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Usability of a user-centered virtual reality system for upper limb motor rehabilitation in chronic stroke patients

AG. Grosmaire, L. David, T. Koeppel, G. Bouyer, S. Otmane, O. Pila, C. Duret

CONTEXT

Stroke → 2/3 patients with persistent upper limb motor impairment
Nonlinear pattern of motor recovery → >M6-M12: decline, especially post-discharge
Effect of community-based therapy at post-discharge → Ineffective on motor impairment
Value of new technologies in self-rehabilitation → Enhance motivation; Interactive with feedback; easily transportable; suitable at home; intensive training based on motor learning principles
Objective: To assess the usability of a Virtual Reality (VR)-based program using a Leap Motion Controller® designed to train pronation-supination movements in chronic patients following stroke

METHODS

Demographics: N=28 (10 F/18 I), Age: 53 ± 15y (Mean ± SD)
Time since stroke: 71 ± 51mo, FMA score: 49 ± 8pts
VR-based program:

<table>
<thead>
<tr>
<th>Leap motion controller®</th>
<th>Exercises</th>
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<tbody>
<tr>
<td>Capture user hands in 3D space simple usability/inexpensive</td>
<td>Goal-directed task in a video environment with gradual difficulty</td>
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</tbody>
</table>

Intervention: 1-day session, forearm pronation/supination tasks with 3 randomized difficulty levels (1, 2, 3)

Evaluations:
- Fugl-meyer assessment (FMA)
- Rating of perceived exertion (RPE 6-20)
- Number of coins collected (NCC)
- System usability scale (SUS)
- Intrinsic motivation inventory (IMI): Value/usefulness, interest and enjoyment, perceived competence and effort/importance

RESULTS

System usability scale (/100): 79 ± 15 → Excellent usability using the VR-based program

Intrinsic motivation inventory

<table>
<thead>
<tr>
<th>Maximal score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value/usefulness</td>
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</tbody>
</table>

Correlations

- FMA vs. RPE 6-20 NCC
- RPE 6-20 NCC vs. FMA

- ρ=0.528, p<0.01
- ρ=0.420, p<0.05

› Good subjective experience related to the VR-based program

CONCLUSION

- Excellent usability of the VR-based program / user-centered approach
- Intensive training (effort) related to the difficulty
- Motivation ++ → long-term rehabilitation program and long-term participation
- Close collaboration between engineers and clinicians ++ in interface conception

Perspectives → Development of various therapeutic games/ to launch a RCT study