

# MyReDiary

## Exploring the design for supporting adherence to physical rehabilitation

Jeppe Boutrup, Kenni Odelheim, Tomas Sokoler

Interaction Design Group  
IT University of Copenhagen, Denmark  
[jeppeboutrup@gmail.com](mailto:jeppeboutrup@gmail.com), [kenni@odelheim.dk](mailto:kenni@odelheim.dk),  
[sokoler@itu.dk](mailto:sokoler@itu.dk)

Naveen L Bagalkot

Srishti Labs, Srishti School of Art, Design and  
Technology, Bangalore  
India  
[naveen@srishiti.ac.in](mailto:naveen@srishiti.ac.in)

**Abstract**— Previous work has indicated how the three concepts, collaborative articulation, self-monitoring and social scaffolding, can guide the design of digital technology for supporting adherence to physical rehabilitation. In this paper we further explore the possibilities through building an interactive sketch of MyReDiary and employing it to collaboratively explore how the design features informed by the three concepts can support the rehabilitees to adhere to the prescribed therapy. We present our findings in the form of three assertive statements: Annotating the self-monitored data enhances collaborative articulation; Rating and retrieving self-perceived pain levels throughout the therapy enhances self-monitoring; and Supporting the synergy between social interaction and physical exercising enhances social scaffolding. While the first statement confirms the design rationale of prior work, the latter findings point to new directions for future research exploring the design for physical rehabilitation.

*Collaborative Articulation; Self-monitoring; Social Scaffolding; Concept Driven IxD Research; Physical Rehabilitation; Incremental Design*

### I. INTRODUCTION

The increasing cost of institutional healthcare to society has triggered an ever-growing interest in enhancing the quality of care beyond the boundaries of a clinic. Case in point is physical rehabilitation. Broadly a rehabilitation process involves periodic sessions at the clinic where the rehabilitees<sup>1</sup> perform the exercises under the guidance of the physiotherapists. In between these periodic sessions, the rehabilitees are encouraged to perform the exercises at home, which is a key element of being successfully rehabilitated.

However, it is difficult for the rehabilitees to perform the exercises at home consistently due to reasons such as low perceived severity of symptoms, perceived ineffectiveness of the intervention, lack of integration with activities of daily living (ADL), and lack of consistent support from therapists and friends and family [3].

Thereby initiatives within the field of HCI have emerged aimed at supporting the rehabilitees to adhere to their therapy when at home [1,4,5,6,7,13,14]. Within this emerging body of work, we align with works that explore the design of digital technology for physical rehabilitation informed by three

concepts: collaborative articulation [1,14], self-monitoring [1,6,7,13], and social scaffolding [4,5].

In this paper we continue the exploration of an early sketch and scenario of MyReDiary, a personal device aimed to support the three concepts. We built and implemented an interactive sketch of the previously envisioned MyReDiary [1] in the form of a Flash based mock-up on an android tablet (Motorola Xoom). This artifact was employed to inform and shape a focus group session with therapists and rehabilitees at a physical rehabilitation clinic. Following a concept-driven interaction design methodology [15] we present our findings from this exploration in the form of three-assertive statements: a) Annotating self-monitored data enhances collaborative articulation; b) Rating and retrieving self-perceived pain levels throughout the therapy enhances self-monitoring; and c) Supporting the synergy between social interaction and physical exercising enhances social scaffolding.

We offer these situated findings as a qualitative enhancement of the understanding of the possibilities offered by the three concepts. The first finding confirms the early understanding as introduced in [1]. However, we offer the latter two findings as pointing to two new possible directions the emerging body of works can take to explore the design of digital technological tools for supporting self-monitoring and social-scaffolding, respectively.

### II. BACKGROUND

The practice of physical rehabilitation is increasingly focusing on the context of the individual rehabilitees to encourage adherence. To support the rehabilitees perform exercises at home, the physiotherapists are prescribing individual rehabilitation procedures and goals that are conducive for the rehabilitees to integrate them with their everyday routines at home [8,10,11]. These therapy procedures are created in close collaboration with the rehabilitee to understand the specific context where the rehabilitee exercises at home [9].

We structure the emerging body of works supporting rehabilitee adherence according to the concepts they aimed to support. We are not aiming for taxonomy of the related work, but the following three concepts inform and locate our design explorations of MyReDiary within the emerging body of works.

---

<sup>1</sup> People undergoing physical rehabilitation

1. Collaborative articulation: Gathering materials about exercising at home to share and discuss with therapists at clinic [1,14].
2. Self-monitoring: Monitoring how one performs the exercises and becoming aware of ones progress in the rehabilitation process [6,7,13].
3. Social scaffolding: Taking advantage of peers and friends to encourage a rehabilitee to perform exercises [4,5].

In summary, the field has identified how supporting the three concepts can guide the design in support of rehabilitee adherence. Collaborative articulation is oriented towards resolving the gap between the rehabilitees and therapists, as rehabilitees may have trouble sharing their experiences with the therapist. Self-monitoring supports the rehabilitees in obtaining a better understanding of their situation and motivating them to follow the exercise regime, as progress is made clearer. Social scaffolding enables the rehabilitees to form social ties amongst peers, as a lack of team spirit may result in lack of adherence.

#### A. Method

In this paper, we used Flash, HTML and a Motorola Xoom tablet to sketch [2] an interactive manifestation of MyReDiary. The sketch (see figure 2, 3) was presented to a focus group (see figure 1) consisting of two therapists (Susan & Marie) and three rehabilitees (Charlotte, Thomas & Kimmie) who took turns to use the sketch and discuss the possibilities of how they could use it in their everyday life and practice. Our intention was not to validate the features and rationale of MyReDiary. We employed the sketch as an evocative artifact to collaboratively discuss the possibilities opened up by the design that was informed by the three concepts.



Figure 1. Focus group: a rehabilitee trying out the flash mock-up in collaboration with a therapist.

We reflect on this exploration to highlight the conversations that inform on how designing for the three concepts can enhance adherence in different ways. We present these findings in the form of assertive statements, not to generalize from a situated study, but to provoke further explorations in the directions these findings point to.

### III. MYREDIARY: AN INTERACTIVE SKETCH

In this paper we report on the follow-up work to MyReDiary [1] that explored how to support the three concepts—collaborative articulation, self-monitoring and social scaffolding—driven by an in-situ participatory design process. Through this exploration the work envisioned MyReDiary, a personal device of the rehabilitees that acts as a rehabilitation journal (see figure 2) facilitating recording, reflection and

sharing of qualitative as well as quantitative data about their individual rehabilitation process.

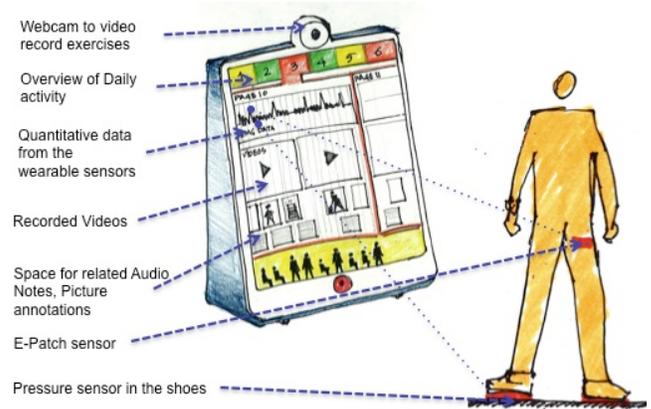


Figure 2. Paper sketch of MyReDiary.

While the early process resulted in a paper sketch, and some speculations, in this paper we implement an interactive form of MyReDiary (see figure 3 and 4) to further explore the possibilities offered by the three concepts. In this section, we describe the design features along with the respective conceptual rationale.

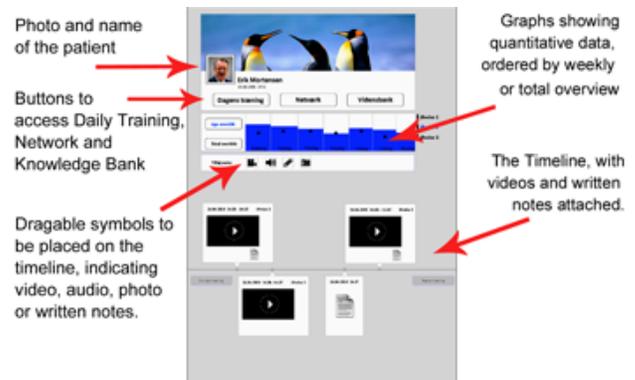


Figure 3. Overview of the interactive sketch. The rehabilitees can scroll through their 'timeline' to see earlier videos, photos or notes.

#### 1) Collaborative articulation:

The rehabilitees can video record or take photographs of their exercise at home through the tablet's camera. The rationale was that this would enable the rehabilitees to share their exercises with the therapist and show the nature of their home surroundings, which may help the therapists to fine-tune their prescriptions.

The rehabilitees can access the recorded videos through the interface mimicking a chronological timeline (see figure 3). They can then annotate the exercise recordings with text and/or voice recordings at a later time. The rationale here was that the rehabilitees can use the notes and annotations as resources to support their description to their therapists about the exact situation of exercise as it happens.

#### 2) Self-monitoring:

Rehabilitees can indicate the level of pain they felt during the exercise on a Visual Analog Scale (VAS) through the touch

interface of the tablet. Presenting the rehabilitees with historic data of their self-perceived pain ratings was intended to give them an overview of their development and motivate them to continue their improvement.

The rehabilitees can view electromyography (EMG) readings along with the videos of the completed exercises on the tablet. This was meant to supply the rehabilitees and therapist with data to understand rehabilitees' current state and progress over time and make it easier to evaluate the rehabilitees' progression.

The rehabilitees can view a live graphical representation of EMG data from the muscle being exercised (see figure 4). This feature shows the rehabilitees the activity of their muscles during exercises and possibly challenges them to be more active.

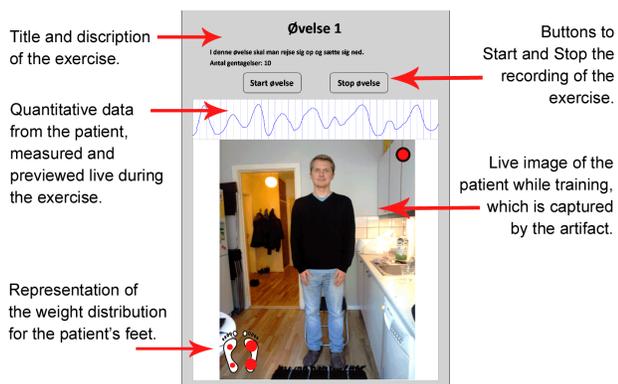


Figure 4. The training part of the artifact. The rehabilitees perform their exercises and record them for later review through their Timeline.

### 3) Social scaffolding

The rehabilitees can access the network feature to have an overview of their peers' exercise activities. Our purpose here was to support the rehabilitees to motivate each other, as they can see if they were falling behind compared to other rehabilitees on their team, or facilitate rehabilitees to exercise simultaneously.

## IV. FINDINGS

In this section we list our findings from the focus group with respect to the three theoretical concepts and discuss respective possibilities.

### A. Annotating self-monitored data enhances collaborative articulation

The participants discussed how annotating the recorded data could help articulate issues better during the periodic meeting with the therapists. Thomas mentioned that he frequently forgot to mention otherwise important experiences when he visited the clinic. The annotation would make it easier to remember what he wanted to share and the specific exercise it related to. As he put it, "You may not remember everything, so it's great to have some kind of assistance." Charlotte added that notes could be used by the therapists to give feedback on the completed exercises. This would make the feedback more contextual and would make it easier for rehabilitees to remember the feedback.

Marie, one of the therapists, appreciated the possibility of the rehabilitees taking pictures of their home environments. She explained: "Sometimes I really want to see how a rehabilitee actually walks at home on her local sidewalk. It would be nice to have a video recording or even just a picture of what it (the sidewalk) really looks like."

### 1. Discussion

The features guided by collaborative articulation were well accepted by the rehabilitees. The feedback from the focus group hints at a lack of communication between the rehabilitee and the therapist, due to factors such as poor memory and reliance on verbal descriptions. As reported in [1,14] videos and pictures could be a solution to support the current forms of therapist-rehabilitee communication. Pictures from the home of the rehabilitee could allow a therapist to address special circumstances that the home environment may create, and even potentially use the home environment as a training ground, using the stairs as a step bench, for example. Notes created during or shortly after the exercise sessions at home could provide the rehabilitees rich materials to discuss how they adhered to the rehabilitation process at home with their therapists. This finding reinforces the original vision of MyReDiary, that supporting the rehabilitees to annotate the self-recorded videos enhances collaborative articulation.

### B. Rating and retrieving self-perceived pain levels throughout the therapy enhances self-monitoring

The participants appreciated the possibility to record and quantify aspects such as muscle activity and perceived pain levels. Kimmie, in particular, liked the idea of monitoring her muscle's activity during exercise, while Thomas found it motivating to record and view the subjective levels of pain and how the pain reduces over time, "This [the pain score readings] will show me if my pain levels have decreased. That would be motivating".

### 2. Discussion

The rehabilitees were all enthusiastic about the possibility of recording and viewing quantitative data about their activities and rehabilitation in general. Their commentary reinforces the vision of MyReDiary, where the quantitative data was envisioned to be displayed synchronous with the rich, contextual video data, making it easier for the rehabilitees to understand and relate to the quantitative data.

The participants appreciated the possibility of recording and viewing self-perceived pain levels. While the practice of physical rehabilitation has standard scales to measure pain at the clinic, these are not available for the rehabilitees at home. Previous works supporting the self-monitoring of physical rehabilitation [6,7] do not consider this aspect of recording the self-perceived pain levels at home. For instance, the focus is on how real time medical data can be acquired to increase the awareness about physical activity [7], and support remote monitoring and gaming [6]. The feedback from the participants, however, point at how recording and viewing their self-perceived pain throughout the process could give them another handle to understand and become aware of their progress and also fill the gap between care when it moves to the home. Becoming aware of personal pain development

would inform the rehabilitees' perceived effect of the exercises on their symptoms, which is one of the factors influencing adherence [3].

### C. Supporting the synergy between social interaction and physical exercising enhances social scaffolding

The network feature supporting social scaffolding was not well received by the participants. They expressed that sharing their personal exercise data with their peers may turn exercising into a competition and hence is not motivating. The rehabilitees explained they were busy with exercising at the clinic and did not communicate much with the others between sessions. Thomas mentioned, "It's not that you don't care about the other people on the team, but between sessions you don't really think about them. Besides, we're not a set team, as people are starting or stopping their rehabilitation at different times"

This meant that the participants of the team were not fixed throughout the whole process, but rather substituted continuously. The result seemed to be a lack of team spirit and not being interested in the exercise habits of team members. The rehabilitees were however interested in knowing about how rehabilitees at a more advanced phase of rehabilitation managed their progress successfully.

### 3. Discussion

The commentary pointed to how enhancing the feeling of team spirit could motivate the rehabilitees to engage in exercising. This finding indicates at a new possibility to support social scaffolding. Following [5] the body of works aiming to support social scaffolding are increasingly moving away from designing for competition amongst the peer-rehabilitees as a way of encouraging adherence [for e.g. 7], to explore other forms of social scaffolding, that include sharing the exercise data as means of conversation [4].

The discussion from the focus group suggests that there is a synergy between the physical and the social aspects of rehabilitation and supporting it could be one of the promising avenues to enhance social scaffolding. A step in this direction is offered by [12] that explores how to support the synergy between social and physical aspects of a yoga class.

## V. CONCLUSION

In summary, we created an interactive sketch to further explore the possibilities offered by the three concepts to inform the design for supporting rehabilitee adherence. We introduced the interactive sketch to a focus group of rehabilitees and therapists. Through this collaborative set-up we explored the design to further inform how the three concepts could be used when designing for physical rehabilitation. We found that supporting the rehabilitees to annotate the self-recorded data could enhance collaboration between therapists and rehabilitees, to rate their self-perceived pain levels could enhance self-monitoring, and to take advantage of the synergy between the physical activities and the social ties could enhance social scaffolding.

However, we presented these findings in the form of assertive statements. By doing so, we make them open for contention and critique by researchers working in the domain, and hence invite them in a process of exploring and articulating the larger space of possibilities in designing for supporting and enhancing rehabilitee adherence to therapy.

## ACKNOWLEDGMENT

We thank the therapists and rehabilitees who participated in the workshop, and the reviewers for constructive and relevant inputs.

## REFERENCES

- [1] Bagalkot, N., & Sokoler, T. (2011) MyReDiary: Co-Designing for Collaborative Articulation in Physical Rehabilitation. In Proceedings of the 12th European Conference on Computer Supported Cooperative Work (ECSCW 2011), (pp. 121-132). Springer.
- [2] Buxton, B. (2007) Sketching User Experiences: Getting the Design Right and the Right Design. Morgan Kaufmann Publishers Inc.
- [3] Campbell R, et al, (2001). Why don't patients do their exercises? Understanding non-compliance with physiotherapy in patients with osteoarthritis of the knee. *J Epidemiol Commun Health*, 55:132-8.
- [4] Consolvo, S., McDonald, D. W., & Landay, J. A. (2009). Theory-driven design strategies for technologies that support behavior change in everyday life. *Proceedings of the 27th international conference on Human factors in computing systems, CHI '09* (pp. 405-414). ACM.
- [5] Consolvo, S., Everitt, K., Smith, I., & Landay, J. A. (2006). Design requirements for technologies that encourage physical activity. In *Proceedings of the SIGCHI conference on Human Factors in computing systems - CHI '06* (p. 457). ACM
- [6] Fergus, P., Kifayat, K., Cooper, S., Merabti, M., & El Rhalibi, A. (2009). A framework for physical health improvement using Wireless Sensor Networks and gaming. *3rd International Conference on Pervasive Computing Technologies for Healthcare, 2009. PervasiveHealth 2009* (pp. 1-4). IEEE
- [7] Maitland, J., Sherwood, S., Barkhuus, L., Anderson, I., Hall, M., Brown, B., Chalmers, M., et al. (2006). Increasing the Awareness of Daily Activity Levels with Pervasive Computing. *Pervasive Health Conference and Workshops, 2006* (pp. 1-9). IEEE.
- [8] Mastos, M., Miller, K., Eliasson, A. C., & Imms, C. (2007). Goal-Directed Training: Linking Theories of Treatment to Clinical Practice for Improved Functional Activities in Daily Life. *Clinical Rehabilitation*, 21(1), 47-55.
- [9] McClain, C. (2005) Collaborative Rehabilitation Goal Setting, *Topics in Stroke Rehabilitation*, Volume 12, Issue 4.
- [10] National whitepaper on rehabilitation, (2004) <http://www.marselisborgcentret.dk/fileadmin/filer/hvidbog/hvidbog.pdf>.
- [11] Nicholls, D.A. & Gibson, B.E., (2010). The body and physiotherapy. *Physiotherapy Theory and Practice*, 26(8), pp.497-509.
- [12] Nagargoje, A., Maybach, K., & Sokoler, T. (2012). Social yoga mats: designing for exercising/socializing synergy. In *Proceedings of the Sixth International Conference on Tangible, Embedded and Embodied Interaction* (pp. 87-90). ACM.
- [13] Pavel, D., Callaghan, V., & Dey, A. K. (2010). Looking Back in Wonder: How Self-Monitoring Technologies Can Help Us Better Understand Ourselves. *2010 Sixth International Conference on Intelligent Environments (IE)* (pp. 289-294). IEEE
- [14] Sokoler, T., Löwgren, J., Eriksen, M. A., Linde, P., & Olofsson, S. (2007). Explicit interaction for surgical rehabilitation. In *Proceedings of the 1st international conference on Tangible and embedded interaction* (pp. 117-124). New York, NY, USA: ACM.
- [15] Stolterman, E. & Wiberg, M., Concept-Driven Interaction Design Research. *Human - Computer Interaction*, 25(2), (2010), p.95-118