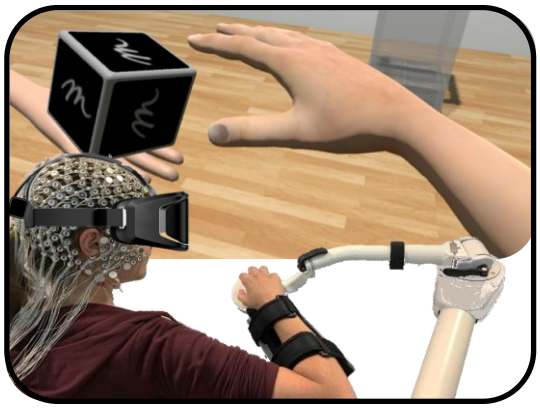
Master Thesis Proposal

Tricking the human brain: Electrophysiological correlates and behavioral benefits of owning a virtual body during motor training in immersive virtual reality

Background: The possibility of using robotic devices to support rehabilitation training following brain injury is promising, since robots can deliver cost-effective and high-intensity training. However, to date, the functional gains obtained after robotic training are limited. The addition of virtual reality (VR) during robotic training has been shown to provide a motivating and safe environment.

Commercial head-mounted displays have a great potential to realistically mimic the subject's limb in a highly immersive training environment. In this 3D virtual reality, the symbolic virtual representation of the own limb may actually become a *self*-representation (i.e., avatar). Previous studies suggest that brain areas involved in body ownership are shared with brain areas linked to motor learning. Thus, increasing body ownership in VR might be an effective tool to promote brain plasticity in motor areas during training. However, to date, less is known about the effect of body ownership on motor brain networks.



Virtual self-representation of the subjects' real limb in a reaching task during robotic motor training in VR and EEG recording.

The aim of this project is to "trick the human brain" through immersive virtual reality and investigate the neural underpinnings of body ownership illusion over an avatar in a virtual training environment using Electroencephalography (EEG). This research project will provide new insights into the neural correlates and behavioral benefits of embodying virtual limbs, and will help to design new robotic training paradigms together with virtual reality games using embodiment as a tool to increase therapy outcomes.

Aims:

1. Literature research: Review relevant literature on (neural correlates of) motor learning and body ownership illusion in VR.
2. Study design: Design a study protocol and implementation of experiment (creation of virtual environment using Unity 3D, avatar interactions, connection with EEG system).
3. Data collection and analysis: Pilot experiment in a small sample of healthy participants to validate the feasibility of study/discover weak spots (optional: full-size study).
4. Scientific writing: Reporting of methods and (preliminary) results.

Materials and Methods: This project will be performed using commercial VR and motion tracking devices: Game Engine (Unity3D) + HTC Vive HMD for the virtual reality development (avatar animation and other plugins for immersive virtual reality are available). HTC Vive controllers and trackers to record movements for real-time visualization and/or further analysis (Python/R notebook and basic scripts from previous projects available for data analysis). The lab is further equipped with commercial high-density EEG systems (e.g., g.SCARABEO/g.HIamp EEG system, g.tec; Geodesic EEG System "GES 400", EGI). Other bio signals (e.g. skin conductance, skin temperature, muscle activity, heart rate) might be implemented using our multimodal acquisition device (g.tec). Addition of robotic device possible if needed.

Requirements: Basic programming (Unity, C#, Python) and basic signal processing skills. Experience in 3D environments, virtual reality, game engine, data processing, kinematics and/or neuroscience/EEG analysis are a plus.

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