Approaches to movement therapy and their relevance to the design of interactive systems to support rehabilitation

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Abstract

Stroke is a major cause of physical disability for those that survive it. Traditionally, treatment of disability involves interaction with professional trained in the movement therapies. However, there is a growing body of research into interactive systems that are intended to provide support for rehabilitation, many of which draw on game-like elements to motivate engagement. A promising tactic to consider when designing such systems is the integration of knowledge from the movement therapies, and this paper is intended to provide support for this tactic. It contributes a detailed consideration of the structure of this knowledge within this domain, considers the challenges inherent in incorporating it into effective designs, and describes a conceptual framework which is intended to support this process. These contributions are illustrated in relation to two influential approaches to movement therapy, namely “Bobath” and the “Motor Re-Learning Program”.

Keywords

Stroke rehabilitation, conceptual frameworks, movement therapy, physiotherapy, occupational therapy, interactive systems, bobath, motor re-learning program, technology, design.

Introduction

Stroke is caused by the short- or long-term disruption of the supply of blood to a region of the brain, which can cause permanent damage leading to impairments in movement, cognition and perception (Martini, 2006). As medical treatments improve, a larger proportion of individuals are surviving through stroke, which then leads to a larger population of individuals who are living with disabilities caused by it (Martini, 2006). The World Health Organisation estimates that around 30 million individuals are living with physical disabilities caused by stroke, and predicts that this number will increase as the population of the world ages (WHO, 2008). Recovery from physical disability is possible, and might ideally be supported by interaction with professional therapists who have expertise in disciplines such as physiotherapy or occupational therapy, which are collectively known as the movement therapies (UK Stroke Association, 2008a; UK Stroke Association 2008b). However, even in a relatively wealthy country like the UK, access to ongoing therapeutic support is often poor. For example, the UK Department of Health (2005) estimated that only half of survivors receive sufficient therapeutic support in the first 6 months post-stroke; this then drops to 20% in the following 6 months.

Researchers have been exploring the use of interactive systems to support rehabilitation for at least two decades. Motivations include reductions in the cost of therapy (Dijkers, 1991), providing motivation to exercise when therapists are not available (Greally, Johnson & Rushton, 1999) or providing training for skills which might be hard to support in the traditional clinical environment (Todorov, Shadmehr & Bizzi, 1997). Recently, research activities have begun to focus on the potential of physical gaming platforms such as the Nintendo Wii to motivate rehabilitatory exercise (Deutsch et al, 2008; WiiHabilitation website). However, games intended to promote movement in the general population are often not suitable for survivors of stroke, given the often-severe constraints on movement which are often experienced by these individuals (Alankus et al, 2010), and the difficulty of controlling physical games given these constraints. As such, the design of interactive systems which are specifically designed to promote physical rehabilitation from stroke (and other forms of traumatic brain injury) is still an active field of research, and one that continues to evolve as technological capabilities develop.

In seeking to design systems which effectively support rehabilitation, researchers have sometimes turned to the movement therapies for inspiration. Prior research suggests that professional training and practice in the movement therapies is strongly influenced by a relatively small number of *named approaches* (Davidson & Waters, 2000), which have been defined by individuals considered to be expert therapists. Large-scale quantitative research suggests that there are seven key approaches which have been particularly influential (Davidson & Waters, 2000). However, a recent review of the literature around rehabilitation technologies, conducted by the author, has suggested that a number of these approaches have not been explored in relation to interactive rehabilitation systems. This potentially represents a missed opportunity for designing effective systems. In seeking to explore such approaches, however, there are number of issues with which designers will need to contend. These include apparent disagreements between the theoretical underpinnings on which these approaches are built, which then raises the question of how to resolve such disagreements.

Drawing on this argument, this paper contributes a discussion intended to support the process of integrating knowledge from the movement therapies into the design of interactive systems into, which draws on both existing literature and on interview material collected by the author as part of the Motivating Mobility project (Balaam et al, 2010; Rennick-Egglestone et al, 2009). It begins with a brief survey of prior work on interactive rehabilitation systems for brain injury, which is intended for those readers who are unfamiliar with this literature. It then introduces the concept of a named approach, and considers its relationship to the practice and teaching of the movement therapies. It then focuses on two approaches which have been particularly influential, namely “Bobath” and the “Motor Re-Learning program”, and briefly describes their key features. This description is then used to highlight apparent disagreements between these approaches, and an analysis of recently-gathered interview material is then used to suggest a resolution of these. The paper concludes with a discussion which presents a conceptual framework intended to support the process of integrating knowledge presented by named approaches within the movement therapies into the design of interactive rehabilitation systems, and which discusses a number of concepts for future rehabilitation systems. It then concludes with a discussion of research questions structured around this framework, and considers a program of future work intended to address them. Although this work focuses on stroke, physical rehabilitation and the movement therapies, it should be of interest more broadly to those working with technologies to support health, as the phenomenon of a named approach is present in a number of other areas of treatment, including psychotherapy. An example here is *person-centred therapy*, as defined by Carl Rogers, which is also known as *client-centred therapy* (Rogers, 1961).

Interactive rehabilitation systems for brain injury

Researchers have been exploring the use of interactive systems to support rehabilitation for at least two decades. This section provides a brief overview of some of the key developments in the field. It is organized into the following three key strands, each of which has been a focus of research:

- Applications of virtual reality in rehabilitation
- Robotic and force-feedback systems in rehabilitation
- The home as a distinctive target for rehabilitation systems

A central focus of much of this research has been to encourage movement. However, a broad variety of approaches to encouraging movement have been explored.

Robotic and force-feedback systems in rehabilitation

Research into the use of robotic and force-feedback systems to support physical rehabilitation has taken place since at least 1991. Because of the expense and bulk of robotic systems, much of this research has focused on the lab or medical environment. Robotics tends to be presented as a distinct strand of rehabilitation to research on virtual rehabilitation systems in the literature, but there are some links between the two areas; some systems have used virtual reality content as a motivator for engaging with robotic rehabilitation systems.

Dijkers et al (1991) described an early system, designed in collaboration with a group of occupational therapists, which involved the use of a robotic arm as a moving target for reaching exercises, and which therefore motivated movement by providing a set of physical challenges for its users. The robotic arm itself was under the control of a set of pre-defined programs, from which a therapist could make a selection, and movement through this program was controlled by a switch which was mounted onto the end of the arm. In each program, the robotic arm paused at a number of pre-defined positions, and only continued after the switch had been pushed by the user. Patient performance on the system was assessed through a metric based upon the number of successful switch activations; this metric was provided to therapists to assess the progress of their patients.

Another approach has been to develop robotic systems to which disabled limbs could be strapped, and which could then be used to guide movement in these limbs, or to respond to movement initiated by the user. Early versions involved robots that could only passively move limbs, through programs selected by a therapist (e.g. White, Schneider & Brogan, 1993). More advanced systems, such as MIT-MANUS, then motivated engagement by setting interesting challenges to their users, such as actively tracing out a shape, and only guided limbs through the required movements if a failure was detected (Krebs et al, 1998).

A number of more recent systems have included a partial assistance mode, in which the initiation of movement was detected, and in which support for the continuation was provided if necessary (Colombo et al, 2007). The level of support required could then be fed-back to a therapist, who could monitor improvement.

An extension of these approaches has been the use of pairs of robotic arms to encourage engagement from both upper limbs in parallel, even when a disability had been acquired in one (Burgar et al, 2000). This design was inspired by documented therapeutic research which motivates the importance of parallel movement (Fischer, 1992).

Applications of virtual reality in rehabilitation

A significant body of virtual reality research has focused on the use of VR to provide training environments which support rehabilitation. Schultheis and Mourant (2001) have described the use of a driving simulator to support stroke survivors who wish to re-learn sufficient motor skills to be able to drive again; Rizzo and Kim (2005) have then argued that this kind of application is very motivational for recovery, because many survivors of stroke wish to regain the use of a vehicle for transport. As a training environment, this simulator provided detailed feedback to a therapist on performance, allowing the identification of physical weaknesses that could be worked on. It also provides an opportunity for users to gain confidence in their skills in a safe environment. Other examples of training environments include work by Todorov, Shadmehr and Bizzi (1997) and Holden et al (1999), who both describe environments which feature a virtual representation of an able-bodied person performing a movement. Users are then encouraged to follow this movement as closely as possible, with various sensors used to integrate a representation of it into the virtual environment.

An alternate approach is provided by the use of virtual environments to encourage significant amounts of movement, based on an argument that this can then support rehabilitation. Examples include work by:

- Deutsch et al (2001), who linked a device intended to support ankle exercise to a flight simulator
- Jack et al (2001), who developed a number of games that were controlled by input from a prototype glove intended for use by stroke survivors with deficits in movement in their hand
- Grealy, Johnson and Rushton (1999), whose used a game constructed around a virtual environment to motivate use of an exercise bike
- Kizony, Katz and Weiss (2003), who developed a set of games to encourage integrated movements of the whole body, constructed around Gesture Xtreme, a prototype whole body interaction system

Similar to robotic research, a number of VR systems have then provided feedback to therapists which might be useful in ongoing treatment. Broeren et al (2008), for example, describe a VR game constructed around interaction with a haptic feedback device which could provide a variety of measures of performance to be used as a reference whilst planning ongoing treatment.

The home as a distinctive target for rehabilitation systems

Robotics and, to some extent, virtual reality, both tend to require items of bulky, expensive equipment. As such, where evaluations of technology have taken place, they have tended to focus on the hospital or lab environment. However, there is an increasing recognition that much rehabilitation takes place post-discharge, and here, an approach to technology design which is more focused on solutions that have a low cost per unit is necessary. Much of the research around this topic has then focused on the home, and has been grounded in a growing emphasis on discharging survivors of stroke from hospital as soon as is practical.

The simplest approach to using such systems seems to have been to use them directly, without modification, but in a context that encourages use which has therapeutic value, and with content that encourages physical movement. As an example, Deutsch et al (2008) describe the use of a Nintendo Wii in the rehabilitation of a child with cerebral palsy, which is often related to similar disabilities to stroke. During an intervention which took place across 11 supervised sessions, the child was allowed to choose which game they wished to play, but the therapist made essential clinical decisions related to duration or ergonomics. The authors then report potential motivational benefits such as the ability to engage in multi-player games with others. A relatively large study of the usage of the Playstation EyeToy has been provided by Rand, Kizony and Weiss (2004), who worked with 23 participants. These authors report that some EyeToy games were usable by this cohort, but that many were de-motivated by games that were too difficult to engage with by individuals with limited movement.

Other authors have then reported on the design of home-based systems that are tailored to the specific needs of stroke survivors.

- Huber et al (2008) have described a set of games constructed around a PlayStation that had been augmented with a glove-based sensing device specifically designed for use by stroke survivors with deficits in hand movements.
- Morrow, Docan and Burdea (2006) have describes a similar intervention involving a modified X-Box which could provided reports of progress back to a therapist.
- Jadhav and Krovi (2004) have described the use of a commodity force-feedback joystick and a series of on-line challenges intended to motivate engagement
- Balaam et al (2011) have discussed interventions which were specifically designed for the needs of individual survivors of stroke

Rennick-Egglestone et al (2009) have also provided a detailed discussion of the experiences of a cohort of stroke survivors living at home, which has been used to identify a set of requirements for rehabilitation systems intended for this environment.

What is a named approach?

The previous section has provided an overview of research into interactive rehabilitation systems. As well as providing useful for background material for readers unfamiliar with this area, this material can also be used to identify three models for the involvement of movement therapy as a profession in the process of design and evaluation:

- Movement therapists acting as a consultant to the process of design, or as a client for the process of design (e.g. the robotic arm described by Dijkers et al, 1991)
- Movement therapists acting as specialist users of particular systems (e.g. the modified X-Box described by Morrow, Docan and Burdea (2006) which can report usage data back to a therapist for consideration in the design of treatment programs)
- Published movement therapy research used as a source of knowledge to inspire design (e.g. Burgar et al (2000), in which a design involving two robotic arms drew directly on published material relating to movement therapy)

This section now considers the third of these points in detail, with a specific focus on a concept known as a "named approach to treatment". Named approaches have a key role in movement therapies as a profession, and are the focus of this paper as a whole. They have been discussed by academics working within the movement therapies for some time, and this section draws on some of the research work that relates to them.

Marsden and Greenwood (2005) have defined a named approach to movement therapy as being a theoretical construct that encompasses a series of ideas and hypotheses about how therapy works, and how therapy sessions should be constructed. Although these may not be fully proven through the scientific process (Pomeroy & Tallis, 2002), they tend to be grounded in concepts developed through scientific research, and tested through their practical application in the treatment of patients. A number of key approaches to therapy have been defined by experienced therapists, often based upon decades of personal experience, and often published in the form of books or other teaching material. This process has produced a set of approaches which have been *named*, and which are presented through conceptual frameworks which are internally consistent. For many, their principles will then be familiar to practicing therapist.

In the UK at least, these named approaches have then had a significant impact on the process of *teaching* movement therapies (Marsden & Greenwood, 2005). An extensive national survey of movement therapists by Davidson and Waters (2000) has then examined the influence that named approaches have had on the *professional practice* of work in the movement therapies. One outcome of this survey was the identification of approaches that were in active use by a significant number of respondents. Table 1 provides a summary of the seven approaches that were identified as being influential by this survey, and provides references for those that wish to learn more about the specific details of each approach.

Table 1 Summary of seven key approaches to movement therapy post-stroke.
Reprinted from Davidson and Waters, 2000

Bobath (Bobath, 1990)	Aims to prevent abnormal movements and adverse plastic adaptation and facilitate normal movement and subsequent plastic change
Brunnstrőm (Brunnstrőm, 1970)	Makes use of abnormal synergies and incorporates them into functional activities
Conductive Education (Cotton & Kinsman, 1983)	Patients encouraged to verbalise the activities as they perform them.
Johnstone	Follows developmental patterns focusing on proximal

(Johnstone, 1989)	stability. Use of orally inflated pressure splints a signicant characteristic
Motor re-learning programme (Carr & Shepherd, 1987)	Training of motor control based on an understanding of kinematics and kinetics of normal movement, motor control processes and motor learning
Proprioceptive neuromuscular facilitation (Knott & Voss, 1968)	To maximise sensory stimulation on the pool of anterior horn cells in order to stimulate purposeful muscular contraction
Rood (Stockmeyer, 1966)	To achieve purposeful muscular contractions by stimulating the skin through facilitatory strokes

Statistics presented by Davidson and Waters suggest that the Bobath approach is the most influential in the UK. As such, during the Motivating Mobility project, of which the author was a member, interviews were conducted with a number practicing movement therapists who self-identify as being Bobath therapists. These interviews suggest that there is a continuing process, within the profession, of reconciling their professional knowledge and experience with the principles of Bobath therapy, and of developing the approach to fit with these experiences. This process is explicitly acknowledged within the book which defines this approach. This is currently in its 3rd edition, with substantial changes present relative to earlier editions.

Such observations indicate that approaches are not static constructs. Rather, they evolve over time, and reflect the knowledge and experience of a large body of practitioners. As such, they should be seen as an important resource for designs of interactive systems that are intended to support rehabilitation. Interactive systems are clearly different to therapists, however, and the question of how to assimilate knowledge presented in named approaches into effective designs is an interesting one for research. In addition, areas of expertise such as game design, or academic disciplines such as human-computer interaction, embed a significant amount of knowledge about how to design systems that invite and sustain long-term engagement, which is vital for rehabilitation. Good design, therefore, must combine knowledge of approaches to movement therapy with knowledge about engaging experiences. We return to this issue later in this paper, but first provide an overview of two key approaches to movement therapy which are currently in use.

An overview of two key approaches

Having introduced the concept of a named approach to movement therapy, this section now provides a brief overview of selected features of two specific approaches. The first of these is Bobath, which is the dominant approach in the UK (Davidson & Waters, 2000). The second is the "motor re-learning program", which is the dominant approach in Australia (Carr et al, 1994). These two approaches were chosen for their global influence, but also because they present elements that appear mutually contradictory. The aim of this presentation, therefore, is both to familiarize the reader with key approaches and the types of issue that they consider, but also to highlight potential dangers of using them as an inspiration for design without further consideration. Material presented in relation to Bobath has been summarized from Bobath (1990). Material presented in relation to the motor re-learning program has been summarized from Carr and Shepherd (1987). Given the space available in this paper, the following summaries are necessarily very brief, and exclude much of the detailed advice for treatment that has been established within these two approaches. As such, they should be interpreted more for their value in illustrating key points and disagreements. The interested reader is therefore advised to read the defining material cited above in detail to gain a full appreciation of these approaches.

This section concludes with a summary of a number of similarities and disagreements between these two approaches. This summary is not intended to be conclusive. Instead, it is intended to be indicative of the presence of similarities and disagreements, and to raise awareness of the need to consider these issues when deciding how to integrate movement therapy knowledge into rehabilitation systems. The next section of this paper then considers the topic of disagreements in more detail, using recently-gathered interview material as an illustration.

An overview of the Bobath approach

Many survivors of stroke struggle to maintain a healthy posture when standing or sitting, and restoring a healthy posture is the primary focus of the Bobath approach to treatment. The process of restoring specific functions, such as gripping objects with the hand, is seen as a secondary consideration, to be addressed only after a relatively normal postural control has been established. Maintaining a healthy posture requires the complex co-ordination of small-scale muscle contractions and relaxations, much of which we are unaware of, and because stroke can lead to significant levels of brain-damage, then Bobath approach is structured around a belief that the neural infrastructure required to co-ordinate effective patterns of muscular response can often be lost. However, the human brain has a proven ability to re-organise the distribution of key functions through a phenomenon known as neuroplasticity which involves the re-establishment of lost functions in areas of the brain where they would not typically reside. Bobath is then constructed around a hypothesis that a movement therapist can support recovery from stroke through a variety of methods that encourage plastic change. Since the reversal of such plastic change is difficult, then a key tenet of Bobath is that, where a choice is available, a therapist should focus on slowly regaining high-quality patterns of movement that can be maintained, rather than on rapidly regaining strength and speed, which might lead to abnormal plastic adaptation.

Treatment typically begins at key *points of control* that effect large-scale movements, and then progresses towards smaller scale movements as appropriate. As such, survivors of stroke may first be encouraged to relearn how to “hold their head in the correct posture”; given the biomechanical linkages in the human body, this then naturally improves the posture of the trunk and the arms and legs. Treatment may begin with direct manipulation around these points of control by a therapist, with the intention of providing stimulation that supports plastic change. Over a period which often lasts from several months to several years, therapy then supports patients in relearning how to maintain a healthy posture naturally, which then facilitates the relearning of specific functions more easy. Given that professional treatment may only be available for relatively short durations (e.g. several months), the practical practice of Bobath therapy often emphasizes passing sufficient knowledge onto clients to allow them to support their own recovery once discharged.

A key consideration of Bobath therapists are the related phenomena of spasticity and flaccidity, which are often encountered in survivors of stroke. Spasticity refers to unusual levels of tension and involuntary movement in particular groups of muscles. Flacidity refers to an unusually low level of tension in muscle groups. Good posture is seen as requiring a moderate and fluid level of muscle tension, given the need to counteract the force of gravity when standing, sitting or moving. Excessive spasticity makes good posture hard to maintain, and can be both uncomfortable and physically exhausting for those that experience it. Excessive flaccidity makes the resistance of gravity impossible, and also makes posture and movement difficult. Within Bobath, both of these phenomena are related to unusual patterns of signaling emerging from the damaged brain of a stroke survivor. Addressing flaccidity then requires support for plastic change that allows more normal patterns of signaling to be established. The identification of spasticity and flaccidity in muscle groups is then a key diagnostic tool in Bobath, and addressing spasticity and flaccidity is seen as a key requirement of re-establishing better function more generally.

An overview of the motor re-learning program

Whereas Bobath emphasizes regaining postural control first, with movement and then function seen as a secondary considerations which will be supported through improvements in postural control, the motor re-learning program (MRP) emphasizes the importance of beginning functional training “as soon as the person’s medical condition is stable”, and considering movement right from the start of treatment. The role of the therapist is seen as being to support the process of re-learning function. This process is only seen as complete once the client can utilize relevant functions outside of the clinical environment, principally without the support of the therapist.

The MRP is made up of seven discrete sections, each of which presents advice for a different component of function. These sections are:

- upper limb function
- oro-facial function
- motor tasks performed whilst sitting
- motor tasks performed whilst standing
- standing up
- sitting down
- walking

The choice of ordering for these sections is pragmatic rather than prescribed; patients begin each section as and when they are able, and there is no pre-defined progression from section to section. However, an important aim is treatment sessions that combine elements of all sections. Integrated treatment of this kind may only be possible after a lengthy period of recovery, however. For patients who are confined to a bed for medical reasons, progression through certain sections may be quite advanced before others begin (e.g. in particular oro-facial function). However, therapists are encouraged to begin sections as soon as is medically possible.

Within each section, the MRP does prescribe four key steps to follow, in a set order. These steps are as follows:

Step 1: *Analysis of task*. This involves the observation of existing function, and its comparison to normal function, with the intention of identifying those individual components of movement which have been damaged by a stroke.

Step 2: *Practice of damaged components.* This might involve multiple cycles of explanation, instruction, manual guidance and practice, accompanied by verbal and visual feedback.

Step 3: *Practice of task*. This step then requires the integration of all of the components of movement that are required for effective function, and also requires instruction, guidance, practice and feedback.

Step 4: *Transference of training*. This step involves the practice of tasks in the context in which it will be used, and may involve interactions with relatives, friends or care staff. The emphasis is on creating a context in which the ongoing practice of tasks can be self-initiated and self-monitored, i.e. without the support of a therapist. As such, the transference step is all about supporting continuing improvement which is robust, even without the presence of a therapist.

Interestingly, whereas the Bobath approach places the identification and treatment of spasticity and flaccidity as central to the treatment of physical disability, MRP explicitly states that spasticity should not be of central importance. Instead, it argues that the neurological basis for it has not been sufficiently proven, and that spasticity can develop as a secondary effect of movement post-stroke. As such, it emphasizes approaches that are intended to stop spasticity developing, rather than treating spasticity as a symptom of the original brain damage caused by stroke.

Illustrations of overlaps and disagreements

Even this very brief overview of two important approaches can be used to identify some interesting disagreements. In particular:

- there is a disagreement in the positioning of the common phenomena of spasticity and flaccidity between the two approaches, with Bobath positioning these as primary effects of the damage caused by stroke, and MRP positioning it as a secondary effect that can develop post-stroke
- there is a disagreement in the treatment of function within the process of rehabilitation. Bobath emphasizes a focus on recovery of posture before function, whereas MRP emphasizes a focus on recovery of function as soon as possible

These disagreements then suggest potentially very different approaches to treatment, and might be linked to very different system designs.

There are, however, some overlaps between these two approaches. Both emphasise the importance of processes that facilitate the transference of regained abilities into normal life, which may well include the education of stroke survivors, their families and friends. Both emphasise the need to relearn healthy patterns of movement, rather than encouraging adaptations to behavior that involve the stroke survivor learning to live with their disability. Bobath (1990) describes this quite graphically:

"If the patient gives in to his neurological disorder, he will become an invalid. If he learns to train his hemiplegic side, he returns to life"

Where overlaps occur between influential approaches, this suggests an area of agreement with which system design might usefully engage, and this topic is considered further in the discussion section of this paper. However, where there are disagreements or contradictions, this then raises two interesting questions for research:

- to what extent should knowledge presented in particular named approaches be used to guide the design of rehabilitation systems?
- how should disagreements between key approaches be resolved during the design process?

This topic is considered further in the discussion section of this paper. However, first, interview data collected during the motivating mobility project is considered.

Interview material around approaches to movement therapies

Much of the prior research around named approaches and their application in the teaching and practice of movement therapies has been quantitative. However, through two workshops organized by the Motivating Mobility project, interview data has been collected with two groups of professional movement therapists, who were asked to discuss the specific details of the approaches that they took in working with clients. Together, these workshops were attended by roughly 30 therapists, and provided roughly 25 pages of transcripts. This section presents a brief analysis of discussions presented in these workshops, and highlights four key themes which are relevant to the design of rehabilitation systems:

1. Pragmatic approaches to integrating knowledge from the movement therapies

Although most attendees agreed that they drew on knowledge presented in these therapies in their practice, a relatively pragmatic approach to the integration of this knowledge appeared common. One therapist argued that:

"*the old school Bobath therapists, who wouldn't allow anyone to do anything unless it was a perfect movement, was obviously wrong, because it would mean that people spend a lot of time doing nothing. And yet, at the other end of the spectrum, and not trying to facilitate a normal spectrum of movement, and just going for it, is equally problematic, because people would just develop abnormal patterns of movement. So somewhere in between is what we are aiming for*"

Another therapist then stated that:

"I've been Bobath-trained, and I do try and work from that approach to an extent, but I think it is getting it right, for what the patient wants …"

As such, for this group of therapists at least, named approaches seem to represent a source of ideas and inspiration, but with final decisions over the approach to treatment being made by the therapists themselves, drawing on their own professional experience and training.

2. The importance of understanding clients

A key issues for attendees was the importance of understanding their clients as people, and structuring treatment programmes around their values, personalities, goals and potential. One therapist described how she was always:

"finding out what their hobbies, interests are …and trying to gear it [i.e. treatment] towards that … if someone is into gardening and things … that that from the patient, find out 'what are your interests, what does motivate you"

Another therapist provided a second example of the importance of understanding clients:

"a patient who might feel embarrassed when they go out for a meal, might want to be able to feed themselves, but they're not bothered how they manage it, but they just want to be able to carry that task out"

The emphasis here is then clearly on the quality of the relationship with the client, and the opportunities for improvement that this affords.

3. Motivating clients to improve

Therapists discussed the motivational role that they could play in relation to their clients. A number of therapists described clients who were overly pessimistic about their future chances, and described interventions that they could make to try and address this pessimism. A therapist described how:

"It's just trying to get the individual away from that thought process of 'it's been a year, how can I get anything back now?'

Another therapist described finding untapped potential in a client, which could then be developed through further therapeutic work:

"I saw a patient yesterday for the first time … when I looked at him, he's done quite well with his mobility, but he couldn't quite use his arm … when I looked at it, he's got lovely movement in his arm, and there was real potential there … "

How to support motivation outside of therapeutic contact time is then an issue which could be addressed through technological means.

4. Helping to set goals

Part of the practice of therapist seemed to be the use of explicit goals as a motivational tool for clients. A therapist described these as:

"Goal meetings … where they come up with goals that are normally big goals … so they might say 'to walk' but we might just work on being able to stand, and they get reviewed every two weeks"

Goals are clearly set in collaboration with clients. One therapist conceptualized these as follows:

"It's like career guidance, it's about thinking with the person, well what do you want to do now?"

5. Supporting learning

In common with the two named approaches outlined above, passing on knowledge to clients and others in their social context seemed important. One therapist described how:

"What I would see my role more would be to try and help somebody to understand what might be an achievable goal and what might not be an achievable goal, and to help them see the steps towards achieving what they might think, what they might want to achieve"

Associated cognitive damage caused by stroke can make this process of teaching difficult:

"and trying to explain that you don't want a compensation … that's really tough, if they're cognitively impaired, and same problems with speech impairment, if they're struggling to understand"

Teaching concepts that support long-term improvement is particularly important, given constraints on available therapeutic time with clients:

"we do have very limited time with the patient, so we have to work a lot with carers, with the family, to try and progress … it's what we can put in place that makes a big difference"

Discussion

Having provided an overview of approaches to movement therapies, the role of the final section of this paper is to provide a discussion which highlights their relevance to the design of future rehabilitation systems. A conceptual model to support the process of integrating knowledge from the movement therapies into such systems is proposed through by this discussion, and a number of questions for further research are raised.

This paper has provided an introduction to the concept of a named approach to treatment, and cited prior research which highlights the influential nature of a number of named approaches, which Bobath and the Motor Re-Learning Programme (MRP) being two influential examples. However, a summary of key features of these approaches has revealed apparent disagreements over core aspects of these approaches. This then raises the question of how system designers should relate to these approaches during the process of design. If fundamental disagreements still exist over the importance of concepts such as spasticity and flaccidity, how should designers orientate themselves to such concepts? This seems like a key question to address in relation to this knowledge.

Supporting teaching and learning

One appealing tactic is simply then to side-step the issue of how to resolve disagreements between approaches, and to focus on those areas of knowledge where there is agreement between influential approaches. As a specific example, material presented in relation to both Bobath and the MRP advocates the importance of passing therapeutic principles onto clients and carers, so that improvement can be robustly sustained after intervention from the therapist has ceased, especially given limited financial resources available to support sufficient therapy. Interview material presented in relation to discussions with therapists also suggests the importance passing on knowledge in this way. The design of supporting systems for the process of passing knowledge from therapist to client could be an interesting topic for research, and little work has been done in this area. A challenge for research here is that of how to build systems which are sufficiently flexible to be used by a wide variety of therapists, and with a broad selection of clients. Issues to consider include:

- how to address difficulties caused by cognitive and perceptual impairments, which are often caused by stroke
- how to support participation from members of the social network around a stroke survivor
- how to support survivors who are socially isolated

Further study of named approaches is likely to yield other areas of agreement which could then be explored through system design activities.

Integrating knowledge from both named approaches and studies of professional practice

A second tactic is then to position named approaches as a source of inspiration for practice in the movement therapies, rather than a defining factor. In relation to this tactic, practice itself would then be seen as a defining factor for how movement therapies work, rather than named approaches. This then suggests research which focuses on the study of practice itself, rather than on theoretical descriptions of how practice should be conducted, and on using this research to uncover principles which are then useful in the design of rehabilitation systems. Observational methods such as ethnomethodology might be appropriate for such studies, and this would be in keeping with a long tradition of the use of ethnographic techniques as a first step in the process of designing computer systems (e.g. see Crabtree, Rouncefield and Tolmie, 2012)). Research published within the field of Computer-Supported Co-operative Work (CSCW), which often emphasizes the importance of understanding how work is carried out in practice, rather than how people describe it as being carried out, is also very relevant.

Contributions from HCI

The introduction of interactive technologies to the process of rehabilitation will necessarily change this process, even if such technologies are mediate through a relationship between a therapist and a client. As such, existing research knowledge in fields which are interested in the design of computers systems, such as HCI and CSCW, are very relevant to the design and understanding of such systems. HCI researchers have already made contributions in relation to this – for example, see (Alankus et al, 2010).

A model

Given these arguments, figure 1 provides a simple illustration of the kinds of knowledge and approach which are relevant to the design of rehabilitation systems, and hints at the necessity of design work which integrates at least these three influences in seeking to make a useful contribution.

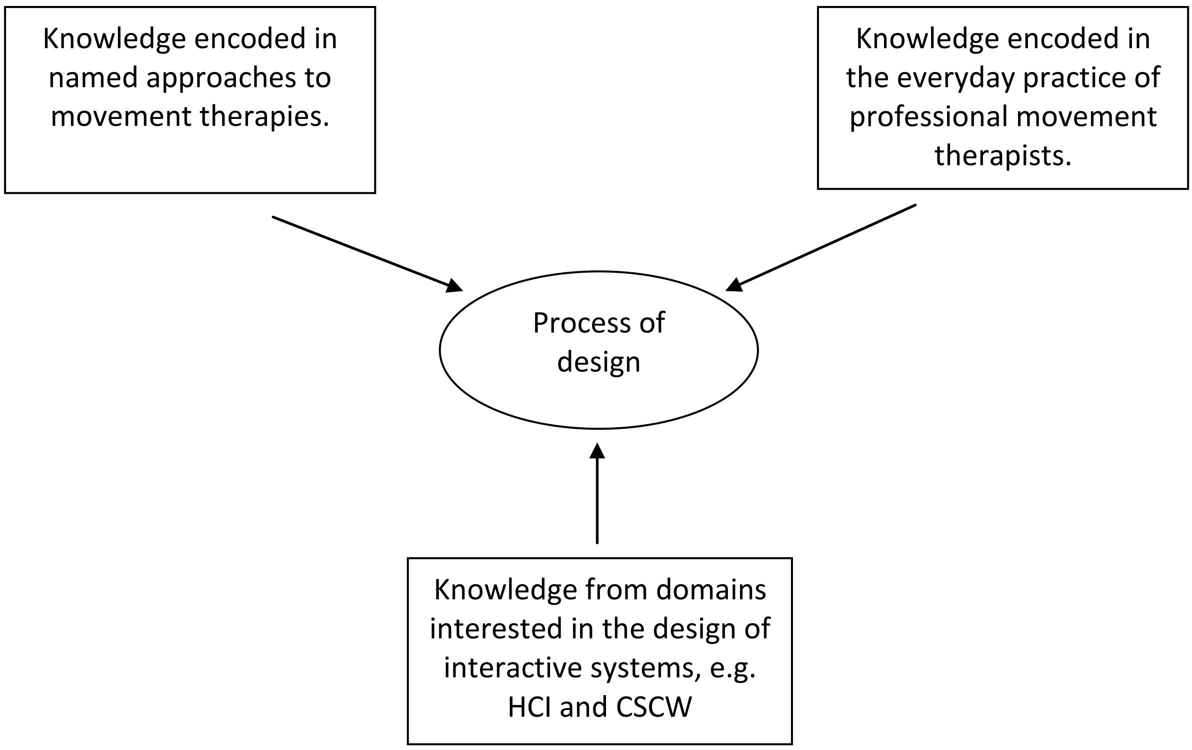

Figure 1 A model for future research.

Conclusions

Although named approaches such as Bobath are clearly influential in relation to the practice of movement therapies, there are disagreements between approaches which raise interesting questions in relation to their integration into interactive rehabilitation technologies. Studying practice itself is one route to addressing these issues. An alternative tactic involves identifying areas in which there is an overlap between named approaches, and using this process to develop technologies which might be more generally applicable to a broad selection of practicing therapists might be possible. An example which might be subject to future research is systems which are intended to support the teaching and learning of therapeutic concepts. Effective systems in this category might support robust recovery after therapeutic interventions have finished. This is important, given that recovery can continue for many years, but that sufficient resources are unlikely to be available to allow therapeutic support to continue for this long across the population of stroke survivors living with physical disability.

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