that helped keep them motivated over time.

I really like the excitement. It was like Christmas to open all these little small things and see what's inside ... it was like a toy, and I think the playful feeling helps to start with it because it's easier to start if it's like a game. P2, Phase 3

Participants expressed a need for novelty and variety over time. Be it through new inspiration, new levels to be unlocked, or further questions to reflect on. Novelty appeared vital in maintaining self-experimenting over time.

I think that if there is something new every time that it really helps me to keep being engaged. P2, Phase 1

3. The need for inspiration

Participants also expressed a need for inspiration during their explorations with changing personal health behaviour. The third prototype delivered inspiration in the form of cards that, on one side, explained a behaviour change technique and, on the other side, contained quotes from past participants about how they applied different interventions and techniques.

It would be nice to see what works for other people and get inspired through that. P2, Phase 2

Besides inspiring the form of stories/examples of relatable and actionable behaviour change tactics, participants expressed a need for novel inspiration from time to time to get new ideas of what else to try.

I would like to be confronted right now, but also inspired to try things that I haven't tried ... I've used this before; it hasn't really worked in the past, it is not working again. And so, it would be nice to see other ways of trying to change my behaviour. P2, Phase 2

4. The need for personal growth

Participants needed feelings of personal growth through overcoming barriers, making progress on their behaviour change quest, or learning about themselves and influential factors. Participants viewed prompts to reflect by asking questions about barriers, enablers and personal learnings as one of the most valuable aspects of ESE. The prototypes allocated space to these reflections with open questions.

This little section saying 'What did I learn about myself?' I really liked that. And so, even if I wasn't interacting with the prototype physically, I was thinking about the question that it was asking me. P1, Phase 2

Participants indicated that the biweekly virtual interviews conducted as part of the study were highly influential to the ESE approach. The meetings helped participants articulate what they had learned and become aware of

their growth and progress. The appointment also created urgency and helped participants follow through with the interventions.

The meeting that we had last time was nice for me to express my thoughts, and even now, it kind of feels like you're speaking to someone that is there by your side and is kind of getting to know your thought process and what works. P2, Phase 2

5. The need for a resilient mindset

What we also found was that participants need a resilient mindset, because self-experimentation involves trying interventions that do not work and feeling frustrated. Participants responded positively to elements of the prototypes that helped foster this resilient mindset. For example, the materials were made to be modified using whiteboard foil and dry-erase markers, allowing participants to erase and rewrite goals. The malleability of the prototype helped reinforce that it is acceptable to make mistakes.

When setting the goal, I need to know that the goal I set might not be the actual goal. I might discover other goals that are still on the same path. P1, Phase 3

As part of the ESE process, participants were asked to come up with multiple interventions they could try out to fulfil their goals. Participants reflected that this diverging on interventions was extremely helpful as when one intervention failed, it provided an immediate alternative. It also reinforces the mindset that there are more ways to reach a goal.

I think it was nice that it sort of forced me to collect several examples for interventions that I could try. It made me look a little bit beyond the seasonal calendar. P5, Phase 2

6. The need for a personal feel

This theme encompasses the participants' need for a personal feel when interacting with the prototypes. The aesthetics and personal feel of the prototype influenced the self-worth participants placed on their behaviour change efforts. Participants expressed excitement about having a physical prototype. The tangibility, the personal aspects and being able to write things down by hand helped some participants feel attached to the prototype, describing it to be 'like a personal scrapbook' or 'journal' they liked to engage with. Participants also valued being able to personalize the prototype to their behaviour change quest.

I've spent a lot of time with it; writing in it and using it to have these kinds of conversations with myself. I feel attached to it. You know, like this is my little mental health journal. I want to keep it. It's mine. P1, Phase 2

Many participants appreciated the attention to detail in the prototype and how it affected the personal worth they attributed to their behaviour change quest.

I feel like this prototype has been crafted with care, which means that I care more about my own goals through that ... the quality of the prototype goes hand in hand with how I see my efforts in a way. P5, Phase 3

The development of the prototypes suggests that having a physical personalisable prototype out of high-quality materials can contribute to participants attributing a higher significance to their behaviour change efforts.

7. The need for flexibility

A recurring theme throughout the study was that participants value flexibility and the adaptability of interventions. This included the flexibility of adjusting goals and interventions, and the physical flexibility facilitated by the prototype. The interviews with participants showed that the prototype was missing room for exceptions. If interventions or goals were not perceived as flexible, they were given up when they became incompatible with day-to-day life. A tool that helps users create adaptable interventions, or include 'jokers' when needed, can help create a more realistic goal for implementation. This gives participants more flexibility and secures motivation over time.

Sometimes I was negotiating with myself. I was wishing for something like a joker. P2, Phase 3

Tracking progress 'on the go' was noted as a desirable characteristic by participants. Therefore, having portable tools that allow participants to continue with their experiments during a location change for a few days/weeks could help maintain the behaviour change efforts.

I like that some of these flippable checklists are smaller – so when I was staying at a friend's place for three days instead of bringing this card, I brought the smaller one. P1, Phase 3

In summary – 7 starting points for designers

The above-mentioned themes outline the core needs and values of home-office workers trying to change their health behaviours through ESE. The codes comprising each theme can be understood as requirements to consider when designing for ESE. Based on our analysis, we propose seven requirements that can be used as points of consideration or starting points for health professionals or designers who work in this context and develop ESE-based health interventions. [Figure 6](#) addresses the seven core requirements and provides concrete examples that were used in the current study.

Starting point for designers	Examples/probes
1. Provide guidance	<ul style="list-style-type: none"> • Create a structured process for self-experimentation with a clear starting point • Provide actionable tips and examples of how others have applied techniques instead of abstract behaviour change theories • Include open questions that encourage a personal reflection on one's goals and circumstances • Provide guidelines for how to formulate a specific, measurable, actionable, relevant and time-bound (SMART) behavioural goal
2. Provide Incentive	<ul style="list-style-type: none"> • Include playful elements to engage, provoke curiosity and anticipation, for example, by adding foldable or pull elements that provide 'just in time' examples • Integrate visual triggers into the physical environment as reminders for the goal/intervention, for example, let people tick off a box • Allow participants to decide what progress should look like and provide a modular element that helps to visualise this • Celebrate small achievements, for example, through provoking joy and pleasure or rewards
3. Provide Inspiration	<ul style="list-style-type: none"> • Provide examples of interventions others have found helpful • Include examples of effective behaviour change techniques such as 'define a trigger' to evoke a behaviour • Embed novelty and variety that reveal over time to keep people engaged, for example, through new behaviour change tips/examples
4. Make room for personal growth	<ul style="list-style-type: none"> • Prompt personal reflections, for example, by asking 'what did you learn about yourself?' • Schedule check-in meetings in groups or one-on-one to reflect on past experience and develop new strategies
5. Form a resilient mindset	<ul style="list-style-type: none"> • Make materials modifiable to allow participants to make mistakes • Set up malleable goals that can be adjusted along the way, for example, by letting participants erase a goal that was written down • Diverge on interventions by asking participants to brainstorm multiple options to have ones to fall back on
6. Make it personal	<ul style="list-style-type: none"> • Make the intervention tangible, for example, by providing physical tools to track progress • Leave room for personalisation of goals, interventions and tracking • Deliver high fidelity tools • Encourage hand-written commitments to the self-chosen goal
7. Provide flexibility	<ul style="list-style-type: none"> • Create room for exceptions, for example, by prompting 'When I can't fulfil my goal, I will at least...' • Make tools compact and portable so they can be carried to different locations

Figure 6. The seven requirements when designing for ESE, including examples and probes.

The examples include different elements relating to user experience, material qualities as well as the content of different prototypes.

Discussion

In this paper, we explored requirements for explorative self-experimentation (ESE) and tools that support end-users in the process to change a self-chosen health-related behaviour. Our analysis resulted in seven themes outlining core requirements that need to be considered when developing interventions, tools and methods that support ESE, which designers and health practitioners can use.

The requirements identified in this study allow focussing on empowering individuals with tools and support during the goal setting, action planning and self-reflection process of explorative self-experimentation. In this way, users can explore, test, and invent behaviour change strategies that consider their unique personal needs and contextual factors. Rather than providing users with a list of techniques to try, we focus on enabling users to reflect, make informed decisions, assess the effect of the intervention and refine the interventions in the process. We suggest interventions that apply ESE are modular and personalisable, therefore, able to be used in different user contexts. ESE interventions can contribute to the field of health behaviour change, by adding a user-led, personalized and reflective perspective to existing more quantitative methods from the quantified self approach. This explorative approach differs from other self-experimentation and single-use studies, which commonly embed elements of hypothesis testing, quantitative assessments and visual analysis (Daskalova et al. 2017; Karkar et al. 2016). Self-tracking so far often focuses on the mechanical objectivity of data, positioning the body as a kind of machine that can be objectively evaluated (Lupton 2016). However, seeing self-tracking as a form of situated objectivity acknowledges that personal and contextual factors influence the perception of data and its interpretation (Pantzar and Ruckenstein 2017). In this context, a need for personalization of tracking one's data has been pointed out (Harrison et al. 2015).

With ESE interventions, we aim to diverge from the objectivity of data and focus on evaluation through intuitive reflection, taking into account personal and contextual factors. This intuitive self-reflection is crucial, also as indicated by our participants in their post-intervention interviews. Reflection might also be seen as overarching, linking the identified themes. Therefore, tools for ESE need to balance elements that allow for personalization and flexibility while providing sufficient guidance and support in the process.

The different prototypes that were developed as part of this study facilitate goal setting, action planning, measuring progress and success, and elicit

an active reflection on these steps. These include existing behaviour change techniques that have been demonstrated to be active and effective ingredients of lifestyle interventions (Michie et al. 2013). We created and presented our prototypes in such a way that allowed users to apply and adjust them to their personal context. For instance, the inspirational cards from prototype three help users explore possible interventions that could work for them. Each card describes a behaviour change technique and includes a quote on how someone used this technique to successfully change behaviour. This provides room for user variability (Ogden 2016) and facilitates users to design an intervention with existing behaviour change techniques that fits their own needs and preferences. For example, we developed a prototype that allowed users to self-track their progress but could also be used as a reminder to work on the chosen behaviour change goal (see Figure 4). Adding examples of self-tracking techniques and systems used in everyday practice (Ayobi et al. 2018) could enable users to develop their own, custom tracking tools if needed.

Numerous digital applications have been introduced that try to support people in their behaviour change journey. In this study, we used high-fidelity physical prototypes which participants received via mail. This physical quality was appreciated by participants and evoked a personal feel. Furthermore, the structure and content of the prototypes allowed them to create personal goals, adjust interventions and goals during the process and leave space for personalizing the experience. The prototypes included elements that allowed playful interaction, such as unfolding and pulling elements that provided 'just in time' inspiration during the process. It was also noted that writing down a goal is beneficial in this context. Including such techniques has been mentioned in the context of specific stroke rehabilitation interventions where patients are asked to sign a behaviour change contract at the start to secure commitment (Taub 2012). Transferring these techniques into a product offers additional room for exploration, for example, by including the elements into the packaging design of a product (Lemke, Rodríguez Ramírez, and Robinson 2017) or developing 'pleasurable troublemakers' that include elements of friction if a determined behaviour is not performed (Laschke et al. 2013). Exploring culture-specific forms of materializing specific goals and commitments could provide further inspiration. For example, the Daruma Doll is a Japanese doll with eyes that are left blank. The user determines a goal and paints in the figure's left eye, positioning the doll afterwards in a visible location as a reminder. Once the goal is reached, the second eye is filled in (Marchforth International Ltd 2019). However, we also acknowledge that physical prototypes offer limited flexibility and quick adjustments once distributed to the user. We do realize that the potential of

digital interventions lies in interactive support that fits the participant during their journey, a level of interactivity that physical tools cannot easily offer.

Future directions

Although we believe that health interventions using ESE have a lot of potential to change behaviour using a human-centred approach, we recognize the need for more research. The effectiveness of ESE-based interventions needs to be evaluated using rigorous but agile methods. Because users in ESE select their own behaviour to change, set their own goals and apply different measures of success, evaluation of the approach is challenging. However, with tools such as sequential n-of-1 methods, micro-randomization trials or other single-case research designs, a rigorous evaluation of effectiveness can be performed (Hekler et al. 2016; Klasnja et al. 2015). ESE interventions need to be evaluated on effectiveness on different time-scales, for example, if initial successes to change health behaviour can transfer into persistent habits and a sustainable change in behaviour. In addition, further studies should explore if and how ESE can motivate people in the pre-contemplation and contemplation stage to change their behaviour (Prochaska 2008). In the current study, we derived the seven themes by testing the different prototypes with office workers motivated to change a self-chosen behaviour. People who do not intend to change their behaviour might need other processes of change before they will initiate a behaviour change approach that relies on self-experimentation and intuitive reflection as much as ESE. Similarly, participants with different characteristics such as reduced cognitive abilities, low economic status, or a more clinical population could need other tools and support to explore their behaviour change through ESE. We recommend exploring the needs and wishes of these populations in regard to self-experimentation before evaluating the feasibility of ESE in these target populations. Finally, in the next steps, we aim to explore if tangible qualities and interaction with the prototype are essential to facilitate ESE or if digital and hybrid applications evoke the same effect. Easy roll-out of more technical approaches (e.g. a smartphone app) warrants further study into the potential of such technology in the ESE context. Digital interventions offer the promise of interactivity and personalization, for example, helping participants overcome issues that they run into while self-experimenting. Digital and interactive approaches can also support playful interactions that might further stimulate adherence to the intended change to healthier behaviour.

Conclusion

Health interventions using ESE provide users with the tools and support to explore, experiment and reflect on different behaviour change techniques,

and empower users to change their self-selected health behaviour in a way that fits their preferences and their context. The seven requirements that we identified in this study can function as a starting point for health professionals and designers engaging in creating personalized and flexible behaviour change interventions that take into account these personal and contextual requirements. We believe that health intervention using ESE can help people achieve sustainable behaviour change by helping them to find what fits.

Acknowledgements

We would like to thank all the participants who took part in the study. We would also like to thank Rick Schifferstein and Boudewijn Boon who contributed to the exploration of ESE for health behaviour change.

Ethics statement

The Human Research Ethics Committee of Delft University of Technology approved this study (number 1281). Participants gave informed written consent.

Author contributions

All authors contributed to the study conception and design. AF conducted the data collection and analysis. Initial codes and themes were discussed among the remaining authors and refined. All authors contributed to the writing of the final manuscript and approved the final version.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This research was funded by the Pride and Prejudice project by the 4TU federation under Grant No. 4TU-UIT-346.

Notes on contributors

Antonia Fedlmeier is a design researcher focussing on human-centered design in healthcare. This research was part of her master thesis at the faculty of Industrial Design Engineering of the TU Delft. Currently she is employed at Designit, Oslo.

Merijn Bruijnes currently works at the Utrecht University School of Governance. Previously he worked at the Interactive Intelligence (II) group at the TU Delft and at the Human Media Interaction (HMI) group at the University of Twente. Merijn does research in Human-Computer Interaction, Behavioural Science and Social Psychology.

Marina Bos-de Vos is Assistant Professor of Strategic Design for Ecosystem Innovation at the Faculty of Industrial Design Engineering, TU Delft. She is involved in a number of healthcare transformation programs, where she investigates how professionals from

different disciplines and organizations incorporate divergent values and deal with multiple embedding contexts in their collaborative processes.

Mailin Lemke is a postdoctoral researcher focussing on the intersection of design and behaviour change interventions in health applications. Her work encompasses designing products and media design solutions for vulnerable users and users with specific health requirements. She is currently affiliated with the Industrial Design Engineering Faculty at the TU Delft. She holds a Ph.D. from the School of Design, Victoria University of Wellington in New Zealand.

Jos J. Kraal is Assistant Professor of Health Behaviour Change at the department of Human-Centered Design, Industrial Design Engineering at the TU Delft. His work focuses on understanding and changing health behaviour to prevent chronic diseases by applying human-centered design methods.

ORCID

Merijn Bruijnes  <http://orcid.org/0000-0002-7842-8213>

Marina Bos-de Vos  <http://orcid.org/0000-0001-7613-891X>

Mailin Lemke  <http://orcid.org/0000-0002-9980-4046>

Jos J. Kraal  <http://orcid.org/0000-0001-9667-6926>

References

- Ayobi, Amid, Tobias Sonne, Paul Marshall, and Anna. L. Cox. 2018. "Flexible and Mindful Self-Tracking: Design Implications from Paper Bullet Journals." In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*: 1–14.
- Braun, Virginia, and Victoria Clarke. 2012. "Thematic Analysis." In *APA Handbook of Research Methods in Psychology, Vol. 2: Research Designs: Quantitative, Qualitative, Neuropsychological, and Biological*, edited by H. Cooper, P. M. Camic, D. L. Long, A. T. Panter, D. Rindskopf, & K. J. Sher, 57–71. Washington, DC: American Psychological Association.
- Choe, Eun Kyoung, Nicole. B. Lee, Bongshin Lee, Wanda Pratt, and Julie. A. Kientz. 2014. "Understanding Quantified-Selfers' Practices in Collecting and Exploring Personal Data." In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*: 1143–1152. doi:10.1145/2556288.2557372
- Dalsgaard, Peter. 2016. "Experimental Systems in Research through Design." *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. doi:10.1145/2858036.2858310
- Daskalova, Nediya, Karthik Desingh, Alexandra Papoutsaki, Diane Schulze, Han Sha, and Jeff Huang. 2017. "Lessons Learned from Two Cohorts of Personal Informatics Self-Experiments." *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 1 (3): 1–22. doi:10.1145/3130911
- Daskalova, Nediya, Jina Yoon, Yibing Wang, Cintia Araujo, Guillermo Beltran, Jr, Nicole Nugent, John McGeary, Joseph Jay Williams, and Jeff Huang. 2020. "SleepBandits: Guided Flexible Self-Experiments for Sleep." In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*: 1–13. doi:10.1145/3313831.3376584
- Frayling, Christopher. 1993. "Research in Art and Design." *Royal College of Art Research Papers* 1 1(1993): 1–5.

- Gaver, William. 2011. "Making Spaces: How Design Workbooks Work." In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems: 1551–1560*.
- Gaver, William. 2014. "Science and Design: The Implications of Different Forms of Accountability." In *Ways of Knowing in HCI*, 143–165. New York, NY: Springer.
- Hagger, Martin. S., Susette Moyers, Kaylyn McAnally, and Lauren. E. McKinley. 2020. "Known Knowns and Known Unknowns on Behavior Change Interventions and Mechanisms of Action." *Health Psychology Review* 14 (1): 199–212. doi:[10.1080/17437199.2020.1719184](https://doi.org/10.1080/17437199.2020.1719184)
- Harrison, Daniel, Paul Marshall, Nadia Bianchi-Berthouze, and Jon Bird. 2015. "Activity Tracking: Barriers, Workarounds and Customisation." In *Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing: 617–621*.
- Hekler, Eric. B., Predrag Klasnja, William. T. Riley, Matthew. P. Buman, Jennifer Huberty, Daniel. E. Rivera, and Cesar. A. Martin. 2016. "Agile Science: Creating Useful Products for Behavior Change in the Real World." *Translational Behavioral Medicine* 6 (2): 317–328. doi:[10.1007/s13142-016-0395-7](https://doi.org/10.1007/s13142-016-0395-7)
- Hekler, Eric. B., Winslow Bursleson, and Jisoo Lee. 2013. "A DIY Self-Experimentation Toolkit for Behavior Change." In *ACM Conference on Human Factors in Computing Systems*.
- Houde, Stephanie, and Charles Hill. 1997. "What Do Prototypes Prototype?" *Handbook of Human-Computer Interaction* 1997: 367–381.
- Karkar, Ravi, Jasmine Zia, Roger Vilardaga, Sonali. R. Mishra, James Fogarty, Sean. A. Munson, and Julie. A. Kientz. 2016. "A Framework for Self-Experimentation in Personalized Health." *Journal of the American Medical Informatics Association* 23 (3): 440–448. doi:[10.1093/jamia/ocv150](https://doi.org/10.1093/jamia/ocv150)
- Karkar, Ravi, Jessica Schroeder, Daniel. A. Epstein, Laura. R. Pina, Jeffrey Scofield, James Fogarty, Julie. A. Kientz, et al. 2017. "Tummytrials: A Feasibility Study of Using Self-Experimentation to Detect Individualized Food Triggers." In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems: 6850–6863*.
- Klasnja, Predrag, Eric. B. Hekler, Saul Shiffman, Audrey Boruvka, Daniel Almirall, Ambuj Tewari, and Susan. A. Murphy. 2015. "Micro-Randomized Trials: An Experimental Design for Developing Just-in-Time Adaptive Interventions." *Health Psychology* 34 (Suppl): 1220–1228. doi:[10.1037/hea0000305](https://doi.org/10.1037/hea0000305)
- Krogh, Peter Gall, Thomas Markussen, and Anne Louise Bang. 2015. "Ways of Drifting—Five Methods of Experimentation in Research through Design." In *ICoRD'15—Research into Design across Boundaries*, Vol. 1, 39–50. New Delhi: Springer.
- Laschke, Matthias, Marc Hassenzahl, Jan Brechmann, Eva Lenz, and Marion Digel. 2013. "Overcoming Procrastination with ReMind." In *Proceedings of the 6th International Conference on Designing Pleasurable Products and Interfaces: 77–85*.
- Lee, Jisoo. 2013. "Supporting Self-Experimentation of Behavior Change Strategies." In *Proceedings of the 2013 ACM Conference on Pervasive and Ubiquitous Computing Adjunct Publication: 361–366*.
- Lee, Jisoo, Erin Walker, Winslow Bursleson, Matthew Kay, Matthew Buman, and Eric. B. Hekler. 2017. "Self-Experimentation for Behavior Change: Design and Formative Evaluation of Two Approaches." In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems: 6837–6849*.
- Lemke, Mailin, Edgar Rodríguez Ramírez, and Brian Robinson. 2017. "Limited Use Only. How Can the Design of an Everyday Object Help Chronic Stroke Patients to Overcome the Learned Nonuse of the Upper Limb?" *The Design Journal* 20 (sup1): S2397–S2417. doi:[10.1080/14606925.2017.1352754](https://doi.org/10.1080/14606925.2017.1352754)
- Lupton, Deborah. 2016. *The Quantified Self*. Cambridge: Polity Press.

- Marchforth International Ltd 2019. "We Love Daruma." *We love Daruma*. Accessed September 21, 2021. https://www.welovedaruma.com/en/about_daruma.html.
- Michie, Susan, Michelle Richardson, Marie Johnston, Charles Abraham, Jill Francis, Wendy Hardeman, Martin. P. Eccles, James Cane, and Caroline. E. Wood. 2013. "The Behavior Change Technique Taxonomy (v1) of 93 Hierarchically Clustered Techniques: Building an International Consensus for the Reporting of Behavior Change Interventions." *Annals of Behavioral Medicine* 46 (1): 81–95. doi:10.1007/s12160-013-9486-6
- Ogden, Jane. 2016. "Celebrating Variability and a Call to Limit Systematisation: The Example of the Behaviour Change Technique Taxonomy and the Behaviour Change Wheel." *Health Psychology Review* 10 (3): 245–250. doi:10.1080/17437199.2016.1190291
- Pantzar, Mika, and Minna Ruckenstein. 2017. "Living the Metrics: Self-Tracking and Situated Objectivity." *Digital Health* 3: 1–10. doi:10.1177/2055207617712590
- Phatak, Sayali Shekhar, Elaine Chen, Stephen Schueller, Richard Kravitz, Ida Sim, Christopher Schmid, and Eric Hekler. 2018. "Design of a Large-Scale Self-Experimentation Tool for Scientific Self-Explorations." *PervasiveHealth – EAI* 2018. doi:10.4108/eai.20-4-2018.2276355
- Phatak, Sayali Shekhar. 2019. "Does It Work for Me? Supporting Self-Experimentation of Simple Health Behavior Interventions." PhD diss., Dissertation Arizona State University. Tempe: Arizona State University.
- Prochaska, James. O. 2008. "Decision Making in the Transtheoretical Model of Behavior Change." *Medical Decision Making : An International Journal of the Society for Medical Decision Making* 28 (6): 845–849. doi:10.1177/0272989X08327068
- Sanders, Elizabeth B.-N, and Peter Jan Stappers. 2012. *Convivial Toolbox: Generative Research for the Front End of Design*. 4th printing ed. Amsterdam, The Netherlands: BIS Publishers.
- Sheeran, Paschal. 2002. "Intention—Behavior Relations: A Conceptual and Empirical Review." *European Review of Social Psychology* 12 (1): 1–36. doi:10.1080/14792772143000003
- Stappers, Peter Jan, and Elisa Giaccardi. 2017. "Research through Design." *The Encyclopedia of Human Computer Interaction*. 2nd Ed. <https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/research-through.-design>.
- Stolterman, Erik. 2008. "The Nature of Design Practice and Implications for Interaction Design Research." *International Journal of Design* 2 (1): 55–65.
- Taub, Edward. 2012. "The Behavior-Analytic Origins of Constraint-Induced Movement Therapy: An Example of Behavioral Neurorehabilitation." *The Behavior Analyst* 35 (2): 155–178. doi:10.1007/BF03392276
- Thabrew, Hiran, Theresa Fleming, Sarah Hetrick, and Sally Merry. 2018. "Co-Design of eHealth Interventions with Children and Young People." *Frontiers in Psychiatry* 9: 481. doi:10.3389/fpsy.2018.00481
- Visser, Froukje Sleswijk, Pieter Jan Stappers, Remko Van der Lugt, and Elizabeth B.-N. Sanders. 2005. "Context- Mapping: Experiences from Practice." *CoDesign* 1 (2): 119–149. doi:10.1080/15710880500135987
- Wensveen, Stephan, and Ben Matthews. 2014. "Prototypes and Prototyping in Design Research." *The Routledge Companion to Design Research* 2014: 262–276.