Stroke patients' motivation for home-based upper extremity rehabilitation with eHealth tools

Langerak, A. J.; D'Olivo, P.; Thijm, O. S.A.; Regterschot, G. R.H.; Meskers, C. G.M.; Rozendaal, M. C.; Visch, V. T.; Bussmann, J. B.J.

DOI
10.1080/09638288.2024.2304091

Publication date
2024

Document Version
Final published version

Published in
Disability and Rehabilitation

Taylor & Francis
Taylor & Francis Group

Disability and Rehabilitation

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/idre20

Stroke patients' motivation for home-based upper extremity rehabilitation with eHealth tools

A.J. Langerak, P. D'Olivo, O.S.A. Thijm, G.R.H. Regterschot, C.G.M. Meskers, M.C. Rozendaal, V.T. Visch & J.B.J Bussmann

To cite this article: A.J. Langerak, P. D'Olivo, O.S.A. Thijm, G.R.H. Regterschot, C.G.M. Meskers, M.C. Rozendaal, V.T. Visch & J.B.J Bussmann (09 Feb 2024): Stroke patients' motivation for home-based upper extremity rehabilitation with eHealth tools, Disability and Rehabilitation, DOI: 10.1080/09638288.2024.2304091

To link to this article: https://doi.org/10.1080/09638288.2024.2304091

Published online: 09 Feb 2024.

DISABILITY AND REHABILITATION
https://doi.org/10.1080/09638288.2024.2304091

Taylor & Francis
Taylor & Francis Group

RESEARCH ARTICLE

Stroke patients' motivation for home-based upper extremity rehabilitation with eHealth tools

A.J. Langerak[a], P. D'Olivo[b], O.S.A. Thijm[a,c], G.R.H. Regterschot[a], C.G.M. Meskers[d], M.C. Rozendaal[b], V.T. Visch[b] and J.B.J Bussmann[a]

[a]Rehabilitation Medicine, Erasmus MC University Medical Center, Rotterdam, the Netherlands; [b]Industrial Design Engineering, Delft University of Technology, Delft, the Netherlands; [c]Rehabilitation Medicine, Leiden University Medical Center, Leiden, the Netherlands; [d]Department of Rehabilitation Medicine, Amsterdam Neuroscience and Amsterdam Movement Sciences, Amsterdam UMC, Vrije Universiteit, Amsterdam, the Netherlands

ABSTRACT

Purpose: eHealth-based exercise therapies were developed to increase stroke patients' adherence to home-based motor rehabilitation. However, these eHealth tools face a rapid decrease in use after a couple of weeks. This study investigates stroke patients' motivation for home-based upper extremity rehabilitation with eHealth tools and their relation with Basic Psychological Needs.

Materials and methods: This is a qualitative study using thematic analysis. We conducted semi-structured interviews with stroke patients with upper extremity motor impairments, who were discharged home from a rehabilitation centre, after they interacted with a novel eHealth coach demonstrator in their homes for five consecutive days.

Results: We included ten stroke patients. Thematic analysis resulted in eight themes for home-based rehabilitation motivation: Curiosity, Rationale, Choice, Optimal challenge, Reference, Encouragement, Social Support and Trustworthiness. Those themes are embedded into three Basic Psychological Needs: "Autonomy", "Competence", and "Relatedness".

Conclusion: Eight motivational themes related to the three Basic Psychological Needs describe stroke patients' motivation for home-based upper extremity rehabilitation. We recommend considering those themes when developing a home-based eHealth intervention for stroke patients to increase the alignment of eHealth tools to the patient's needs and reduce motivational decreases in home-based rehabilitation.

IMPLICATIONS FOR REHABILITATION

- Stroke patients show motivational decreases and decreased use of eHealth tools in home-based rehabilitation after a couple of weeks.
- Eight motivational themes describe home-based rehabilitation motivation in stroke patients: Curiosity, Rationale, Choice, Optimal challenge, Reference, Encouragement, Social Support and Trustworthiness.
- Those themes are embedded into three Basic Psychological Needs: "Autonomy", "Competence", and "Relatedness".
- Those themes should be considered when developing a home-based eHealth intervention for stroke patients to increase the alignment of eHealth tools to the patient's needs and reduce motivational decreases in home-based rehabilitation.

ARTICLE HISTORY
Received 19 May 2023
Revised 3 January 2024
Accepted 5 January 2024

KEYWORDS
Stroke; rehabilitation; upper extremity; eHealth; motivation; adherence

Introduction

Over two-thirds of stroke survivors experience upper extremity (UE) motor impairment, limiting capacity and resulting in significant daily functioning limitations and decreased quality of life [1]. Rehabilitation programs involve stimulation of UE use and intensive UE exercises (e.g. a high number of repetitions per time unit) [2]. Adherence to intensive daily UE use and exercise is essential to optimise UE capacity and daily life functioning [3–5]. Exercise adherence may be specifically challenging for patients discharged from the controlled and supportive environment of a rehabilitation facility and expected to continue exercising at home [6–8].

One of the most common perceived barriers to adherence to rehabilitation exercises and physical activity in stroke patients is a lack of motivation [9]. Motivation can be generally explained as a fundamental "drive" towards change. According to Deci and Ryan's Self Determination Theory (SDT), motivation has three underlying Basic Psychosocial Needs (BPNs): Autonomy, Competence and Relatedness (10). The need for autonomy refers to the belief in being agentic and volitional in your actions, and it implies self-initiation and a choice over your behaviour. The need for competence refers to feeling capable and effective in the physical and social environment. The need for relatedness refers to connecting to a community or group and having a secure relational base [10]. These three BPNs are critical resources for psychological well-being and autonomous, self-determined motivation and satisfying them increases motivation to pursue desired

CONTACT J.B.J. Bussmann j.b.j.bussmann@erasmusmc.nl Rehabilitation Medicine, Erasmus MC University Medical Center, Rotterdam, the Netherlands.

behaviour [10]. Literature shows that higher motivation levels positively correlate with higher adherence to a rehabilitation program [11,12] and better rehabilitation outcomes [3,4,13].

Various motivational strategies targeting at least one of the three BPNs are used in face-to-face sessions between therapists and patients [14,15]. Examples of this are the application of patients' preferences (increasing autonomy), control of task difficulty (increasing competence) and involvement of a family member (increasing relatedness) [14,15]. During home-based rehabilitation, patients' motivational needs are expected to differ from inpatient rehabilitation since there is no direct supervision, less face-to-face contact between patients and therapists and more distraction from the physical and social environment. Besides, stroke often affects the social relationships and roles of the patient in their home environment, for example, family members may become informal caregivers, and patients are less involved in community activities [16,17].

Recently, a Delphi study was conducted to identify strategies to facilitate adherence to home-based exercises after a stroke [18]. Multiple strategies were classified, including using eHealth applications to prescribe exercises, provide feedback and motivate patients to follow home-based rehabilitation. However, the expert panel in this study did not include stroke survivors, and the study does not provide insights into patients' needs [18]. Since many eHealth applications face a rapid decrease in use and low adherence in the home environment [19], a better understanding of their motivational needs regarding using home-based rehabilitation eHealth tools is needed.

To increase the understanding of motivation in stroke patients, evaluating the BPNs in combination with patient-specific contextual and personal factors that influence motivation is important. Multiple studies documented motivation as the interplay of individual characteristics, including individual factors such as personality, psychological attributes and health status, and contextual factors, which are the social context and the culturally enforced norms [11,14,20,21]. BPNs, as described by Deci and Ryan, are generic and do not specifically take into account these personal and contextual factors. Moreover, the feeling of autonomy, competence, and social roles and relationships change due to a chronic disabling condition, such as stroke [22]. Thus, a specific patient population's characteristics and home environment should not be neglected when providing or developing home-based rehabilitation.

This study investigates stroke patients' motivation for home-based UE rehabilitation using eHealth tools and how this is embedded in the three BPNs. To account for the specific personal and contextual factors, we choose a qualitative study design, allowing us to acquire rich personal and contextual data conducted within a representative group of stroke patients at their own homes. With this knowledge, we expect to better align eHealth tools to the patient's needs, resulting in increased therapy adherence.

Materials and methods

We conducted a qualitative study using thematic analysis [23] to identify and describe the patterns in the data collected from individual stroke patients. Participants used an interactive demonstrator of a novel eHealth coach for five consecutive days in their home environment. The demonstrator supported participants in reflecting on and expressing their experiences, feelings and attitudes regarding using an eHealth tool to perform UE therapy in their daily lives [24].

Participant recruitment

A convenience sample was recruited from Rijndam Rehabilitation Centre (Rotterdam, The Netherlands) between February and April 2022. We included adults (> 18 years) who suffered from an ischemic or haemorrhagic unilateral stroke, who received rehabilitation for a UE impairment and who were discharged home. Patients had to be able to voluntarily lift the impaired UE against gravity. Patients were excluded if they had comprehensive aphasia resulting in the inability to provide informed consent or understand the interview questions or if major UE complications or comorbidities (e.g. frozen shoulder, severe UE pain) were present. Inclusion was stopped when data saturation was reached (i.e. no additional information regarding themes or definitions of the themes emerged) [25].

Ethics

The study was approved by the Medical Ethical Committee of the Erasmus Medical Centre, Rotterdam, Netherlands (MEC-2021-0862) and the Human Research Ethics Committee of the Delft University of Technology. All participants provided written informed consent before the start of the study.

Therapists notified the research assistant to contact potential participants who gave their permission. Participants' therapists were not actively involved in this study. However, participants were instructed to contact their physiotherapist and discontinue exercise if they felt pain or discomfort during or after the exercises in their affected UE. They only continued if their physiotherapist concluded it was safe.

Procedure and materials

After inclusion, participants were left to interact with a demonstrator device ("EDO") in their home environment for five consecutive weekdays, and data were collected through semi-structured interviews.

Materials

The interactive demonstrator EDO design was based on research conducted by our research group [26]. EDO was designed as an interactive coach supporting patients to perform UE exercises at home, independently from a formal caregiver (Figure 1). EDO was presented to the participant as a package containing three components: a tablet with a *digital application*, an *interactive disk*, and an *interactive tool*. The tablet application provided exercise instructions using videos. The disk emitted light to show and remind the participant when EDO was available to exercise and emitted sound when the exercises were completed. The tool was used to perform three functional exercises: a cylinder grasp ***(***Figure 1(a)), a pinch grasp ***(***Figure 1(b)***)***, and a lifting and tilting movement ***(***Figure 1(c)***)***. The tool provided feedback by emitting light when it was grasped, pressed or tilted according to the given instructions. EDO did not provide other feedback on patients' performance, such as progress tracking over time or rewards. Additional materials included a tablet holder, a charger and USB cables, an introductory booklet with the weekly plan to get acquainted with EDO, and a diary (Appendix 1) to note the perceived experience while exercising.

Figure 1. The interactive demonstrator "EDO" and the three exercises included in the interface: (a) cylinder grasp, (b) pinch grasp, and (c) lifting and tilting movement.

Procedure

During the five weekdays, participants could freely decide how many times and how long they wanted to use the demonstrator to perform exercises. Informal caregivers (e.g. family members) were not actively involved in using EDO. However, they were allowed to assist when requested by the participant. On the first day, two researchers with a design or medical background (PD and AL or DS) introduced EDO to participants in their homes. On the second day, participants were invited to discover EDO and look at the proposed exercises for the next two days. On the third and fourth days, participants were asked to perform up to three UE exercises with EDO. After each exercise session, participants were asked to fill in a diary, including the notation of which exercises they did, for how long and their experience with the training session with EDO (Appendix 1). On the fifth and last day, participants again were visited at home by two researchers (PD and AL or DS) to collect the demonstrator and conduct a semi-structured interview to evaluate participants' experiences with EDO, including an evaluation of patients' notes in the diary. Participants were also asked whether, and if so, how they received assistance from an informal caregiver. An interview guide was used (Appendix 2), which comprised open-ended questions to generate discussion around the following topics: (1) participants' experience with an eHealth coach; (2) participants' experience of exercising at home; (3) participants' motivation triggered by an eHealth coach and reflection on the long-term use of an eHealth coach at home.

Data collection

Baseline characteristics of the participants were collected and included age, gender, time since stroke, UE function level and affinity for technology. Participants' affinity for technology was quantified using the Dutch Affinity for Technology Interaction (ATI) questionnaire [27]. The questionnaire presents a scale ranging from 1 (very low affinity for technology interaction) to 6 (very high affinity for technology interaction). The total score can be calculated as the mean of the item scores [27]. UE impairment was quantified using the valid and reliable bedside Utrecht Arm Test (UAT) [28]. The scale ranges from 0 ("a-functional arm") to 7 ("clumsy hand").

The number of days and the number and duration of sessions per day participants practised with EDO were extracted from the diary.

All interview sessions were audio-recorded and transcribed verbatim. Interviews conducted in Dutch were translated into English. A participant number code anonymised the transcripts and questionnaires in the form of P#. If the partner or informal caregiver was involved in the interview to support a patient, it was indicated by the following code: PA#.

Data analyses

Quantitative analysis

Descriptive statistics (Median, Inter Quartile Range (IQR)) were calculated and presented for the baseline characteristics (age, gender, time since stroke, UE function level (UAT), affinity for technology (ATI)), the number of days (Median, IQR) and the number and duration of sessions per day (Median, IQR) participants practised with EDO using *R studio 2022.02.0-443*. In addition, characteristics not directly traceable to participants' identities and presenting a large variability based on the IQR, were reported for each individual separately.

Qualitative analyses

We performed a thematic analysis following the guidelines of Brown and Clarke [29]. Transcribed data were imported into *Atlas.ti 22* for each participant. We analysed the data with two researchers concurrently until data saturation was reached.

One researcher (AL) repetitively read all transcripts to achieve data familiarisation. This researcher highlighted relevant quotes – linked to the participant number - in the transcripts. The identified quotes were then organised into meaningful codes by identifying patterns between the data segments by two researchers (AL, OT) separately. The codes were sorted and combined into initial themes. The two researchers reviewed and refined the initial codes and themes. The themes that contained similar data were merged until all themes were distinct and supported by multiple data segments. In case of discrepancy, a third researcher (PD) was involved in the discussion until agreement on the final codes and themes was reached.

To investigate how the motivational themes are related to the BPNs, two researchers analysed the themes derived from the data in relation to the three BPNs described in the Self Determination Theory. Based on the descriptions and existing literature about the BPNs, we classified themes into one of the three concepts. If themes did not fit into one of the BPNs, themes were classified as 'other'. The classification was reviewed and discussed with a third researcher (PD) until an agreement was reached.

To enhance the credibility and dependability of the study, the two researchers (AL, OT) kept a record of the data analysis using reflective memos that we linked to each step of the analysis process. To ensure the neutrality of the research findings, the researchers and participants were unacquainted prior to the study. Investigator triangulation was embedded in our study firstly by involving a third researcher (PD) to review the analysis and discuss discrepancies, and secondly by discussing the findings within our

research group, including experienced researchers with backgrounds in rehabilitation medicine, human movement science, psychology and industrial design, who provided different perspectives on the findings. Moreover, we induced theory triangulation by investigating how the motivation themes derived from the data related to the BPNs from the SDT which enhanced the confirmability of the study findings.

Results

Participant characteristics

Ten stroke patients, six in the chronic (≥ six months) and four in the subacute (< six months) post-stroke phase, were included after being discharged home from rehabilitation. Participants were predominantly male, scored a medium affinity with technology on the ATI scale, and most could perform a pinch grip (median UAT score of 6). Participants' characteristics are presented in Table 1; for each participant providing quotes, the ATI total score and the time since stroke (TSS) in months are reported individually.

Self-reported use of EDO (diary)

Nine (9/10) participants filled in the diary. Most participants (7/9) practised with EDO as scheduled, i.e. two days; one practised only on one day, and one on three days (Median 2; Range: 1 to 3). Most of them (5/9) did one exercise session with EDO per day (Median: 1; Range: 1 to 2). The exercise sessions varied between ten and sixty minutes per session (Median: 15; Range: 10 to 60).

Thematic analysis

The thematic analysis of ten semi-structured interview transcripts resulted in 538 coded data segments, twenty-one codes, and eight themes. Data saturation was reached after analysing the transcripts of eight participants. The themes; Curiosity, Rationale, Choice, Optimal challenge, Reference, Encouragement, Social Support and Trustworthiness, their underlying codes and relations with the three Basic Psychological Needs are presented in Table 2. We further explain the themes using participants' quotes and how those themes are embedded in the BPNs, supported by the literature. Table 2 shows the frequency of the codes Personal ability, Link to daily life and Feedback on results (53, 43 and 54 times, respectively) are higher than the other codes. Those three codes resulted in the themes Optimal Challenge and Encouragement and are related to the BPN "Competence".

Curiosity

Participants expressed curiosity about learning, trying or discovering something new. Participants were curious to try a new way to exercise to get better ("… it is new, and you want to get better, you want to see if it helps.") [P1: ATI 4; TSS 17; UAT 6], and some participants were mainly interested in discovering the technical aspects of the new tool ("It is technically, I like technical stuff.") [P9: ATI 5.3; TSS 2; UAT 6].

Table 1. Participant characteristic.

Characteristics ($n = 10$)	Median [IQR]
Biological sex (male/female/other)	9/1/0*
Age (years)	60.5 [13]
Time since stroke (months)	6 [11]
ATI (total score)	3.6 [2.5]
UAT	6.0 [0.8]

*presented as total numbers; *IQR*: Inter Quartile Range; *ATI*: Affinity for Technology score, with a range of 1 to 6; *UAT*: Utrecht Arm Test score, with a range of 0 to 7.

Rationale

Participants expressed the need to understand why they have to do the exercises to feel motivated to exercise ("You have to do better for yourself. Because if you practise a lot, it gets better.") [P8: ATI 2.6; TSS 6; UAT 5]. Besides understanding the benefits of exercise, this could also require information about the prognosis of UE impairments ("… I am also well aware that I have little recovery left now. You recover the most in the first three months after your infarction. That's when you really have to do it, and [it would] be stupid not to do it.") [P5: ATI 2.7; TSS 6; UAT 6].

Choice

Participants also expressed their need to be able to make choices regarding their exercise program, e.g. the type of exercises and their exercise routine ("Yes [I would like to be able to choose myself from more exercises], because then you can say 'today I will take that arm behind my back' and tomorrow I will take that bottle again. …then I will keep doing it.") [P1: ATI 4; TSS 17; UAT 6]. In contrast to this need, most participants indicated they would like to have a guideline on the intensity (e.g. the number of repetitions in a time frame) of exercise instead of choosing this freely themselves: ("The number of repetitions, I think it is important that you indicate that in advance. Do this five times, then take a break and do it five more times") [P1: ATI 4; TSS 17; UAT 6].

Optimal challenge

Our analysis showed that finding the right balance between the level of an exercise and the functional level and abilities of the patient is highly important for participants. Participants indicated that the exercises should contain three aspects to provide an optimal challenge. The first aspect relates to the patient's *personal abilities;* namely, exercises should be adjusted to the level of abilities of each person, not too easy nor too hard ("It motivates you if you cannot do it yet because you want to do it better…If you can already do it, it becomes boring.") [P3: ATI 4.3; TSS 3; UAT 6]. The second aspect is the *link to daily life;* namely, exercises should be related to daily life activities and personal goals of the patient and also involve the use of common objects ("You see it as a bottle. That's also that pouring exercise that I did on Thursdays [during a UE therapy session], that you have to tip it over. Yes, that is good") [P7: ATI 3.2; TSS 4; UAT 6]. The third aspect relates to the *level increasement* to help patients feel challenged even when performing the exercises multiple times ("It [the exercises] should become increasingly difficult. What you have here is actually only on one level.") [P3: ATI 4.3; TSS 3; UAT 6]. The fourth aspect, *Exercise focus,* describes the participants' need to be able to focus on the exercise itself and restrict the presence of other factors at the same time, as that may distract the patient from the exercise. These distracting factors can be related to the exercise environment ("[I do the exercises] in my own study, then all those things are off the table, and you are not disturbed.") [P7: ATI 3.2; TSS 4; UAT 6] or to the exercise tool itself ("…if you can integrate a few things, it will be easier. Now, you have to think about three things, the tablet, the tool and the disk.") [P6: ATI 2; TSS 4; UAT 6].

Table 2. An overview of the eight motivational themes describing stroke patients' motivation for upper extremity home-based rehabilitation with eHealth tools.

Quote excerpts	Codes	n	Themes		Literature
"it is different, it is new." [P1: ATI 4; TSS 17; UAT 6]	Curiosity	9	**Curiosity** The desire to learn or discover something new.	**Autonomy**	"the experience of volition and willingness" [1] Higher levels of autonomy are linked to greater curiosity. Rationale is known as an autonomy supportive factor. The sense of choice enhances intrinsic motivation by allowing greater feelings of autonomy.
"do better for yourself… if you practise a lot, it gets better." [P8: ATI 2.6; TSS 6; UAT 5]	Understanding why to exercise	12	**Rationale** The need to understand why to perform exercises and the need that the given feedback is understandable.		
"know how it works…know why the machine say this this." [P2: ATI 5.1; TSS 29; UAT 5]	Understanding feedback	13			
"be able to choose …then I will keep doing it." [P1: ATI 4; TSS 17; UAT 6]	Choose exercise	20	**Choice** The freedom to choose exercises and create a personalised exercise routine. However, the exercise intensity should be preferably instructed.		
"have other practices as well….a combination of things I have to do." [P6: ATI 2; TSS 4; UAT 6]	Personal exercise routine	25			
"number of repetitions…indicate that in advance." [P1: ATI 4; TSS 17; UAT 6]	Exercise intensity instruction	14			
it is different for everyone, which exercise is good" [P3: ATI 4.3; TSS 3; UAT 6]	Personal ability	53	**Optimal challenge** The balance between the exercise level and the abilities of the patient.	**Competence**	"the experience of effectiveness and mastery" [1] Optimal challenges and positive feedback are external factors that increase perceived competence.
"should help eventually to …do your household better again" [P7: ATI 3.2; TSS 4; UAT 6]	Link to daily life	43			
should become increasingly difficult") [P3: ATI 4.3; TSS 3; UAT 6]	Level increasement	11			
"then you are not disturbed" [P7: ATI 3.2; TSS 4; UAT 6]	Focus	13			
"to look every time to see if I am improving… to see over a couple of weeks" [P4: ATI 5.1; TSS 6; UAT 6]	Over-time reference	23	**Reference** The need to evaluate personal progress during UE rehabilitation, by comparing yourself to a reference.		
"This [mirror] is feedback….I judge myself." [P10: ATI 1.3; TSS 15; UAT 4]	Personal reference	21			
"to know what stage I am in, like 1, 2, 3, 4" [P10: ATI 1.3; TSS 15; UAT 4]	Measurable reference	12			
"tell you whether you reached the goal" [P2: ATI 5.1; TSS 29; UAT 5]	Feedback on results	54	**Encouragement** The words or behaviour that provide support to start, continue or wrap-up your exercise program.		
"a kind of aid, that make you think do that again now"[P5: ATI 2.7; TSS 6; UAT 6]	Starting & wrapping-up	32			
"make it more personal… say 'hello [name of P8], come practice" [P8 +PA8: ATI 2.6; TSS 6; UAT 5]	Becoming personal	24	**Social support** The need for support by significant others in the professional or personal environment.	**Relatedness**	"the experience of warmth, bonding, and care" [1] Self-determined motivation is more likely to flourish in an environment where people are socially supported and feel secure.
"feedback of other people…directed personally to you" [P10: ATI 1.3; TSS 15; UAT 4]	Personal support	11			
"the nurse said…that touched me" [P5: ATI 2.7; TSS 6; UAT 6]	Professional support	12			
"He did what he did, so you can trust that" [P4: ATI 5.1; TSS 6; UAT 6]	Clear instructions	29	**Trustworthiness** The feeling of trust and safety while doing UE exercises		
"she is a professional, I trust her" [P10: ATI 1.3; TSS 15; UAT 4]	Professional involvement	16			
"to make it safe, I may need some sensors or something" [P2: ATI 5.1; TSS 29; UAT 5]	Feedback on performance	32			

Quote excerpts represent participant quotes grouped into codes, with n showing the frequency each code occurs in the data. Themes were based on codes. Themes were embedded into the Basic Psychological Needs.

[1] Steenkiste van M, Ryan RM, Soenens B. Basic psychological need theory: Advancements, critical themes, and future directions. Motivation and Emotion. 2020;44(1):1-31.

Reference

Participants expressed the need to evaluate their personal progress during home-based rehabilitation. Our analysis resulted in three main types of references. The first type is an *over-time reference,* which concerns the evaluation of their progress between exercise sessions and over more extended time periods, such as comparing their results from the start of the UE rehabilitation with their results at the end of the first week. ("I want to look every time to see if I am improving […] To see over a couple of weeks, to look back and see what you did and what you couldn't do in the beginning.") [P4: ATI 5.1; TSS 6; UAT 6]. The second type is a *measurable reference* that allows patients to compare scores; this could also be used within an exercise session ("When you see feedback, you know whether there is progress. I want to know what stage I am in, like 1, 2, 3, 4.") [P10: ATI 1.3; TSS 15; UAT 4]. The third type is a *personal reference,* such as a visual reference of themselves performing a UE exercise. Other personal references mentioned were self-reported ratings of perceived workload, pain or mood after exercise. How participants value the use of self-reported references was mixed among participants; some would like to use it for specific reasons ("It was not [useful] in my case, it [the exercises] wasn't painful or difficult. But when it was earlier, it would help to report it.") [P1: ATI 4; TSS 17; UAT 6]. Others don't find it helpful and think it could negatively affect

their mental status ("I won't use that… I don't think it would help me much. If you start thinking about it [feelings and pain], I think you will only get sad.") [P5: ATI 2.7; TSS 6; UAT 6].

Encouragement

Participants expressed the need to feel encouraged to do home-based exercises. Encouragement refers to the feedback provided to the patient about the result of their action in relation to the goal while doing the exercises, *feedback on results*. Specifically, this feedback should be mainly positive ("I expected there was a coach in the distance who made compliments and gave feedback when things were going well or good enough.") [P6: ATI 2; TSS 4; UAT 6] although feedback on negative results could also be experienced as supportive ("Or be honest: you're not doing it well. You can do better. Be positive, but also honest: Sorry, you're not doing your best. I like to see you do better.") [P10: ATI 1.3; TSS 15; UAT 4]. In addition, participants want to feel encouraged in *starting* exercises ("I don't really need the stick [behind the door], encouragement maybe a little bit… a kind of aid, so to speak, that you remember I have to do that [exercises] again now.") [P5: ATI 2.7; TSS 6; UAT 6] and in a few participants also in *wrapping up* exercises ("It is useful. It is the end of the exercise, you can put your hand on this [button] and actually it is finished. That's it.") [P3: ATI 4.3; TSS 3; UAT 6].

Social support

Participants expressed their need to feel supported by their social environment while doing home-based exercises. Support could come from fellow stroke patients with UE deficits, family or friends, categorised as *personal support* ("So if you got other people incorporated into this. That I like because you get feedback […] That is social, and it's directed personally to you […] That is super good.") [P10: ATI 1.3; TSS 15; UAT 4]. Or from caregivers, such as therapists, nurses and coaches, we categorised this as *professional support* ("… motivation has to be boosted. I remember being in the hospital, and the nurse said: 'You are going to [name of rehabilitation centre] tomorrow, and keep one thing in mind: you have to do it.' And I really took that with me, just something that touched me.") [P5: ATI 2.7; TSS 6; UAT 6]. *Becoming personal* describes participants' need for interaction on a personal level when doing exercise therapy. However, preferences of how participants would like to be approached differ between patients. Some patients prefer a gentle and caring approach ("It [EDO] is not a strict thing; it's friendly. Really a helpful coach, so to speak. I like that. For me personally, he [EDO] was pleasant as he is, there's no need to kick my ass" [P9: ATI 5.3; TSS 2; UAT 6]). In contrast, others prefer a stricter, sporty approach ("Yes, exactly [EDO should be more a sports coach than a helper]. Oh yes, those texts [supportive text] were always in between [in rehabilitation]. That is quite nice. But it doesn't have to be too soft for me." [P7: ATI 3.2; TSS 4; UAT 6]).

Trustworthiness

When doing exercises with an eHealth tool at home, it is important for participants that it is trustworthy and can be relied on. To be trustworthy, it should contain *clear instructions and visualisation* of the exercises so participants do not doubt how they should perform the exercises. Participants prefer to be instructed with a video ("On paper, they have to explain a lot more, that you have to wave your hand, but if you see that then it's immediately obvious. I would like videos, concise and to the point.") [P7: ATI 3.2; TSS 4; UAT 6]. The feeling of trust and safety in patients is also induced by getting *feedback on performance,* namely the information provided to the patient regarding the execution pattern of the movement to reach a goal ("I think for me make it to make it safe, I may need some sensors or something. or some way to know where the elbow is or so…. Because many of these exercises I can actually do by using my shoulder, and that makes them useless because then I learn myself the wrong things") [P2: ATI 5.1; TSS 29; UAT 5]. Lastly, *professional involvement*, namely the involvement of health care professionals such as therapists, nurses or professional coaches to allow the patient to share their experience or concerns regarding the exercises, induces patients' trust in home-based rehabilitation ("I got a good communication with her [the therapist] because then she says how far I go…. She can judge, she is a professional, and I trust her") [P10: ATI 1.3; TSS 15; UAT 4].

Classification of the themes into Basic Psychological Needs based on quotes and literature

The eight motivational themes were classified into the three underlying BPNs, "Autonomy", "Relatedness", and "Competence" (See: Table 2). Literature supports the embedding of the themes into the three BPNs.

Autonomy

Curiosity and *Rationale* give patients the intention and willingness to perform a home-based exercise program. In the literature, curiosity is described as a critical motive influencing human behaviour by stimulating the pursuit of learning new skills and personal growth [30]. Curiosity and autonomy are related, as higher levels of autonomy are linked to greater curiosity [30]. Rationale, the reasoning why putting forth effort during an activity might be beneficial, is known as an autonomy-supportive factor [31]. Additionally, the Self Determination Theory argues that rationale may also support satisfaction of competence, the belief of being able to succeed at a task [32]. *Choice* gives patients the feeling of being in charge of their exercise program. The sense of choice enhances intrinsic motivation by allowing greater feelings of autonomy [10]. These three themes are important in stroke rehabilitation since patients' experience of autonomy might have changed after a stroke. Patients need to learn to live with their new situation ("…It appears I had to learn to live with it [impairments after stroke]. Adapt to it. It gave me another dimension to look at things.") [P10: ATI 1.3; TSS 15; UAT 4]. When these needs are satisfied, people experience a sense of integrity as when a person's actions, thoughts, and feelings are self-endorsed ("…You always have to try to improve, you have to do better for yourself") [P8: ATI 2.6; TSS 6; UAT 5]. When dissatisfied, people may experience a sense of pressure or conflict, such as feeling pushed in an unwanted direction.

Competence

To feel competent, exercise therapy should be an *Optimal challenge,* the right balance between the challenge level of an exercise and the functional level and abilities of the individual patient. Challenge typically shows an inverted U-shaped curvilinear relationship with self-determined motivation: people perform better and report greater joy to a "near miss", with the optimal challenge at the apex of this curve [33]. However, performance and enjoyment decreases in a "complete miss" condition [33]. Reviewing exercise progress using a *Reference* induces a feeling of effectiveness and self-confidence. *Encouragement* to start, wrap up or continue exercise also causes those feelings of self-confidence and effectiveness.

Feedback on results induces a sense of mastery. This need becomes satisfied when people engage in activities and feel they have opportunities to use and extend skills and expertise ("…Eventually you do it to do things better again. You want to do your household better again. It should help to train that kind of things") [P1: ATI 4; TSS 17; UAT 6]. When dissatisfied, people experience a feeling of ineffectiveness, failure and giving up ("…It's like, like learning to use a knife. I try that for like, six months or nine months. At some point, you kind of give it up") [P2: ATI 5.1; TSS 29; UAT 5]. The SDT describes optimal challenges and positive feedback as external factors that increase perceived competence [10]. Perceived competence can enhance intrinsic motivation, but only when accompanied by the feeling of autonomy [10].

Relatedness

The SDT describes relatedness as the need to feel belongingness and connection with others and suggests that self-determined motivation, enhanced by feelings of autonomy and competence, is more likely to flourish in an environment where people feel a secure base and are socially supported [10]. When doing home-based exercises with an eHealth tool, this need can be satisfied by the presence of *Social support* from peers, loved ones, or health care professionals in the exercise program, and by *Trustworthiness*, the feeling of safety and being able to trust ("He [EDO] did what he did. Exactly what the thing says he did. So you can trust that" [P4: ATI 5.1 TSS 6; UAT 6]). Dissatisfaction with the relatedness may result in people experiencing social alienation, exclusion, and loneliness ("I think mainly a good conversation [is important to feel motivated]. […] I also know people who lie in bed, do the exercises and lie in bed again […] They need a push. I think it is important in rehabilitation to do things together. To give each other a boost.") [P5 ATI 2.7; TSS 6; UAT 6].

Discussion

This study in ten stroke patients discharged home from a rehabilitation facility aimed to investigate their motivation for home-based UE rehabilitation with eHealth tools and their relation with Basic Psychological Needs. The thematic analysis of ten stroke patients' interview transcripts resulted in twenty-one codes and eight overreaching motivational themes: Curiosity, Rationale and Choice (related to the BPN Autonomy), Optimal challenge, Reference and Encouragement (related to the BPN "Competence"), and Social Support and Trustworthiness (related to the BPN Relatedness).

The themes of Rationale, Optimal challenge, Reference, Encouragement, and Social support show similarities with previously reported results in the literature. In stroke patients admitted to inpatient rehabilitation, understanding rehabilitation (why and how), patient-specific goals, experiences of success and failure, patients' physical and cognitive abilities, encouragement and support from the social environment were previously found to influence motivation [11,34]. Studies describing motivation during inpatient rehabilitation emphasise that motivation derives from the ultimate goal of getting home [11,34]. Thus, when a patient is already at home, patients may have different goals and needs that drive their motivation. Notably, in our study, codes within the themes Optimal challenge and Encouragement, embedded in the BPN "Competence", were most frequently present. This might indicate that the need to feel competent and master skills effectively is a fundamental need that drives their motivation.

Using eHealth tools in the home environment may also involve different patient needs compared to inpatient rehabilitation [35]. The themes of Curiosity, Choice and Trustworthiness seem specific to the context of home-based rehabilitation with eHealth tools. Curiosity was defined as the eagerness to learn or discover how to use something new, specifically a new eHealth tool. This theme was related to the BPN Autonomy. Patients' experiences of autonomy increased after being discharged home compared to an inpatient setting (28). However, patients still experience restrictions in their autonomy when discharged home [36]. They typically rely on their therapists and the rehabilitation centres' schedule during rehabilitation. At the same time, our study shows that making their own treatment choices and developing their routine is important in rehabilitation in the home environment. Data from the self-reported use of the demonstrator support this. Patients reported different schedules for the use of EDO; some of them used it once a day, while others broke up the training into multiple sessions per day with a broad range of duration per session. Besides, to experience Relatedness, Trustworthiness is an important theme. The involvement of a therapist in home rehabilitation with an eHealth tool increases the experience of trustworthiness since patients feel they can trust on their therapist's expertise. Besides the involvement of their therapist to provide a secure relational base, participants expressed how the eHealth tool itself could meet the need for relatedness by increasing trustworthiness. An eHealth tool should give patients the feeling that they can rely on it by providing clear instructions and supportive feedback on patients' exercise performance. Following up on these findings, we investigated how social interaction with users could be established using agentic objects for home rehabilitation and if those interactions could enhance a trustful feeling of relatedness that motivates for home-based rehabilitation [26].

The good fit between the themes derived from our data and three BPNs supports the validity of the themes. Moreover, the present study provides insights into how those three BPNs are explicitly expressed in stroke patients performing home-based UE rehabilitation with eHealth tools. It was suggested in the literature to improve the design of eHealth interventions by implementing the concepts of the Self Determination Theory [37]. The theory differentiates two types of motivation: self-determined and non-self-determined [10,20,38]. Self-determined motivation is mainly driven by internal sources. The three BPNs support this type of motivation. Non-self-determined motivation is comprised of external control. This is a type of motivation in which an individual acts out of the desire for external rewards or fear of punishment. The SDT proposes that behaviour should be more self-determined for individuals to be optimally motivated [39]. However, it is hard to distinguish between internal and external sources since external sources are often only partially external and may affect the inner sense. For example, support from loved ones can be seen as an external source. However, it involves the feeling of relatedness, a more self-determined type of motivation. Therefore, combining more external forms of motivation, such as rewards, which are currently often used in the design of eHealth interventions [34], with insights on how the BPNs are expressed in patients in relation to home-based rehabilitation with eHealth tools can guide designers, researchers and clinicians to motivate stroke patients for at-home treatment. Although we did not analyse our results in relation to patients' adherence to exercise, we hypothesise that the development of home-based interventions incorporating these BPNs may increase stroke patients' self-determined motivation and improve long-term adherence to home-based rehabilitation.

Our study used the interactive demonstrator "EDO," allowing participants to reflect on their experiences and share their thoughts about using an eHealth tool in their home instead of imagining

using an eHealth tool in their house. The demonstrator can be seen as a 'strong concept'. Strong concepts are described in design literature as generative design concepts that stimulate new ideas for a design problem situation [40], i.e. social robots for elderly living at home. Strong concepts take the shape of dynamic and interactive demonstrators that provoke a behavioural response in people using the demonstrator. The incomplete nature of a strong concept allows it to remain general enough to embed a design idea, but can eventually be used across particular situations and applications [40]. The core design idea of EDO is to represent an eHealth tool for home-based stroke rehabilitation. Its components represent various eHealth applications, such as providing exercise feedback, reminding of, and instructing exercise [18]. Representing a broad range of eHealth applications, EDO facilitated generating knowledge about stroke patients' motivation regarding using eHealth tools for home-based stroke rehabilitation. This knowledge is beyond the particular use case of EDO. Therefore, the results are expected to be transferable to other applications of eHealth tools for home-based stroke rehabilitation. Although the approach allowed patients to express themselves in an alternative and creative way, during the interviews, some still encountered difficulties due to deficits in memory, cognition and expression (i.e. aphasia), which may have influenced our results. However, excluding them would not provide a realistic representation of the target population.

Still, there are limitations regarding the transferability of the results of our study. This is a generative study to describe the motivation of a sub-population of stroke patients in a specific context. We included a convenience sample of predominantly males in the chronic post-stroke phase, with limited UE impairment measured with the UAT. Furthermore, we did not assess cognitive deficits, depressive symptoms, and self-efficacy, which are factors associated with patients' motivation [41]. Therefore, translation of these results to stroke patients with distinct characteristics (e.g. later post-stroke recovery phase, lower UE function) or a different context (e.g. different rehabilitation settings, regions, or countries) may be limited.

In future research, qualitative data about motivational drivers and experience with home-based UE rehabilitation could be combined with quantitative data collected with wearable sensors (e.g. to detect the amount and intensity of exercise and the amount of use of the coaching device). With these data, the relationship between motivation and the actual use of a coaching device and therapy adherence could be further assessed. To further evaluate the validity of the themes we derived from our research, we advise testing whether these themes are recognised and deemed important by other stroke patients in the home environment. Besides, if such a validation study is conducted without the demonstrator EDO, researchers could also test our hypothesis that the results are not specific to the use of EDO. Furthermore, including a larger sample with a wider variety of patients is recommended to allow data analysis within meaningful subgroups (e.g. subgroups based on time post-stroke, level of arm function, or cognitive deficits).

Conclusion

This study, in ten participants with upper extremity impairments who were discharged home from a rehabilitation facility, investigated stroke patients' motivation for home-based UE rehabilitation with eHealth tools and the relationship with the BPNs. Performing a thematic analysis, we found eight motivational themes: Curiosity, Rationale, Choice, Optimal challenge, Reference, Encouragement, Social Support and Trustworthiness, which are related to the Basic Psychological Needs: "Autonomy", "Competence", and "Relatedness". Although our study has limitations regarding the transferability of the results to stroke patients with distinct characteristics or within a different context, we recommend considering these themes when developing a home-based eHealth intervention for stroke patients to reduce motivational decreases in home-based rehabilitation.

Acknowledgements

The authors would like to thank: Adriaan Bernstein from the ID-Studiolab (Delft University of Technology) and Agnese Gualandi (Eindhoven University of Technology) for the support and development of EDO's prototype, Hugo Onink for the photographic support, Deanne Spek (Delft University of Technology) for her contribution in facilitating the field study, and Marc Evers for his support in the involvement of participants and staff in the Rijndam Rehabilitation Centre. We also want to thank all the patients who dedicated their time to join this research.

Disclosure statement

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

Funding

The work presented in this paper is part of a multidisciplinary project named ArmCoach4Stroke. This work was supported by ZonMw the under Grant N-10-10400-98-18055.

ORCID

A.J. Langerak http://orcid.org/0000-0002-7724-4439

References

[1] Langhorne P, Coupar F, Pollock A. Motor recovery after stroke: a systematic review. Lancet Neurol. 2009;8(8):741–754. doi: 10.1016/S1474-4422(09)70150-4.

[2] Hayward KS, Brauer SG. Dose of arm activity training during acute and subacute rehabilitation post stroke: a systematic review of the literature. Clin Rehabil. 2015;29(12):1234–1243. doi: 10.1177/0269215514565395.

[3] Gunnes M, Indredavik B, Langhammer B, et al. Associations between adherence to the physical activity and exercise program applied in the LAST study and functional recovery After stroke. Arch Phys Med Rehabil. 2019;100(12):2251–2259. Dec doi: 10.1016/j.apmr.2019.04.023.

[4] Putrino D, Zanders H, Hamilton T, et al. Patient engagement Is related to impairment reduction During digital Game-Based therapy in stroke. Games Health J. 2017;6(5):295–302. doi: 10.1089/g4h.2016.0108.

[5] Pollock A, Farmer SE, Brady MC, et al. Interventions for improving upper limb function after stroke. Cochrane Database Syst Rev. 2014;12(11):CD010820.

[6] Miller KK, Porter RE, DeBaun-Sprague E, et al. Exercise after stroke: patient adherence and beliefs after discharge from rehabilitation. Top Stroke Rehabil. 2017;24(2):142–148. doi: 10.1080/10749357.2016.1200292.

[7] Levy T, Jc L, Killington M, et al. Just that four letter word, hope": stroke survivors' perspectives of participation in an intensive upper limb exercise program; a qualitative exploration. Physiother Theory Pract. 2021;12:1–15.

[8] Koh WLE, Barr CJ, George S. Factors influencing post-stroke rehabilitation participation after discharge from hospital. International Journal of Therapy and Rehabilitation. 2014;21(6):260–267. doi: 10.12968/ijtr.2014.21.6.260.

[9] Nicholson S, Sniehotta FF, van Wijck F, et al. A systematic review of perceived barriers and motivators to physical activity after stroke. Int J Stroke. 2013;8(5):357–364. doi: 10.1111/j.1747-4949.2012.00880.x.

[10] Ryan RM, Deci EL. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. Am Psychol. 2000;55(1):68–78. doi: 10.1037//0003-066x.55.1.68.

[11] Maclean N, Pound P, Wolfe C, et al. Qualitative analysis of stroke patients' motivation for rehabilitation. BMJ. 2000;321(7268):1051–1054. doi: 10.1136/bmj.321.7268.1051.

[12] Maclean N, Pound P, Wolfe C, et al. The concept of patient motivation: a qualitative analysis of stroke professionals' attitudes. Stroke. 2002;33(2):444–448. doi: 10.1161/hs0202.102367.

[13] Rapolienė J, Endzelytė E, Jasevičienė I, et al. Stroke patients motivation influence on the effectiveness of occupational therapy. Rehabil Res Pract. 2018;2018:9367942. doi: 10.1155/2018/9367942.

[14] Oyake K, Suzuki M, Otaka Y, et al. Motivational strategies for stroke rehabilitation: a descriptive Cross-Sectional study. Front Neurol. 2020;11:553. doi: 10.3389/fneur.2020.00553.

[15] Oyake K, Suzuki M, Otaka Y, et al. Motivational strategies for stroke rehabilitation: a delphi study. Arch Phys Med Rehabil. 2020;101(11):1929–1936. doi: 10.1016/j.apmr.2020.06.007.

[16] Ramazanu S, Loke AY, Chiang VCL. Couples coping in the community after the stroke of a spouse: a scoping review. Nurs Open. 2019;7(2):472–482. doi: 10.1002/nop2.413.

[17] Woodman P, Riazi A, Pereira C, et al. Social participation post stroke: a meta-ethnographic review of the experiences and views of community-dwelling stroke survivors. Disabil Rehabil. 2014;36(24):2031–2043. doi: 10.3109/09638288.2014.887796.

[18] Mahmood A, Deshmukh A, Natarajan M, et al. Development of strategies to support home-based exercise adherence after stroke: a delphi consensus. BMJ Open. 2022;12(1):e055946. doi: 10.1136/bmjopen-2021-055946.

[19] Van Gemert-Pijnen J, Peters O, Ossebaard HC. Improving ehealth. The Hague: Eleven International Publishing; 2013.

[20] Deci EL, Ryan RM. Motivation, personality, and development within embedded social contexts: an overview of self-determination theory.2012.

[21] Maclean N, Pound P. A critical review of the concept of patient motivation in the literature on physical rehabilitation. Soc Sci Med. 2000;50(4):495–506. doi: 10.1016/s0277-9536(99)00334-2.

[22] Eassey D, Reddel HK, Ryan K, et al. It is like learning how to live all over again' A systematic review of people's experiences of living with a chronic illness from a self-determination theory perspective. Health Psychol Behav Med. 2020;8(1):270–291. doi: 10.1080/21642850.2020.1794879.

[23] Clarke V, Braun V, Hayfield N. Thematic analysis. In: Smith JA, editor. Qualitative psychology: a practical guide to research methods. London: SAGE Publications; 2015. p. 222–248.

[24] Sanders E, Stappers PJ. Probes, toolkits and prototypes: three approaches to making in codesigning. CoDesign. 2014 03/06;10;10(1):5–14. doi: 10.1080/15710882.2014.888183.

[25] Ando H, Cousins R, Young C. Achieving saturation in thematic analysis: development and refinement of a codebook. Comprehensive Psychology. 2014;3(03):03.CP.3.4. doi: 10.2466/03.CP.3.4.

[26] D'Olivo P, Langerak AJ, Spek D, et al. Designing social relationships between patients and eHealth: 'EDO' an embodied coach for stroke rehabilitation in the home context. Submitted to Design for Health Journal – Awaiting Decision. 2023

[27] Attig C, Franke T, Wessel D. Personal Resource for Technology Interaction: Development and Validation of the Affinity for Technology Interaction (ATI) Scale, International Journal of Human–Computer Interaction. 2019;35;6:456-467,DOI: 10.1080/10447318.2018.1456150

[28] Reenen E-V, Post M, Mulder-Bouwens K, et al. A simple bedside test for upper extremity impairment after stroke: validation of the Utrecht arm/hand test. Disabil Rehabil. 2009;31(16):1338–1343. doi: 10.1080/09638280902846855.

[29] Braun V, Clarke V. Using thematic analysis in psychology. Qual Res Psychol. 2006;3(2):77–101. doi: 10.1191/1478088706qp063oa.

[30] Cankaya E, Liew J, Pinto Pizarro de Freitas C. Curiosity and autonomy as factors that promote personal growth in the cross-cultural transition process of international students. jis. 2018;8/(4):8. doi: 10.32674/jis.v8i4.225.

[31] Steingut R, Patall E, Trimble S. The effect of rationale provision on motivation and performance outcomes: a meta-analysis. Motivation Sci. 2017; 3(1):19–50. doi: 10.1037/mot0000039.

[32] Grolnick W, Deci E, Ryan R. Internalization within the family: the self-determination theory perspective. In: Grusec JE, Kuczynski L, editors. Parenting and children's internalization of values: a handbook of contemporary theory. New Jersey: Wiley; 1997. p. 135–161.

[33] Ma Q, Pei G, Meng L. Inverted U-Shaped curvilinear relationship between challenge and one's intrinsic motivation: evidence from Event-Related potentials. Front Neurosci. 2017;11:131. doi: 10.3389/fnins.2017.00131.

[34] Yoshida T, Otaka Y, Osu R, et al. Motivation for rehabilitation in patients With subacute stroke: a qualitative study [original research]. Front Rehabil Sci. 2021;7(2):664758. doi: 10.3389/fresc.2021.664758.

[35] Chen Y, Abel KT, Janecek JT, et al. Home-based technologies for stroke rehabilitation: a systematic review. Int J Med Inform. 2019;123:11–22. Mar doi: 10.1016/j.ijmedinf.2018.12.001.

[36] Palstam A, Sjödin A, Sunnerhagen KS. Participation and autonomy five years after stroke: a longitudinal observational study. PLoS One. 2019;14(7):e0219513. doi: 10.1371/journal.pone.0219513.

[37] Swanson LR, Whittinghill DM. Intrinsic or extrinsic? Using videogames to motivate stroke survivors: a systematic review. Games Health J. 2015;4(3):253–258. doi: 10.1089/g4h.2014.0074.

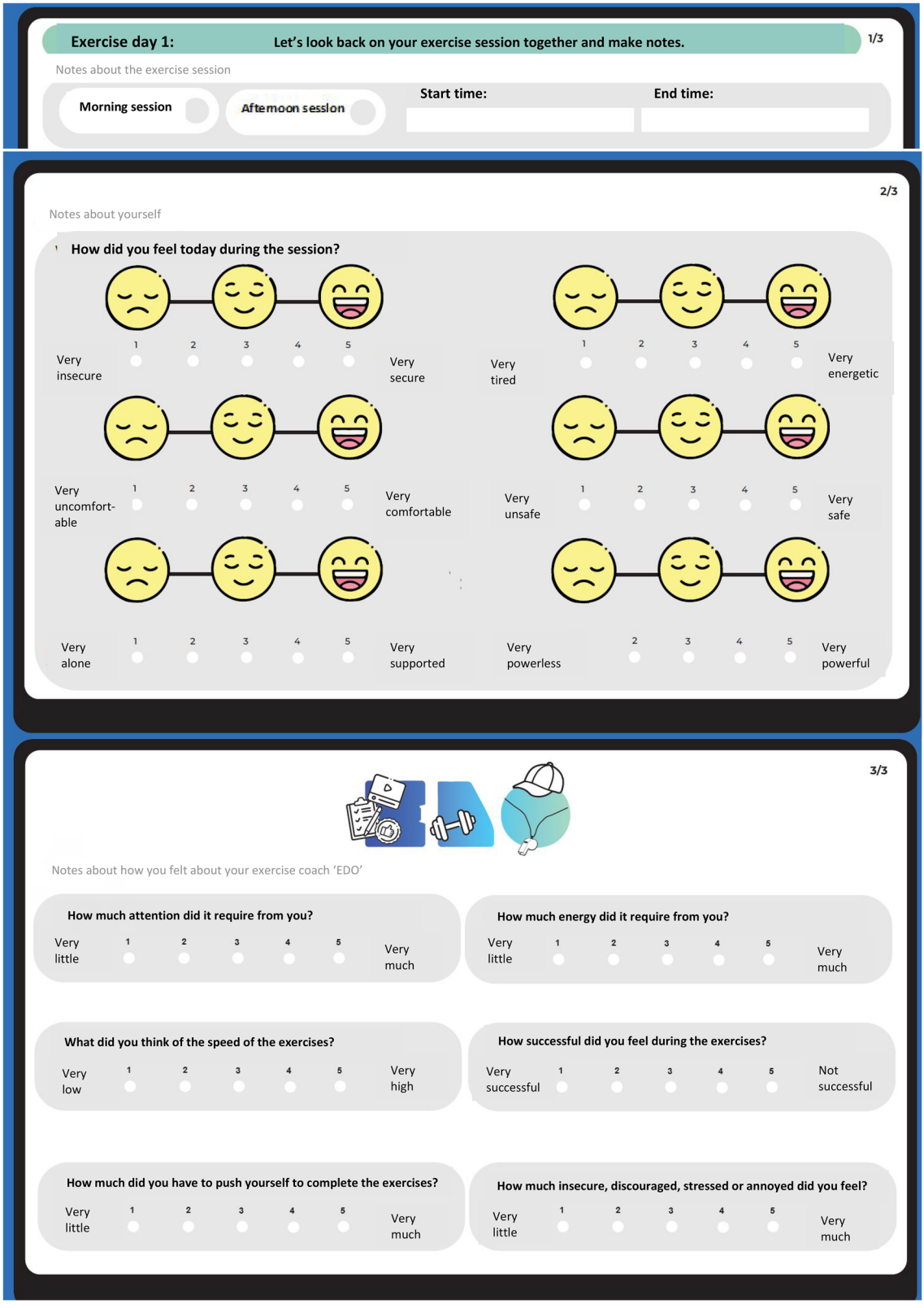
[38] Ryan R, Deci E. Intrinsic and extrinsic motivation from a self-determination theory perspective: definitions, theory, practices, and future directions. Contemporary Educ Psychol. 2020; 61:101860. doi: 10.1016/j.cedpsych.2020.101860.

[39] Teixeira PJ, Carraça EV, Markland D, et al. Exercise, physical activity, and self-determination theory: a systematic review. Int J Behav Nutr Phys Act. 2012;29(1):78. doi: 10.1186/1479-5868-9-78.

[40] Höök K, Löwgren J. Strong concepts: intermediate-level knowledge in interaction design research. ACM Trans Comput-Hum Interact. 2012;19(3):1–18. doi: 10.1145/2362364.2362371.

[41] Cheong MJ, Kang Y, Kang HW. Psychosocial factors related to stroke patients' rehabilitation motivation: a scoping review and Meta-Analysis focused on South Korea. Healthcare (Basel). 2021; 9(9):1211. doi: 10.3390/healthcare9091211.

Appendix 1: Participants' diary.*



*Translated from Dutch to English for the purpose of this publication.

Appendix 2: Interview guide*

Warming up

a. What was it like to have EDO at home for a week?
b. Could you share interesting moments you had with EDO this week?
- e.g. please describe or show to us what happened;

About EDO

a. How would you describe EDO to one of your friends or to a family member that doesn't know it yet?
b. How would you describe EDO as a kind of coach?
e.g. style or approach, manner of conducting you, way of speaking to you;
c. How would you describe the behavior of the different components of EDO?
d. How did you experience using EDO as a coaching system?
e.g. usability, communication, enjoyment;

About exercising with EDO

a. Could you talk about how you experienced doing exercises with EDO?
- e.g. when and how often;
- e.g. difficult / hard;
b) Where did you do the exercises with EDO?
- e.g. where did you place EDO when you did not actively use it;
c. Did you feel like you could count on EDO in doing and performing these exercises?
d. Did you use EDO in different ways than instructed?
e. How did the use of EDO fit into your daily routines?
- e.g. length of the exercises;
- e.g. possibility to repeat the exercises as many times as you wanted;
f. Where others involved in the use of EDO for exercising or otherwise?
g. What would you like to change about how EDO's allows you to exercise?

About motivation with EDO

a. Could EDO motivate you to do the exercises? If so, how?
b. How would you rate the motivation triggered by EDO from 1 (Lowest) to 10 (Highest)?
c. How could EDO motivate you even more?
d. Did you find EDO useful as a coaching system at home? If so, why?
e. Do you think you can trust EDO as a coach? What would help you to trust EDO more?
f. What should EDO do to build up a relationship with you over time?
g. Would you recommend it to other people undergoing rehabilitation?

*Translated from Dutch to English for the purpose of this publication.