

PHOENICS: PHysiotherapy and action- Observation thErapy: aN Integrated approaCh supported by novel technologies

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- **Working Group**
- **Background**
- **Hypotheses**
- **Objectives**
- **Activities & Main Results**
- **Project Outcomes**
- **Future Developments**



Working Group



**Fondazione
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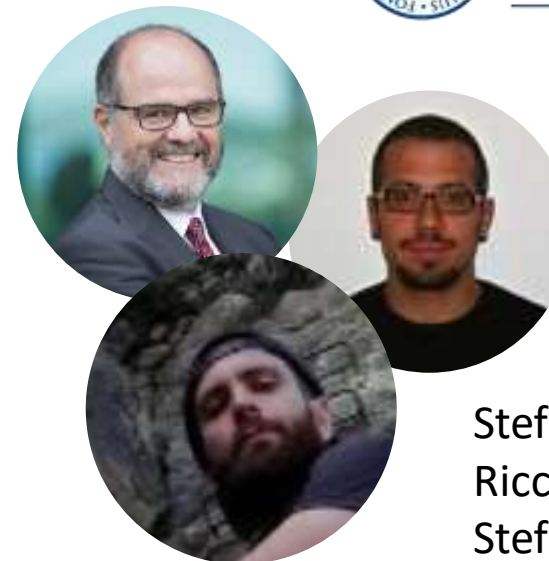
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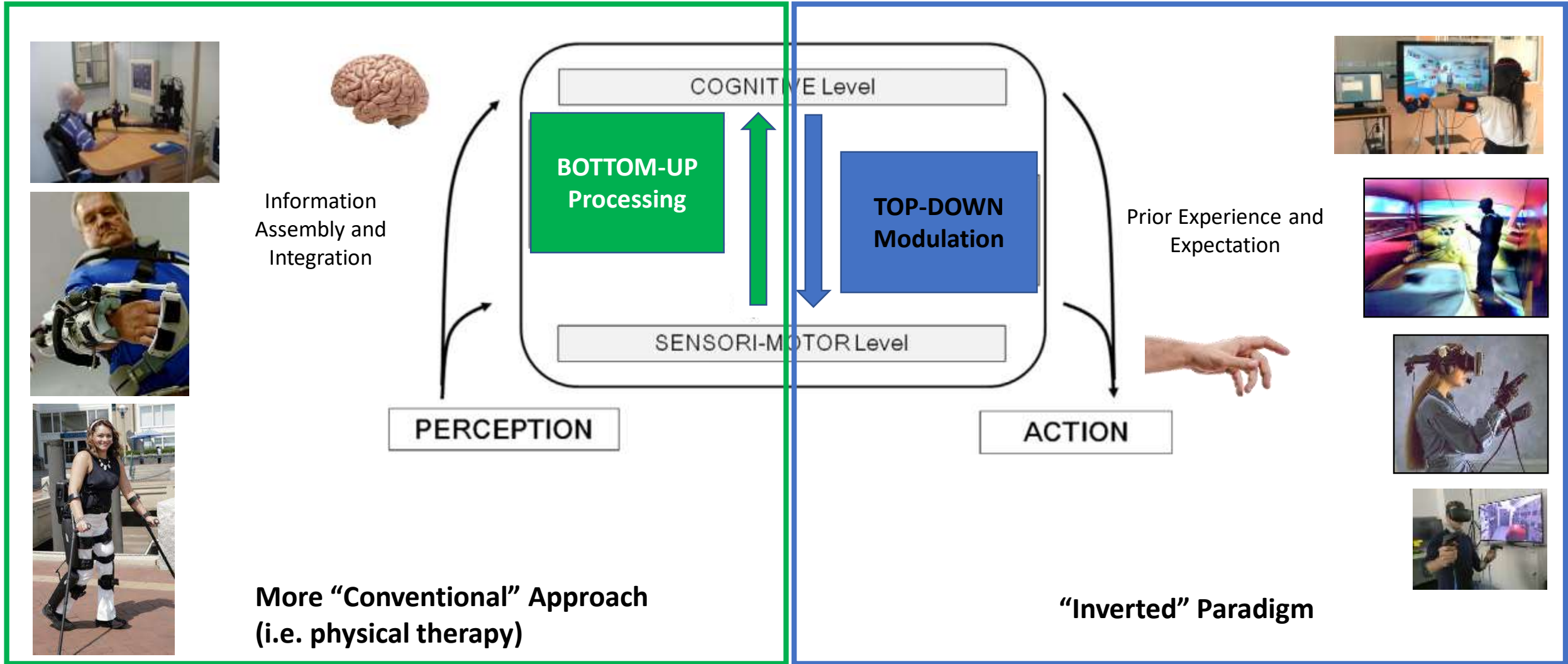


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Background

General Approaches in Motor Rehabilitation



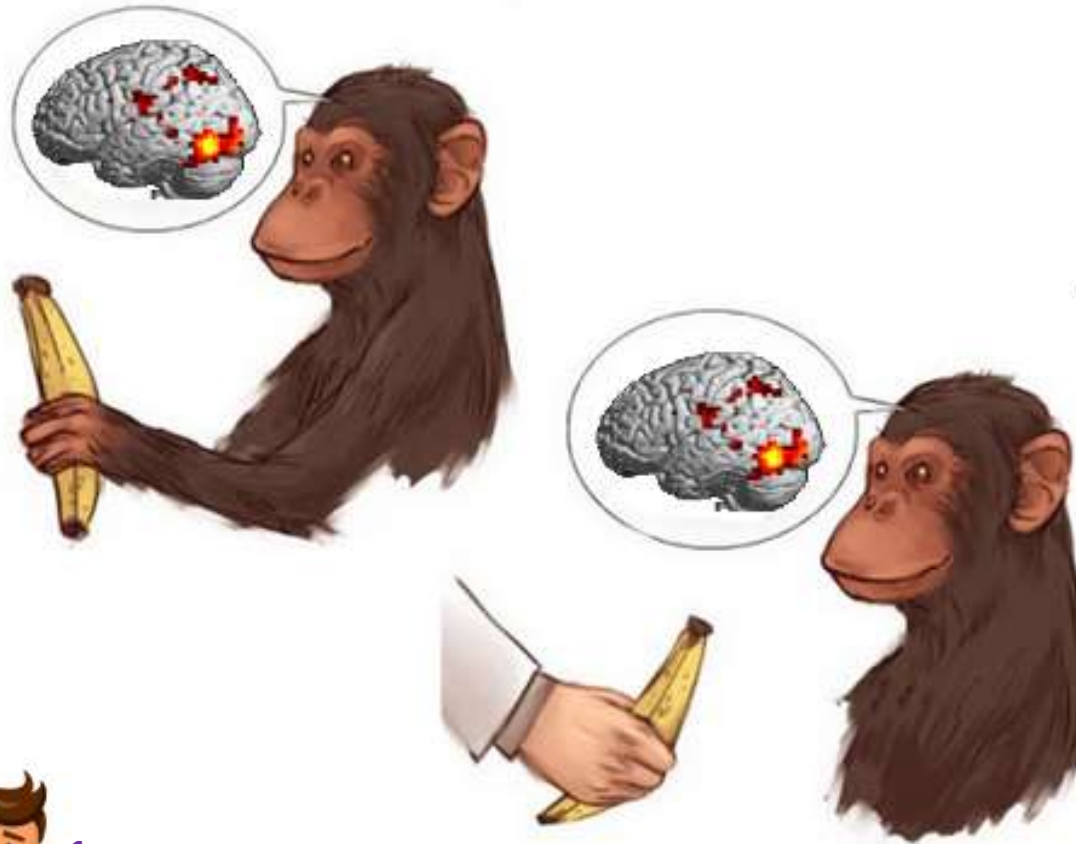
Background

General Requirements

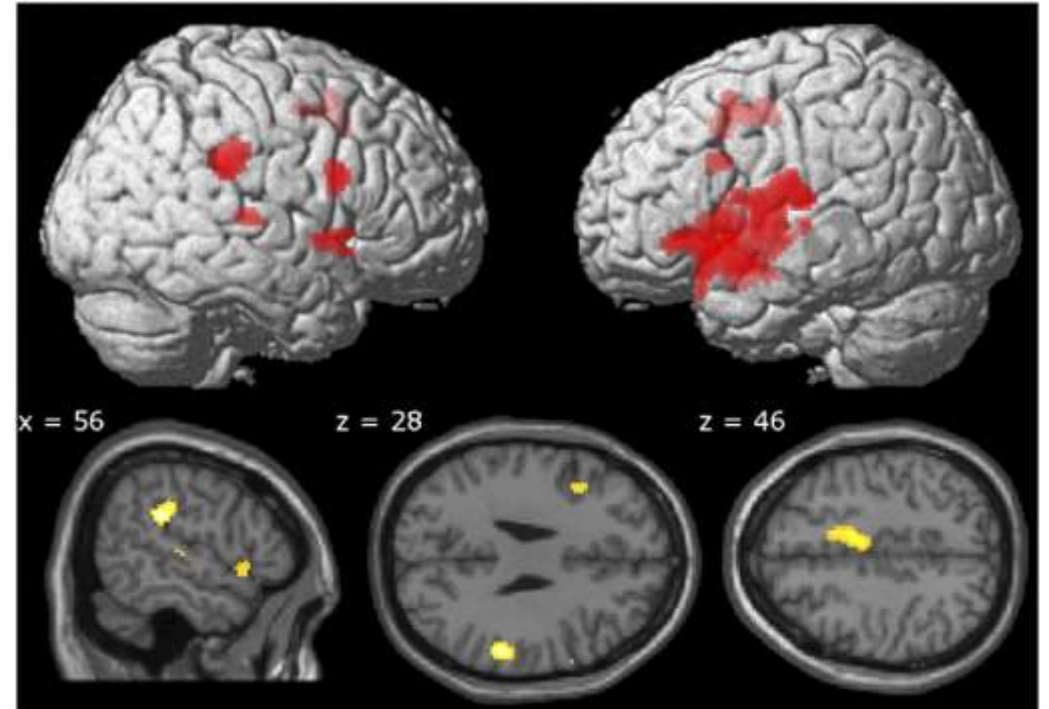
- Sustain/guide the subject during the practice
- Provide adequate real-time feedbacks to the subject
- “Speak” with the clinician
- Objectively monitor progress and tracking outcomes
- Provide adaptive level of practice learning by situation
- Be motivating, engaging, stimulating
- Be “always” available

Hypotheses

Action Observation Therapy



MIRROR NEURONS Concept

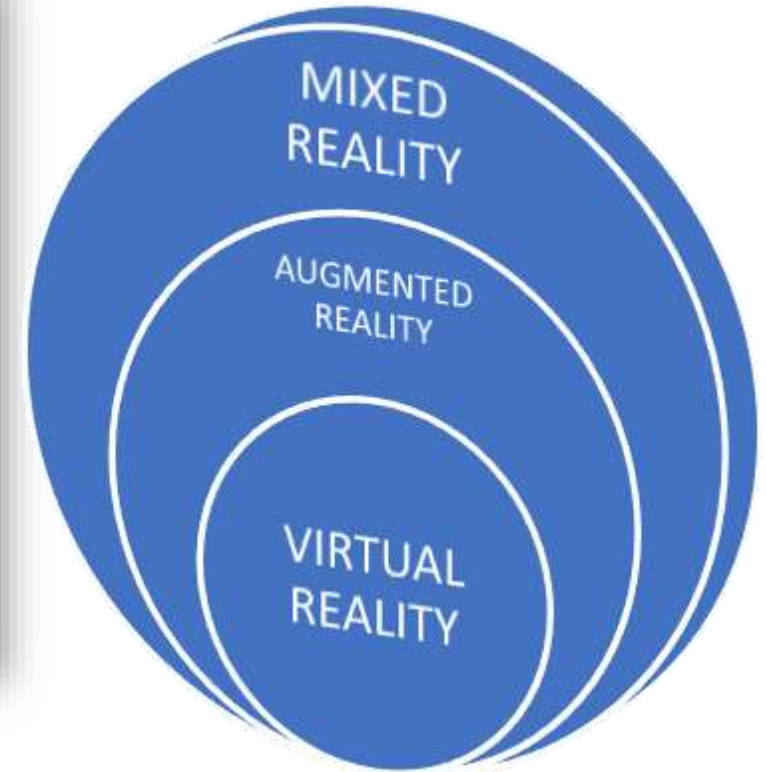


Action observation has a positive impact on rehabilitation of motor deficits after stroke

[Ertelt 2007 NeuroImage]

Hypotheses

Exergaming in Mixed Reality



**Integration in the real world of virtual elements
with which it is possible to interact in "motivating"
games**

Adapted from Mann 2002

Objectives

VERIFY WHETHER AOT MAY IMPROVE CONVENTIONAL REHABILITATION

1

OPTIMIZE AOT PARAMETERS



DEVELOP A COMPUTER ASSISTED REHAB SYSTEM BASED ON AOT

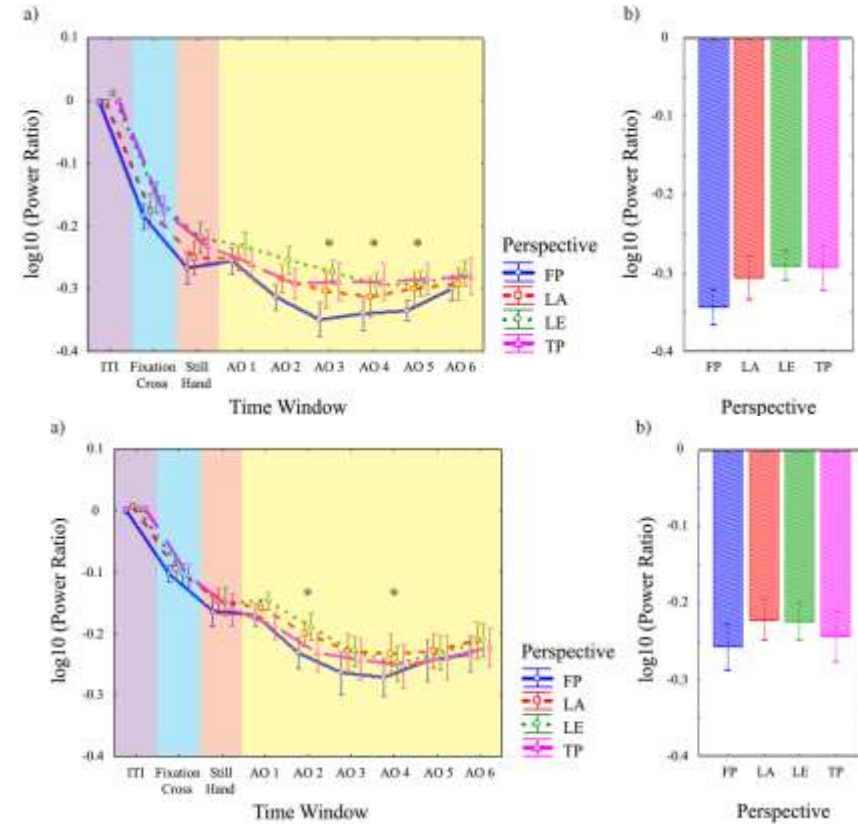
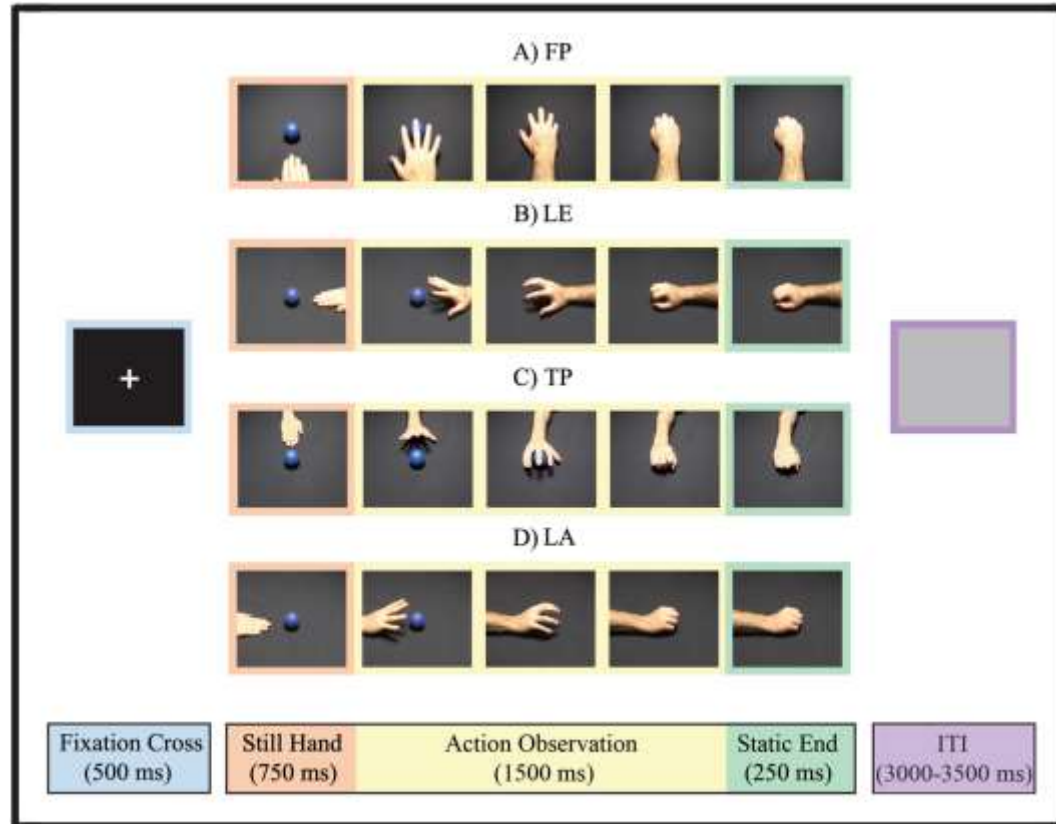
3

CLINICALLY VALIDATE THE APPROACH

1

OPTIMIZE AOT PARAMETERS

hdEEG analysis including different **stimuli** and **conditioning parameters** (i.e., perspective, gestures, etc.)





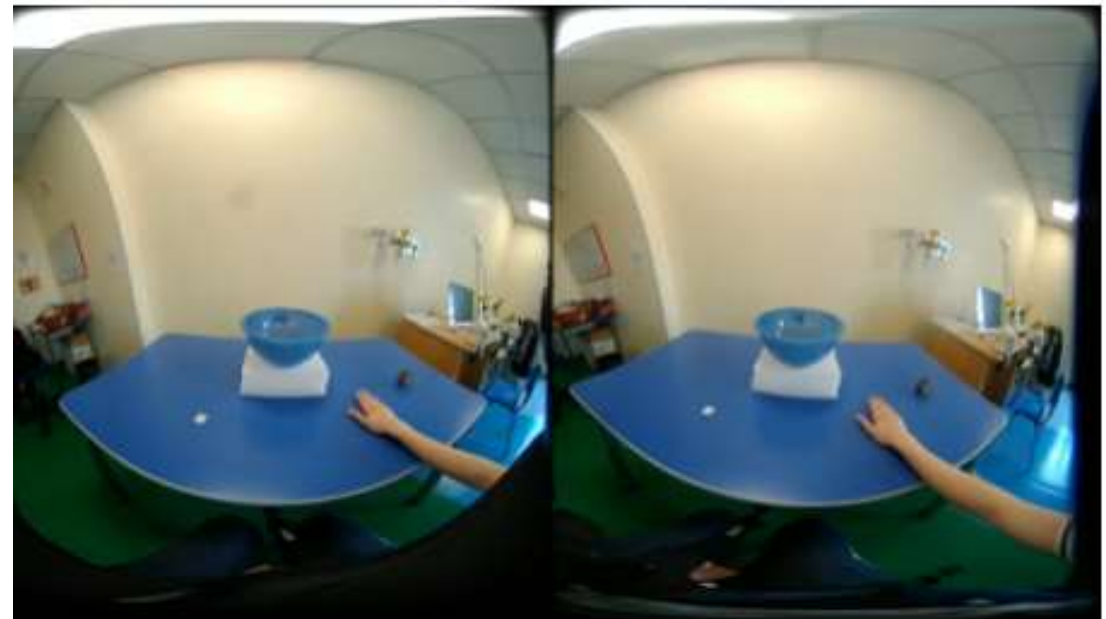
DEVELOP A COMPUTER ASSISTED REHAB SYSTEM BASED ON AOT



3d Camera



VR Headset

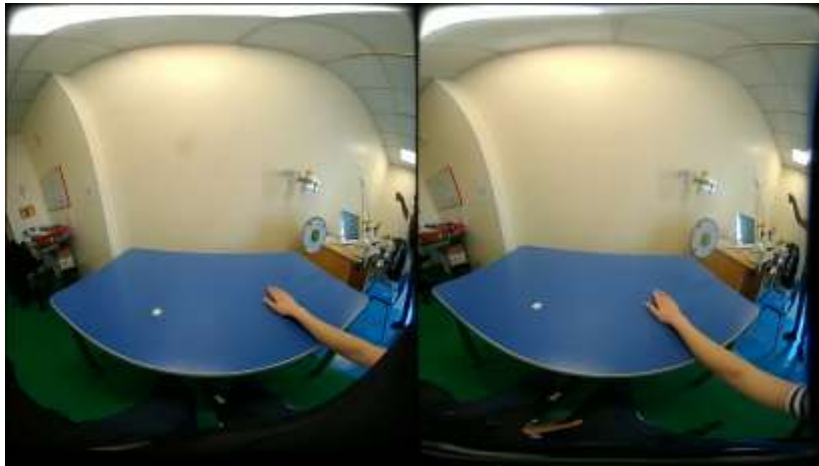


1. **Acquire and provide optimal visual stimuli**

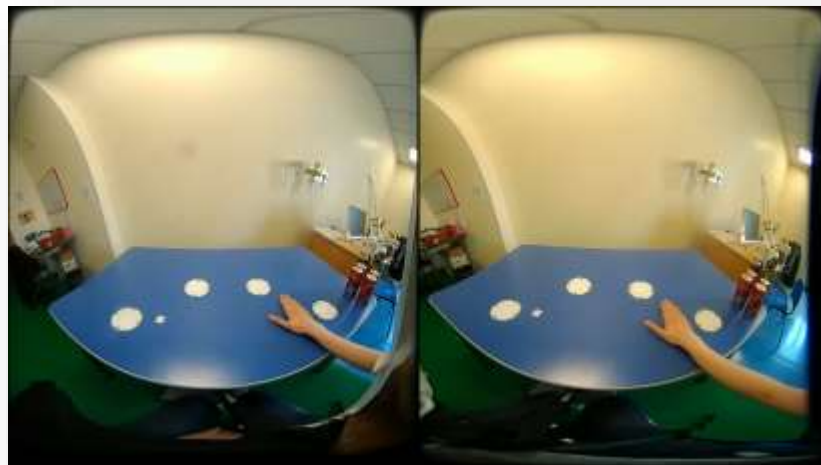
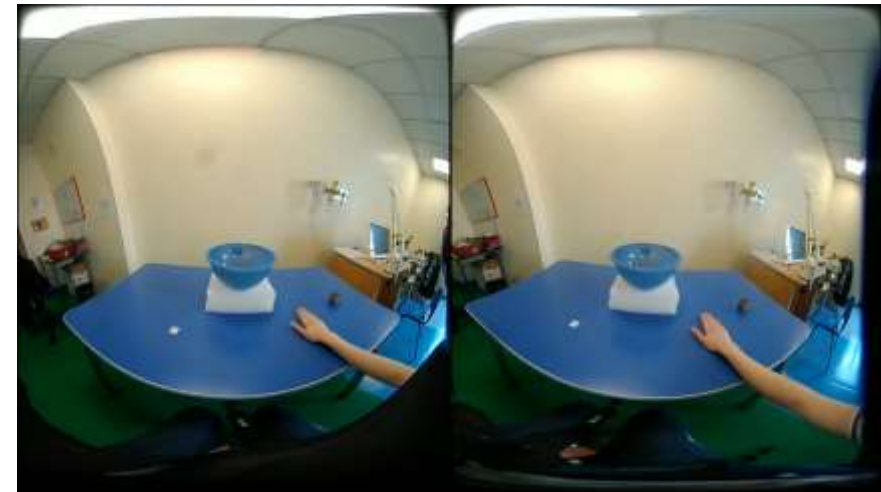


DEVELOP A COMPUTER ASSISTED REHAB SYSTEM BASED ON AOT

Pointing



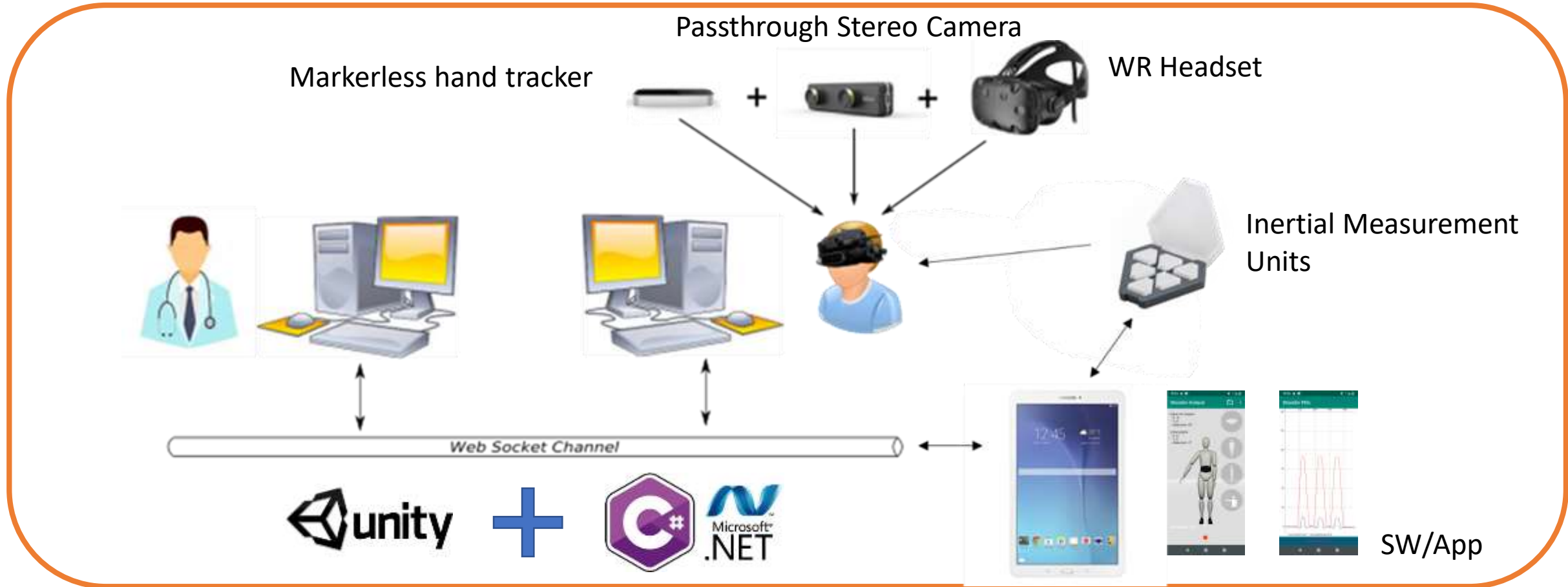
Reaching&Grasping



Daily-Life Activities



DEVELOP A COMPUTER ASSISTED REHAB SYSTEM BASED ON AOT



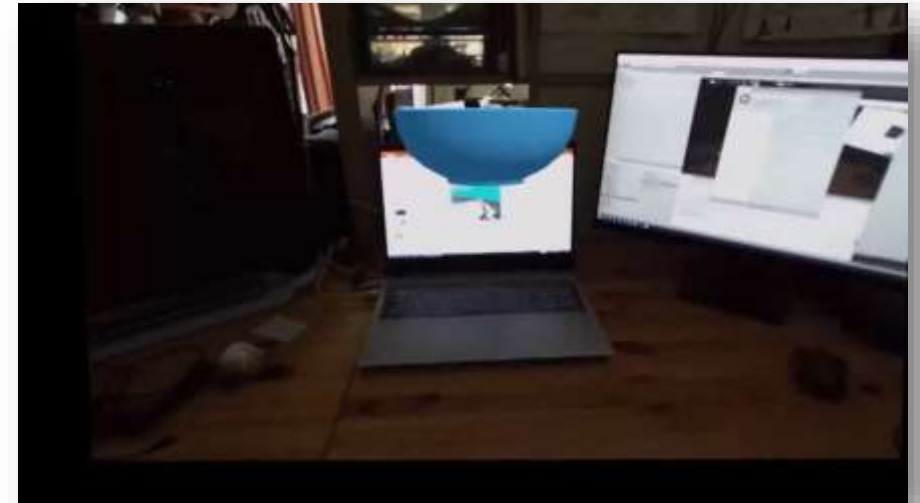


DEVELOP A COMPUTER ASSISTED REHAB SYSTEM BASED ON AOT

Pointing



Reaching&Grasping



Daily-Life Activities

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CLINICALLY VALIDATE THE APPROACH

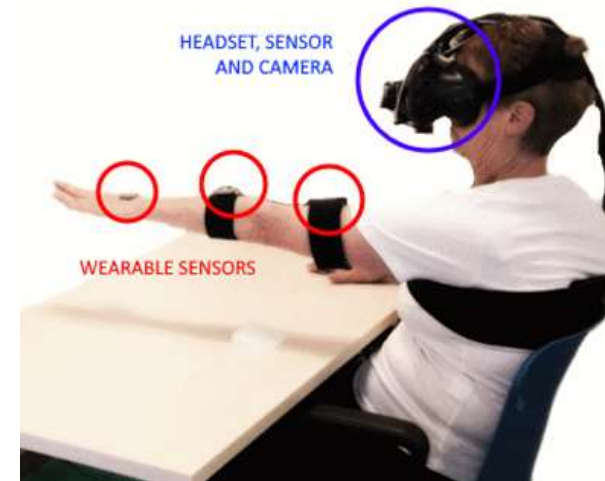
Proof-of-concept and Usability Study

Inclusion criteria:

1. Ischemic and hemorrhagic ictus **acute patients** (3-6 months).
2. **Fugl-Meyer scale** score between 20-60.
3. **Age > 18 years old.**
4. Include **both genders.**
5. Acceptance of the informed consent.

Exclusion criteria:

1. Conjunction of other neurologic diseases.
2. Presence of **visual deficit** (hemianopia or ipovisus).
3. **Neuropsychological deficits** that could affect the comprehension of instructions or the treatment execution (aphasia, apraxia or neglect).
4. **Mini-Mental State Examination (MMSE) < 24.**
5. **Orthopedic or musculoskeletal limitations.**
6. Clinical **instability.**
7. **Epileptic patients.**
8. Subjects with implanted **electronic** medical devices (pacemakers).

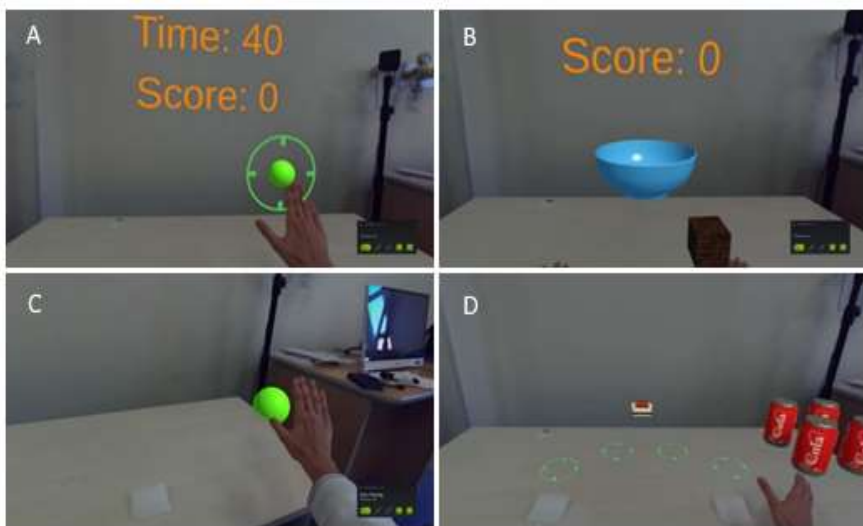


Post-stroke Patients

3

CLINICALLY VALIDATE THE APPROACH

Exercises



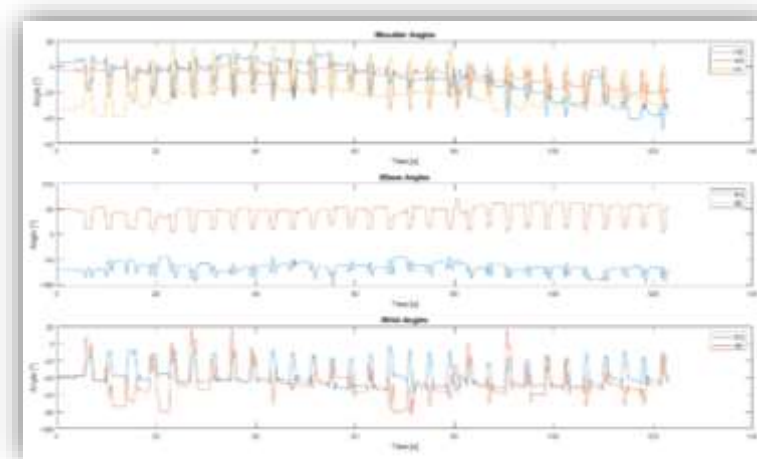
Subjects



Information

Metrics

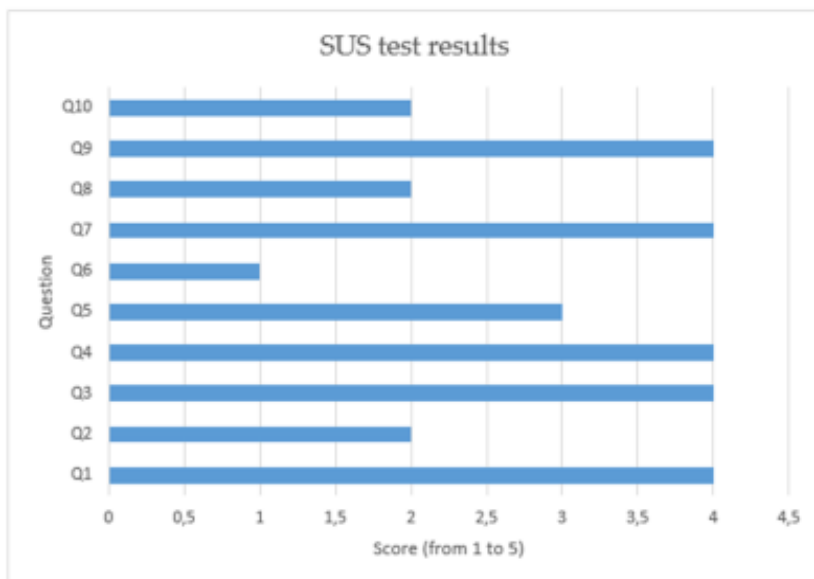
PRIMARY KEY INDICATORS
<i>Hand max reaching velocity (HMRV)</i>
<i>% Cycle Hand Max Velocity (CHMV%)</i>
<i>Mean Spectral Arc Length (SPARC)</i>
<i>Mean Reach Path Ratio (MRPR)</i>
<i>Tip Max Distance (TMD)</i>
<i>Mean Interaction Time (MIT)</i>
<i>Mean Resolution Time (MRT)</i>



3

CLINICALLY VALIDATE THE APPROACH

System Usability Scale (Clinician)



Usability Questionnaire (Patient)

No **motion sickness** problems

No **major critical** issues in completing tasks

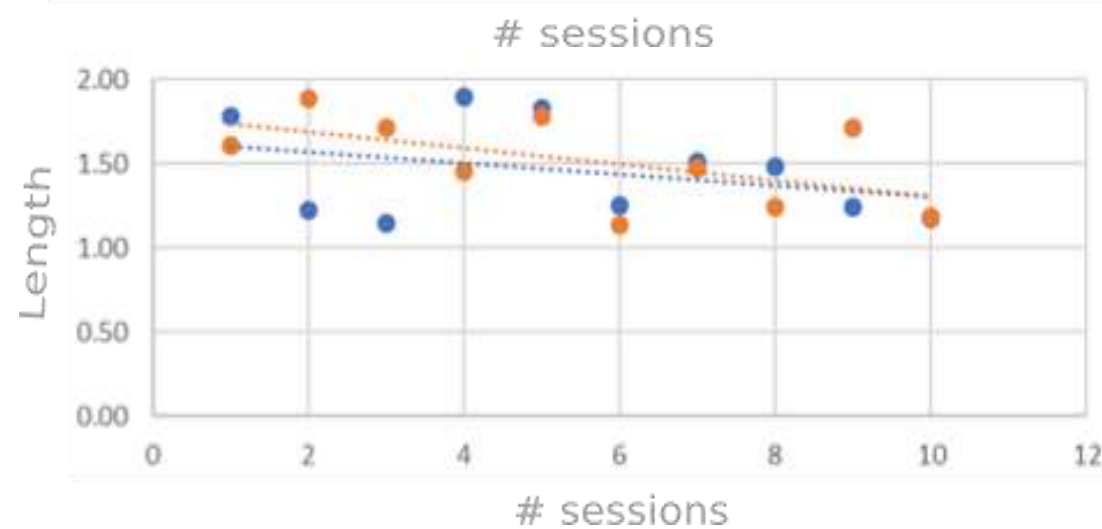
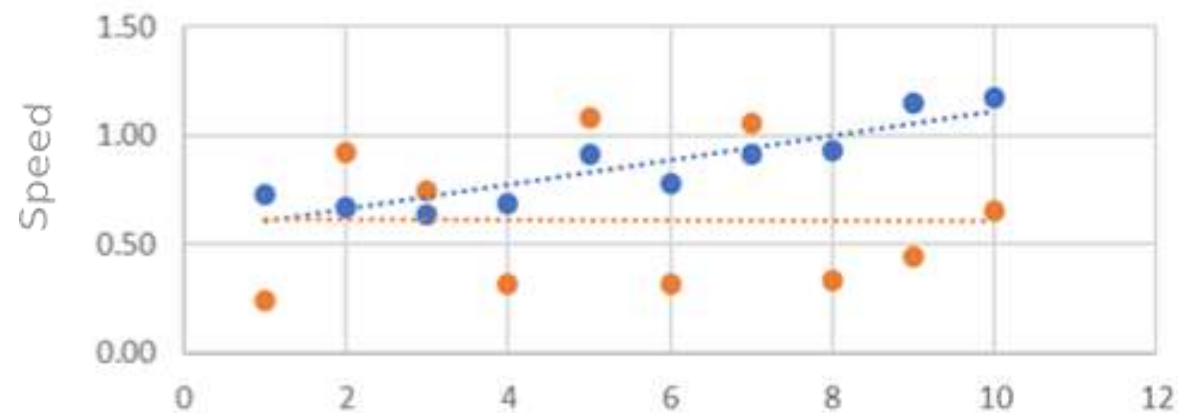
Medium impact issues related to the **hand-virtual object interaction**

Minor issues related to the **interface information** (e.g., end of the task)

Action observation phase was considered “quite” **boring**

High involvement in the **gaming phase**

Hand **max reaching velocity** during the **reaching** task with respect to the session



Mean reach path during the **goalkeeper** exercise with respect the sessions

Outcomes

2 PhD Students:

- PhD scholarship funded by the project
- Visiting PhD at the **Synthetic, Perceptive, Emotive and Cognitive Systems (SPECS)**



6 Theses:

- 2 Physiotherapy
- 3 Bachelor in Electronics and Mechanics/Materials Engineering
- 1 Master in TLC

1 Activation of a **research associate** position with **CNR** on project **funded** by **INAIL**.

Published papers/abstracts:

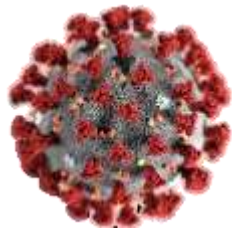
- Angelini M., et al. *Perspective-dependent reactivity of sensorimotor mu rhythm in alpha and beta ranges during action observation: an EEG study*. **Scientific Report**, 2018.
- Angelini M., et al. *Short-term immobilization reduces the extent of the self-perceived peripersonal space: an immersive virtual reality study*. **Gait & Posture** 2019.
- Mosna P., et al., *Integrated Rehabilitation Platform based on Action Observation Therapy, Mixed Reality An and Wearable Technologies*. **ICNR2020**, WeRob2020 and WearRAcon Europe 2020, October 13 to 16, 2020.
- Lenzi S.E., et al. *Integration of 3D Action Observation Therapy and Rehabilitation Exercises in Mixed Reality: A Feasibility Study on Post-Stroke Patients*. **GNB** 2020.

Papers under review:

- Angelini M., et al. *Perspective-dependent activation of frontoparietal circuits during the observation of a static body effector*. **Brain Research**.
- Lenzi S.E., *Grading visual stimuli in personalized action observation therapy: a kinematic-based approach*. **SIAMOC** 2021.

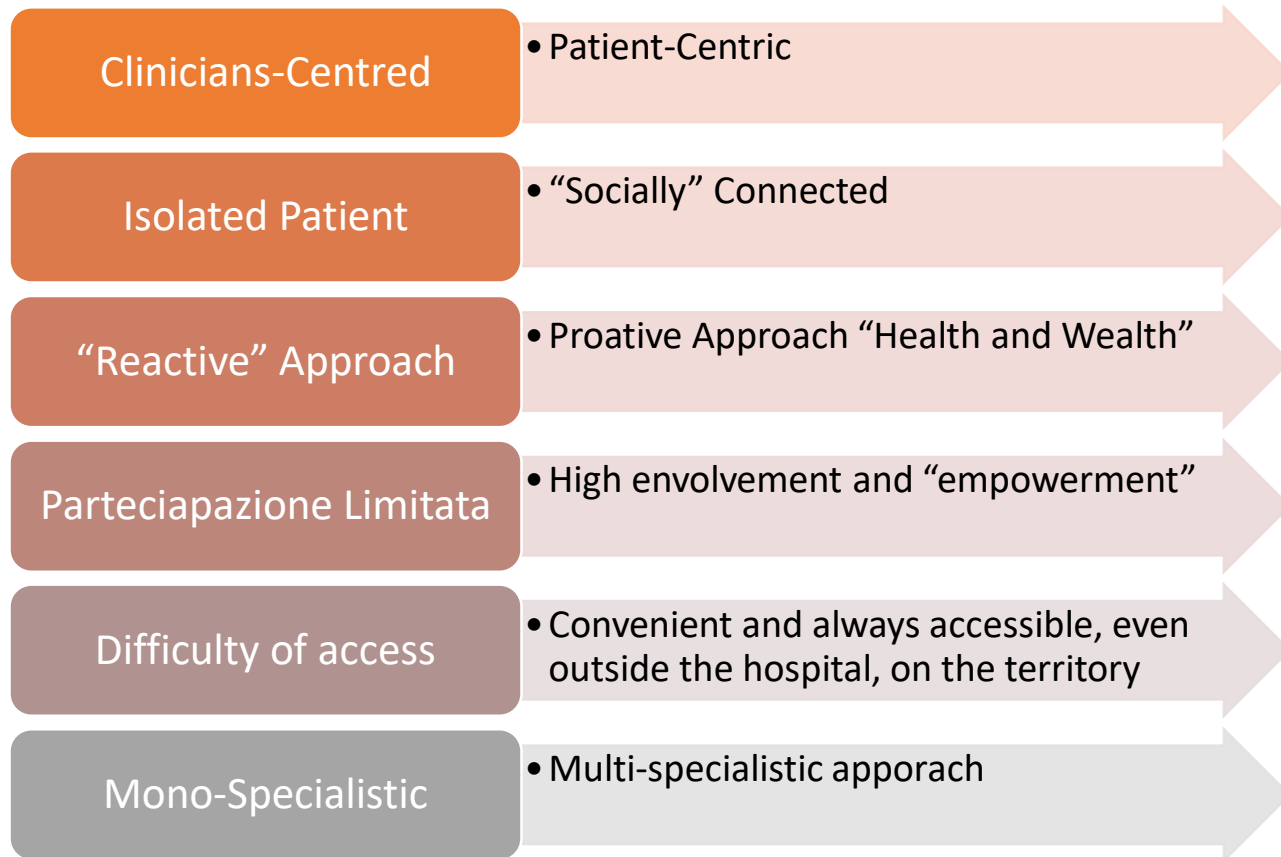
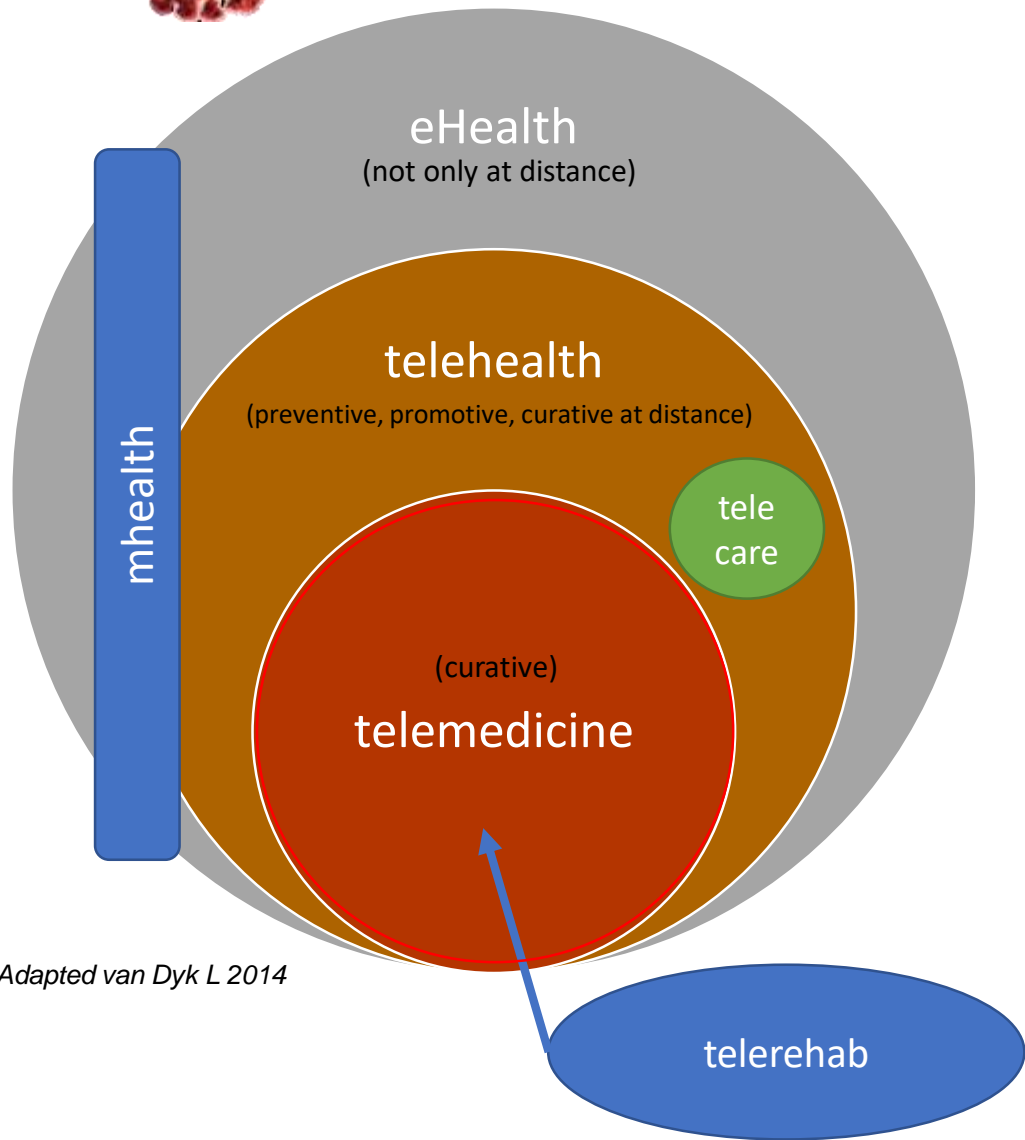
Papers in Submission:

- Lenzi S.E., et al. *An Integrated Framework for Action-Observation Therapy and Game-Based Upper Limb Rehabilitation Exploiting 3D Visual Stimuli, Mixed Reality and Motion Capture Systems*. **Sensors**.



Further Developments

Adapted from Cognizant 2015



Powered by Information Technologies



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