Investigating Osseoperception in Distal Regions of the Upper Limb for Augmented Sensory Feedback

Cristian Felipe Blanco-Diaz, Mariateressa Pedone, Sophie Skach, Camilla Baselli and Leonardo Cappello

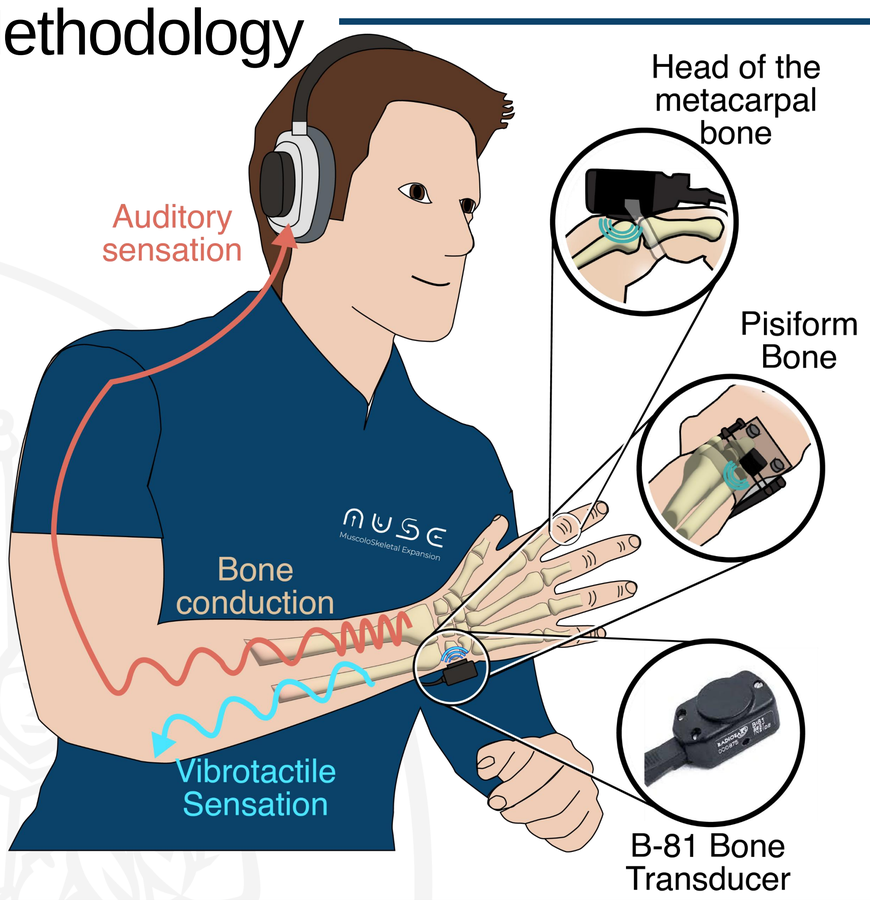
ISTITUTO DI BIOROBOTICA
Sant'Anna Scuola Universitaria Superiore Pisa
Viale R. Piaggio, 34, 56025 - Pontedera, Italy

Introduction

Neurological disorders often result in impaired **sensorimotor** control [1]. Robotic exoskeletons and soft exosuits have emerged as solutions to assist the execution of motor tasks but often **overlook sensory feedback**, which is **crucial** to execute coordinated movements [2-4].

Osseoperception is a promising – yet underexplored – modality to provide **augmented feedback,** in form of **tactile or auditory cues,** in upper-limb assistive technologies, by taking advantage of the **bone conduction** [3],[5],[6]. In this study, we investigated **osseoperception** by applying **vibratory stimuli** to the **pisiform bone (PB)** of the wrist and the **Metacarpal Head (MCH)** bone of the index finger.

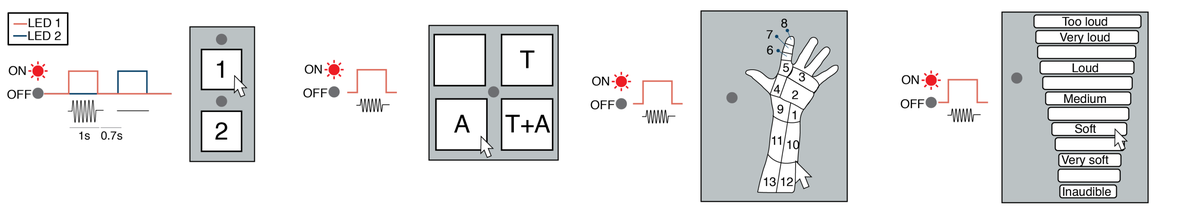
Methodology



- A B-81 **bone transducer** was used to provide **oscillatory vibrations** to the **PB** and **MCH.z**
- Four psychometric tests (**A, B, C** and **D**) to assess tactile, auditory, and combined sensory responses across different stimulation **frequencies**
- Twelve healthy participants were recruited for this study.

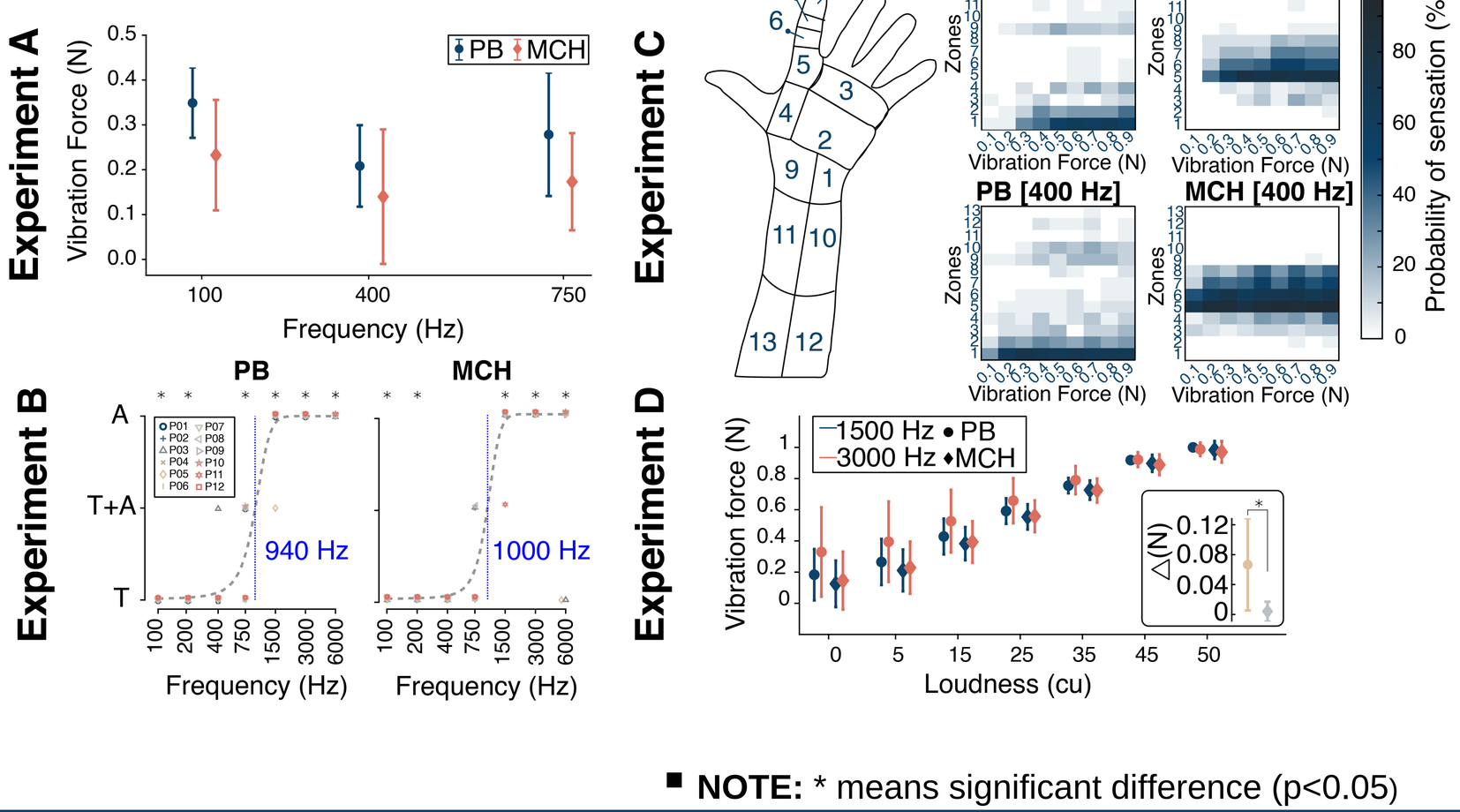
Psycophysical experiments

A Perception threshold — **B** Sensation Discrimination — **C** Sensory map — **D** Loudness evaluation



Results and Discussion

- **A:** Lowest and Highest average threshold were observed at 400 Hz (MCH: 0.14±0.15 N) and at 100 Hz (PB: 0.35±0.08 N), respectively.
- **B:** Frequency threshold distinguishing tactile from auditory sensations was around 940 Hz (PB) and 1000 Hz (MCH) [5] [6].
- **C:** Vibration strength and frequency significantly influenced the zones where tactile sensations are perceived.
- **D:** A significant variation vibration force (Δ) was observed in **PB**, indicating a frequency-dependent effect on loudness perception [7]



- **NOTE:** * means significant difference ($p<0.05$)

Conclusion and Future Work

Expanding the current understanding of **osseoperception** [3],[5],[6][7], our findings indicate that the **MCH** region is more effective for eliciting **tactile sensations**, while the **PB** showed greater efficacy for **auditory sensations.** These differences may be attributed to **anatomical** and **physiological** factors [7].

We aim at conducting other studies involving both healthy individuals and people with **neuromotor impairments**, focusing on functional tasks and possibly exploring its application to deliver **augmented sensory feedback** in assistive devices.

References

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cristianfelipe.blancodiaz@santannapisa.it



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