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Title:
"I only want to play if I get better" - Designing Visualized Game Performance For Stroke Patient Trust & Motivation

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Supervisors:
Hendrik Knoche

Projectgroup no.
MTA181030

Members:
Bastian Hougaard

Abstract:

Self-care systems shift responsibility to patients which require prudence and motivation. Data visualizations of performance in rehabilitation games support patient motivation, but health numeracy pose barrier to interpretation. This paper contributes a case study of how one therapist used storytelling to aid 14 patients in understanding timeline and heat map visualizations, provided by a co-designed tablet game. The therapist's verbal storytelling catered to patients' level of self-awareness while she used pointing gestures to draw patient attention to the visualizations. Patients with no awareness did not link performance to their injury, which resulted in distrust in the therapist-provided training. The study presents guidelines for designing visualizations in self-care systems targeted to stroke patients in clinical and home contexts.

"I only want to play if I get better" - Designing Visualized Game Performance For Stroke Patient Trust & Motivation

Bastian Hougaard
MTA181030
bhouga13@student.aau.dk

ABSTRACT

Self-care systems shift responsibility to patients which require prudence and motivation. Data visualizations of performance in rehabilitation games support patient motivation, but health numeracy pose barrier to interpretation. This paper contributes a case study of how one therapist used storytelling to aid 14 patients in understanding timeline and heat map visualizations, provided by a co-designed tablet game. The therapist's verbal storytelling catered to patients' level of self-awareness while she used pointing gestures to draw patient attention to the visualizations. Patients with no awareness did not link performance to their injury, which resulted in distrust in the therapist-provided training. The study presents guidelines for designing visualizations in self-care systems targeted to stroke patients in clinical and home contexts.

1. INTRODUCTION

Aging societies increase demand and cost of health care due to higher chronic disease frequency. Stroke is a neurovascular disease which require rehabilitation for months to restore physical and cognitive abilities. Victims and caregivers face diminished quality of life caused by illness deficits and psychological disturbances. Therapists coach stroke patients in goal-setting and collective training to restore function but face limited capacity to attend individual patient needs. Self-care technology provide avenue for clinic expansion and self-management after ceased hospitalization. Blood glucose monitors, for example, support diabetes patients' decision-making. For stroke patients absence of motivation and low self-awareness pose barrier to self-management. Visualization of trends and patterns in patient performance enables insight and motivation but without interpretation assistance, patients face health numeracy challenges. In rehabilitation contexts, therapists provide verbal storytelling to patients, but how self-managed contexts should provide storytelling around visualizations is poorly understood.

I collaborated with an occupational therapist and 14 patients to observe how therapists form narratives around visualization in cognitive training and how patients respond to therapist feedback. The therapist trained patients with poor focus and visual neglect using a digital tablet game *Trail it*, which was further developed to visualize patient performance using heat maps and timelines. This paper contributes a) thematic analysis of 7 cognitive training sessions and b) guidelines for storytelling through performance visualization in self-care systems.

2. BACKGROUND

Stroke is a sudden event caused by disturbances in the brain [33]. Survivors with impairments undergo rehabilitation to recover lost abilities. Rehabilitation is costly and challenging because patients lack hope, self-awareness or are in denial [26]. Stroke patients carry individual deficits, for example visual neglect which is diagnosed when patients fail to respond to visual stimuli on the contralateral side of their lesion [12]. Therapists operate under models from neurorehabilitation research to determine the nature of awareness and acceptance problems [21, 29, 32]. For example, Malia's model of self-awareness for patients with brain injury which contain three levels of awareness: *Intellectual Awareness* (Intellectually perceiving diminished function), *Emergent Awareness* (Recognizing a problem while it is occurring) and *Anticipatory Awareness* (Anticipating that a problem will happen due to diminished function) [21]. The models enable the therapist to understand patient behavior, establish a supportive relationship and propose goals to aid the patient's deficit [29]. Self-care technology aim to empower patient self-management and reduce the burden for therapists and caretakers through self-tracking of health [18]. Visualization of patient progress and clinical parameters enable reflection [5, 6] which can contribute to new training schedule changes and strategies. Research in visualization has studied effects of framing [19], annotation [24] and prediction [9] on reflection, but the studies often lack contextualization.

When self-care systems are placed in clinical contexts, they face barriers such as poor patient adherence and difficult integration with clinical systems [31]. Patients value visualizations of their data [4], they need additional textual features to aid interpretation [7, 27]. Visualizations are prone to misinterpretation due to oversight of trends [16] caused by patients' negative world views [33]. Kosara and Mackinlay presented storytelling in visualization as a means to overcome interpretation barriers [20], but research in how storytelling forms in self-care and clinical contexts is scarce. In a clinical setting, Mentis et al.[22] studied how patients with walking deficits formed stories with a therapist through co-interpretation of outliers and trends in patient data visualizations . In a self-care setting, Bagalkot and Sokoler[1] found that the activity of recording and reading rehabilitation data enabled patients to articulate concerns and involved the spouse actively in the patient's physical rehabilitation . Clinical practices form stories around self-care data through their healthcare frameworks in use [22]. No study has so far investigated how stories around data visualiza-

Figure 1: Trail it's aggregated data summaries & buttons leading to a timeline (left) and a heat map (right)

tion take form in stroke rehabilitation between therapists and stroke patients. For example, it is not clear what storytelling strategy therapists devise for patients who are in denial nor how these patients respond to the training. Neither has the storytelling between actors and boundary objects in rehabilitation been articulated into applicable knowledge for designing self-care technology which aid therapists in meeting increased work demand.

To address this, the tablet rehabilitation game *Trail it* was appropriated (see [11, 16]) and developed and deployed to study storytelling practice between therapist and stroke patients in rehabilitation. Co-design with an occupational therapist advised the development of heat map, timeline and aggregate visualizations of patient performance, which enabled field observations of storytelling in cognitive training. This paper contributes thematic analysis of interactions observed between therapist and patients across three months of cognitive training and derives design guidelines for enabling storytelling visualizations which can provide motivation and insight in self-care contexts.

3. DESIGN PROCESS

Design work commenced on top of the existing tablet rehabilitation game *Trail it*. In Trail it, patients perform visual search to connect numbers and letters consecutively. The game is modelled on the Trail Making Test, which is a neuropsychological instrument used in clinical work to assess processing, sequencing and visual-motor skills [3]. Trail it measures patient's reaction time to connect numbers or letters which appear as circles across the screen semi-randomly in a grid of 12×8 possible positions. After each ended level, the median reaction time, level duration and remaining time of training highlighted the patient's performance. When a training session finished, Trail it displayed a median reaction time across the entire training and for the left and right side of the patient's field of view. Prior to the design process, these measurements were shown using four sentences of text.

Trail it was subsequently redesigned through four rapid iterative deployments, 7 usability studies and 9 debrief interviews with an occupational therapist in the rehabilitation context. Initial iterations of Trail it introduced individual patient profiles and user interface to adjust difficulty, training length, visual, and auditory assistance. When patients finished training, Trail it collected data on their performance and demographic background if the patient had consented to do so and informed the design of the data visualizations. Visualization design proposals were brought to the therapist as paper cutouts and reviewed collaboratively where the following was emphasized:

- Keep the number of visual features low and simple to enable stroke patient reflection of their performance.
- Hide detailed visualizations by default to give the therapist opportunity to skip them if she does not deem them relevant to her storytelling.
- Use of colors to highlight performance enables better therapist recall of past results.

The review outcome directed the design and implementation of an aggregate data summary, a timeline visualization and a heat map visualization shown in Figure 1. The summary described the training time, compared correct hits to errors and calculated the session median reaction time using text, symbolic icons and a donut chart. Two buttons placed underneath the aggregate data summary provided access to the timeline and heat map.

3.1 Timeline

An interactive timeline showed the daily average of the median reaction times. The x-axis utilized a fixed scale to show daily reaction times and became scrollable when data exceeded screen width. When reaction time for the present day was less than 5 seconds, the Y-axis ranged from 0 to 5 seconds. If the current reaction time was higher, the Y-axis range was twice the reaction time to adapt relatively to patient performance and ensure that smaller fluctuations in the reaction time would not appear as steep changes. Each data point showed a textual representation of the reaction time it represented and the Y-axis was hidden to minimize superfluous information. The latest training session was given extra emphasis in the timeline through a pulse animation and a clearly marked label. Clicking a data point would show textual information about the data point's ranking and how long time the patient had trained that day.

3.2 Heat Map

A heat map showed median reaction times across the screen which was divided into six fields, inspired by design of cancellation tests [12] (with the two middle fields joined). The heat map used an algorithm to interpret and color reaction times red, orange or green. Due to high variance in stroke patient reaction times, the algorithm decided the colors using a combination of absolute values and values calculated relative to the patient's overall median reaction time. Reaction times which were twice the overall median reaction time or higher than 7.5 seconds were colored red. Other reaction times which were higher than 1.5× the overall median reaction time or higher than 5 seconds were colored orange. Remaining fields were then colored green.

4. METHODOLOGY

The study aimed to observe themes in therapist storytelling around stroke patient performance which Trail it visualized after ended training. Action-based research [14] and technology probes [2] inspired the study design which involved close collaboration with a single therapist and remote tracking of patients who attended cognitive training at a rehabilitation center. Preliminary research investigated therapist practices through a therapist interview followed by observations of a goal meeting and a therapy session. A three-month collaboration provided opportunity for design and evaluation of four iterations of Trail it (See Table 1). The first iteration provided textual feedback on patient performance but was followed by iterations which provided performance visualizations. Note-taking captured patient-therapist interactions during 7 cognitive training sessions followed by debrief with therapist to discuss of events of interest. The ongoing collaboration created fluid boundaries between field observations, design and evaluation to accommodate rapid iteration and deployment.

4.1 Therapist Collaboration

An experienced occupational therapist responsible for the rehabilitation center's cognitive training offered close collaboration on the design and development of Trail it which she used in training for a few years. She provided literature on neurorehabilitation research, empirical knowledge and judgment during the visualization design process. Important visual changes in the Trail it user interface underwent her review before implementation. Deployments were tested in cognitive training where she identified abnormal system behavior and made suggestions. The structure and order of cognitive training was not changed, except for the presence of an observer and the introduction of additional tablets to facilitate simultaneous Trail it training and self-care. The therapist operated under Malia's hierarchical model of self-awareness [21] and under Townsend and Polatajko's Canadian Practice Process Framework [29].

4.2 Participants and Setting

14 patients with moderate to severe brain injury participated the 7 cognitive training sessions, in which nine used Trail it. Five patients opted to share demographic data which is available in Table 2 together with the patients' level of self-awareness as judged by the therapist when able. The therapist selected 2-5 patients to participate based on type of deficit and schedule availability. The patients had displayed varying levels of self-awareness in cognitive training with the highest level being emergent awareness. Three patients (Flora, Alfred, Martha) were diagnosed with visual neglect.

Week	Trail it version	Participants
Wk12	2018.04.04	Eddy, Lenard, Flora, Zack
Wk16	2018.04.10	Flora, Sara
Wk17	2018.04.20	Flora, Alfred, Sara, Charlie
Wk18	2018.05.01 / 04.20	Jessie, Flora, Joe, Amy, Brad
Wk18	2018.05.01	Alfred, Joe
Wk19	2018.05.01	Amy, Alfred, Joe, Eric
Wk21	2018.05.01	Alfred, Joe, Jasper, Martha

Table 1: List of studied cognitive training sessions.

Patient	Age	Condition	Self-awareness
Martha	70 - 79	Visual neglect	-
Flora	60 - 69	Visual neglect	Emergent
Alfred	70 - 79	Visual neglect	Near emergent
Eddy	-	-	Emergent
Sara	70 - 79	Poor focus	Emergent
Jasper	40 - 59	Poor focus	-
Amy	40 - 59	Poor focus	Intellectual
Eric	-	-	Intellectual
Zack	-	-	Intellectual
Brad	-	-	No awareness
Joe	40 - 59	Other	No awareness
Lenard	-	-	-
Jessie	-	-	-
Charlie	-	-	-

Table 2: Patient opt-in background and awareness.

Patients typically performed two hours of cognitive training per week. The cognitive training took place in an open space used for leisure and dining. Patients sat in groups of up to four around a table and trained using tablet rehabilitation games or paper assignments selected by the therapist. During the study, a few patients were given the opportunity to continue training on their own with the rehabilitation games during off-schedule hours or home visits.

4.3 Data Collection and Analysis

An open coding analysis [28] identified themes of patient-therapist interactions in the collected field notes after each interview and training session. The qualitative analysis used an ongoing inductive process to refine the interpretation of how the therapist used patient performance visualizations. Patients were cross-identified, represented in the data by pseudonyms and matched to available quantitative data.

5. FINDINGS

Data collection in cognitive training measured patients' training on 27 days across three months (see Figure 2). The analysis of the gathered qualitative data resulted in the themes seen in Table 3 and produced insight into three larger topics: *Self-Awareness Determines Response*, *Therapist Assessment of Patient Ability* and *Trust and Distrust in Cognitive Training*.

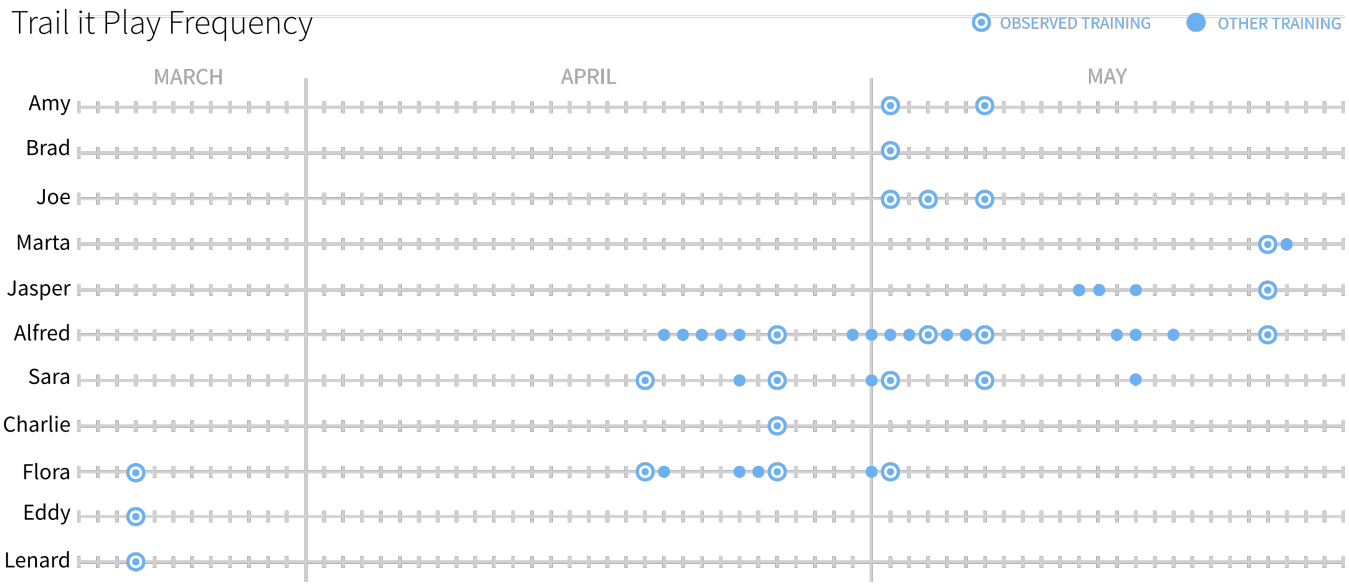

Figure 2: Measured daily play frequency of Trail it for 11 patients from 23rd March to 23rd May.

5.1 Self-Awareness Determines Response

The visualizations became foundation for both positive and negative therapist-to-patient feedback. Patients who were trying Trail it for their first time hesitated to interact with the results and awaited therapist guidance which she gave verbally while pointing towards specific visualization elements to direct the patient's attention (*Guiding Interpretation*, Quote 19). Many of the patients did not talk much during training and differed in their response to the therapist feedback.

Patients with no awareness like Brad did not accept that they had a deficit and were unaware of the symptoms associated with it. Brad and Zack stated that they found the training easy to perform and responded defensively to the therapist when she pointed out their mistakes in her feedback. Joe refused the therapist's suggested strategies to help him solve assignments and Brad refused to continue training with Trail it which he belittled with aggressive wording (*Patients Felt Evaluated*, Quote 46).

Patients with intellectual awareness like Alfred were aware of their deficit, but displayed annoyance when they were reminded of it. They had difficulty accepting their results when no short-term improvements were visible. Alfred commented that he would only play if he got better (*Needs Positive Support*, Quote 34).

Patients with emergent awareness like Flora displayed acceptance of the therapist's feedback by replying in agreement. Flora understood that the slow reaction times she saw on the left side were visual neglect associated to her deficit. She replied to Alfred that the only way to get better, was to continue training.

5.2 Therapist Assessment of Patient Ability

The therapist assessed patients' abilities through her interactions with them in cognitive training. She selected three patients (Alfred, Flora and Sara) whom she determined could benefit from cognitive training as self-care. When patients finished training, she asked them whether they found the training easy or hard. Their response, together with her review of their results, gave her understanding of the patient's level of self-awareness. The therapist identified lack of self-awareness if a patient responded that assignments were easy, but showed poor performance in solving them or if the patient did not recall previous performance. The therapist commented that patients who refuse to train or interrupt training like Brad are difficult to assess because these patients do not want to perform their best. The visualizations compared to text-only feedback, enabled the therapist to enter discussion with self-aware patients around the patient's deficit (*Awareness of Deficit*, Quote 6). The heat map informed the therapist of possible signs of visual neglect and was the most frequently used detailed visualization. The therapist used the timeline less frequently but she anticipated its use to understand how cognitive patient performance evolves over time for individual patients and how much the patient trained outside the cognitive training sessions.

5.3 Trust and Distrust in Cognitive Training

Observing the cognitive training gave opportunity to see the dynamics of patient, system and therapist relations. Alfred's questions regarding how Trail it calculates his results tied together with a mismatch between his own perception of performance and Trail it's measurements which resulted in distrust in the system. Brad rejected training with Trail it and did not understand why he had to solve assignments which he perceived to be below his intellectual level. Brad displayed distrust in the system's ability to provide training which was adequate for him and displayed distrust in the therapist's training.

Table 3: List of themes emerged from analysis of dialogue on patient performance.

Theme	Description	Illustrative Quote
Guiding Interpretation	The therapist showed patients how to read and interpret the visualizations through verbal explanation and pointing gestures.	The therapist inspects Joe's heat map. Therapist "*This one shows where you have been slow. It shows something over in this corner here, but it might be because there is a longer distance to it. But next time we can take a look again and try to see if there is a general trend to be found here.*" `Quote 19, Wk18 Cognitive Training 04/05/2018`
Awareness of Deficit	The therapist used the visualizations to explain self-aware patients how their deficit linked to symptoms, such as fatigue.	Alfred said "*I only want to play, if I get better.*" The therapist answered Alfred that by knowing that he has issues on the left side, he could try to remember to look over there when he has trouble finding the targets, for the next training. She also hypothesized that Alfred's performance may relate to time of day. `Quote 17, Wk17 Cognitive Training 26/04/2018`
Relative Change Emphasis	The therapist and patient discussed performance, improvement and anticipation of improvement relative to results of previous training sessions.	The therapist inspects Alfred's heat map. Therapist "*Well, I can see that you have improved*". "*Up here, I'm pretty sure it used to say 4 seconds.*" The therapist switches to the timeline. Therapist "*Yes, well there definitely is a decrease.*" `Quote 20, Wk18 Cognitive Training 04/05/2018`
Self-Awareness Assessment	The therapist used dialogue around perceived difficulty to assess the patients' level of awareness which she used to form her storytelling after.	Therapist "*Let's see if I can review this. It's a hard one.*" Zack: "*I don't think it was hard.*" Therapist "*The first one is right. Good, Both of them look fine.*" The therapist later clarified she had omitted mistakes because Zack lacked self-awareness. `Quote 5 (Wk12 Cognitive Training 23/03/2018)`
Needs Positive Support	The visualizations can become discouraging reminders of the patient's deficit.	Alfred "*I think the result is the same again.*" Therapist "*What do you think about it?*" Alfred "*If it doesn't get better, then I don't want to play.*" `Quote 34, Wk17 Cognitive Training 26/04/2018`
Improvement Anticipations	Therapist and patients had anticipations of future improvements. The therapist shared her positive anticipations to provide patients encouragement.	As Alfred left the room, the therapist told him that she was excited to see how the timeline in Trail it looks like when Alfred returns from his weekend home visit. `Quote 30, Wk17 Cognitive Training 26/04/2018`
Patients Felt Evaluated	Patients with no self-awareness felt that the therapist was testing their intelligence.	The therapist reviews Brad's assignments and points out a mistake. Brad spurts that he recognizes that his whole assignment is wrong and that the therapist should give him a poor grade. He writes "*02*" (lowest passing grade) on the assignment with his pen. `Quote 46, Wk18 Cognitive Training 02/05/2018`
Result Perception Mismatch	Patients saw results which they believed were wrong compared to their own performance perception.	Alfred "(...) *I made 7 mistakes. I don't think I made those mistakes.*" `Quote 26, Wk19 Cognitive Training 07/05/2018`
Need for Data Transparency	Patients wanted additional information on how the calculation of their reaction time was made.	While playing a new training session, Alfred asked, "*A reaction time, is that the average?*" `Quote 23, Wk18 Cognitive Training 04/05/2018`

Therapist actions tied to trust through her design and execution of cognitive training. When Brad asked why he could just play his own preferred video games, the therapist explained that she distrusted the games as training utilities because too many variables impact performance. Likewise, the therapist entrusts selected patients to self-care based on their response during cognitive training.

6. DISCUSSION

Self-awareness was a prominent theme in all patient and therapist interactions. Alfred displayed lack of emergent self-awareness with his comment "*I only want to play if I get better*" (*Needs Positive Support*, Quote 17). Flora displayed emergent awareness when she replied to Alfred "*You only get better if you keep on playing.*" The emphasis on relative change, guiding interpretation and anticipation of improvement re-occurs in other non-stroke contexts [1, 22]. The therapist's need to control visibility of detailed visualizations is in line with recommendations by Greis et al. [10] but her storytelling linked symptoms to the patient's deficit and assess self-awareness seem specific to stroke patient rehabilitation. Mentis et al. found that storytelling around patient data was shaped by the therapist [22], but oppositely the data visualizations shaped what storytelling the therapist performed. The therapist formed stories for the patients around their performance and for patients with lack of self-awareness, she used the visualizations as proof of the patient's deficit in her verbal feedback. This paved way for the therapist to articulate what strategies the patient could use when faced by limitations of his deficit. Unlike other contexts in which patients were contextualizing their results [22], the stroke patients' lack of self-awareness made it difficult for them to provide input. Self-awareness determined much of the therapist's feedback which indicate that self-care systems should adapt their feedback based on patient awareness level.

Interpretation of stroke patient performance is difficult because it is hard to predict compared to physiological improvements which the therapist perceive to be approximately linear. The visualizations helped interpretations of the stroke patient performance through coloring and scaling and yielded rich feedback between therapist and patient compared to the previous textual description of patient performance, including pointing gestures, verbal comments and reflections. The textual representation used absolute numbers which relies on familiarity with the measurement unit and the patient's own standard of reference which may be non-existent or misinformed. Using measurement data without contextualization or interpretation is a hazard for both visualizations and textual representations which can lead to aversion of use, overreaction to fluctuation and reinforcement of inappropriate goals [17]. For example, Trail it provided access to visualizations regardless of performance and sample size, but timelines with too few data points risk giving wrong impressions of trends in patient performance to patients. Alfred looked at his timeline and stated "*"It is annoying that I don't get any better.*" (*Improvement Anticipations*, Quote 35), after five days of consecutive training.

Issues of trust emerged during cognitive training which tied into lack of self-awareness. It appeared in interactions between patient and system and created tensions, for example when Alfred perceived his results differently from what the system reported his results to be. The need for data transparency had direct relation to tensions in trust. Brad refused to train and reacted negatively towards to therapist feedback which indicates a trust issue between patient and therapist. The role of trust in a goal-setting driven context such as rehabilitation, fits with the self-tracking model by Niess and Wozniak [23]. Unlike other contexts, the raised issues of trust were emphasized by the patients' low self-awareness which makes trust an important goal to achieve with self-care systems targeting stroke patient rehabilitation.

The study revealed tensions between designing for what patients wants to know and designing what patients benefits from seeing according to the therapist and motivation theory. Visualization of positive results is ideal to achieve feelings of competence [25] in motivation theory, but patients may occasionally benefit from dissatisfaction to fuel the desire to overcome challenging situations [32]. When visualizations showed poor results, it became hard for the therapist to provide positive storytelling. Visualization of patient performance relative to normative performance may seem useful to aid interpretation, but also hinders positive storytelling. If visualizations showed no progress, therapist storytelling was hardly present.

The emerged themes found in the case study of therapist-patient interaction led to the following design recommendations for self-care systems which visualize stroke patient performance:

- Storytelling should explain how to interpret visualizations when shown for the first time, to bootstrap patient understanding.
- Self-care systems should use highlighting to direct the patient's attention to specific features of the visualization, which are essential for the storytelling, to match the therapist's use of pointing gestures.
- Avoid visualizations which do not show progress. Performance visualizations are not always ideal storytelling devices because performance fluctuate easily and improvement can be slow. For daily basis, consider other visualizations, for example training frequency, time spent playing which show more consistent training progress.
- Negative feedback is necessary, for example to link poor patient performance to patient deficit, but this should be infrequent compared to positive support and controlled by a therapist in clinical contexts.
- Let visualizations interpret data relative to a standard of reference, for example past training performance or goal-setting, to provide a frame for the storytelling.
- Visualizations should indicate if patient performance reaches the boundary of best possible performance.
- When a patient reaches performance boundary, the system should facilitate action to either support performance maintenance or increase of difficulty.

The following guidelines apply to storytelling in self-care systems which adapt to patient awareness levels:

- Enforce an upper training limit for patients who lack self-awareness to prevent fatigue from overwork.
- Link deficit and results for patients with intellectual awareness.
- Provide strategies which can help patients with emergent awareness overcome their condition.

The case study's unbalanced design limits the applicability of the study findings. Talkative patients contributed more themes, which stem from the study's use of passive field observations as main information source. The rapid iterative development of Trail it introduced inaccurate calculations of patient reaction times. To improve accuracy of patient results, future versions of Trail it could calculate reaction times between targets based on normalized distances or position consecutive targets with equal distance from each other at level generation. The stability of the hi-fidelity self-care system was given higher priority than the accuracy of results to support the ongoing study of storytelling for patients with differing self-awareness.

Further research within storytelling for self-awareness could investigate integration of peer presence, which has had positive results on patient motivation to perform their exercise consistently in other self-care contexts [1, 8]. In a rehabilitation context, spouse or family could take on co-operative roles in the training to increase the role of the family in rehabilitation [30] and facilitate competition or aid storytelling. Progression in training could be emphasized and rewarded through use of unlockable level themes and other motivational affordances from gamification literature [13]. Insight gained from visualization storytelling could be enriched through collaborate annotation of patient-generated observations of daily living and patient-supplied clinical parameters which may co-variate with performance [4, 15]. Determination of appropriate feedback could be controlled by therapist or deduced from prediction of self-awareness level by matching patient performance with perception of difficulty. In the long term, this enables visualizations to support supervised patient goal-setting in self-care systems for both practice and home contexts.

7. CONCLUSION

Stroke patients in self-management contexts lack motivation to train because and face health numeracy challenges when interpreting data visualizations. The case study used a tablet game to study how therapists in rehabilitation communicated visualizations of patient performance to patients and found that therapist storytelling emerged based on patient self-awareness level. Co-design with a therapist and field observations of patient cognitive training laid foundation to the implementation of timeline, heat map and aggregate visualizations. The therapist used the visualizations to link patient performance to the patient's injury and devised strategies for patients to help understanding the symptoms of their deficit. The visual feedback in the self-care system yielded rich verbal and gesture-based interactions compared to textual feedback. Patients and therapist showed anticipation of training results, but tensions in trust arose between patient, therapist and system when a patient in denial refused to continue training. The paper has proposed design guidelines in designing self-care technology for stroke patient rehabilitation to increase motivation and reflection. I hope the case study can stimulate further research on storytelling affordances in information visualization.

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