Bringing New Voices to Design of Exercise Technology

participatory design with vulnerable young adults

Kanstrup, Anne Marie; Bertelsen, Pernille Scholdan

Published in:
PDC '16 Proceedings of the 14th Participatory Design Conference

DOI (link to publication from Publisher):
10.1145/2940299.2940305

Publication date:
2016

Document Version
Publisher's PDF, also known as Version of record

Bringing New Voices to Design of Exercise Technology: participatory design with vulnerable young adults

Anne Marie Kanstrup
Aalborg University
Department of Communication and Psychology
Rendsburggade 14, 9000 Aalborg, Denmark
kanstrup@hum.aau.dk

Pernille Bertelsen
Aalborg University
Department of Development and Planning
Vestre Havnepromenade 5, 9000 Aalborg, Denmark
pernille@plan.aau.dk

ABSTRACT
Physical activity is important for people's health, but it can be challenging especially for people who are vulnerable because of mental disorders. This paper contributes to participatory approaches developed to include vulnerable people in the design of exercise technology and situates participatory design to an exercise location and exercise activities. The results expand the current design space of exercise technology, which is dominated by sports enthusiasts and persuasive strategies. Visions for digital support that mediates local social exercise horizons are presented as a design alternative. The results exemplify that a participatory approach, which includes marginalized people in the design of technology, offers new knowledge for making existing and future applications useful to a broader audience. Specifically, the results point to opportunities for opening up the design space of health-promoting technology to support the cooperation of available health resources among residents in a community with attention to people who are in a vulnerable situation.

CCS Concepts
- **Human-centered computing → Interaction design**
- **Participatory design.**

Keywords
Participatory design; vulnerable people; sport; exercise technology; methods

1. INTRODUCTION
Knowledge comes in many voices and it is a fundamental ambition for participatory design (PD) to include people with a low voice or no voice in technology production [41]. In the early Scandinavian projects, this aim was practiced by a strong commitment to broaden stakeholder participation by including workers and workplace democracy into the design of information and communication technology (ICT) normally dominated by management [4; 17]. In recent PD, this aim is found in a commitment to include people who are marginalized by global and local societies and a competitive elite-oriented technology industry [5]. We joined this commitment, and in this paper we present how we included vulnerable young adults in the design of health-promoting ICT, which, in this case, is technology designed to support exercise.

PDC '16, August 15-19, 2016, Aarhus, Denmark.
ACM 978-1-4503-4046-5/16/08.
DOI: http://dx.doi.org/10.1145/2940299.2940305

The term 'vulnerable' is a construction made by contemporary society for groups of people who are marginalized, socially excluded, have limited opportunities, suffer abuse or discrimination [26]. In health policies, people with mental disorders are defined as vulnerable since they have a high risk of early death (15–20 years earlier than the average population) due to physical and medical conditions caused by a series of risk factors, including a low physical activity level [51]. We use the term 'vulnerable' since the participants in this study were recruited based on this constructed definition. The participants were young adults (aged 18–30) who were suffering from mild depression and anxiety, and had a low level of physical activity. Their current situation defines them as vulnerable. However, their conditions are not chronic; that is, initiatives supporting health improvements are important.

The World Health Organization (WHO) has identified physical inactivity as the fourth leading risk factor of mortality worldwide [50]. At the same time, the market for digital technology designed to support exercise is expected to quadruple within the five years from 2013 till 2018. It has been estimated that wearable fitness and health technology will become the eighth largest revenue driver within consumer and mobile devices [49]. Although the general aim of exercise technology is to encourage people to increase and improve their physical activity, participatory approaches to its design are scarce. In general, research is dominated by health-behaviour-change theories and context-independent technological tests with few situated and exploratory studies that aim to understand exercise situations and exercise technology users [36]. Significantly, current research is centred on people already engaged in exercise activities while those who are challenged to exercise and are at risk of ill health and premature death due to a low physical activity level (and often other risk factors) receive little or no attention and have a limited voice in technology design. The WHO has called for the inclusion of multiple voices in the development of health initiatives [50]. The inclusion of multiple voices in design and situating technology production to facilitate the engagement of people, practices and locations of a design problem is pivotal to PD [31; 41; 43]. Therefore, the development of participatory approaches to the design of exercise technology that targets vulnerable users is a relevant strategy to pursue as a supplement to the dominating technological and theoretical approaches.

This paper presents results from a PD process with young adults suffering from depression and anxiety, who have a low level of physical activity, are living in a neighbourhood identified as a high-risk health zone and are motivated but face challenges to exercise. Our research has focused on the development of appropriate participatory methods for bringing new voices to the design of exercise technology and to gain insights to inform the future design of digital support for exercise. The study is part of a

larger investigation on how ICT can support health balance. Health imbalance is a global challenge and a prioritized area within health promotion policies [13; 50]. Digital health technology seems to reinforce this problem [42]. Thus, engaging with people who face extra challenges in improving their health is important for the designers of health promoting ICT, such as exercise technology.

2. RELATED WORK

Physical activity is defined as 'any bodily movement produced by skeletal muscles that results in energy expenditure' [9]. Exercise is physical activity that is 'planned, structured, repetitive, and purposive in the sense that improvement or maintenance of one or more components of physical fitness is an object' [9]. Most technology designed for exercise aims to support people in a planned and structured way to improve and maintain a preferred fitness level. The area of biophysical monitoring (wearables and quantified self-technologies) is rapidly emerging among professional and amateur athletes [47]. We searched for related work on exercise technology via the ACM digital library and in a follow-up thread search including papers from the last 10 years (2006–2016). In this search, we identified 24 papers presenting designs aimed at supporting exercise. We excluded papers that solely presented technical solutions and doublets of papers presenting the same research study. The following sub-sections present our analysis of related research on exercise technology and PD.

2.1 Technology designed to support exercise

Exercise technology has many forms; for example, drones designed as jogging buddies [16], yoga mats equipped with sensors and digital picture frames [32], interactive training towers designed for elite athletes [14] and interactive floating units to stimulate exercise in a swimming pool [18]. There are several examples of mobile applications ('apps') designed to track and encourage physical activity [11; 15; 37; 38; 48] and specifically jogging [16; 21; 30]. Some designs focussed on motivation by delivering rewards in the form of tasty beverages [24] or 3D prints of measured heartbeats [25]. Some papers presented technology designed to assist people in training activities via digital training schedules and virtual trainers [7; 27; 34]. Other papers presented designs supporting reflections on wellness [2; 10]. There was a broad variation of so-called 'exergames', which are designed to motivate exercise via games using avatars [1; 28; 33] and social rewards [20]. Additionally, there were empirical studies of the use of consumer technology for exercise [36; 39]. Most exercise technologies are designed for persuasive purposes using prompts, rewards, feedback, tracking and social groups to encourage people to exercise [2]. Most designs are loosely based on health-behaviour-change theories exploring features for motivating people to exercise (e.g. by setting goals and tracking activity) and supporting people when they are exercising (e.g. by the use of music) [36].

2.2 PD and exercise technology

Most of the identified papers present a technology-driven process where designers/researchers develop a design suggestion, and, in some cases, explore the design with possible future users. We have identified only five papers that presented user participation as being central to the design process. As in PD literature in general, these papers presented not only diverse definitions of participation, but also a shared understanding of users as competent practitioners and an ambition to improve the quality of technology design by engaging with and responding to human needs [19].

The design of 'social yoga mats' is presented as a 'co-design' and based on (a) initial observations and interviews with seniors in yoga classes; (b) researchers' participation in yoga classes for a few weeks; (c) an exploratory co-design session with 12 seniors from different yoga classes; and (d) a workshop with four seniors based on a developed prototype [32].

The design of interactive floating units for exercise in a swimming pool is presented as 'participatory design'. The design process consists of (a) observations of rehabilitation activities in a swimming pool; (b) workshops with a rehabilitation unit; (c) development of scenarios; and (d) prototypes explored with the participants [18].

The design of 'social features for mobile and ubiquitous wellness applications' is presented as PD where design researchers conducted (a) phone interviews; (b) a PD session (i.e. a workshop); and (c) informal observations of various daily activities [1].

The design of interactive training towers was based on (a) interviews with seven coaches of elite sport teams; (b) video observations of four different sports; and (c) a workshop with a group of elite athletes and coaches [14].

One study [36] is presented as an 'exploratory situated study' where the researchers studied the use of wearable monitoring technology in a gym to inform design with the understanding of use and non-use of exercise technology in situ. The study was based on (a) contextual interviews; (b) participant observation; and (c) dialogue during exercise in a gym.

These presented approaches to the design of exercise technology comply with the existing repertoire of PD techniques by using observations, interviews, workshops, scenarios and prototypes [31]. However, the examples also present how the participatory designers' developed exercise activities as part of the PD process. For example, a study explored various types of exercise in a 'sports camp' [14]; one set-up exercise activities in a swimming pool [18], one enrolled in yoga classes [32] and one collected data during exercise in a gym [36]. In all examples, paper, pens, post-its, conversations and the like are replaced by exercise activities facilitating a situated and mutual learning process about the design space being explored. Additionally, all papers present exercise facilities as complex settings, and stress the value of understanding the situation in which users, activities and technologies are embedded [44].

2.3 PD and vulnerable people

In the identified related work, we discovered that all cases were occupied with people already engaged in exercise activities; for example, the elderly enrolled in yoga classes [32], people with disabilities engaged in swimming activities [18], elite athletes [14], people jogging [21; 30] and people walking and going to the gym on a regular basis [1; 36]. Two papers recruited people for their design activities among academic staff [24] and employees at a larger international software enterprise [28]. These examples support the arguments that most health ICT is designed for 'people like us'; that is, 'people who believe to understand healthcare and health issues, take care of their own health, are literate, well to do, tech-savvy, and hold a tertiary qualification' [42].

National studies (from Denmark where the PD activities take place) showed that people with mental disorders have a high interest in health improvement, but that a change in lifestyle is a major challenge [45]. Consequently, policies are made for developing and investigating opportunities for supporting vulnerable people in improving their health, including exercise

[46]. However, there are no current policies or experiences with the use of technology to support vulnerable people in exercise.

Insights from contexts that are different from the ones dominating a domain are likely to reveal new knowledge and requirements that can be used to make existing and future apps more useful to a broader audience [1]. The limited attention to vulnerable people in the design of exercise technology presents a gap between technology designers and people in need of health support and, consequently, presents an opportunity for bringing new voices and new insights into the design of exercise technology.

3. METHODS

Ambitions for the empirical study presented in the following sections have been to bring

a) a methodological perspective to the design of exercise technology by contributing further development of the so far limited participatory approaches to this design space; and
b) a conceptual perspective to the design of exercise technology by replacing dominating persuasive strategies with an open interest in the exploration of human needs and supplementing a technology-driven design space with new voices.

On this basis, we have started the 'Pulse Up project' aimed to engage vulnerable people in the PD of exercise technology. The project is a co-operation between a general practice (GP), community workers and citizens in a neighbourhood identified by the national health authorities in Denmark as being a high risk health area due to a high percentage of residents at risk of or with ill health. The design process in the Pulse Up project consists of two iterations (cf. Figure 1). The first iteration focused on developing appropriate participatory methods for bringing new voices to the design of exercise technology and to gain initial insights to inform future design. The second iteration focused on exploring and manifesting design ideas.

3.1 Participants and data

The neighbourhood GP recruited 18 young adults (aged 18–30) who suffered from depression and/or anxiety and who had a low level of physical activity. Each participant received written information about the project and signed an informed consent form. The GP conducted a health test of all participants before and after the intervention; likewise, the authors conducted qualitative interviews with all participants both before and after the intervention (36 interviews).

The intervention started with a group introduction where all participants were introduced to each other, to the gym and to the planned activities. All participants started wearing an activity tracker to (a) monitor their activity level; and (b) explore consumer technology for exercise. For eight weeks the group met twice a week to do exercise with an instructor. In the first intervention, 11 young adults participated, 4 of whom wished to continue to the second iteration where 7 new participants were recruited. Community workers from the neighbourhood's health centre and a nurse from the local GP were responsible for the weekly exercise activities during the interventions. The authors were responsible for exploring exercise technology with the participants. We met with the group for one hour every week in the neighbourhood's local gym and facilitated a total of 16 PD activities (cf. Figure 1). Each intervention was concluded with an evaluation workshop. All recruited participants completed the interventions but with different degrees of participation. To support communication among the participants, a secret Facebook group was set-up. Communication within the Facebook group supplemented the qualitative interviews and the weekly participatory activities in the gym.

3.2 Setting and activities

In contrast to existing research, we had to create a safe environment since several of the participants were uncomfortable with public spaces (e.g. afraid of going to a gym that was open to the general public). Also, several participants had private concerns and bad experiences about doing exercise in public (some participants had been mocked in gym classes at school, several participants were embarrassed about their bodies, some were insecure about their physical condition and one had severe anxiety towards balls). The participants who joined the intervention were searching for a small and safe exercise network. They were attracted to the idea of exercise but were challenged by their situation. For eight weeks they met for two hours twice a week to explore various types of exercise. This included dancing, badminton, power walking, Zumba, body biking and workouts.

Our initial idea was to stage PD activities in the meeting room once a week for one hour followed by exercise activities with a professional instructor. However, this non-situated approach, sitting at tables in jeans in a meeting room talking about exercise, prompted (not surprisingly) a call for change. The participants expressed a dislike of meeting rooms and school-like environments with chairs and tables; they preferred activities in the gym. They did not like too much talking; they requested music and action. They did not like serious reflections; they hoped for amusing interactions. As we progressed, the participants increasingly felt that they were part of a group and requested social activities.

Similar to the related PD research on exercise technology, we faced a need to fuse PD activities with physical activity. Additionally, the participants needed a safe and predictable environment. Thus, exploration had to be set up with a firm structure and a predictable rhythm. Based on the lessons learned from the initial meetings with the participants, we made a set of rules for PD activities at the exercise location:

1. When in Rome, do as the Romans do: dress and do as the participants – wear *sports gear* and engage yourself.
2. Use *music* to underpin physical activity.
3. Chairs and tables are prohibited – *exercise*.
4. Create *ludic* elements and facilitate a cheerful space for sharing and exploring exercise.
5. Support *social* exercise activities (vs individual training in a gym) and group communication.
6. Be *exploratory* – use visual tangible artefacts to share and co-create insights, visions and sketches.
7. Set-up a predictable structure in all activities – create a safe environment by the use of *rhythm*.

In our earlier studies on health promotion in the neighbourhood, we learned that walking (as a supplement to talking) with participants significantly improved the PD activity by offering a mix of formal and informal interactions and situated reflections [22]. However, similar to the above experiences, we also learned that walking methods needed development if they were to be included and useful in the design process. For this reason we set up three conditions for a PD approach emphasising the need for professionalism, effectiveness and the ability to trigger design:

1. PD *professionalism* points to a fundamental request for participatory reflections. It is not enough 'just to add users and steer' [31]. The participatory designer must reflect on how to facilitate participation supporting mutual learning.
2. The *effectiveness* requested from PD methods is occupied with investment and outcome from PD activities. The participatory designer must be systematic and concerned with how to contribute to software design cycles in a resource-wise fashion.
3. The ability of methods to *trigger* design and transcend traditions is pivotal to PD. The participatory designers must be occupied with the development of 'triggers' that can facilitate a 'common language, to discuss existing reality, to investigate future visions' [12].

Together with the set of rules for PD activities at the exercise location, these three conditions formed the foundation for the development of a design cycle with progressive stages from (a) establishing a common ground among participants; to (b) attention to insights; (c) visions; (d) sketching as an ambition to converge design knowledge with the participants; (e) diverging via re-framing activities, provotyping and design alternatives; and (f) re-converging and evaluating (Figure 1).

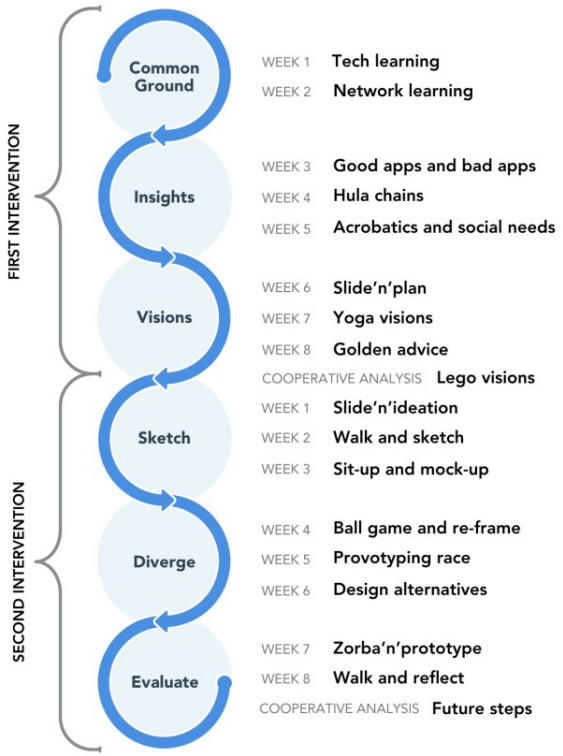

Figure 1. Design cycle.

For each stage in the design cycle, we developed participatory activities with attention to our set of rules for PD at the exercise location and the three PD conditions. To support *rhythm*, each session started with a two-minute warm-up followed by a break with water where we gathered around a 'pulseOmeter' – a visual tangible artefact developed for sharing ongoing reflections on 'how we are doing'. The pulseOmeter is a poster with a barometer ranging from red (negative) to green (positive). The poster was placed on the floor or a wall. The participants placed one sticker on the pulseOmeter as a self-assessment of their current exercise situation and afterwards shared their successes and challenges. The keywords of importance in the conversation were chosen by the participants and noted on the poster. All activities were developed as a fusion of training sessions including *music* and *exercise* combined with PD activities. The gym – the space used for PD activities – provided exercise artefacts like hula hoops, yoga mats, mirrors, a stereo, bars, benches for step aerobics, fit balls, etc. In addition, we developed a variation of artefacts as *triggers* for exploring exercise and technology design.

3.2.1 Exercise insights

We *explored* exercise apps via a technique called 'good apps and bad apps'. During recruitment we had gained knowledge about apps known and/or used by the participants for everyday health. We made a laminated card representing each of the apps identified by the participants and added a band to each card/app. These were then distributed among the participants who attached them as a tail to their pants (Photo 1).

Photo 1 and 2: Prints of exercise apps known by the participants. They were laminated, used in a race and for follow-up reflections.

The music was started and the participants raced against each other to steal apps/tails. The one with most apps/tails when the music stopped won the race. After racing, all tails/apps were placed at the floor and prioritized in stacks of good apps and bad apps (Photo 2). The conversation was recorded and the race repeated.

Photo 3 (left): Motivation and challenges for exercise combined with a hula hoop. Photo 4 (right): Yoga. Artefacts for shared reflections in the centre including (a) the pulseOmeter-poster; and (b) group goals.

We explored motivation and barriers for exercise via a technique named 'hula chains'. During the initial interviews, the participants had shared their motivations and challenges for exercise. We printed a paper for each motivation and challenge mentioned in the initial interviews. Papers were distributed on the floor in the gym. When the music started, we did a hula hoop exercises, and afterwards the hula hoops were used to prioritize and reflect about

motivations and challenges (Photo 3). The conversation was recorded and followed by more music and more hula hoop exercises. We explored social needs with acrobatics. In pairs of two, we did acrobatics to music followed by reflections on the question of 'How can we support each other?' Shared reflections on social needs and ideas were recorded and followed by music and more acrobatics.

3.2.2 Exercise visions

We explored visions for exercise via two techniques where we combined slide and yoga with conversations about how to set and maintain exercise goals for the group (Photo 4). Following the *rhythm* of all activities, we started with warm-up and self-assessment by use of the pulseOmeter. Then we started the music and exercise activities followed by water breaks with shared conversations. Shared reflections on the visions were recorded.

We explored the participants' values by asking them to share advice with people similar to themselves. We called this activity 'golden advice'. First, the participants wrote 'advice' on a piece of paper, which they crumpled into a pellet. This resulted in 14 pellets of advice that were placed into two hula hoops at each end of the gym. Second, the participants were then divided into two teams. Third, the music started a race where the goal was to steal 'golden advice' from the other team. Fourth, the team that had the most 'golden advice' when the music stopped won the game. During the water break, we unfolded and read aloud the golden advice. Shared reflections on the social needs and advise were recorded ..

3.2.3 Sketching for exercise

We worked on manifesting design ideas for the digital support of exercise by following a lifecycle iteration of sketching alternating between divergent and convergent steps [8]. We set up a series of consecutive activities to generate multiple solutions (divergence) and work towards a gradually specified understanding of the design space (convergence). We did 'walk'n'sketch' with empty wireframes and combined slide *exercise* with the design of paper mock-ups (Photo 5) to start sketching in a *social* and *exploratory* manner. We created a digital sketch of the participants' design ideas and brought this to the gym where we projected the design onto the wall to support plenum conversation. We asked the participants to use their 'gut feeling' and combined sit-ups with a walk-through where we discussed the conceptual model and actions in the digital mock-up (Photo 6).

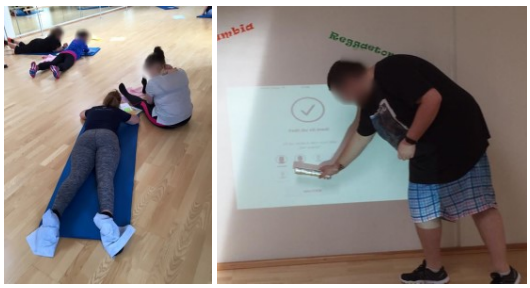

Photo 5 (left): Participants doing paper mock-ups after the slide exercise. Photo 6 (right): A participant doing a walk-through of the participants' design ideas displayed in a digital mock-up.

To support divergence and to *trigger* design, we did silly ball games and re-framing activities where the participants engaged in conversations about imaginary use scenarios like 'what if we are designing for (a) your neighbour; (b) for truck drivers; (c) for elite athletes; and (d) for elderly people?' We created a provotyping race similar to the race with good apps and bad apps (Photos 1 and 2) but with tails of the participants' identified barriers to support constructive dialogue on the challenges [29]. First, the participants noted barriers on cards attached to a tail. Second, we played music and raced to steal the tails. Third, the participants reflected on possible solutions to each card/barrier. We staged discussions about design alternatives by bringing ideas to the group. We facilitated evaluating reflections by combining Zorba dance and group walks with turn-taking activities where the participants shared their thoughts on both the present and the imagined app.

3.2.4 Evaluation and analysis

We evaluated each intervention via workshops where the participants created collages to support an open expression of experiences [40]. Data gathering and analysis followed the procedures for thematic analysis and were carried out in an iterative process where we immediately transcribed interviews and recordings from activities in the gym to support our ability to verify emerging themes and to adapt focus in subsequent activities [6]. The participants were engaged in the analysis via the iterative analytic process. Additionally, we shared analytic results with the participants halfway through the process (between the first and the second intervention; cf. Figure 1). We presented and engaged the participants in conversations about the analysis by visualizing analytic results with LEGO and Playmobile figures and by inviting the participants to reflect on the presented analysis and to reconstruct any misinterpretations, missed insights and future visions (cf. Photos 7–9). After the second intervention we engaged participants in cooperative analysis of technology visions at a two-hour workshop. We shared identified design visions and invited participants to prioritise the discovered elements and point out important future steps for design of exercise technology.

4. RESULTS

The results related to the participants' use of existing exercise technology are presented in section 4.1, and the design of future exercise technology is presented in section 4.2.

4.1 Use and non-use of exercise technology

An important insight from the project was the participants' use and non-use of existing exercise technology. The use and non-use of technology represent different forms of socio-technical practice and analysis of these forms can open up important insights for interaction designers [3].

Table 1. Exercise apps known by the participants before starting the Pulse Up intervention

Application	Know	Use
Pedometer	1	2
Apps for tracking exercise	2	4
Apps for calorie counting	2	1
Websites with information about weight loss and recipes	3	2
Apps with exercise instructions	6	1

Table 1 lists exercise apps known and used by the participants before beginning the Pulse Up project. Apps known by some of the participants include pedometers (wearables and pedometers in mobile phones), apps for tracking exercise (the Danish app Endomondo is used by four of the participants and two have tried

the app once), apps for calorie counting (Lifesum, Foodlog, MyFitnessPal) and various websites were used to browse for information about healthy food, recipes and weight loss. Six participants had once used apps with exercise instructions (SevenMinutes and YouTube channels) and one participant was using an app with instructions for mindfulness.

4.1.1 Non-use of apps

A general important finding is that the amount of known apps (middle column in Table 1) exceeded the amount of used apps (right column in Table 1). The majority of the participants reported the non-use of exercise apps when asked, 'Do you know of or use apps for exercise or health in general?' Examples of answers are: *'I know that there are many apps but I don't use them'; 'My sister uses a lot of apps for health but I don't'; 'I know Endomondo and apps for calorie counting. There are so many apps but I don't use them'; and 'I have a lot of apps to support healthy living but I don't use them.'*

An investigation of accounts related to the non-use of apps indicated that non-use was only in two cases voluntary and characterised by active resistance: *'I know that there are apps for calorie counting but I don't have the patience for it';* and *'I simply don't find it relevant to measure your exercise and, for example, monitor your daily steps.'*

The majority of accounts related to the non-use of exercise apps presented cumbersome interaction and problems of applying apps to everyday life situations:

'I have all of them I just don't use them. I have Endomondo, MyFitnessPal and you name it. I have tried so many apps and set up a profile on all of them but I have never used them. Somebody always tells me that it is smart and then I think that I have to try it and then I never get to use it because I cannot figure out what to do and if I need to spend too much time to get started and ask people for help and so on then it becomes complicated and then I give up'.

'I don't remember the name of the app but I tried to set up a profile but it was very confusing and then I dropped the plan and deleted the app'.

In the good apps and bad apps activity, where we went through apps known by the participants (Photos 1 and 2), the participants easily identified 'bad apps'. However, when asked to pick a 'good app' and explain their choice, the participants presented their visions for future health improvements and how they wished that selected apps could support this (i.e. the apps were presented as a means to a desired health outcome). For example: *'This YouTube channel has so many videos with nice instructions. We could all use this at home and share experiences with each other';* and *'I picked this one because I wish that we can all find and share recipes and support each other in weight loss'.*

4.1.2 Use of apps

The participants who used existing exercise apps (right column in Table 1) described their use as on/off and ad hoc. For example:

'I don't use MyFitnessPal everyday but more on an on/off basis. At work I am in a group where we sometimes count calories so I use it in these periods'.

'I use the Apple Health app. It tracks my daily steps and distance. All I have to do is to keep my phone in my pocket. I don't look at it every day but sometimes I open the app. It is fun'.

All participants wore an activity tracker during each intervention, which included a smart phone app where they could see their own steps and a ranking list with members in the group. We evaluated this use in the concluding interviews and during weekly conversations around the pulseOmeter. The participants used the activity tracker app approximately twice a week during the project. None of the participants significantly improved their activity level or physical fitness during the intervention, but they did remark that they had become more aware of physical activity in their daily life. Four of the participants wished to continue using an activity tracker after the eight-week intervention. 14 participants wished to stop using the tracker. Four participants felt that the tracker was *'controlling'*; three explained the monitoring as a burden to keep up with goals set by the tracker (e.g. *'counting steps is too much pressure'*). One participant explained that the tracker intensified obsessive-compulsive disorders (OCD): *'I have OCD and it means that I have several number systems and the activity tracker influences this in a negative way'.* This experience of control caused these participants to stop using the tracker immediately after the end of the project; whereas others stopped at that point because of disinterest.

Competition is fundamental to most exercises and, probably for this reason, it is a common mental model in existing exercise technology. However, experience from the use of the activity trackers' ranking list showed that this only motivated a minority of the participants (4 of the 18). Notably, these four participants were at the top of the ranking list and all expressed how competing against others motivated them while individual use was less interesting to them; for example: *'The ranking list for the group is the feature that I use most. If it was only me and my data it would not interest me, but competing against others is great fun. Now when the project stops it becomes less interesting'.*

When asked about competition and the ability to share data with others in the group, the majority of the participants (14 out of 18) shared that their disinterest was related to their low performance and an experience of failure; for example: *'I am so behind in the ranking list that my fighting spirit is completely gone'*; and *'I don't use the ranking list because I have the lowest score'.*

4.1.3 Unexpected use

The Facebook group was, to our surprise, the best digital support for exercise during the interventions, according to the participants. The fact that Facebook allowed them to communicate with fewer constraints (compared to data sharing and ranking lists supported by the activity tracker) was emphasized as being essential: *'We can all see the same posts, for example, sudden opportunities to join a walk or a tour to the gym'.* Following others' achievements was presented as a primary motivation by the 14 participants who did not appreciate the activity tracker's ranking list. An example of how the Facebook group functioned as a type of motivating technology for exercise was explained: *'It reminds me that I must exercise because every day I can see someone in the group doing some kind of exercise and then I think "Pulse, I better go for a walk or something" and then I walk and if it rains I walk in front of the TV. When I see the Facebook group it reminds me that I must exercise'.*

The participants posted encouragement, accomplishments, appreciation and apologies in the Facebook group: *'Thanks for a great power walk. You made my day'*; *'Sorry, I missed it today. Fell asleep and just woke up'*; and *'who will join me in the gym at 12?'*. The participants who were most challenged to participate presented the Facebook group as a chance to participate from home; for example: *'It was so nice that I could see the photos*

from the walk last Thursday. I just could not go but I could follow the activities and it made me happy to see that you were there and to be part of the activities in that way'. In the 'social needs' activity, the participants presented the Facebook group as a *'safe zone'*. A safe zone was expressed as being essential and was described as local (close to home) and tolerant (people of like mind). For example: *'Our secret Facebook group is the best because we can share things that others cannot see. Nobody can see the ugly photos. We can be sweaty and have a big bum and no one judges you and thinks "oh my God". It is safe to share'.*

4.1.4 Implications

The participants' low and non-use of existing exercise apps caused by experiences of cumbersome interaction and problems of applying apps to everyday life situations identifies a gap between exercise technology and the needs of the participants.

The participants stated that exercise apps were used ad hoc as a means to a desired health outcome. This supplements existing research, which indicates that people rarely change their behaviour because of technology, but they use technology in situations where they wish to make a change [39]. Tracking technology created increased awareness for most participants, but was problematic and controlling for those with OCD. Competition is a fundamental part of exercise and exercise technology; however, the majority of the participants were discouraged by seeing themselves as bad performers compared to others in the group. These findings support calls for research into design alternatives for health information management [23; 42].

The participants in the group experienced Facebook as the most supportive exercise technology and emphasized a need for local social exercise horizons. The appreciation of social support for exercise is also found in existing research [1; 2; 10; 30; 52]. However, findings from this study supplement the existing research with a specific call for tolerant and local social horizons (in contrast to worldwide performance communities).

4.2 Exercise challenges and design visions

An important finding related to exercise was that it was not the exercise itself that was a challenge to the participants. During the two interventions we explored various types of exercise and found that the series of sub-activities, which must be done before exercise, were the primary barriers to the participants. One participant explained:

'In my world, exercise is a tremendous activity because there are so many things related to exercise and it is really difficult for me to manage all these little things. You need to bring a change of clothes. You need to get out of the house. You need to walk to the gym. Then you do the exercise and after that you need to shower, do your hair and all that. There are so many things related to exercise that makes me think that it is easier just not to go'.

Although the exercise activities took place in the local gym close to where the participants lived, they considered the distance to be immense. The weekly conversations around the pulseOmeter referred to ongoing difficulties related to leaving the house: *'It is difficult to get out of the house'*; *'the weather is bad'*; *'I don't know why but it is so hard for me to get out of the house'.* There were the most dominating challenges addressed by the participants.

In the 'hula chain' activity (Photo 3) this barrier to exercise was verified as *'leaving the house'*. The participants suggested *'being part of a group'* as the most important instrument to support exercise since the group encouraged the process of getting out of the house: *'We all have this thing that it is difficult to get out of the house and then it helps when you know that others are on their way too'.* Another participant expressed concerns during the evaluation of the first intervention: *'I need something that reaches out for me in what I do otherwise I won't see anything through. The exercise activities on Tuesdays and Thursdays have done that for me. I know it will be difficult now'.*

All the participants were in a somewhat liminal phase motivated to improve their physical fitness but were challenged in its accomplishment. The transition from home to the gym, and from a very low physical activity level to increased physical activity was their goal and they called for technology to support them in this transition. We identified these barriers as 'the liminal phase of exercise' and engaged the participants in the creation of visions and sketches for this design challenge.

4.2.1 Visions: drag, peep and join

As part of the co-operative analysis, we displayed 'the liminal phase of exercise' to the participants by setting up a long road of LEGO. We asked the participants to verify, elaborate or revise this understanding and to create visions for this design challenge by the use of Playmobile figures (Photos 7, 8 and 9).

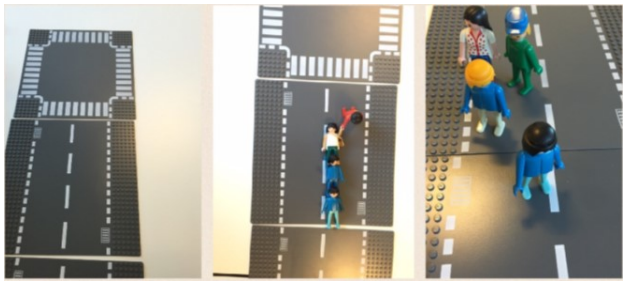

Photo 7 (left): The difficult road of exercise with an empty end and blocked vision. Photo 8 (middle): The vision of a friend dragging friends to exercise. Photo 9 (right): The vision to 'peep' and 'join' exercise activities.

The participants said that the liminal phase of exercise was difficult because it involved a series of preparing sub-activities. It was particularly difficult when their vision was blocked and they could not see the horizon at the end of the road. One participant explained: *'This road is easy if I can see something at the end'.* Another participant commented: *'...but, in the beginning you hated going to the gym and now you just do it'* and the first participant responded *'yes, but that is because we go together. I can see YOU at the end'.* The participants created three visions to meet 'the liminal phase of exercise':

<u>Vision #1</u> was coined 'drag' and displayed with one miniature figure dragging three others. A participant explained: *'This is a solution. Here is a person who wants to exercise but he is afraid of going to the gym on his own. None of his exercise friends have the strength to go so he drags them, one by one, all the way to the gym'.*

<u>Vision #2</u> was occupied with the ability to keep an eye on the activities of the group members. Who is planning exercise today? Who is in the gym? We named this vision 'peep' since it was related to a desire for an ongoing at-a-glance view to opportunities for exercise; that is, possibilities to see exercise horizons. One participant explained: *'Often I wish to exercise but cannot pull myself together. When I see that others are at the gym, for example, when I can see your plans and photos in the Facebook group, then I feel like going. Then I feel that it's not exercise but that I can just go and say hi and hang out with you and maybe also do some exercise'.*

Vision #3, coined 'join', was developed on top of the peep-vision and presented a call for easy ways to join exercise activities. The participants emphasized the importance of supporting fluent participation; that is, opportunities to keep an eye on exercise opportunities ('peeping') and 'join'.

4.2.2 Sketches: fluent, cooperative, resources

We engaged in various sketching activities to explore how to design digital support for 'dragging', 'peeping' and 'joining' exercise (cf. Figure 1). In these activities, most conversations dealt with a delicate balance related to the visions; that is, acceptable ways of dragging group members to exercise, peeping into others' exercise activities and joining exercise activities.

Examples of rough initial sketches developed during the process of exploring opportunities of how to 'drag' friends to exercise are shared in Photo 10. The sketches visualize the participants' ideas for smartphone functionality supporting easy ways to take the initiative to exercise and easy ways to invite friends to join. The sketching activities highlighted attention to the importance of dynamics in exercise groups – the importance of a design that supports mutual interests but diverse resources. Some participants stated that they would never be able to take the initiative to exercise. However, they hoped for and would definitely join activities if possible. Other participants shared that they would be happy to initiate activities that others could join: *'I feel committed if I have invited people to an activity like an evening walk. I often do this in our Facebook group. I need to have these commitments and I need to have others that can help me stay committed'.*

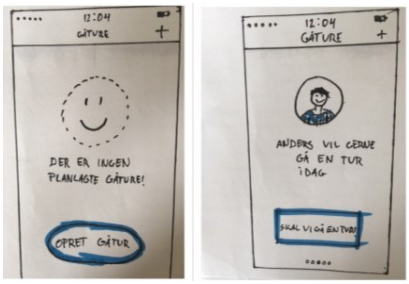

Photo 10: Sketches exploring how to 'drag' friends to exercise. Left: The screen displays the text 'there are no planned walks' and the button 'create a walk'. Right: The screen displays the text 'Anders wants to go for a walk today' and the button 'let's go for a walk'.

The most important finding during the sketching of 'dragging-functionality' was the need for an acceptance of fluent participation. The participants were all challenged in their everyday life; commitment was difficult and was accompanied by concerns about failing to meet obligations. One participant explained: *'I never commit myself to anything because I hate myself when I have to cancel, which often happens, but if somebody knocked on my door and asked if I wanted to join I would go'.* While inclusive functionality is a positive ideal, the risk of creating a feeling of failure among the participants who cannot meet invitations is a challenge that calls for easy and acceptable ways to decline invites and support the tolerance called for by the participants (cf. section 4.1.4). Smartphone sketches, as in Photo 10, were presented by the participants as *'nice'*; however, calling attention to the importance of easy and polite opportunities to refuse to be 'dragged'. One participant explained:

'Something like this [Photo 10] *makes it easy. In the Facebook group you need to explain and think about your choice of words and it can be complicated. This design makes it easy if we just remember polite buttons'.*

Examples of rough initial sketches developed in the process of exploring opportunities to 'peep' and to 'join' are shared in Photo 11. The sketches visualize smartphone functionality supporting easy access to ongoing and upcoming exercise activities and opportunities to join these.

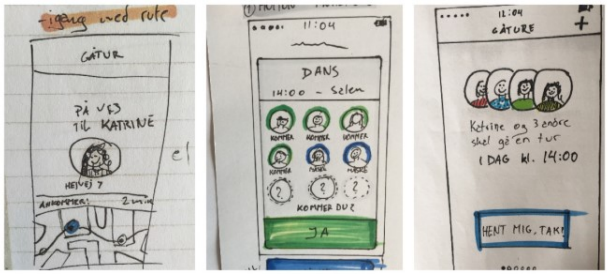

Photo 11: Sketches exploring how to 'peep' and 'join' exercise. Left: The screen displays the text 'walk', 'on the way to Katrine' and a map with a route. Middle: The screen displays the text 'dance', with circles representing people signed into the exercise activity with the text 'are you joining us?' and the buttons 'Yes' and 'No'. Right: The screen displays the text 'walk' and 'Katrine and 3 others are going for a walk today at 14:00' and the button 'Please pick me up'.

The provotyping activity (cf. Figure 1) especially challenged the design for these functionalities. While the participants requested a tolerant environment with acceptance of fluent participation, they felt provoked by passive participants who were primarily 'peeping'. This resulted in requirements for active participation defined as active at least once a month and being deleted from the group if passive for more than three months. A local social exercise group is not a virtual community for sharing information as supported by several existing apps. Rather, a local social exercise group relies on the participants' contribution of their available resources (or participation in, or initiatives to, exercise with peers). The design of digital support for the participants to cooperate around available exercise resources was the overall requirement for the design of local social exercise horizons.

4.2.3 Implications

The participants' visions for exercise technology differed from their known ad-hoc and non-used exercise apps since they did not prioritize tracking and competition, health information and exercise instructions (cf. Table 1). They created visions for digital support to mediate local social exercise horizons. Table 2 summarises the difference between the participants' known exercise technology and their visions for future designs. This reminds technology designers that people intended as the users for designs (in this case vulnerable people) can indeed contribute with original design ideas [8].

While the visions seem simple at the outset, the sketching activities revealed a need to work with a fine balances of how to initiate, join, decline, orient towards and share exercise activities. These findings are supported by related work, which highlights the relevance of digital support to form exercise groups at a local level (i.e. the same post-code) in contrast to worldwide communities [52]. Most significantly, the findings supplement related research that emphasise the potential of collectivistic health promoting tools where users develop capacity by cooperating with people in their local community [35]. This perspective is a new approach to exercise technology (cf. section

2). The created visions move beyond an understanding of exercise technology as simply information apps, towards an ambition to design digital mediators of community health resources.

Table 2. The participants' visions for the design of exercise technology (right column) related to design known by the participants (left column, cf. section 4.1)

Known design	Visions for design
Counting, monitoring and competing with exercise data	Fluid cooperation around available exercise resources
Browsing the world wide web for health information	Peeping at the local exercise horizon
Exercise instructions	Drag peers and/or join local exercise opportunities

Results from the PD process will be digitalized and implemented in cooperation with the health centre to support local social exercise networks among residents in the neighbourhood.

5. CONCLUSIONS

Physical activity is important but difficult, especially for people who are vulnerable because of mental disorders. This study has contributed with (a) a methodological perspective of participatory approaches to include vulnerable people in the design of exercise technology and (b) a conceptual perspective of the design of exercise technology to replace dominating and persuasive strategies with visions for design that mediate community health resources. The study confirms a suspected gap between existing exercise technology and the participation of vulnerable young adults, and supports a call for design alternatives of exercise technology and the importance of interaction designers to reach out to marginalized people in need of functional health support.

The design process developed and explored a series of techniques created to situate PD to an exercise location and to exercise activities. The set of rules identified for PD activities at the exercise location outline important constraints for participatory designers entering the design space of exercise technology. Developing approaches that fuse PD activities and exercise is an interesting challenge.

The long-term participatory process allowed the authors to become immersed in the exercise situation. As we progressed, we experienced a decreased motivation to exercise but an increased motivation to meet with the group of young adults. Although it is difficult to make generalizations beyond the group of participants, our experience suggests that several findings from the study are relevant to a larger target group.

6. ACKNOWLEDGEMENTS

TrygFonden supports the Pulse Up project. Thanks to all the participants and the partners in the PulseUp project.

7. REFERENCES

[1] Ahtinen, A. et al. 2009. Designing Social Features for Mobile and Ubiquitous Wellness Applications. *MUM09,* Article No. 12. Doi: 10.1145/1658550.1658562.

[2] Baumer, E. et al. 2012. Prescriptive persuasion and open-ended social awareness: expanding the design space of mobile health. *CSCW'12,* ACM, New York, NY, 475-484. Doi: 10.1145/2145204.2145279.

[3] Baumer, E. et al. 2015. Why study technology non-use? *First Monday*, 20, 11 (Nov. 2015). Doi: 10.5210/fm.v20i11.6310.

[4] Bjerknes, G., Ehn, P., and Kyng, M. 1987. *Computers and Democracy – A Scandinavian Challenge.* Avebury, Aldershot, England.

[5] Björgvinsson, E., Ehn, P. and Hillgren, P.A. 2010. Participatory design and "democratizing innovation". *PDC '10*. ACM, New York, NY, 41-50. Doi: 10.1145/1900441.1900448.

[6] Braun, V. and Clarke, V. 2006. Using thematic analysis in psychology. *Qual. Res. Psychol.* 3, 77-101. Doi: 10.1191/1478088706qp063oa.

[7] Buttussi, F., Chittaro, L., and Nadalutti, D. 2006. Bringing mobile guides and fitness activities together: a solution based on an embodied virtual trainer. *MobileHCI'06*. ACM, New York, NY, 29-36. Doi: 10.1145/1152215.1152222.

[8] Buxton, B. 2007. *Sketching User Experiences – Getting the Design Right and the Right Design*. Morgan Kaufmann, Elsevier, San Francisco, CA.

[9] Caspersen, C., Powell, K., and Christenson, G. 1985. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. *Publ. Health Rep.* 100, 2, 126-131.

[10] Choudhury, M.D. et al. 2013. "Moon phrases": a social media facilitated tool for emotional reflection and wellness. *PervasiveHealth'13*. IEEE, 41-44. Doi: 10.4108/icst.pervasivehealth.2013.252106.

[11] Consolvo, S. et al. 2006. Design requirements for technologies that encourage physical activity. *CHI 2006*. ACM, New York, NY, 457-466. Doi: 10.1145/1124772.1124840.

[12] Ehn, P. and Sjøgren, D. 1991. From system descriptions to scripts for action. In *Design at Work: Cooperative Design of Computer Systems*, J. Greenbaum & M. Kyng, Eds. Lawrence Erlbaum Associates, Inc., Aarhus, Denmark, 241-268.

[13] EU. 2016. European Portal for Action on Health Inequalities. The European Union. http://www.health-inequalities.eu/.

[14] Fogtmann, M., Grønbæk, K., and Ludvigsen, M. 2011. Interaction technology for collective and psychomotor training in sports. *ACE 2011*. ACM Press, New York, *NY,* Article No. 13. Doi: 10.1145/2071423.2071440.

[15] Fritz, T. et al. 2014. Persuasive technology in the real world: a study of long-term use of activity sensing devices for fitness. *CHI '14*. ACM, New York, NY, 487-496. Doi: 10.1145/2556288.2557383.

[16] Graether, E. and Mueller, F. 2012. Joggobot: a flying robot as jogging companion. *CHI'12*. ACM, New York, NY, 1063-1066. Doi: 10.1145/2212776.2212386.

[17] Greenbaum, J. and Kyng, M. 1991. *Design at Work: Cooperative Design of Computer Systems*. Lawrence Erlbaum Associates, Hillsdale, New Jersey.

[18] Grönvall, E., Marti, P., Pollini, A., and Rullo, A. 2006. Active surfaces: a novel concept for end-user composition. *NordiCHI 2006.* ACM, New York, NY, 96-104.

[19] Halskov, K. and Hansen, N. B. 2015. The diversity of participatory design research practice at PDC 2002-2012. *Int. J. Hum. Comput. Stud.* 74, 81-92. Doi: 10.1016/j.ijhcs.2014.09.003.

[20] Hamilton, I., et al. 2012. Walk2Build: A GPS game for mobile exergaming with city visualization. *MobileHCI '12.* ACM, New York, NY, 17-22. Doi: 10.1145/2371664.2371670.

[21] Hao, T., Xing, G, and Zhou, G. 2015. RunBuddy: A Smartphone system for running rhythm monitoring. *UbiComp'15*. ACM, New York, NY 133-144. Doi: 10.1145/2750858.2804293.

[22] Kanstrup, A. M., Bertelsen, P., and Madsen J. 2014. Design with the feet: walking methods and participatory design. *PDC '14*. ACM, New York, NY, 51-60. Doi: 10.1145/2661435.2661441

[23] Kanstrup, A. M. 2014. Design concepts for digital diabetes practice: design to explore, share and camouflage chronic illness. *International Journal of Design,* 8, 3, 49-60.

[24] Khot, R.A. et al. 2015. TastyBeats: designing palatable representations of physical activity. *CHI 2015.* ACM, New York, NY, 2933-2942. Doi: 10.1145/2702123.2702197.

[25] Khot, R. A., Mueller, F., and Hjorth, L. 2014. SweatAtoms: materializing physical. IE 2013. ACM, New York, NY, Article No. 4. Doi: 10.1145/2513002.2513012.

[26] Larkin, M. 2009. *Vulnerable Groups in Health and Social Care*. Sage, London, UK.

[27] Lessel, P. et al. 2014. OmniSports – encouraging physical activities in everyday life. *CHI 2014.* ACM, New York, NY, 2413-2418. Doi: 10.1145/2559206.2581344.

[28] Lin, J. et al. 2006. Fish'n'Steps: encouraging physical activity with an interactive computer game. *Ubicomp 2006,* Springer, Berlin, Germany, LNCS 4206, 261-278. Doi: 10.1007/11853565_16.

[29] Mogensen, P. 1992. Towards a prototyping approach in systems development. *Scand. J. Inform. Syst.* 3, 31-53.

[30] Mueller, F.; S. O'Brien and A. Thoregood (2007). Jogging over a distance. *CHI 2007.* ACM, New York, NY, 1989-1994. Doi: 10.1145/1240866.1240937.

[31] Muller, M. and Druin, A. 2012. Participatory design – the third space in human-computer interaction. In *Human-Computer Interaction Handbook,* J. A. Jacko, Ed. 3rd edition. CRC Press, Boca Raton, FL, USA, 1125-1153.

[32] Nagargoje, A., Maybach, K., and Sokoler, T. 2012. Social yoga mats: designing for exercising/socializing synergy. *TEI 2012.* ACM, New York, NY, 87-90. Doi: 10.1145/2148131.2148151.

[33] Nguyen, E. et al. 2014. Fitnamo: using bodydata to encourage exercise through Google Glass. *CHI EA 2014.* ACM, New York, NY, 239-244. Doi: 10.1145/2559206.2580933.

[34] Park. T. et al. 2013. ExerSync: interpersonal synchrony in social exergames. *CSCW '13.* ACM, New York, NY. 27-30. Doi: 10.1145/2441955.2441963

[35] Parker, A. and Grinter, R. 2014. Collectivistic health promotion tools: accounting for the relationship between culture, food and nutrition. *Int. J. Hum. Comput. Stud.* 72, 185-206. Doi: 10.1016/j.ijhcs.2013.08.008.

[36] Patel, M. and O'Kane, A. 2015. Contextual influences on the use and non-use of digital technology while exercising at the gym. *CHI 2015*. ACM, New York, NY, 2923-2932. Doi: 10.1145/2702123.2702384.

[37] Purpura, S. et al. 2011. Fit4Life: the design of a persuasive technology promoting healthy behavior and ideal weight. *CHI 2011,* ACM, New York, NY, 423-432. Doi: 10.1145/1978942.1979003.

[38] Rooksby, J. et al. 2015. Pass the ball: enforced turn-talking in activity tracking. *CHI 2015,* ACM, New York, NY, 2417-2426. Doi: 10.1145/2702123.2702577.

[39] Rooksby, J. et al. 2014. Personal tracking as lived informatics. *CHI 2014.* ACM, New York, NY, 1163-1172. Doi: 10.1145/2556288.2557039

[40] Sanders, L. 2000. Generative Tools for Co-designing. In *Collaborative Design - Proceedings of CoDesigning 2000,* S. A. R. Scrivener, L. J. Ball, and A. Woodcock, Eds. Springer, London, UK, 3-12.

[41] Simonsen, J. and Robertson, T. 2012. *Routledge Handbook of Participatory Design*. Routledge, London, UK.

[42] Showel, C. and Turner, P. (2013). The PLUproblem: are we designing personal ehealth for people like us? *Stud. Health Tech. Informat.* 183, 276-280.

[43] Suchman, L. 2002. Located accountabilities in technology production. *Scand. J. Inform. Syst.* 14, 2, 91-105.

[44] Suchman, L. 1987. *Plans and Situated Actions: The Problem of Human-Machine Communication.* Cambridge University Press, Cambridge, UK.

[45] Sundhedsstyrelsen. 2014a. *Den Nationale Sundhedsprofil 2013.* Sundhedsstyrelsen, Copenhagen, Denmark.

[46] Sundhedsstyrelsen. 2014b. *Struktur på sundheden – inspiration til sundhedsindsatser til borgere med psykiske lidelser.* Sundhedsstyrelsen, Copenhagen, Denmark.

[47] Swan, M. 2012. Sensor Mania! The internet of things, wearable computing, objective metrics, and the quantified self 2.0. *J. Sens. Actuator Netw.* 1, 3, 217-253. Doi: http://dx.doi.org/10.3390/jsan1030217.

[48] Tajadura-Jiménez, A. et al. 2015. As light as your footsteps: altering walking sounds to change perceived body weight, emotional state and gait. *CHI 2015*, ACM, New York, NY, 2943-2952. Doi: http://dx.doi.org/10.1145/2702123.2702374.

[49] Walker, S. 2013. *Wearable Technology – Market Assessment. An IHS Whitepaper*. IHS Electronics & Media, London, UK.

[50] WHO 2014. *Twelfth General Programme of Work: Not Merely the Absence of Disease.* World Health Organization, Geneva, Switzerland.

[51] WHO 2016. *Information Sheet: Premature Death Among People with Severe Mental Disorders.* World Health Organization, Geneva, Switzerland.

[52] Wu, M., Ranjan, A., and Truong, K. 2009. An exploration of social requirements for exercise group formation. *CHI 2009*, ACM, New York, NY, 79-82. Doi: http://dx.doi.org/10.1145/1518701.1518714.