The Embodiment Station:
experiencing a virtual fighting scenario

Evaluating Virtual Embodiment with the ALEX Exoskeleton

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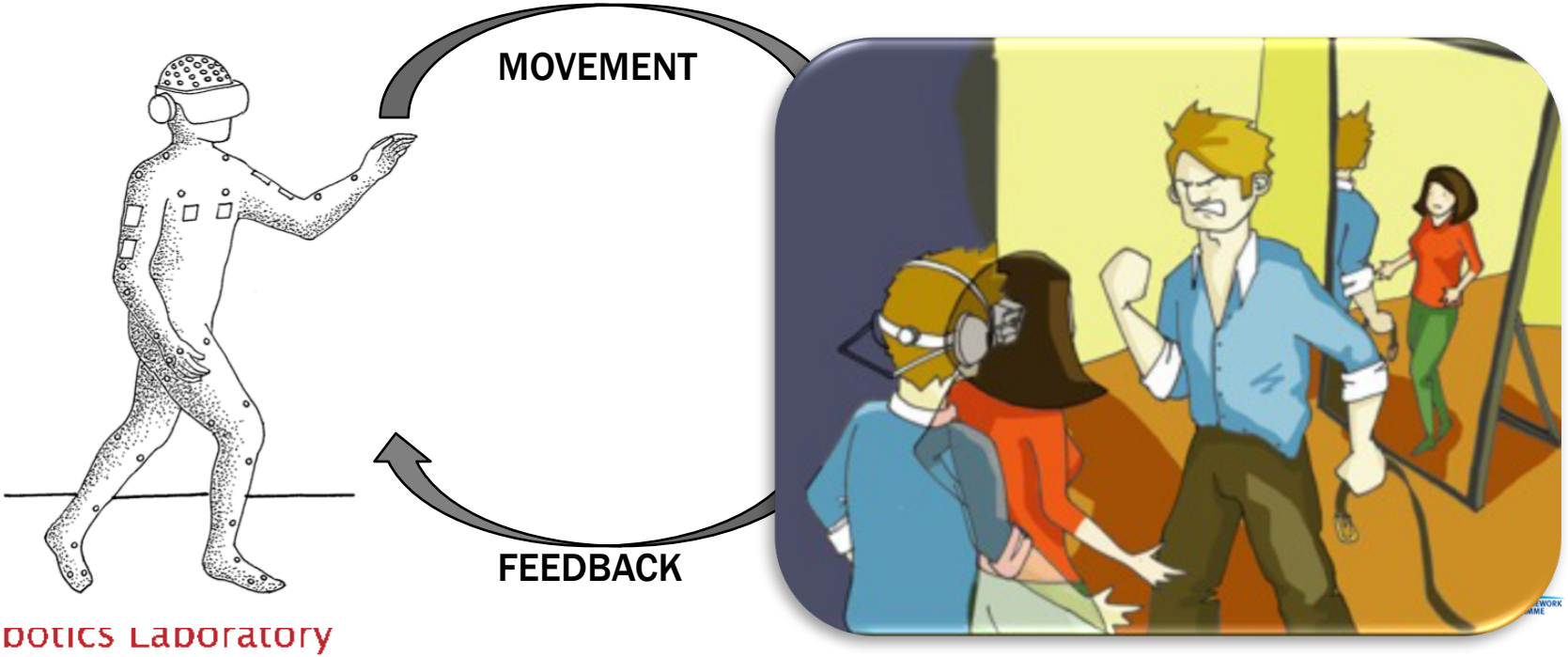
The ALEX exoskeleton

The scope of the kinesthetic vest is that of allowing the bidirectional communication between moving participant and virtual environment during the virtual embodied mode.

- In particular the possibility of wearing a light arm exoskeleton is that of simulating force interaction with an avatar, such as in the case of experiencing what it is like to be the victim of the kind of abuse that he administers to others in reality. By means of the kinesthetic vest the user can experience forces at the level of arms as during a violent struggle with another person.
- The kinesthetic vest can be used to modify the conditions of embodiment, by increasing perceived strength in a simulated VR scenario,



Physical interaction with ALEX exoskeleton

- Shaking a hand to an incoming avatar
- A fight interaction with an opponent

Shaking Hand

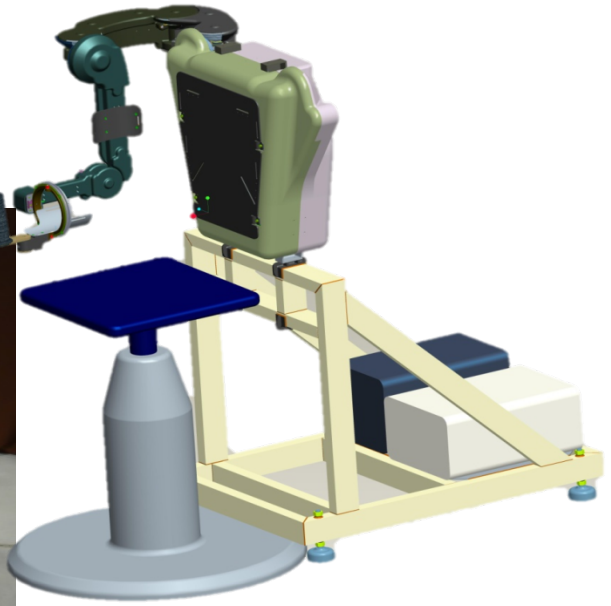
Fighting

Shaking Hand

Fighting

The kinesthetic vest: ALEX exoskeleton

- **The Arm Lightweight EXoskeleton (ALEX) is a mechanically compliant robotic manipulator (soft arm), actuated by means of electric actuators, remotely located with respect to the robotic joints.**
- **Can we use kinesthetic feedback to enhance embodiment? And in which context this is going to be relevant?**

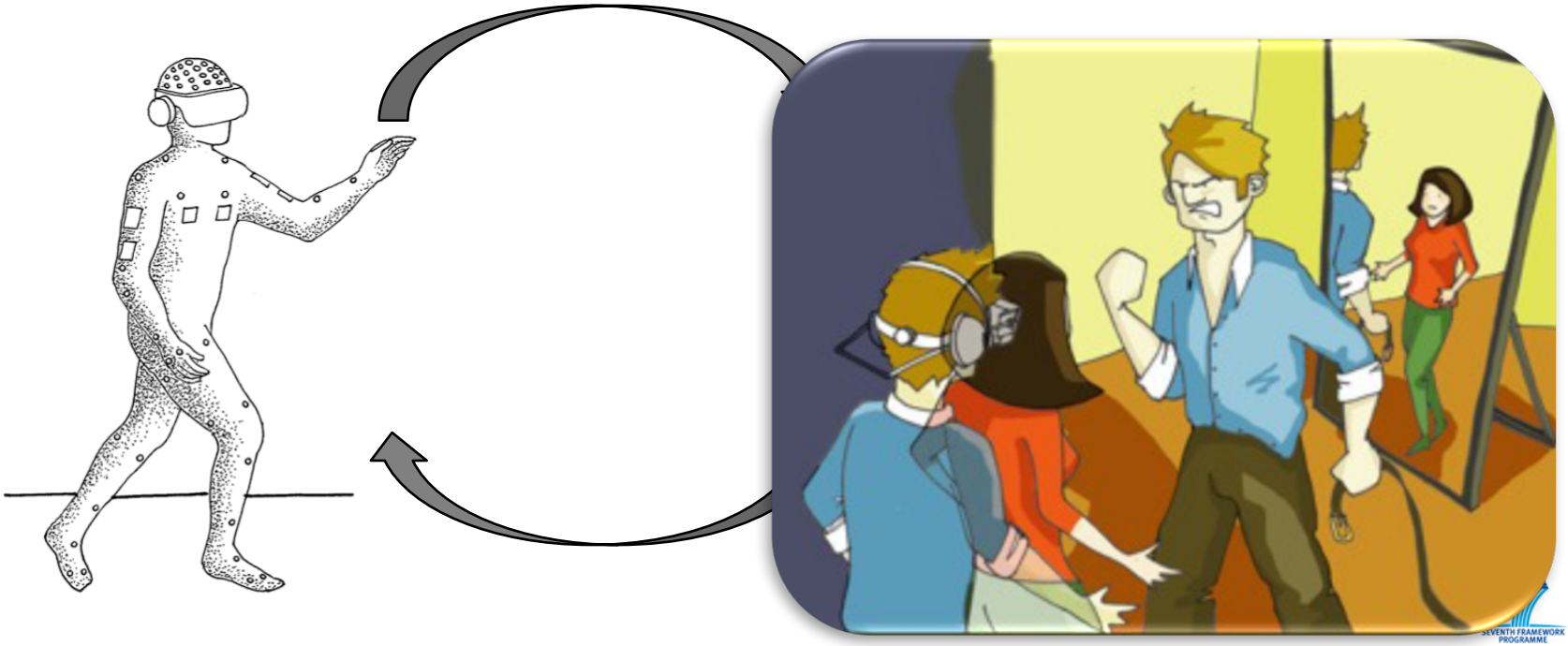


ALEX Embodiment Integration

Video

Virtual Embodiment and Violence Perception

How the Virtual Embodiment affects perception of Violence? Which is the role of multimodal stimulation?



Avatar Haptic Interaction in Aggressive Setup

Objective

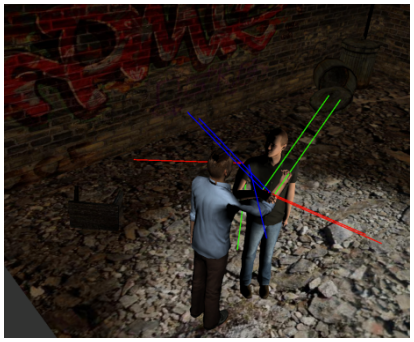
- Investigate the physiological and behavioral response to the exposure of aggressive behaviors coupled with haptic feedback
- Enhance the level of embodiment by allowing physical interaction with virtual humans through

Design

- Create behaviors of the avatar based on combinations of motion capture and interaction with the user
- Integrate physical contact and haptics

EXPERIMENT DESIGN

- **PARTICIPANTS: 16 subjects (8 males and 8 females)**
- **EXPERIMENT DESCRIPTION:**
  - "Phase 1": the subject explores the space with mirror and ALEX in transparent mode
  - "Phase 2": after a fade out/in the attacker appears in front of the subject
  - "Phase 3": attacker moves the arm of subject's avatar. In visual condition only the virtual arm is moving
  - "Phase 4": attacker starts hitting the subject



- **Within Subject Design**
- **Two Conditions** (Random Sessions across subjects)
  - Visual only during "Phase 2"
  - Haptic+Visual during "Phase 2"
- **Evaluations**

Evaluation **Questionnaire** with questions concerning the rating of their experience, covering different aspects of embodiment, presence and control items.

Analysis of **Physiological** data measured during the experiences:

-**SpO2 [%]**, -**Heart Rate [bpm]**, -**GSR [µS]**), -**Respiration Rate [1/min]**

EXPERIMENT CONFIGURATION

The user experiences the environment in first person, and through a mirror
The opponent moves the subjects's arm using a recorded trajectory
Visual only, or Visual + Haptics depending on condition
Motion capture is used to synthesize opponent motion

ALEX exoskeleton
OCULUS HMD

Physiological Measures

- GSR
- HRV
- SPO2
- Plestismogram
- Questionnaire

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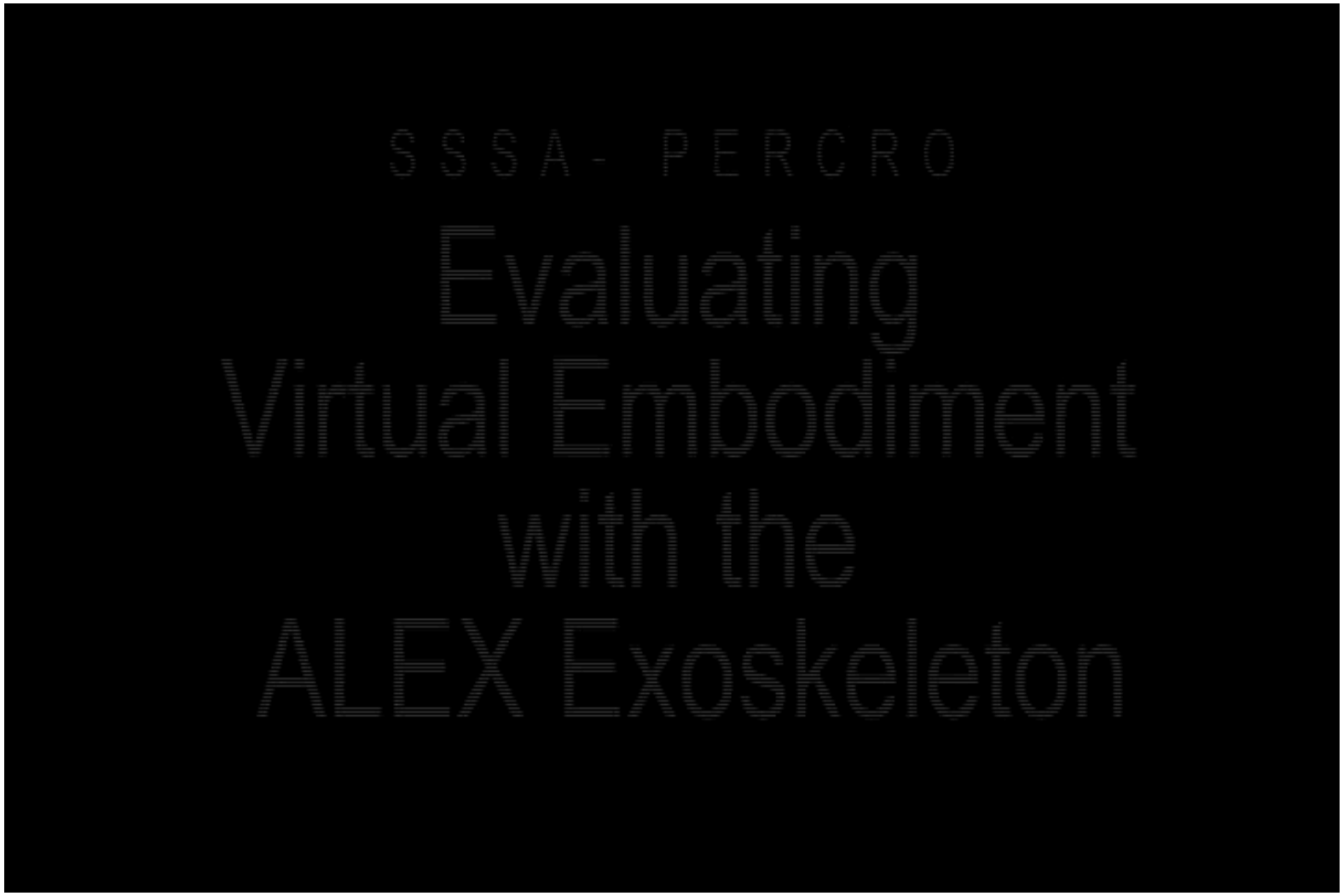
Video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Questions

P1 Vis - L'aspetto visivo dell'esperienza era convincente

P2 Phys - L'aspetto fisico dell'esperienza era convincente

P3 Congruence - L'informazione percepita attraverso i tuoi diversi sensi era congruente

P4 FinActMov - Nella fase finale dell'esperimento hai avuto la sensazione di muovere attivamente il braccio

P5 FinPasMov - Nella fase finale dell'esperimento hai avuto la sensazione di muovere passivamente il braccio

P6 IniPasMov - Nella fase iniziale dell'esperimento hai avuto la sensazione di muovere passivamente il braccio

P7 IniActMov - Nella fase iniziale dell'esperimento hai avuto la sensazione di muovere attivamente il braccio

E1 – HiInt - Il livello di interazione con l'ambiente virtuale era elevato?

E2 – NatInt - L'interazione con l'ambiente virtuale era naturale?

E3 – IniDanger - Nella fase iniziale dell'esperienza nell'ambiente virtuale hai percepito una sensazione di pericolo?

E4 – FinalDan - Nella fase finale dell'esperienza nell'ambiente virtuale hai percepito una sensazione di pericolo?

E5 – IniOppression - Nella fase iniziale dell'esperienza nell'ambiente virtuale hai percepito una sensazione di oppressione?

E7 – FinalOppression - Nella fase finale dell'esperienza nell'ambiente virtuale hai percepito una sensazione di oppressione?

E8 – BodyPerception Hai percepito il corpo virtuale come tuo?

E9 – Grasp - Hai avuto la sensazione che il secondo personaggio virtuale afferrasse il tuo vero braccio?

E10 – Punch - Nella parte finale dell'esperienza, hai avuto la sensazione che il secondo personaggio potesse colpirti?

SYSTEM ARCHITECTURE

Experiment Manager

Application

Network

Avatar Environment

ALEX Driver

ALEX Avatar Mapper

ALEX Recorder

ALEX Virtual Driver

Vicon

Mocap BVH

Live Kinematic Retarget

Mechanics based animation and motion retargeting

This framework will be reused in future experiments

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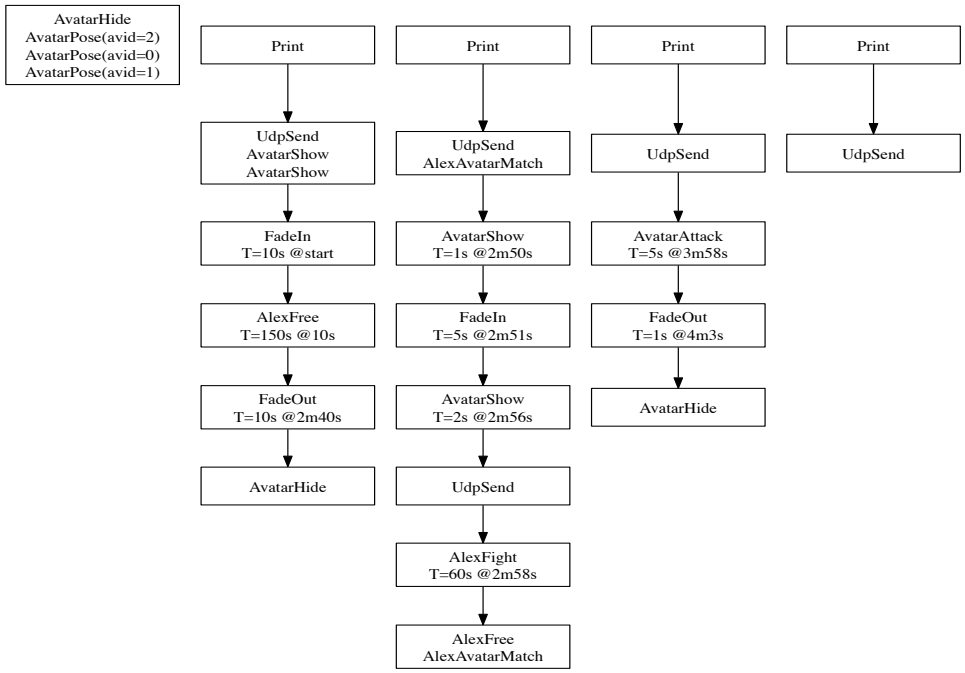
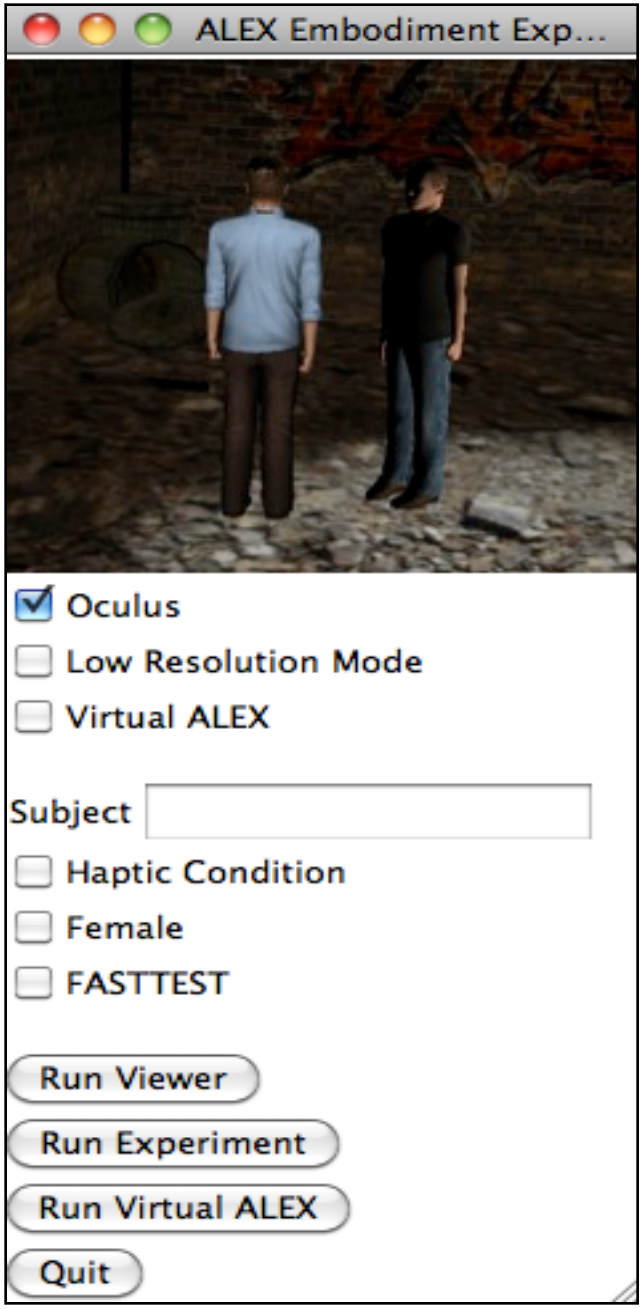
EXPERIMENT FLOW AND GUI

Automatic decomposition of experiment for supporting the experimenter





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VERE

THE EMBODIMENT STATION FOR THE MOVING PARTICIPANT

DOES HAPTIC FEEDBACK ENHANCE THE SENSE OF EMBODIMENT?

- PRELIMINARY RESULTS -

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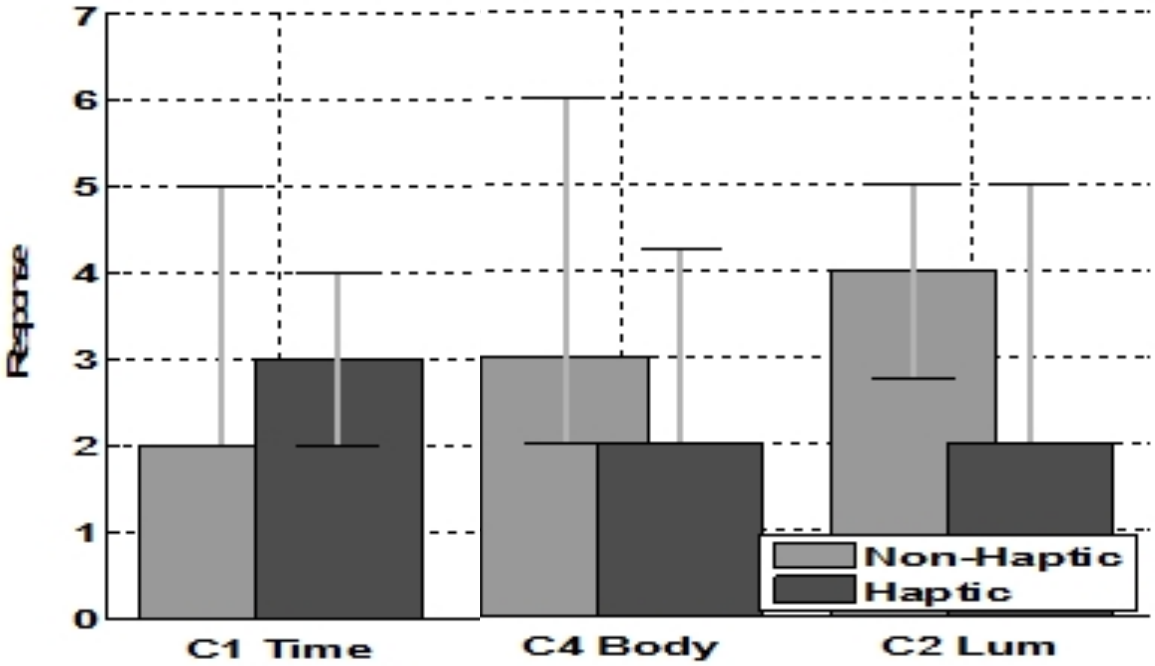
SEVENTH FRAMEWORK PROGRAMME

QUESTIONNAIRE ANALYSIS

CONTROL QUESTION



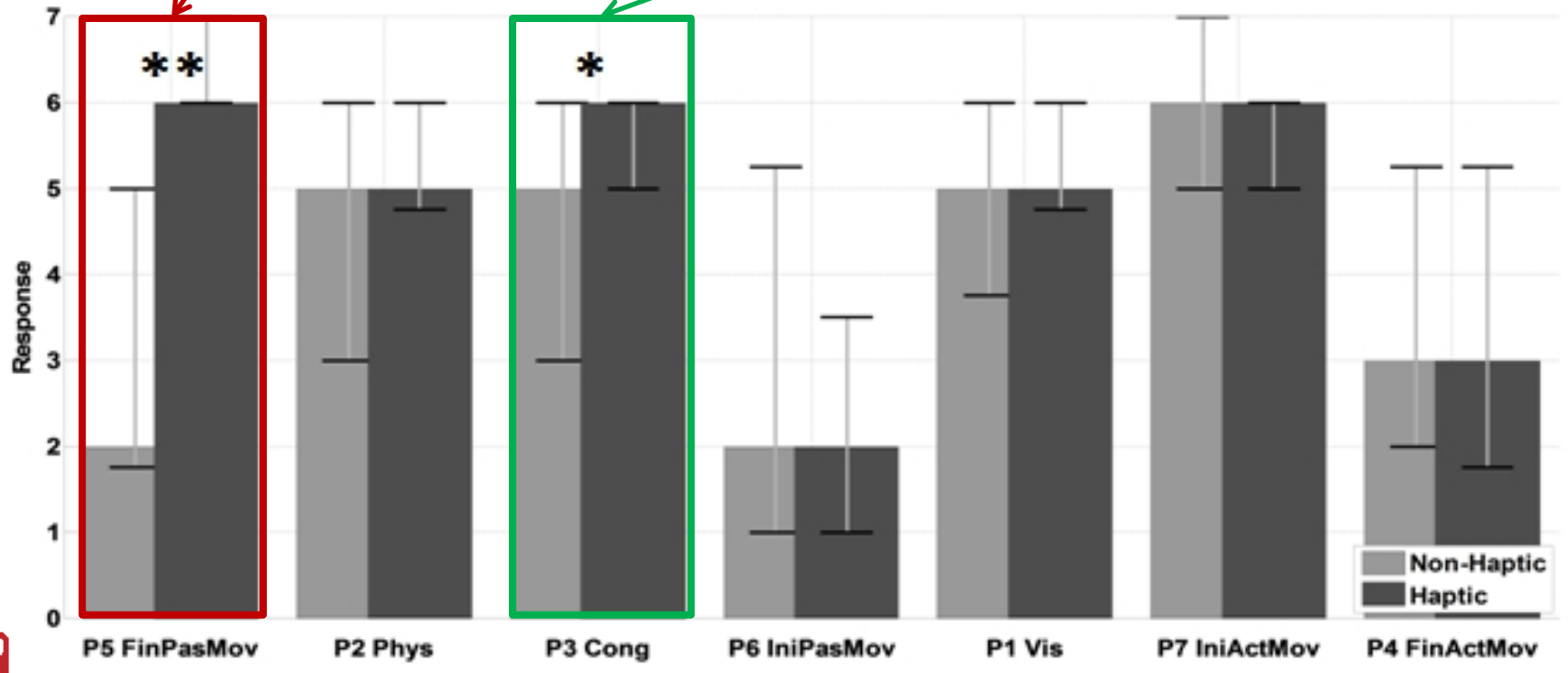
QUESTIONNAIRE ANALYSIS

PRESENCE QUESTION

In the final part of the experiment, did you have the sensation to move passively your

Did the information perceived through your different sense was fitting

** : High significativity
* : Significativity

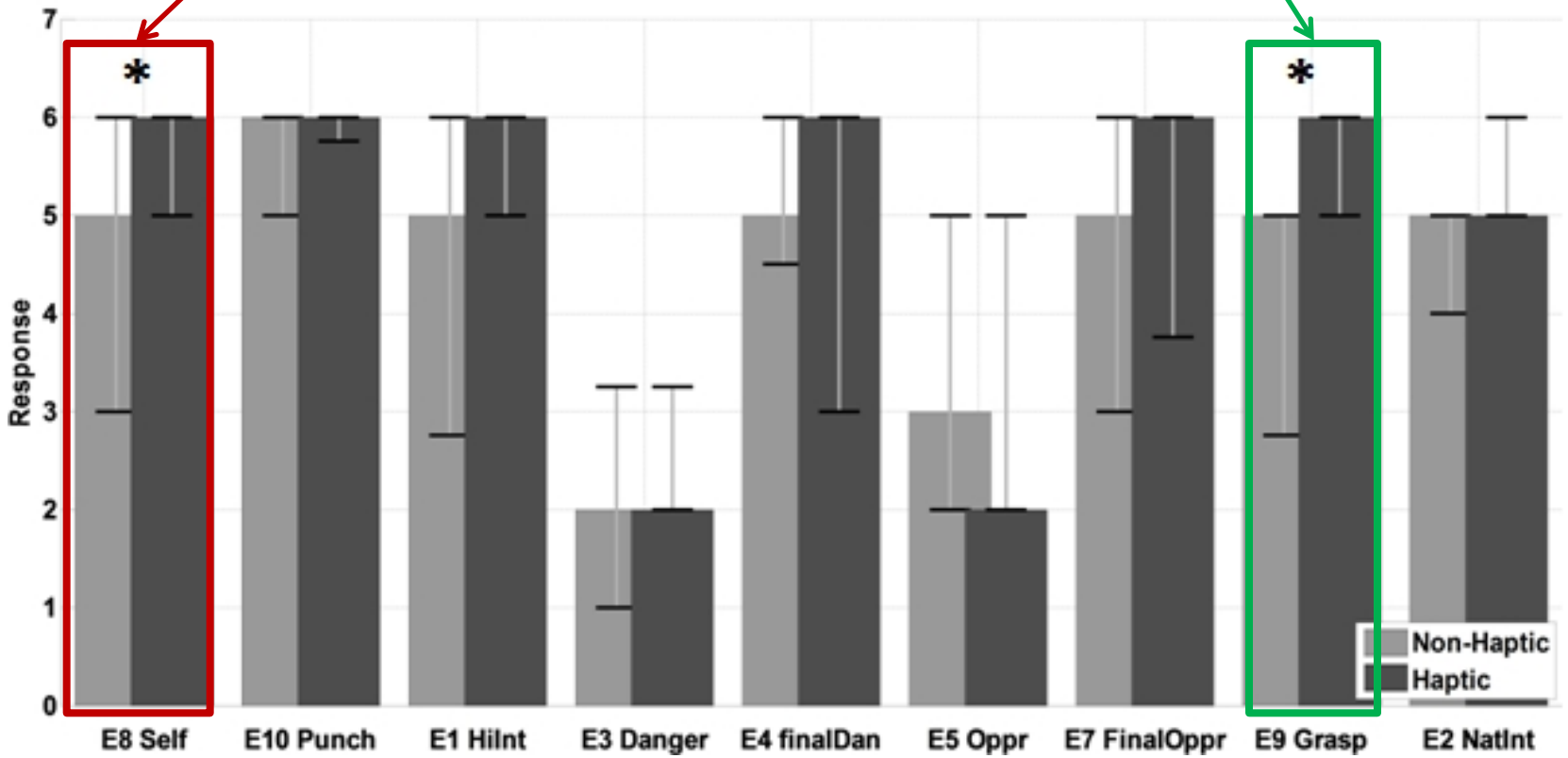


QUESTIONNAIRE ANALYSIS

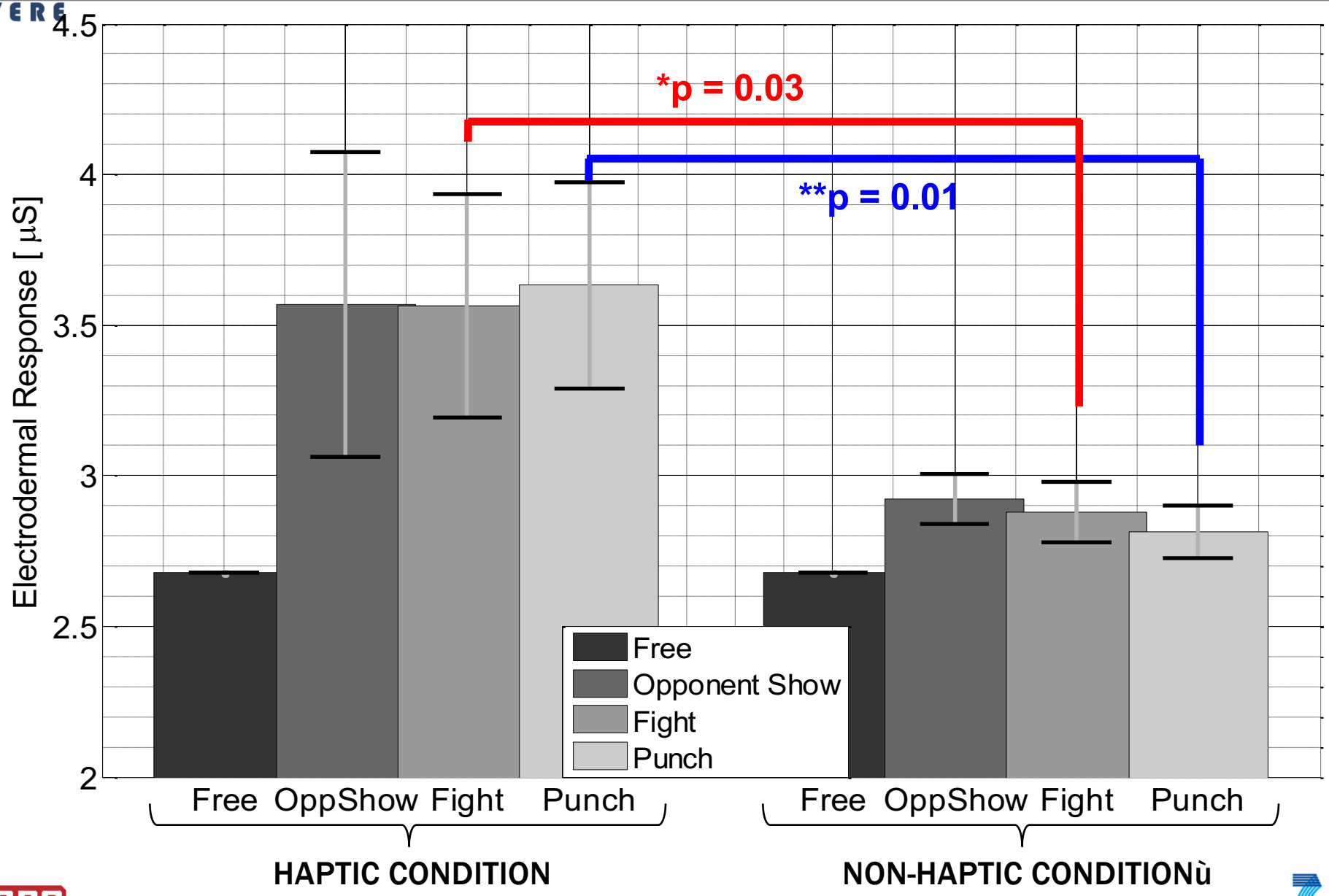
EMBODIMENT QUESTION

Did you perceive the virtual body as yours?

Did you have the feeling that the second virtual avatar was grasping your real arm?



PHYSIODATA PRELIMINARY RESULTS



Conclusions

The platform is promising for experimenting on human virtual embodiment involving interaction with Virtual Humans.

The proposed architecture can be extended to experiments in Cognitive Neuroscience provided the ability to synthesize Virtual Human behaviors and reactions to subject motion.