Serious Games in Neurorehabilitation

A Systematic Review of Recent Evidence

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Intl Workshop on Serious Games –
@ Multimedia 2014
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Orlando, Florida
Overview

1. Introduction

2. Methods

3. Results

4. Discussion

5. Conclusion
1. Introduction

- **Neurorehabilitation** – a challenging mission:
  “…training has to be challenging, repetitive, task-specific, motivating, salient, and intensive for neuroplasticity to occur” (Saposnik & Lewin, 2011, p.1380)

- **Serious Games in Neurorehabilitation** – selected benefits
  - “… they will get better while having fun!“ (Burdea, 2003, p.520)
  - Motivation & engagement
  - Immediate feedback
  - Rewards
  - Adaptation – personalization
1. Introduction

- Serious Games in Neurorehabilitation – current state:
  - Many publications
  - Main issues: Quality of SG systems & evidence

![Published papers – Feb 2014](image)
# 2. Methods – Research questions

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Study design</strong></td>
<td>RCT, pilot, case study, feasibility study</td>
</tr>
<tr>
<td><strong>Hardware</strong></td>
<td><strong>Type</strong>: robot, PC interface, game interface; <strong>Category</strong>: off the shelf, custom-made, mixed</td>
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<tr>
<td><strong>Experimental design</strong></td>
<td>e.g., pre-post study with control group</td>
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<tr>
<td><strong>Disease</strong></td>
<td>e.g., stroke, multiple sclerosis, morbus Parkinson, generic</td>
</tr>
<tr>
<td><strong>Sample</strong></td>
<td><strong>Quality</strong>: patients, healthy <strong>Quantity</strong>: sample size</td>
</tr>
<tr>
<td><strong>Focus of intervention</strong></td>
<td>e.g., upper extremity, lower extremity, gait, balance</td>
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<tr>
<td><strong>Treatment</strong></td>
<td>duration, focus</td>
</tr>
<tr>
<td><strong>Effects</strong></td>
<td>performance and attitude</td>
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</table>
2. Methods – Literature search

- **4 sources:**
  PubMed, ACM, IEEE, and Google scholar

- **4 search terms:**
  - Serious Games & Neurorehabilitation
  - Computer Games & Neurorehabilitation
  - Video Games & Neurorehabilitation
  - Games & Neurorehabilitation

- **Date:** February 28, 2014

- **Inclusion criteria:**
  - Publication year: 2013 and 2014
  - Empirical study relevant to neurorehabilitation

- **Papers included:** 30 (plus 4 RCT)
3. Results

- **4 RCT studies** (published **before** 2013)
  - Preliminary positive evidence
  - Quality issues:
    - multiple testing
    - considerable dropout rates
    - small sample size

- **30 further studies**
  - Design

Source: [http://www.bing.com](http://www.bing.com)
3. Results

- (30 further studies - continued)

**Interface**

- Game: 46%
- Robot: 27%
- PC: 17%
- Other: 10%

**Focus of intervention**

- Upper extremity: 60%
- Lower extremity: 7%
- Perceptual/ cognitive functions & balance: 10%
- Other: 23%

Source: [http://www.bing.com](http://www.bing.com)
3. Results

- (30 further studies - continued)

### Performance effects

- **Positive**: 44%
- **No report**: 43%
- **No effect**: 3%
- **Mixed**: 10%

### Attitude effects

- **Positive**: 33%
- **No report**: 57%
- **Mixed**: 10%

Source: Vandermaesen et al. (2013, p.2)
4. Discussion

- **Evidence**
  - Positive trends – strong bias
  - Quality of evidence: poor
  - Shortcomings:
    - Research design
    - Dependent variables
    - Sample size and recruitment

- **Dominant research designs:**
  - Feasibility, pilot, case
  - No recent RCT

- **Hardware:** OTS dominating

- **Trends:**
  - Individualization & adaptation
  - RehaGames@home
  - Brain-game interfaces

Source: Hocine et al. (2014, p. 120)

Source: http://www.bing.com
5. Conclusion

- Further studies needed
- Improved quality
- **Reminder: “double mission” of Serious Games**

<table>
<thead>
<tr>
<th>Skill level</th>
<th>Task difficulty</th>
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<tbody>
<tr>
<td>low</td>
<td>low</td>
</tr>
<tr>
<td>high</td>
<td>high</td>
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</table>

- **Boredom**
  - No improvement
  - Deterioration

- **Flow**
  - High, effectivity low
  - Medium, effectivity medium
  - Low, effectivity high

- **Anxiety**
  - Failure
  - Maladaptation


Source: http://www.bing.com