Mesures physiologiques pour la robotique collaborative

Doctorant

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Sous la direction de

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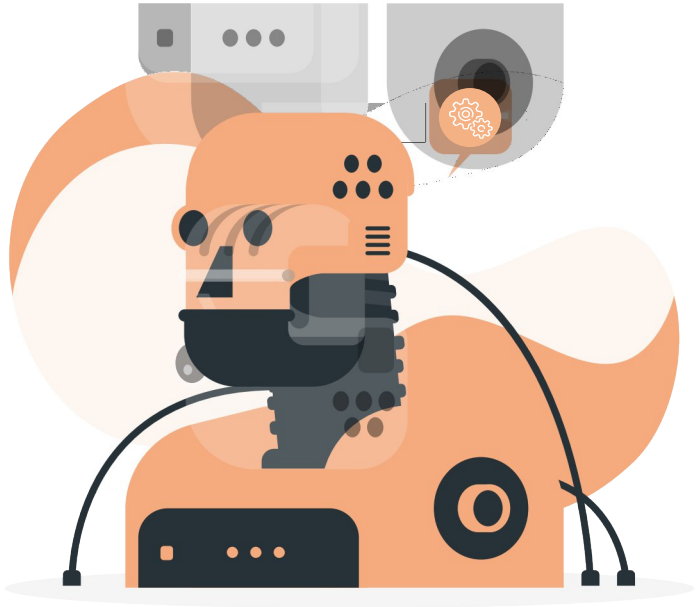

ISAE SUPAERO Institut Supérieur de l'Aéronautique et de l'Espace
LAAS CNRS
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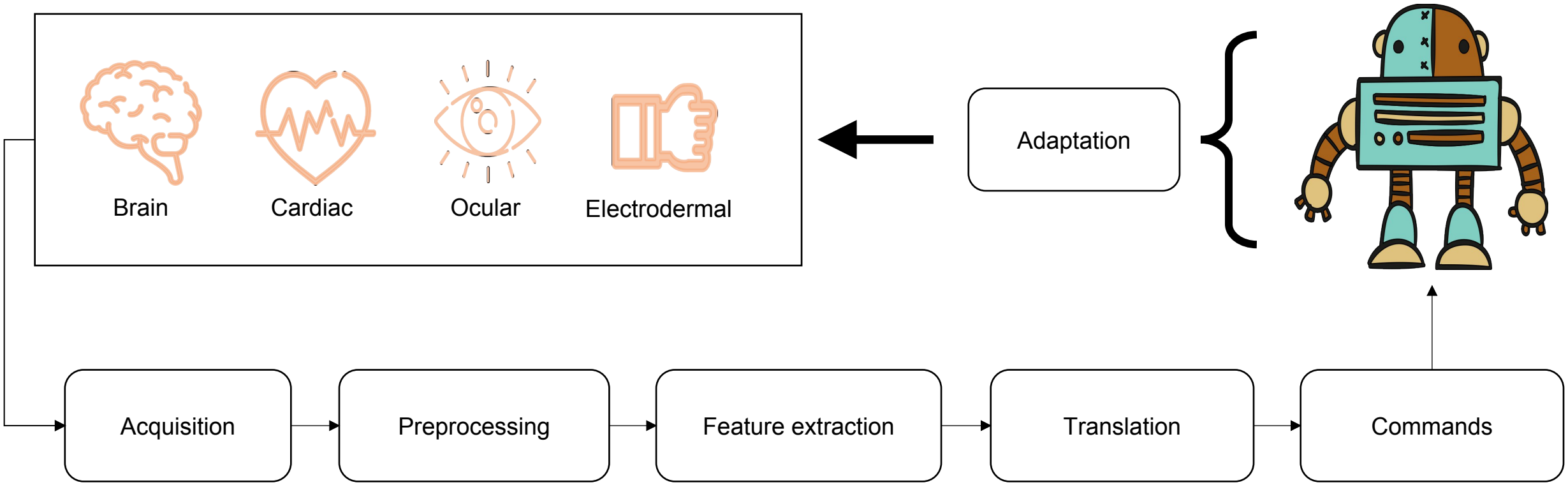
ROBOTIQUE CENTRÉE SUR L'HUMAIN
La Région Occitanie Pyrénées - Méditerranée

My PhD

In one figure

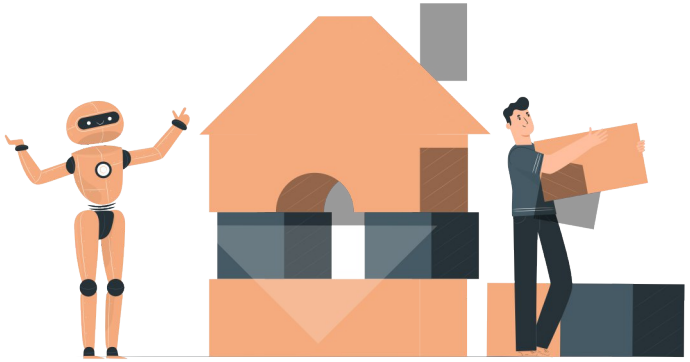


Model Collaborative HRI

Adapted from Ajoudani et al. 2018[1]

Improve QoI

HRI Scenario



Complement Partner

Inferred context

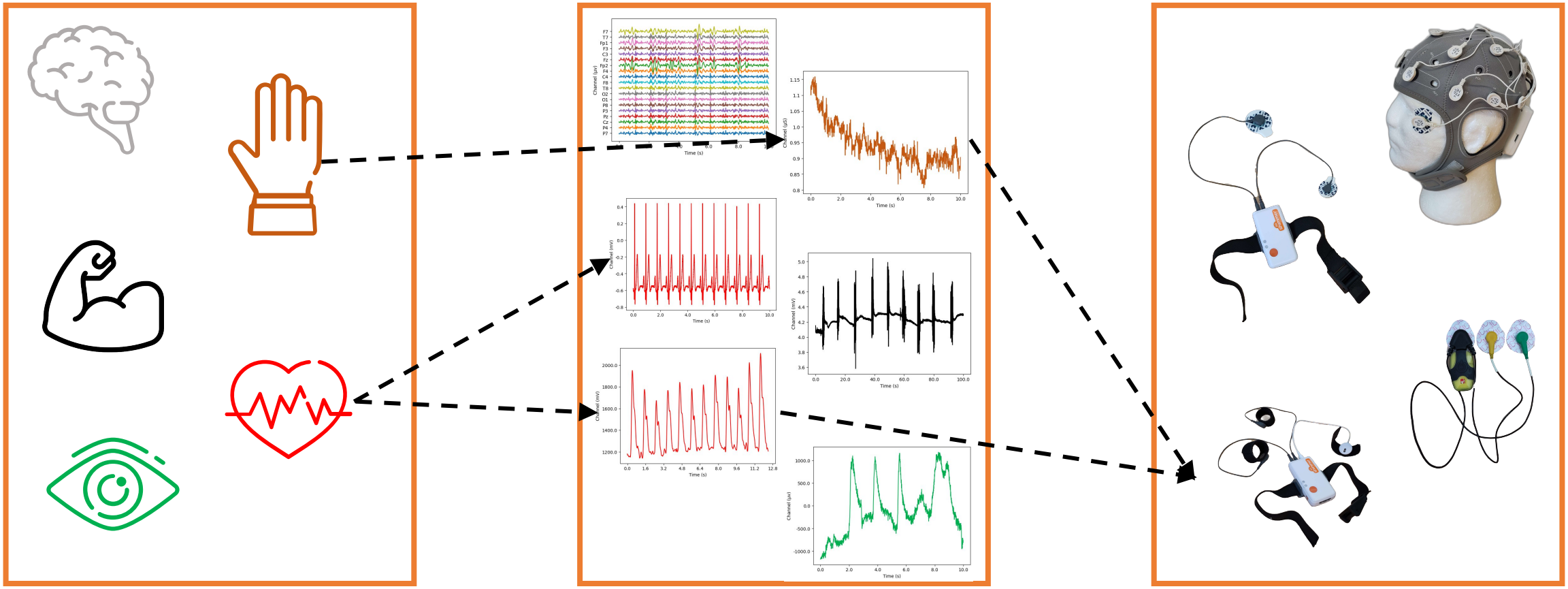
Estimate Quality of Interaction

Reactive behaviour

1. Ajoudani, A., Zanchettin, A. M., Ivaldi, S., Albu-Schäffer, A., Kosuge, K., & Khatib, O. (2018). Progress and prospects of the human–robot collaboration. *Autonomous Robots*, *42*, 957-975.

Electrophysiological Signal Acquisition

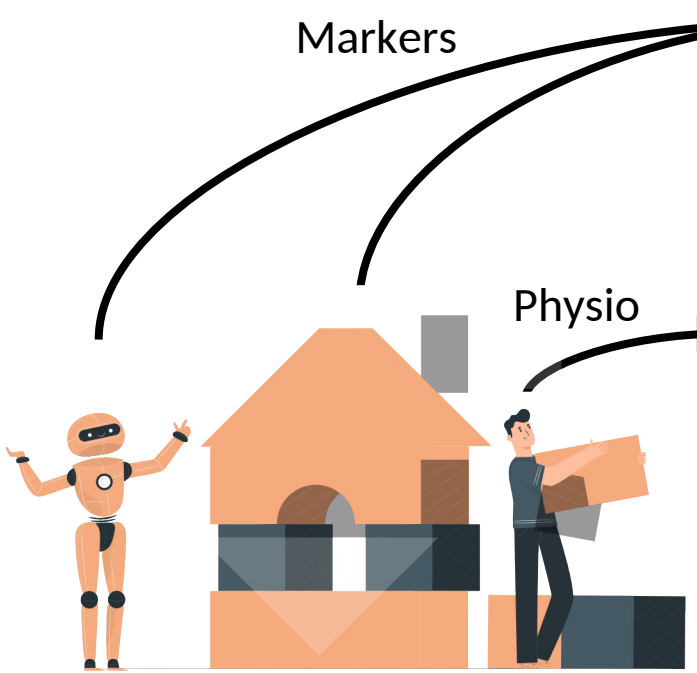
In a nutshell



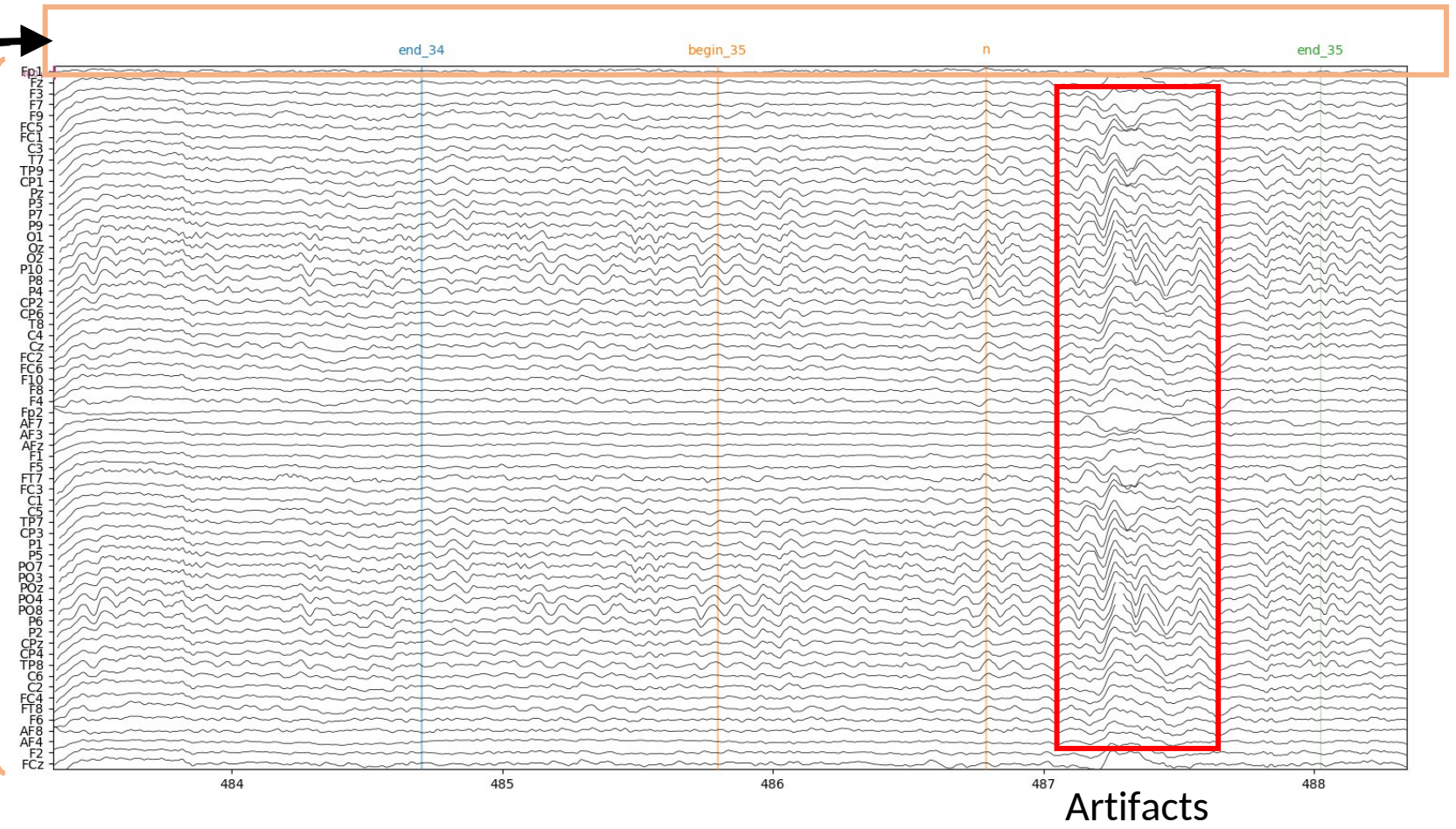
Sources Signals Sensors

Electrophysiology for Collaborative HRI

Collecting data



HRI Scenario



Artifacts

Electrophysiology for Collaborative HRI

Technical challenges

Synchronization
& Markers

Artifacts

Filtering

Source reconstruction

(ICA, ASR)

Participants

Number & Diversity

Expertise with robot

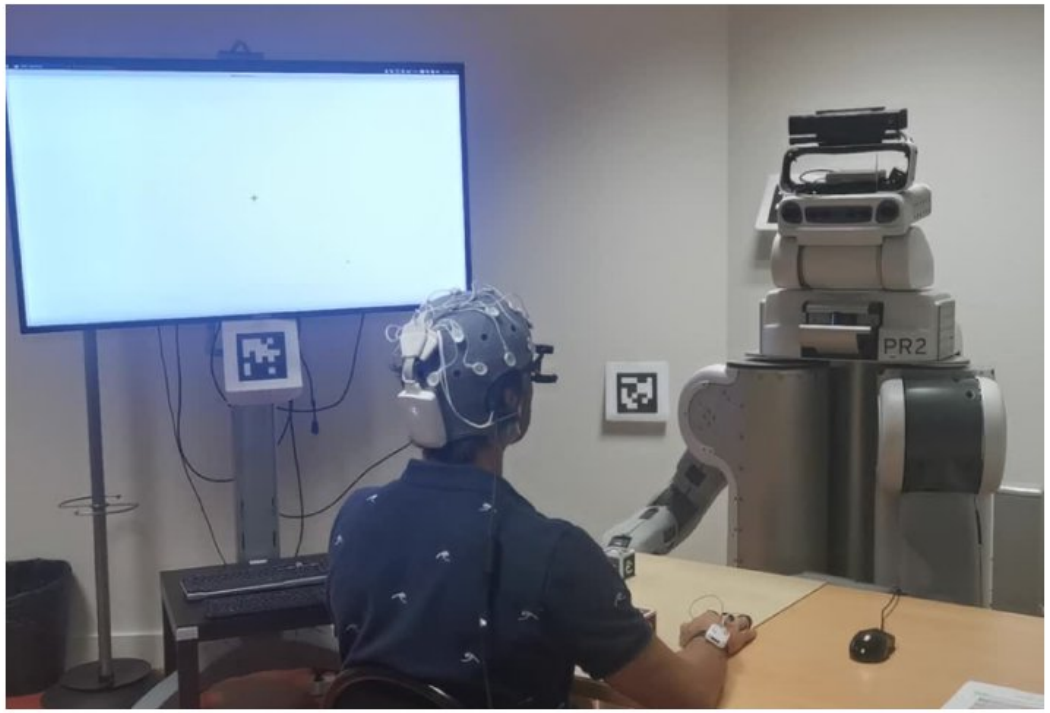
Novelty effect

Lab Streaming Layer[2]

2. https://labstreaminglayer.org

Electrophysiology for Collaborative HRI

User study



Cube pilling task with cognitive effort induction[3]

Cognitive effort

Engagement ratio[4] ($\frac{\beta}{\alpha+\theta}$)

Heart rate

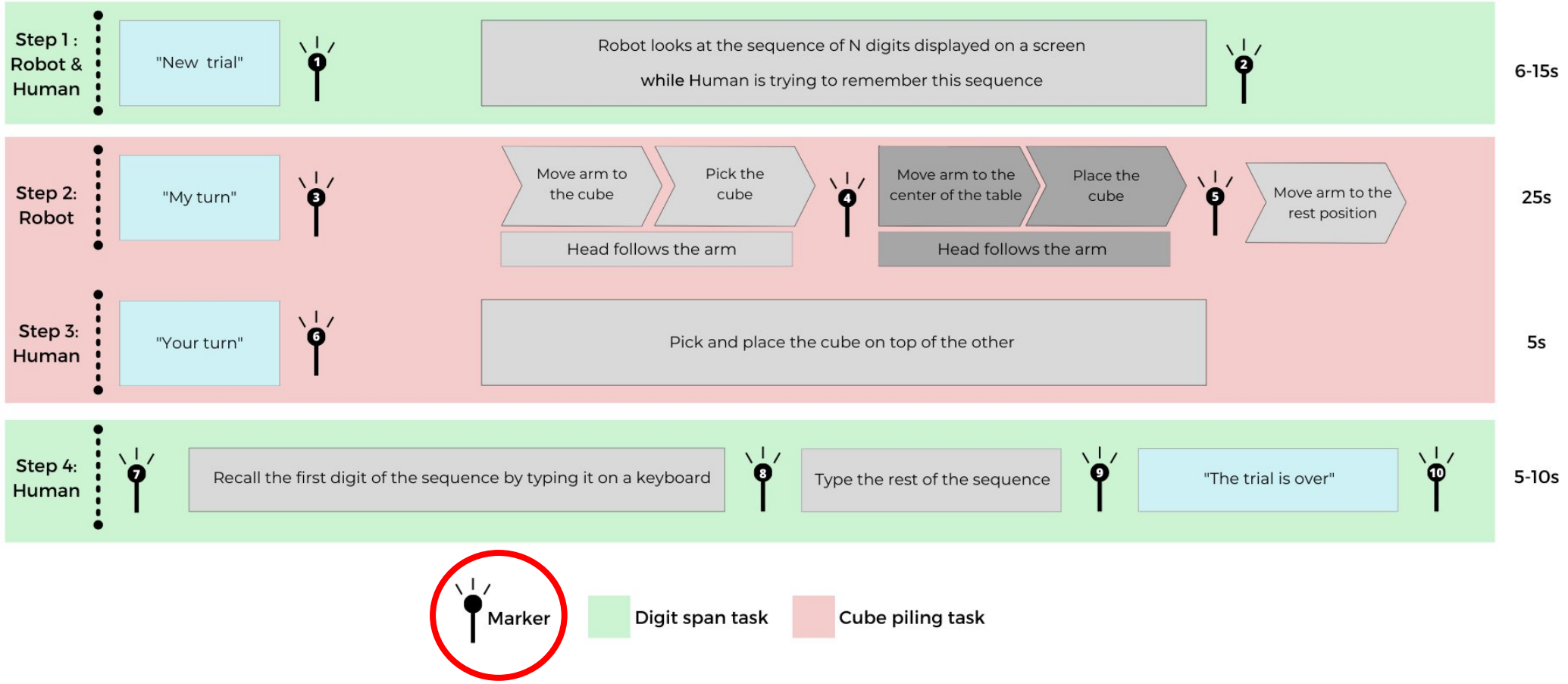
Electrodermal activity

x2 sessions
x30 participants

3. Rihet, M., Clodic, A., Sarthou, G., Roy, R.N. (2024). Investigating the session effect in human-robot interaction with electrophysiological features. THRI. [*submitted*]
4. Pope, A.T., Bogart, E. H., Bartolome, D. S.(1995). Biocybernetic system evaluates indices of operator engagement in automated task. Biological psychology, vol. 40.

Electrophysiology for Collaborative HRI

Markers



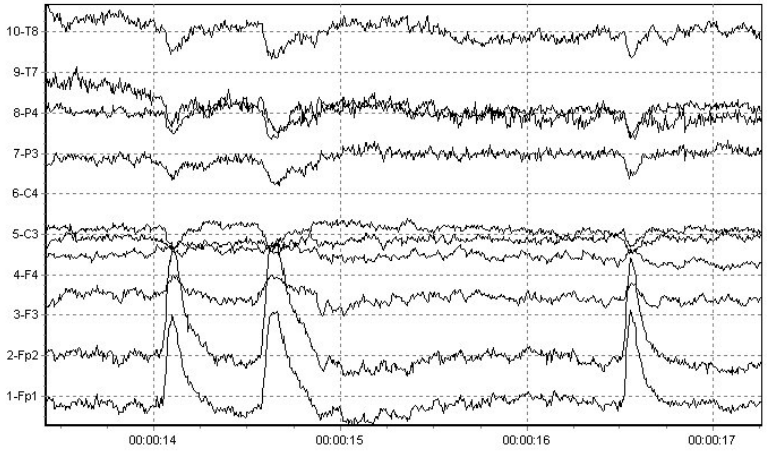
Electrophysiology for Collaborative HRI

Artifacts

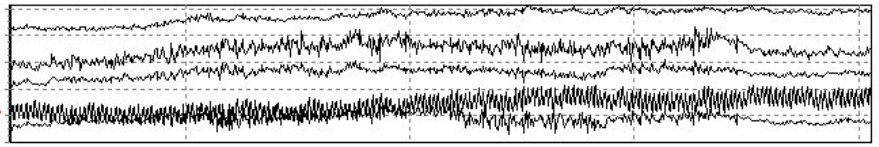
Human related artifacts

Environment related artifacts

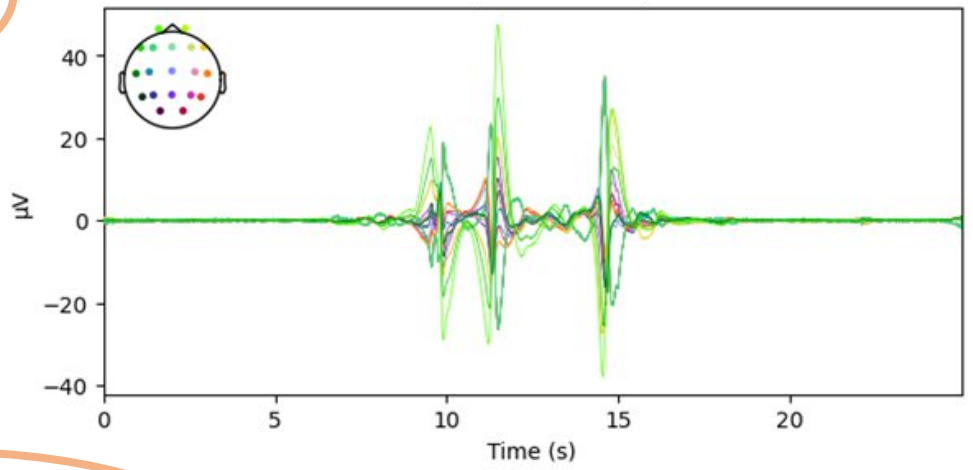
Eye blinks



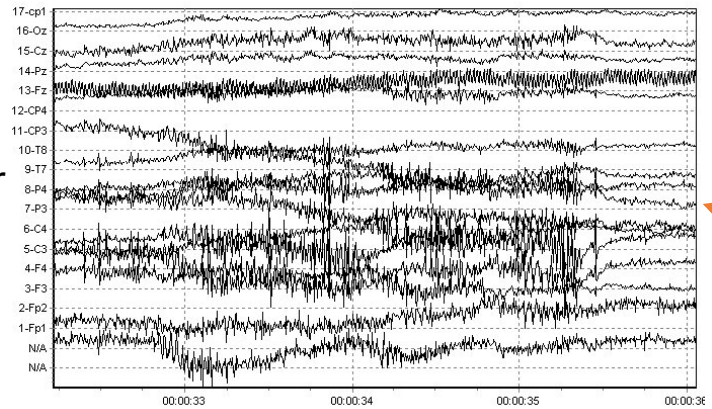
60 Hz



filtering



Muscular artifacts



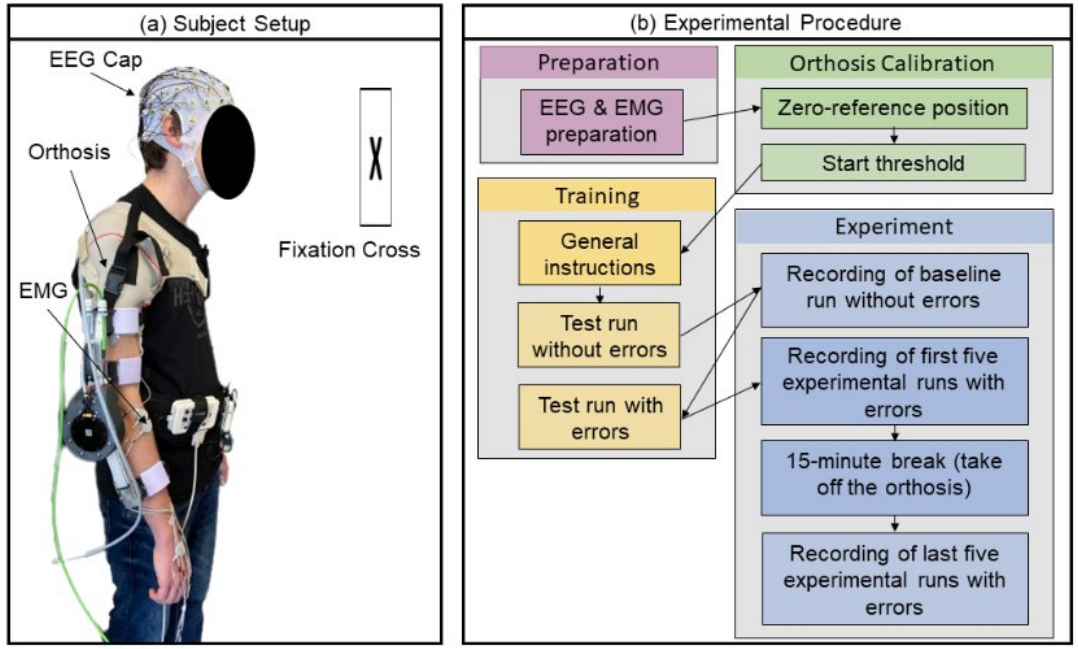
« source reconstruction » using ICA, ASR

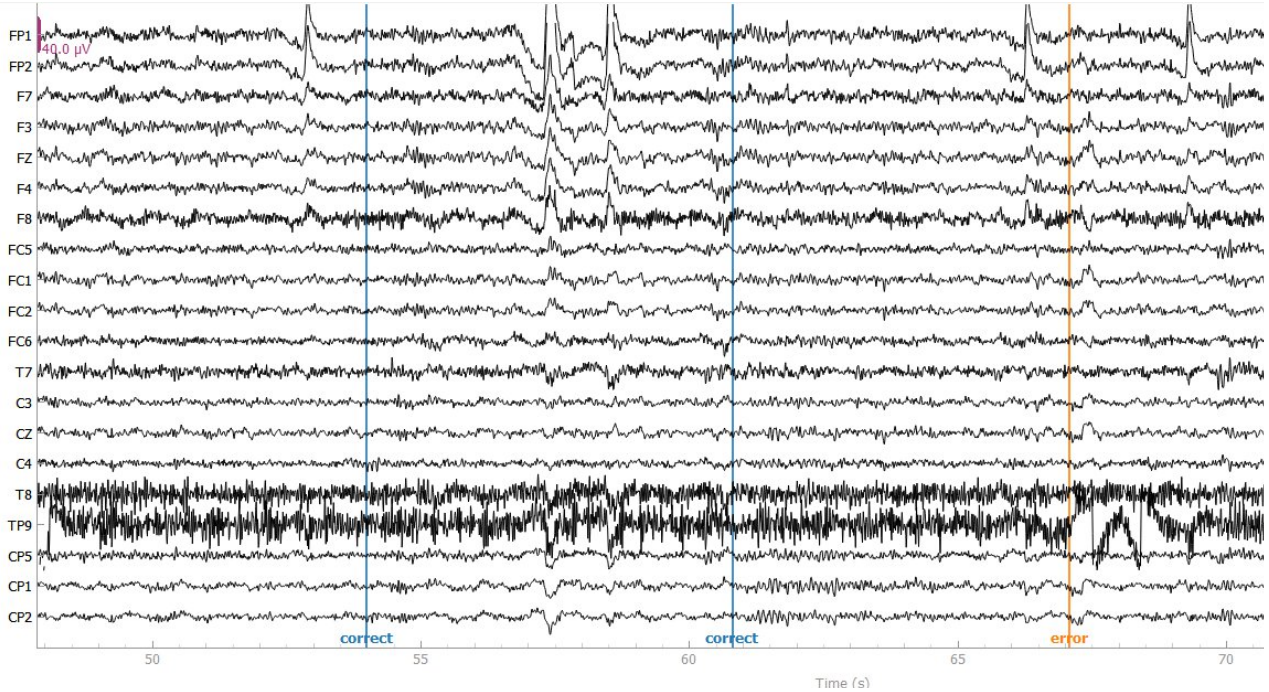
Robot induced noise[5]

5. Rihet, M., Clodic, A., Roy, R.N. Robot Noise: Impact on Electrophysiological Measurements and Recommendations. HRI '24 Companion, Boulder, CO, USA.

Electrophysiology for Collaborative HRI

User study



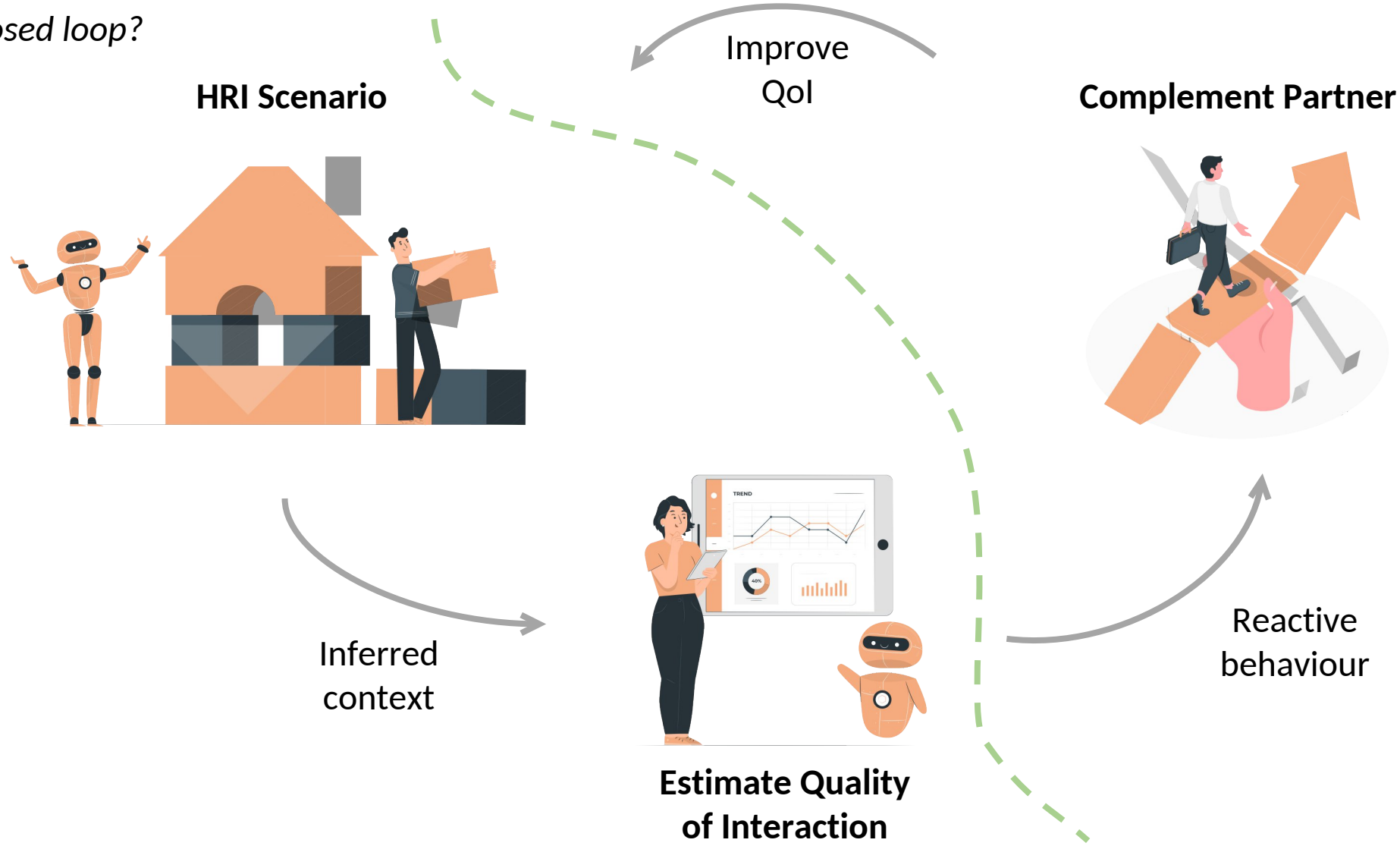


Error detection of orthosis failure[6]

6. Rihet, M., Castillo, K.C., Scannella, S., Torre Tresols, J.J., Dehais, F., Roy, R.N. (2023). Enhancing Human-Robot Interaction: Riemannian Classification and Clustering for Error Potential Detection and Error Occurrence Estimation. IntEr-HRI Competition: Intrinsic Error Evaluation during Human -Robot Interaction.IJCAI, Macau, China, August 2023.

Designing an experimental campaign

Open or closed loop?



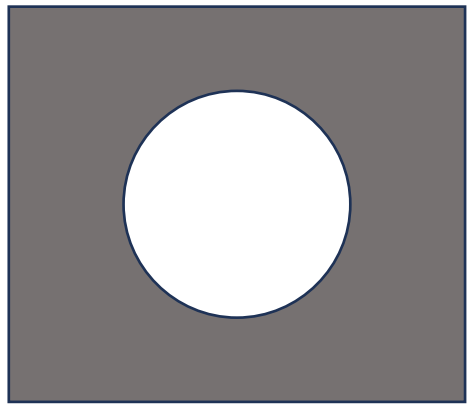
Designing an experimental campaign

Opening the loop

Physiological Variability

Intra-session
Inter-session
Inter-participant

Require a lot of data



Require time

Physical interaction

Planification
Security
Hardware

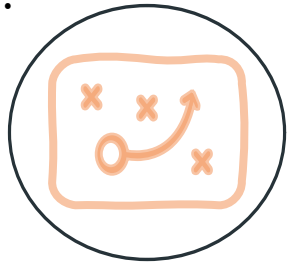
Participant engagement, comfort

Designing an experimental campaign

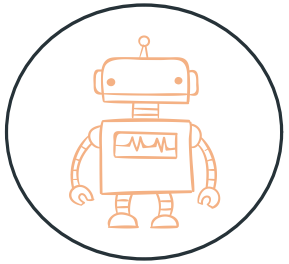
Closing the loop

Require an adaptable task !

Physical, cognitive or social adaptation[7] ?



Cognitive



Physical

Social

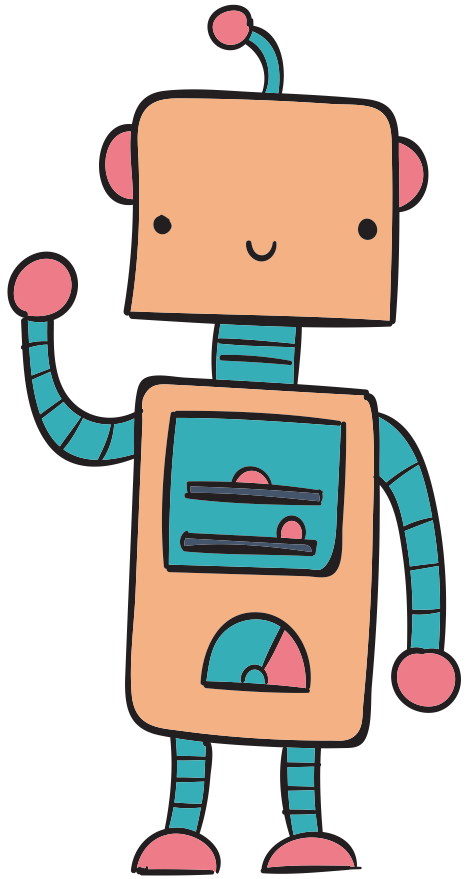
7. Rossi, S., Ferland, F., & Tapus, A. (2017). User profiling and behavioral adaptation for HRI: A survey. *Pattern Recognition Letters*, *99*, 3-12.

Designing an experimental campaign

Robot as stimuli

L_Torso_Z_For

L_Arm_Y_Back

R_Head_X_For

Thank you for your attention !