Games people play: interactive systems to promote rehabilitation, physical activity and leisure

Jane Burridge
Overview of the presentation

• Games and learning
• Commercial systems
• Personalised games
• Motivation
• Wider Context
Social and Clinical drivers for a new approach to stroke rehabilitation

- Demographic changes
- Evidence
  - Intensity – Repetition
  - Motivation – adherence - relevance
- Challenges
  - Limited access to support services at home after discharge
  - Exercises are difficult to do correctly, and can be boring
- Post-hospital stroke care 'needs to improve‘ Care Quality Commission review Published Jan 2011
Seriously Considering Play

- Games exist in almost every culture and involve children and adults
- Essential to learning
- What is play: Work is respectable – Play is frivolous?
- Current theories:
  - play as progress – learning through play
  - play as power - competition
  - play as fantasy – emersion imagination and creativity
  - play as self - quality of the experience rather than learning
- Micro-worlds: A framework for learning through meaningful and playful interaction – computer games and VR obvious media but so is the sand pit!
- Flow theory (Mihaly Csikszentmihalyi - 1990) – avoiding anxiety and boredom – challenge must match ability
- Play and imitation – relevant to rehabilitation

Games in stroke rehabilitation

• Applying the ‘play’ theories to rehabilitation
  – Imitation
  – Flow and motivation
  – Competition and desire to succeed
  – Fantasy - Micro-worlds

• Explicit vs. implicit learning

• Conflict between achieving a goal and performing a ‘correct’ movement
Serious Toys

Game No.2

Addressed Motor Skills
1. Extension of wrist
2. Extension of elbow
3. Supination
Wii Upper limb: sub-acute – Saposnik 2010

• Despite much publicity there is currently very little evidence for the effectiveness of the wii

• 22 people with stroke
  – mean age = 61 years
  – mild to moderate stroke
  – time since stroke mean =24 days

• Randomized to Wii (n=11) or standard recreational therapy (n=11).

• 8 x 1 hr sessions over 2 weeks
  – Wii sessions: virtual tennis and Cooking Mama
  – Regular therapy: card games, Jenga, stamping a card (as in a bingo)
Wii Upper Limb: sub-acute - Results

- Assessed 4 weeks after intervention finished
  - Wolf Motor Function Test (WMFT)
  - The Box and Block Test
  - Stroke Impact Scale

- Wii group significant improvements in
  - Grip strength
  - 30% faster on WMT tasks (20secs v 27secs)
Wii upper limb: chronic – Christie et al, 2010

• Stroke patients (n=11)
  – completed standard upper limb rehabilitation
  – median age 55 years
  – mean time from stroke 216 days (7 months)

• Wii Sports daily for six weeks.

• Assessments were performed at baseline and after 6 weeks.
  – Jebsen-Taylor Hand Function Test
  – Action Research Arm Test
  – grip strength (E-Link Mule)

• A questionnaire was used to assess participant engagement in Wiihab
Wii Upper limb: chronic - results

- 9 people completed research.
  - 1 DNA;
  - 1 found console too challenging
- Grip strength doubled (21 to 42 lbs) (p=0.03)
- Trends improvement in all domains Jebsen-Taylor
  - picking up and placing small objects (p=0.008)
  - moving light large cans (p=0.05).
- High levels of enjoyment
- Majority (>75%) reported improved UL function in ADL
- Transient pain and upper limb stiffness reported by all
Motivating Mobility using personalised home-based games
Overview

• User-centred design of personalised home based systems by:
  – Understanding what motivates each patient
  – The needs of each patient

• Preparatory work for design
  – Creation of “personas”
  – Project team workshops with mock-ups of ideas
  – Development of games

• Case studies to investigate:
  – Motivation and behaviour change
  – Clinical effectiveness
Background work with patients, families, therapists and carers

Therapy centre visits

Stroke club workshops

Home visits

Exploratory ‘cultural’ probes

Design workshops
# Personas

## Clinical rehabilitation matrix

<table>
<thead>
<tr>
<th>Level of ability</th>
<th>Class of activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOW</td>
<td>Elbow/shoulder</td>
</tr>
<tr>
<td></td>
<td>Grasp and release</td>
</tr>
<tr>
<td></td>
<td>Elbow / shoulder combined with grasp and release</td>
</tr>
<tr>
<td></td>
<td>2 DOF</td>
</tr>
<tr>
<td></td>
<td>Slow (own time)</td>
</tr>
<tr>
<td></td>
<td>Close to the body</td>
</tr>
<tr>
<td></td>
<td>or directly in front of the body</td>
</tr>
<tr>
<td>MEDIUM</td>
<td>3 DOF</td>
</tr>
<tr>
<td></td>
<td>Faster encouraged to increase speed</td>
</tr>
<tr>
<td></td>
<td>Further from the body and out to the</td>
</tr>
<tr>
<td></td>
<td>Grasp and release mod large, soft, non-slippery objects placed close to the body</td>
</tr>
<tr>
<td></td>
<td>Grasping objects, moving them through small distances close to and in front of the body in 2DOF releasing them</td>
</tr>
<tr>
<td>HIGH</td>
<td>3 DOF greater distances away from the body</td>
</tr>
<tr>
<td></td>
<td>Activities in standing</td>
</tr>
<tr>
<td></td>
<td>Speed / competition</td>
</tr>
<tr>
<td></td>
<td>Grasping smaller objects that require manipulation</td>
</tr>
<tr>
<td></td>
<td>Including pronation / supination</td>
</tr>
<tr>
<td></td>
<td>Speed / competition</td>
</tr>
<tr>
<td></td>
<td>Using small objects performing highly skilled complex tasks that involve 3 DOF</td>
</tr>
<tr>
<td></td>
<td>Speed / competition done in standing</td>
</tr>
</tbody>
</table>

Personas to convey diversity of patient experience, interests & level of ability
Methods

- Recruitment of four patients

- Co-design:
  - Clinical needs: initial design meeting with patient and carer physiotherapist and designer
  - Personal needs: Semi-structured interview
  - Project team exploration of potential ideas for designs of games to satisfy clinical and personal needs
  - Two further iterative design meetings between design team and patients during development

- Deployment

- Assessment
Design ideas

Personas

Storyboard

Exploring potential technologies
Key lessons

- Home - safe space
- Space, especially surface space, is limited
- Every person needs individualised solution
- Understanding how to map theories of motivation for practical self-motivation is challenging

**Aim:** COTS low cost technical components that are simple to tailor and ‘prescribe’, assemble & use
Rehabilitation activity matrix to aid communication between engineers, designers and therapists

<table>
<thead>
<tr>
<th>Level of ability</th>
<th>Class of activity</th>
<th>Class of activity</th>
<th>Class of activity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low</strong></td>
<td><em>Elbow/shoulder (reach)</em></td>
<td><em>Hand (grasp release)</em></td>
<td><em>Combined reach and grasp</em></td>
</tr>
<tr>
<td></td>
<td>2 DOF</td>
<td>Minimal grasp and release of moderately large, soft, non-slippery objects placed close to the body</td>
<td>Sliding easy-to-grasp objects in front of the body</td>
</tr>
<tr>
<td></td>
<td>Slow (own time)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Close to or directly in front of the body</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Medium</strong></td>
<td>3 DOF</td>
<td>Grasp and release a range of objects at varying distances from the body</td>
<td>Reach, grasp and lift a range of objects through small distances close to and in front of the body</td>
</tr>
<tr>
<td></td>
<td>Encourage to increase speed</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Further from body and to the side</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>High</strong></td>
<td>3 DOF</td>
<td>Grasp small objects requiring manipulation including pro-supination</td>
<td>Using small objects to perform skilled complex tasks in 3 DOF including speed and competition</td>
</tr>
<tr>
<td></td>
<td>Speed &amp; competition</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Extended range</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Activities in standing</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Study Design

- Designing and prototyping technologies for 2 participants at Southampton
- Designing and prototyping technologies for 2 participants at Sheffield
- Outcome measures at Southampton
  - Fugyl Meyer
  - Teler measures identified
  - Motivation for Therapy
- Outcome measures at Sheffield
  - Fugyl Meyer
  - Teler measures identified
  - Motivation for Therapy
- Technologies deployed for four weeks in participants’ homes
- Weekly phone calls to check Teler scores
- Output case reports
Chess Board for Solomon

- Keen chess player – played online for ~1 hour a day using his non-hemiplegic hand
- Device supported shoulder and elbow movement (Ergorest). Pincer grip/release to select a chess piece moved using a sensor mat
Before playing chess
Playing chess
Hand movement after playing chess
Ball funnel game for Sophie to play with her son

• Practice 2-handed activities

• Each ball had an RFID tag enabling sounds and voice messages to be recorded.

• When the ball was successfully placed in the shute the sounds were played back

• Highly configurable, educational and fun for mother and son
Exercise system and ‘Rehab Reader’

• Press the button when you are you ready to exercise

• Audio description of the exercise, how to do it, how many repetitions (# on screen) etc.

• Everyday items which related to the skills she wanted to improve

• Press the button to do the next exercise/receive the next instruction.

• Very basic - what she wanted but potential to expand

• Squeezing the bladder advances the text
Lessons learnt

• Toolkit – different content for mood variations
• Observation – motivational factors over time
• Designing for rehabilitation around the social context
• Embedding education
• Social Engagement
Future work

• Trial with CIT Using a motivational interactive software – LIFEGUIDE - ordinary PC + internet access – (‘virtually all UK households by 2012’ www.ofcom.org.uk)

• Embedding education before discharge from hospital

• Changing NHS culture

• Experimenting with social engagement
Changing the concept of aging

• New theories of aging (Erikson, Tornstam)
  – aging as a positive developmental process
  – experiential/phenomenological view

• What older people say they want technology to do
  – Keeping in touch – family, friends
  – Contributing, volunteer work
  – Hobbies, ongoing learning
  – Information seeking
  – Connecting with family history, life stories
Using technology - Issues

- Patients – healthcare problem to be solved OR Autonomous individuals with rich varied lives
- Home as extension of rehab clinic OR as “my space”
- Technology to meet clinical and real quality of life needs
- Clinicians as “controller/monitor” of care or guide and advisor
- Opinions of carers
Barriers and Opportunities

• Barriers
  – Lack of patient confidence and experience with technology
  – Lack of motivation

• Opportunities
  – Therapist can monitor progress, advise and support
  – Motivating individualised programmes with personalised activities, advice and feedback
  – Improve compliance and opportunities - more intensive exercise
What about games?

• Right level of difficulty
  – appropriate to the patient’s ability – challenging but not uncomfortable

• Time per game
  – set time limit in which the patient should attempt to score as highly as possible. The time limit should be fairly short to avoid exhausting the patient.

• Direct feedback
  – How best to deliver visual and auditory feedback. When should it be delivered? Patient’s progress in comparison to previous sessions.

• Reward
  – Controlling for undesired or abnormal movement patterns
Other work

• Joo - sub acute stroke in-patients using Nintendo Wii
  - Gaming enjoyable and comparable to, if not better than, conventional therapy

• Yavuzer - RCT comparing effects of using conventional care vs. conventional care plus Playstation and EyeToy Games.
  - Sig change FIM self-care score for gaming device, no sig differences for Brunnstrom stages for hand and arm

• Saposnik - RCT with the Wii vs recreational therapy
  - Wii group show an improvement in the Wolf Motor function

• Szurturm used an interactive gaming device with common objects
  - Positive effects on the recovery of active finger range of motion and hand function
Summary

• We are not just designing new technologies and interventions
• We are designing new ways of working, living, playing, socialising, connecting, communicating, loving, being creative…
• …new ways of being human
Development and pilot evaluation of a web-supported programme of Constraint Induced Therapy following stroke (LifeCIT)

Jane Burridge, Lucy Yardley, Ann-Marie Hughes and Mark Weal
Welcome to LifeCIT!
Click on whatever you would like to do first
OR Tap the number of what you want to do

1. Plan today’s activities
2. Play a game
3. Enter my progress
4. Check my progress
5. Check for or send messages
Today’s activities
Just click the dot if you want to change an activity

For myself
• Comb my hair
• Brush my teeth

For the home
• Wash the dishes

For fun
• Play fetch with the dog

Click here to go back to MENU
OR tap Enter
Play a game?
Just click on the game you want to play

I want to be a millionaire

Chicken shoot

Click here to go back to MENU
OR tap Enter
Enter your progress
How long did you wear the mitt for? Hours/mins

Click on each activity you completed today OR Tap the number of each activity you completed

For myself
1. Combed my hair
2. Brushed my teeth

For the home
3. Washed the dishes

For fun
4. Played fetch with the dog
Check your progress

Click on whatever you would like to see OR

Tap the number of what you want to see

1. A graph of changes in my arm speed and reach

3. A list of all the activities I have completed

4. A graph of the number of planned activities successfully completed each day

5. A graph of how long I wore the mitt each day

Click here to go back to MENU OR tap Enter
Check for or send messages

Messages from Jane

4.10.10

Your reach is definitely getting longer – why not try cleaning the car tomorrow?

Messages from Mandy

6.10.10

No slacking Dad – how come you didn’t enter your activities yesterday?

Write your messages here:

Message to Jane

Message to Mandy

Click here to go back to MENU OR tap Enter
Acknowledgements

• Funding bodies: EPSRC, NIHR

• Colleagues in Southampton: Ann-Marie Hughes, Lucy Yardley, and Sara Demain

• Colleagues from other Universities, especially:
  - Sheffield Hallam (Sue Mawson and Anna Wilkinson)
  - Nottingham University (Stefan Rennick-Egglestone)
  - Sussex University (Geraldine Fitzpatrick, Eric Harris and Maddy Ballam)

• Willing and helpful patients
References


Rehab reader

• Ida
• Design sessions
• Deployment
• Analysis of deployment
## Participants

<table>
<thead>
<tr>
<th>Participant ID</th>
<th>Age (years)</th>
<th>Gender</th>
<th>Time from stroke (months)</th>
<th>Stroke Type</th>
<th>Side of hemiparesis</th>
<th>Previous dominant side</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ida</td>
<td>Female</td>
<td>51</td>
<td>Haemorrhage</td>
<td>L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rhea</td>
<td>Female</td>
<td>41</td>
<td>Haemorrhage</td>
<td>L</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td>Solomon</td>
<td>Male</td>
<td>19</td>
<td>Ischemic</td>
<td>L</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td>Sophie</td>
<td>Female</td>
<td>69</td>
<td>Haemorrhage</td>
<td>R</td>
<td>R</td>
<td></td>
</tr>
</tbody>
</table>
Exploring design ideas

With Patients, carers and physiotherapists

Demonstrating physical and video prototypes to stimulate ideas and gather feedback
Micro-worlds and more practical worlds!