Developing an Android-Based Game Tool with Monitoring Support to Track Stroke Patient Progress During Rehabilitation

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Research Goal

• To develop a suite of engaging Android-based tablet games that will treat the fine motor skills of stroke survivors, particularly improving their fine finger dexterity. An assessment and monitoring tool is incorporated to provide an automated tracking of their progress during rehabilitation.
Stroke

- Cerebral Vascular Accident (CVA)
- Occurs when a blockage or rupture in blood vessels disrupts the blood supply to the brain
- Second leading cause of death and primary cause of disability worldwide
- Stroke rehabilitation as means to achieve optimal stroke recovery
- Those whose fine motor skills are affected are subjected to physical and occupational therapies
Research Questions

• How can Android-based tablet games be designed to enhance fine finger dexterity?
• How does one design an engaging game that motivates the patient to practice physical and functional exercises?
• What objective factors does one need to consider in monitoring the stroke patient’s progress in their fine motor skills?
• How does one go about testing the efficacy of the game?
How does one design an engaging game that motivates the patient to practice physical and functional exercises?
## Designing an Engaging Game

<table>
<thead>
<tr>
<th>Basis</th>
<th>How?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recreational Pursuits</td>
<td>Based on everyday functional tasks</td>
</tr>
<tr>
<td>User-friendly interface</td>
<td>Large enough for easy manipulation</td>
</tr>
<tr>
<td>Uncomplicated rules</td>
<td>Easily understood game mechanics</td>
</tr>
<tr>
<td>Challenging (sense of achievement)</td>
<td>Achievement star rating system</td>
</tr>
<tr>
<td>Overall atmosphere of emotional support</td>
<td>Character support, audio rendering</td>
</tr>
</tbody>
</table>
How can Android-based tablet games be designed to enhance fine finger dexterity?
Fine Finger Dexterity

• **Dexterity** - “speed of coordinated movement”

• **Gross versus Fine**

• **Fine finger dexterity** - “fine manipulative movements of objects held between the thumb and fingers”

• **Finger control, finger range of motion, and finger isolation and coordination**
Dragging Task

Finger control

• exercises which involve movement and placement of things in designated areas
Tapping Task

Finger isolation and coordination

- straight finger lifts
Stretching Task

Finger range of motion

- exercise involving the extension of fingers resisted by rubber bands
What objective factors does one need to consider in monitoring the stroke patient’s progress in their fine motor skills?
Objective Measures

• Drawn from two reliable and valid finger dexterity assessment tools

• Purdue Pegboard and Rosenbusch Test of Finger Dexterity

• Time and Accuracy
## Assessment Basis

<table>
<thead>
<tr>
<th>Game Type</th>
<th>Fixed Variable/s</th>
<th>Monitored Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dragging</td>
<td>Total no. of toppings</td>
<td>Accuracy</td>
</tr>
<tr>
<td></td>
<td>Time</td>
<td>Time taken</td>
</tr>
<tr>
<td>Tapping</td>
<td>Total no. of notes</td>
<td>Accuracy</td>
</tr>
<tr>
<td></td>
<td>Time</td>
<td></td>
</tr>
<tr>
<td>Stretching</td>
<td>Total no. of plant plots</td>
<td>Time Taken</td>
</tr>
<tr>
<td></td>
<td>Accuracy</td>
<td></td>
</tr>
</tbody>
</table>
Data Rendering

• Progress tables and charts for easy monitoring
How does one go about testing the efficacy of the game?
Testing

• Two phases: *Subjects with normal hand function and Stroke survivors*
• Inclusion/exclusion criteria
• First phase - *baseline setting*
• Second phase – adapts *Constraint Induced Movement Therapy or CI therapy*
• Three principles - “constraining the unaffected limb, forced use of the affected limb, and massed practice”
• 8 consecutive testing sessions + 1 final session
## Inclusion/Exclusion Criteria

### Subjects with Normal Hand Function

1. Between 30 to 60 years of age
2. With normal hand function
3. Did not suffer from any hand impairments during his lifetime

### Stroke Survivors

1. Able to extend wrist and fingers at least 10 degrees
2. Functional hearing and vision
3. Undergoes a standard rehabilitation program

### Exclusion criteria

1. Severe pain in the impaired arm
Results: 1st Phase

- 15 participants: 9 males and 6 females

App overall rating 4.78
Results: 2nd Phase

- 3 stroke survivors

Medical Contribution

<table>
<thead>
<tr>
<th>Subject</th>
<th>Helped Me Improve Fine Motor Performance</th>
<th>Prefer Using Than Standard Finger Dexterity Exercises</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient A</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Patient B</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Patient C</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Average</td>
<td>4.67</td>
<td>4.33</td>
</tr>
</tbody>
</table>

App overall rating 5
## Results: 2\textsuperscript{nd} Phase

<table>
<thead>
<tr>
<th>Subject</th>
<th>Easily Drag Toppings</th>
<th>Faster in Dragging Toppings</th>
<th>Most Fingers are Able to Respond in Tapping Keys</th>
<th>Respond Faster in Tapping Keys</th>
<th>Able to Expand Fingers in Wider Ranges</th>
<th>Flex Fingers Easily</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient A</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Patient B</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Patient C</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Average</td>
<td>3.67</td>
<td>4</td>
<td>4.33</td>
<td>4.33</td>
<td>4.67</td>
<td>4.33</td>
</tr>
</tbody>
</table>

Subjective Progress
Results: 2\textsuperscript{nd} Phase

**Dragging Task**

- **Average Accuracy Level**
  - Difference of 3-4%
  - Patient A & B: 92-96%
  - Patient C: 94-97%

- **Average Time Taken per Topping**
Results: 2\textsuperscript{nd} Phase

Tapping Task

Average Accuracy Level
Results: 2\textsuperscript{nd} Phase

Stretching Task

Average Time Taken per Soil Slot
Thank you!