Understanding Persuasion and Motivation in Interactive Stroke Rehabilitation

A Physiotherapists' Perspective on Patient Motivation

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Abstract. For the research reported in this paper ethnographic research methodologies were used to explore patient motivation, feedback and the use of interactive technologies in the ward. We have conducted in-depth interviews with physiotherapists, who work closely with stroke patients to help them regain movement and function. From this research, a set of design guidelines have been developed which can be applied in the design of interactive rehabilitation equipment.

Keywords: Rehabilitation · Stroke · Healthcare · Feedback · Design research

1 Introduction

Stroke patients often deal with changes in motivation during rehabilitation. There are a number of reasons for this, including the physical change to the brain resulting from the stroke, psychological issues such as depression as well as improvements and setbacks in their mobility as they complete their rehabilitation. The use of persuasion, both in the interactions between the patient and the physiotherapist and the equipment in the rehabilitation gym is important to help patients succeed with rehabilitation. To explore this topic, we have completed observations of the ward and interviewed physiotherapists. These interviews explored the physiotherapists' perspective on patient motivation as well as patient feedback and the use of technology in the ward.

The research presented in this paper is one part of a larger research initiative into developing equipment that helps stroke patients with their rehabilitation. This research will inform the user centered design approach we will use. This approach will include the researchers, the patients and the physiotherapists working together to design suitable equipment.

The goals for the study presented in this research paper are:

1. To understand patient motivation from the perspective of the physiotherapist.
2. To understand what types of feedback physiotherapists provide patients during rehabilitation.
3. To understand the day-to-day use of technology used by physiotherapists in the rehabilitation gym..

The objective of this paper is to provide researchers and designers in the field of Human-Computer Interaction (HCI) with the information they need to understand stroke patient motivation as well as a set of guidelines for designing rehabilitation equipment for stroke patients.

2   Background

Whilst this paper focuses on motivation in the context of stroke rehabilitation, the following topics are relevant to acquire an understanding of this multi-faceted area of research. Alongside motivation, the topics of persuasive technology, stroke and stroke rehabilitation are important as well as an understanding of previous work in this area.

2.1   Motivation

The definition of motivation for this study is 'any primary cause of behaviour' [1], however there is an understanding in the physiotherapy domain that motivation is a personality trait that a person either does or does not have [2]. Motivation is a multi-faceted topic that is affected by an understanding of needs and goals. This will be explored through Maslow's 'hierarchy of needs' and goal setting theory.

Basic human motivations result from basic human needs. This is most clearly described through Maslow's 'hierarchy of needs' [3]. Maslow segments human needs into five types - in order of importance – physiological needs, safety needs, social needs, esteem needs and self- actualisation. Maslow also states that needs which have been satisfied no longer motivate. Patients completing their rehabilitation in Sydney hospitals have their physiological needs such as food, air, water and shelter accommodated. However, for patients, lacking safety needs can affect a patient's willingness to complete rehabilitation. For example, patients often fear falling over, due to losing feeling in one leg as a result of their stroke.

As well as the 'hierarchy of needs', there are a range of different motivation theories. The theory that we focus on for this research is goal-setting theory that proposes that goal setting and task performance are directly related. This theory proposes that goals need to be small, specific and clear. It is also important that goals are achievable as setting unachievable goals can be detrimental to motivation. Goals must also be realistic and challenging to increase motivation. Research into goal-setting in stroke rehabilitation [4, 5, 6] has identified that goal setting is a significant factor for successful rehabilitation. However, in a day to day clinical environment, patients do not always have input into their goal setting and therefore do not have a sense of ownership over their rehabilitation and progress [7].

2.2   Persuasive Technology

Persuasive technology is the study of using computing technology to aid behaviour change. Persuasive technology can most commonly be seen in the design of applications for weight loss and giving up smoking. It has been identified that ambitious persuasive technology often fails as a result of taking on too great a behavioural change in one step [8]. It has also been observed that creating a behaviour that is simple, easy and can be done by anyone has a higher chance to yield success. An example of a simple task for stroke patients would be for them to do the same exercise with both hands at the same time. This allows patient to mimic between one hand and the other. As they see improvement, a second task could be introduced. However, it is important that this information or second skill is offered to the patient at the right time [9]. If the patient is bombarded or becomes overwhelmed it may cause them to give up on the system, regardless of how simple.

The introduction of persuasive technology to a rehabilitation setting is likely to have a positive role. However, it is important to carefully design the human computer interaction to reduce any sense of bombardment or belittling of the patient. Instead it should be used as a way of empowering the patient to stay motivated whilst tracking improvements in their performance.

2.3   Stroke and Stroke Rehabilitation

An understanding of the physiology of stroke is essential to understanding the physical and psychological changes to the body that are caused by stroke. A stroke is caused by an interruption to the blood supply to the brain, either by a blockage (ischaemic stroke) or bleeding (haemorrhagic stroke) [10]. A patient's conditions following a stroke vary depending on the severity and location of the stroke. Whilst some patients only suffer minor symptoms that can be rehabilitated quickly, others can have significant impacts on mobility, speech, vision and behavioural changes.

Stroke rehabilitation is a labour intensive process that includes extensive interaction between a patient and their therapist [11]. Two factors that negatively impact the outcome of rehabilitation are lacking motivation and patients not understanding the reasons for doing their rehabilitation exercises [12].

The materials used in the rehabilitation gym include, styrofoam cups, paddle pop sticks, wooden blocks and tape which are manipulated by patients in the process of rehabilitation. Whilst these materials are rudimentary, they can be used with success. However, they do not provide the patient with feedback about the small improvements in their limb movements.

The Nintendo Wii Fit including the Wii Balance Board, and the Xbox Kinect have been introduced to hospitals with mixed results. Some issues with using this technology in a rehabilitation setting are the short length of the games alongside the mapping limitations between the physical interface and game console parameters [13].

2.4   Related Work

This section outlines existing work in the area of designing for stroke rehabilitation, as well as research into the physiotherapist perspective of patients' motivation. These

publications come from a range of different research backgrounds, including HCI, technology and clinical research.

In HCI, studies have been completed [14, 15] focusing on tailored rehabilitation solutions for home-based patients. These studies utilise a user centered design process, including extensive research into individual user needs. The designed solutions focused on individual patients, therefore they may not be translatable in a rehabilitation gym context for use by a wider patient audience.

Other research focuses on solutions that can be used by a wider audience. In many cases, researchers have developed their own games by integrating sensors into rehabilitation equipment and designing relevant interfaces for patients. This allows for simple interfaces that can be understood by patients alongside rich and varied feedback, such as those found in video games [13].

The potential of existing gaming consoles for use in rehabilitation context has also been explored in a number of different studies [16, 17]. This research particularly focusses on the Xbox (Kinect) and the Nintendo Wii (fit). Both games have proven useful for patients who are cognitively able and who have a good range of motion, however as they are designed for able-bodied people, they are not able to be used successfully by all patients [18].

The perspective of physiotherapists on patient motivation is not a widely researched topic. A similar study in this area of research looks at physiotherapists attitudes towards motivation and their definition of motivation. As a result motivation is widely seen by physiotherapist as a personality trait [2].

3   Study Design

From our previous work on a set of sensor floor tiles and a sensor sleeve [19], we identified that it is important to understand patient motivation in detail. This includes understanding the causes of increases and decreases in motivation as well as how interaction with computer interfaces adds to or hinders motivation. The following section outlines the study design for this project.

3.1   Participants and Recruitment

All participants work as physiotherapists at the Bankstown Lidcombe Hospital, in the greater Sydney area. The six physiotherapists who were recruited for this study focus primarily on stroke rehabilitation. Physiotherapists were initially contacted via email. The email included an invitation to contribute to the study as well as information about the interviews.

The small sample size of this study is due to the ethics approval under which this study is being completed limiting the study's sample size to the stroke specific physiotherapists at the Bankstown-Lidcombe hospital. This hospital was chosen due to the long-standing relationship between the hospital and the university. As a result of these factors, it must be noted that this may bias the results as different stroke wards throughout the world operate differently and the adoption of technology can vary.

3.2   Observations and Interviews

Physiotherapists were observed completing their day to day work for over 40 hours over a ten week period. The researcher took a fly on the wall approach for the majority of the observations, but at times the researcher would follow the physiotherapists through 'walk-throughs' as they completed their work.

Of the six physiotherapists interviewed, two were senior physiotherapists, two physiotherapists, one a physiotherapist assistant and one a physiotherapist manager. These physiotherapists work directly with stroke patients and have between 5 weeks and 27 years of experience. The interviews had the aims of understanding the physiotherapist perspective on types of patient feedback, patient motivation and the use of interactive technologies in the ward.

3.3   Setting

All interviews took place in the physiotherapist office at the Bankstown-Lidcombe Hospital. This setting was chosen, as it is a quiet location where the interview would not be disturbed. All interviews explored the physiotherapy activities that are conducted at the Stroke and Aged care rehabilitation gymnasium at the Bankstown-Lidcombe Hospital. The equipment used in the gymnasium includes height-adjustable beds, tilt tables which tilt from horizontal to vertical, a treadmill, a Nintendo Wii Fit, Balance Tiles, a set of stairs as well as a range of smaller materials for rehabilitation including styrofoam cups, wooden blocks, clothes pegs, balls and tape.

4   Results

This section presents the combined results from the observations and the interview with the six physiotherapists. Thematic analysis [20] was used to identify the themes and affinity diagramming was used to review and further define these themes.

4.1   Importance of Motivation

All physiotherapist commented that motivation is not essential to patient rehabilitation but in most cases results in better outcomes. It was commented that patient motivation makes a physiotherapist's job easier as they do not have to repeatedly remind and encourage the patients to do their rehabilitation exercises. "(Motivation) makes my job easier, but I wouldn't say that it is essential, people can still get better without being highly motivated, but to get really good results I would say it is important" (Participant 5).

The signs of motivation were also explored. 'Engagement' was the word most commonly used by the physiotherapists to describe patients who were motivated. It was commented that these patients were eager to come down to the gym and would exercise in their rooms outside of their time at the gym. In contrast, unmotivated patients were described as "having a lack of interest" (Participant 1).

4.2   Factors Affecting Motivation

There are a range of different factors which can affect the motivation of a patient. These findings have been grouped into positive factors and negative factors.

The *positive factors* that affect motivation include changes to the patient's ability over time, understanding of improvement, support from family and friends and lifestyle factors before stroke.

During the interviews, all physiotherapists commented that changes to the patient's ability over time are important for changes to motivation. Physiotherapists commented, "When they start seeing a bit of improvement, they kind of just get more motivation and they want to come down to the gym" (Participant 6). However, it was also commented that if the patient is not improving or instead sees declines in their ability, they can lose motivation. "It does change when their function either improves or declines" (Participant 6).

The patients understanding of their improvement is also a factor in their motivation. Physiotherapists commented, "it's all about tracking. You track their improvements for them" (Participant 4). This was explained in the context of one patient who did not recognize and celebrate their improvements, even though they were improving on a weekly basis.

'Family' was discussed as being a motivator in two ways. One was the support provided by family members whilst the patient was completing rehabilitation. The other was that they represent an incentive for the patient to get home. It was observed that patients who were completing their rehabilitation with the support of family members were, in many cases, more motivated to continue doing their repetitions. The second type of motivation that was explored during the interviews was the patient's motivation to return home to live with family, especially when they have family who are dependent on them. In some cases this was a pet such as a dog or a cat.

Lifestyle factors that impact stroke rehabilitation include the patient's level and frequency of exercise before the stroke. During the interviews, physiotherapists commented that patients who have "been intentionally very physically active" (Participant 1) before their stroke usually have more success in the gym.

Negative factors that affect patients' motivation include pain, sickness and psychological issues, difficulties with communication and environmental factors.

During the interviews, 'pain and sickness' were discussed as common factors that result in a change of motivation. Physiotherapists commented that the most common issue affecting confidence was patient falls during the night. The effect of psychological issues on patient motivation was also explored. Physiotherapists commented that a patient's willingness to complete their rehabilitation often has to do with their emotions and mood. "It has a lot to do with their mood and how they are feeling and their emotions about everything that has happened" (Participant 3).

Communication difficulties are another factor that affects motivation. Physiotherapists commented that patients who do not speak English often struggle with motivation as communicating with and understanding the physiotherapist is difficult.

Environmental factors were also discussed as affecting patient motivation in a negative way. "Little distractions stop patients from doing their exercises" (Participant 5)

was a comment by one of the physiotherapists when discussing the factors which impede patients from completing the numbers of repetitions they are prescribed.

4.3   Understanding Feedback

In HCI, feedback is defined as 'any form of information from a system, the environment, or a person in response to an action of a person on that system' [21]. During the interviews, feedback was described as "Communication of any type of knowledge of performance back to the patient" (Participant 2). The interviews explored feedback given to the patient during their exercise and following their exercise.

The types of feedback that are given to the patient during their exercise include feedback given by the physiotherapist and feedback given by external factors. It was observed that physiotherapist feedback is usually in the form of verbal or visual feedback. This can be broken into motivational feedback where physiotherapists tell the patient that they are doing a good job, or simply smile at them. The other type of feedback is knowledge of performance where the physiotherapist communicates to the patient what they need to do to complete the exercise correctly or manipulates the patient's limbs.

Feedback given by external factors was identified during the observations. Types of external feedback include the feedback from games such as the Nintendo Wii and the stepping tiles, as well as feedback from the manual hand counters telling the patients how many repetitions of the exercise they have completed. Other feedback includes visual cues that are usually in the form of pieces of tape, set up by the physiotherapists to tell the patients where they need to reach for an exercise. There can also be audio cues such as walking in time with music.

When discussing these external forms of feedback with the physiotherapists, we explored the level of feedback offered by games such as the Nintendo Wii and balance tiles. Physiotherapists commented that games such as the Wii would still require that patients have one-on-one attention from the physiotherapist as these exercises allow for adaptive compensation, meaning that the patient does not have to complete the exercise correctly to receive positive feedback and therefore can be completing the exercise incorrectly without knowing. In many cases, this is due to the technology not being designed to accommodate "spatial relationships, for example where someone is in space" (Participant 1). Feedback following exercise was also explored. Physiotherapists commented that "measurement is really important so there is some concrete example of how patient's movement has changed" (Participant 1).

4.4   Personalisation of Feedback

Observations of the physiotherapists in the rehabilitation ward showed that physiotherapists give different types of feedback depending on the patient and the exercise. The idea of personalisation of feedback was also explored in the physiotherapist interviews. Factors such as age, patient motivation, severity of stroke, cognitive issues and patient goals were discussed as being reasons for giving patients different types of feedback. Physiotherapists also consider the type and amount of feedback provided.

During the interviews, age and patient motivations were explored particularly in relation to the types of exercises performed by different patients. This exploration focused on use of interactive technologies such as the Nintendo Wii. Physiotherapists commented that "It's a lot easier for the younger patients in their 20s, 30s, or even 40s...whereas patients who are in their 70s, 80s and 90s will sort of think that it is a game rather than something that can help them in terms of their rehabilitation" (Participant 2).

Severity of the patient's stroke or a patient's cognitive issues also affect the type of feedback physiotherapists use. Physiotherapists commented that verbal feedback is most commonly used for patients with cognitive issues. They also commented that complex feedback such as that provided by the Wii, often does not work for these patients.

Physiotherapists commented that "setting goals whilst you are practicing is important" (Participant 6). In particular, it is important to set smaller day to day goals which relate to the patient's larger rehabilitation goals. One physiotherapist commented, "I try to give feedback about their broader goals as well as feedback about specific movements" (Participant 1).

The amount and type of information was discussed with the overall consensus that too much information can compromise the patients understanding of what they are meant to do. This can also have a negative effect on their confidence.

5   Discussion

In this section we will discuss the results of the study in relation to the research goals.

Research goal 1 - To understand patient motivation from the physiotherapist perspective.

The results of this study show that there are many different factors affecting patient motivation. These include positive factors such as improvements in performance and support from family. They also include negative factors such as pain, sickness and psychological issues. It was found that whilst motivation is important for patient rehabilitation outcomes, it is not always a necessity for a positive outcome.

Some existing research that focuses on interviewing patients about their perception of rehabilitation, aligns with our results as well as contributing additional findings which were not found in our study. This research aligns with the understanding that a physiotherapist's relationship with a patient can effect their motivation [14]. The additional research findings include patients not understanding the role of the physiotherapist or what is required to reach their goals. This misunderstanding of how to reach goals is exemplified in existing solutions designed for encouraging healthy eating [22] and physical activity [23].

Other existing research that aligns with our findings explores the possibility of the hospital being a demotivating place. This existing research focuses on environmental considerations such as lack of autonomy and comparisons with other patient's rehabilitation [24].

The effect of this on the design of equipment for stroke rehabilitation is that whilst it is important to design to motivate patients, it is not the only or most important factor. Other factors that may be important include correct feedback and the design of equipment that is easy to use and allows for personalisation.

Another factor that needs to be taken into account is that in the context of the rehabilitation ward, physiotherapists motivate patients. However, the importance of motivation may be different for patients who have left the rehabilitation ward and are an outpatient completing their rehabilitation at home. Whilst not covered in this study, this is an important consideration.

Research goal 2 - To understand what types of feedback physiotherapists provide to patients during rehabilitation.

Physiotherapists commented that the types of feedback they use differs depending on the patient, alongside factors such as severity of the stroke, cognitive issues, patient goals and the patients personality traits. It was identified that there are a range of different feedback types used in the gym. These include verbal, visual and physical feedback from physiotherapists, carers and technologies. The relationship between feedback, especially long term feedback, and motivation was also discussed.

Existing research also identifies that feedback is important to act as encouragement and motivation over time. An area of feedback which is covered by this existing research but was not identified during the interviews was the intrinsic (internal) feedback patients receive from their bodies when completing a movement [25].

The effect of this on designing rehabilitation equipment for patients is the need to personalize feedback. It was identified that there are limitations to the technology currently used in the rehabilitation ward, particularly the Nintendo Wii. Physiotherapists identified the short falls of this technology as being the lack of appropriate feedback as well as the ability for patients to use compensatory movements by using the wrong muscles when doing their exercises. Alongside this was the comments that older patients perceive the Wii as a game for children which will not help them with their rehabilitation.

Research goal 3 - To understand physiotherapists day-to-day use of technology in the rehabilitation gym.

We found that physiotherapists use the balance tiles and the Nintendo Wii Fit with patients in the rehabilitation gym because it is set-up and accessible. Physiotherapists commented that whilst the balance tiles can be useful for patients and give appropriate feedback in the form of knowledge of results, the Wii is limited in the useful information that can be provided to the patient. We also found that the majority of the physiotherapists we interviewed would not call themselves 'technically knowledgeable' as they are not required to use complex technology in their day to day work.

Existing research that looks at the feasibility of the Wii for stroke rehabilitation also identifies these short falls. This research discusses the poor patterning and bad selectivity of muscles that is referred to in our interviews as 'adaptive compensation'. Alongside this, it identifies the shortfalls of the Wii as it is an 'off-the shelf' technology designed for use by able-bodied people, therefore the feedback for patients is negative such as being 'unbalanced; or having a high 'Wii Fit age' [26].

In many cases, patients are unable to get meaningful feedback from the Wii. This shows the importance of designing equipment that provides feedback that is specific to the individual patient and related to the patients previous exercise results.

6   Design Guidelines

These five design guidelines that resulted from this research can be used to design equipment to help patients with motivation when completing their rehabilitation.

DG1 - Allow for ease of setup - Interactive equipment should be simple and easy for physiotherapists and patients to set up. The interviews discussed how technology that is difficult to setup does not get used, as physiotherapists don't have the time and in some cases the technical knowledge to do so. Therefore the equipment needs to be 'plug and play' with no complex technical setup.

DG2 - Provide immediate and longer term feedback - Interactive equipment needs to provide immediate and longer term feedback. Initially a baseline needs to be created from which to measure improvement. Following this, patients need to receive immediate feedback about their movements when they are completing their exercises. This should be in the form of knowledge of performance, where the patient is getting consistent information about how to complete the exercise correctly as well as knowledge of results informing the patient of how many successful repetitions they did in a session. Alongside the immediate feedback, the equipment should track the patient's performance over time to allow the patient to understand if they have improved or not. It was found that this is an important factor for motivating patients.

DG3 - Allow for goal setting - The equipment should allow for patients to set both short and long term goals to help with motivation. The short term goals could be the number of repetitions which a patient will aim to complete in one day, whereas the long term goals are those which the patient wants to achieve over a longer period of time such as being able to walk. Breaking patient's long term goals into a number of short term goals helps with motivation.

DG4 - Design to be multilingual and multimodal- Patients come from a range of different language backgrounds and have varying levels of English. Therefore it is important that feedback is both multimodal and understandable by patients from a range of different backgrounds. An example is the use of a more universal language, such as icons.

DG5 - Allow for personalisation - A patient needs to be able to personalize their feedback depending on what works best for them. Factors such as age, severity of stroke and cognitive issues affect the types of feedback that are most useful for individual patients. For example, physiotherapists commented that older patients often do not relate the game based nature of the Nintendo Wii. Therefore it is important to allow patients or physiotherapists to personalize the type and frequency of the feedback provided, to suit the individual patient.

7   Conclusion

This study focused on understanding the motivation of stroke patients and the factors that affect motivation. Through observing physiotherapists doing their daily work, as well as interviewing six therapists, we gained an understanding of the physiotherapists' perspective of patient motivation as well as the types of feedback which are most

suitable for patients. Our findings have resulted in a set of guidelines for researchers and designers who are designing equipment for stroke rehabilitation.

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