The walk again project: Sensory feedback for brain controlled exoskeleton

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ABSTRACT

→ Walk again project is an international consortium that aims to restore locomotion in patients with complete Spinal Cord Injury (SCI).

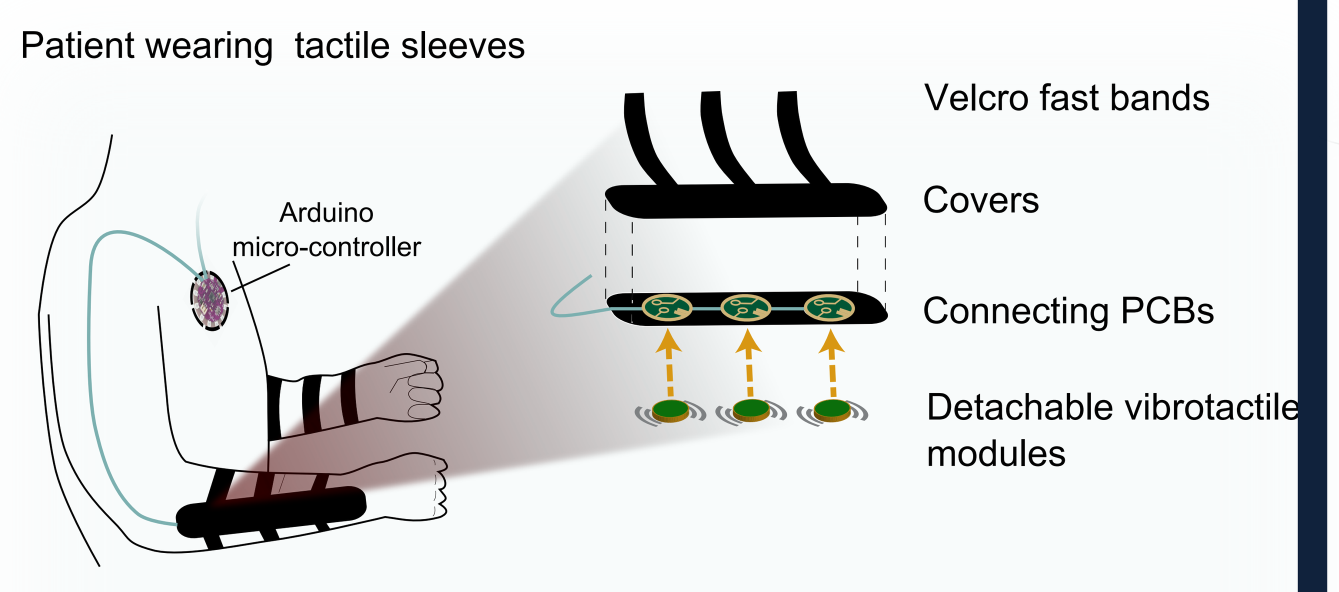
→ Additionally to the loss of motor functions, SCI patients have loss of sensory feedback from their legs.

→ We believe sensory feedback is essential for accurate control of an exoskeleton (O'Doherty 2011) and for reacquiring brain representation of the lost body part (Shokur 2013).

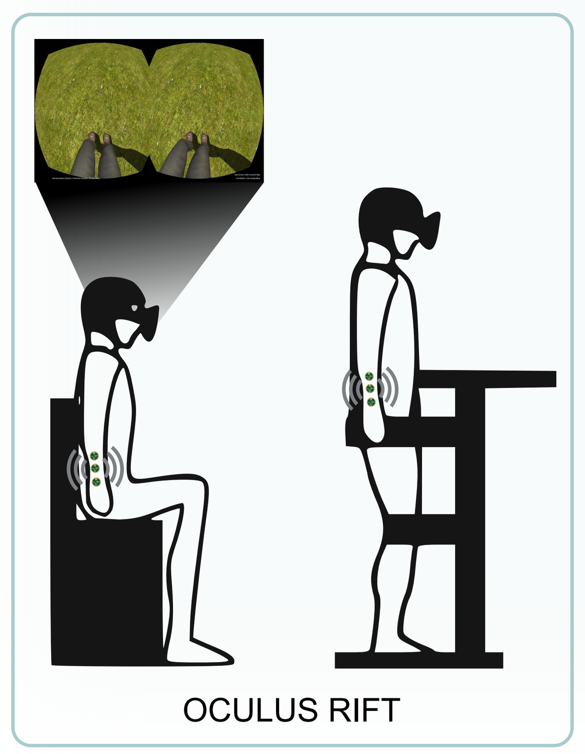
→ The 'Tactile Sleeve', tested with 8 SCI patients for over 500 hours, uses an illusion called apparent movement (Masataka 2004) to provide patient with tactile and proprioceptive information.

METHODS

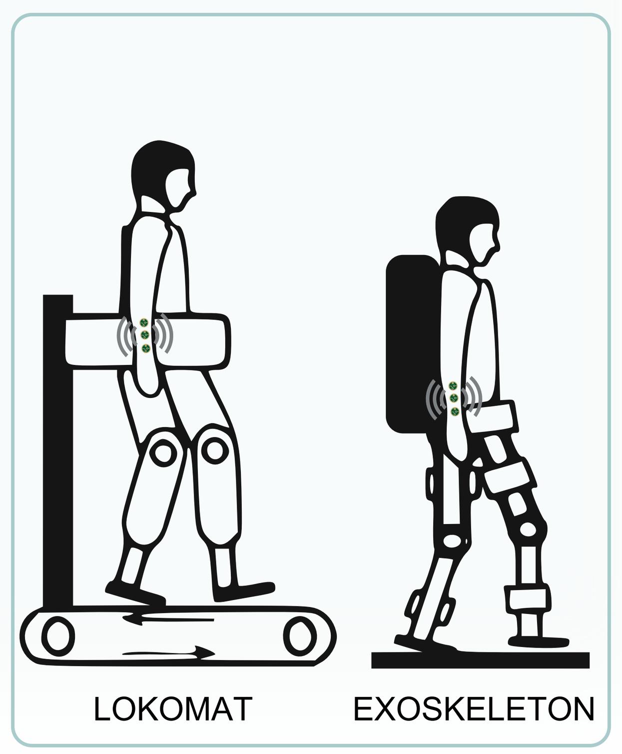
Tactile sleeve



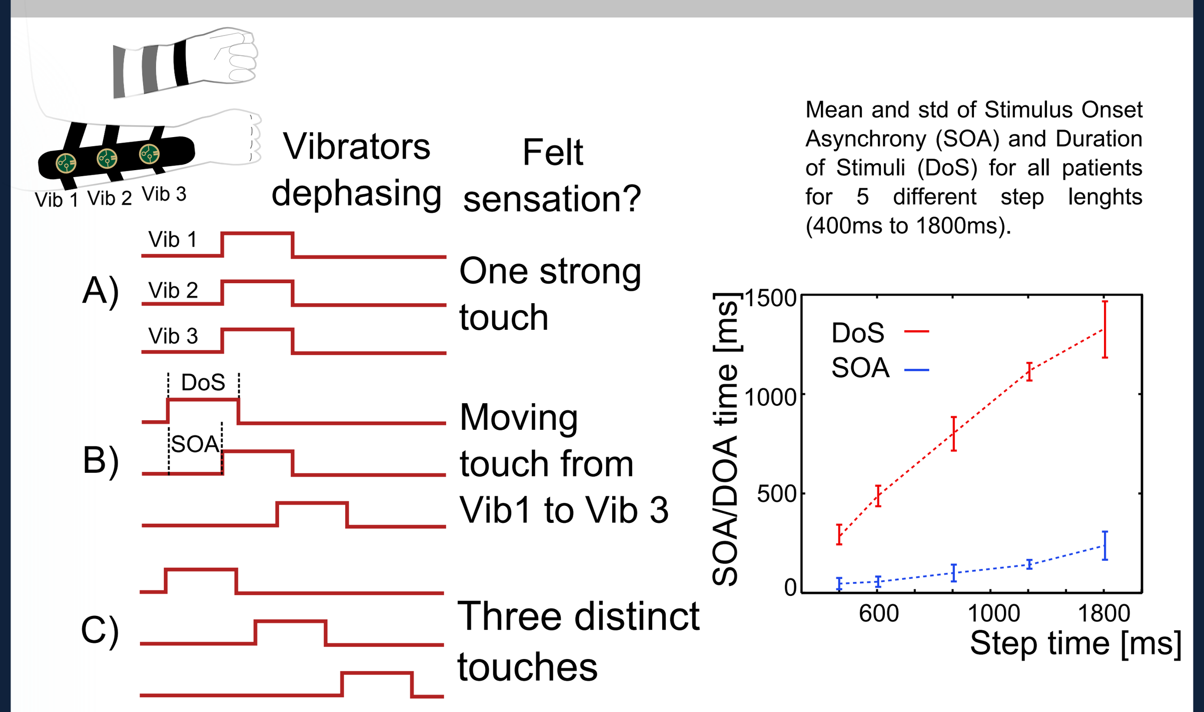
Training with virtual reality



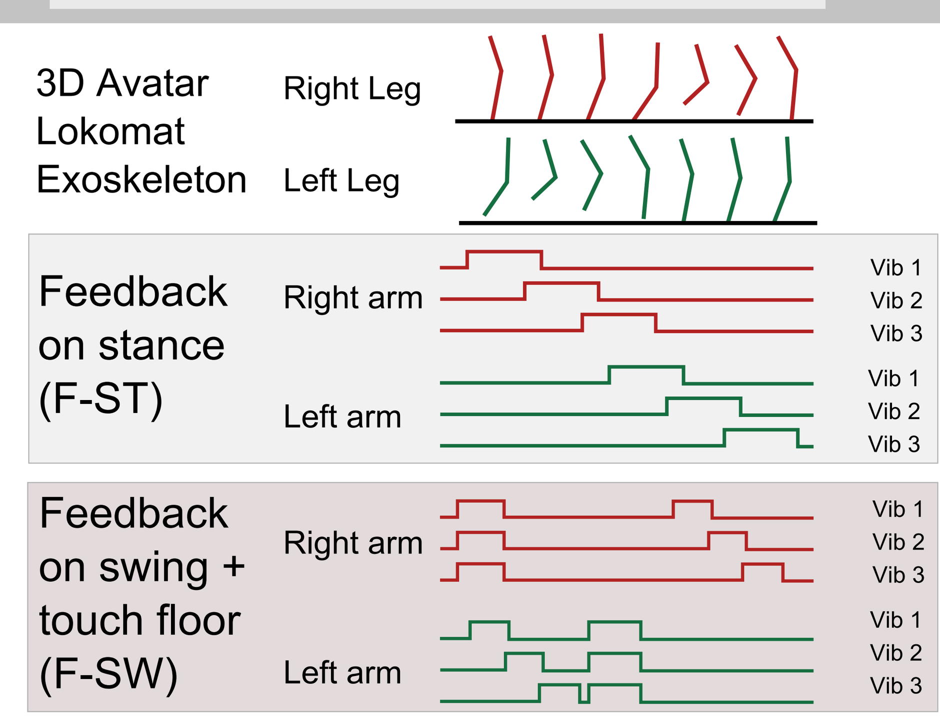
Training with walking devices



Apparent Movement Illusion



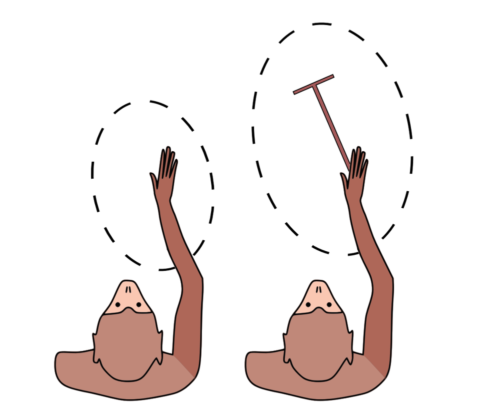
Feedback on stance or swing



RESULTS

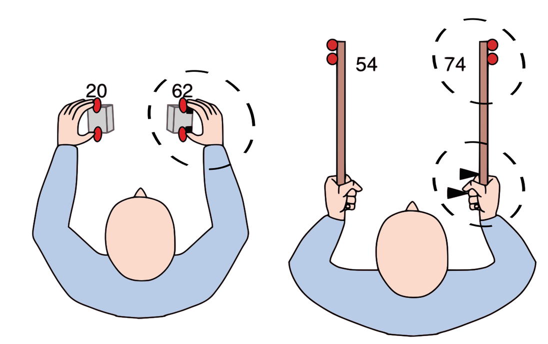
Incorporation

A. Tool use and extension of body representation (Iriki 1996)



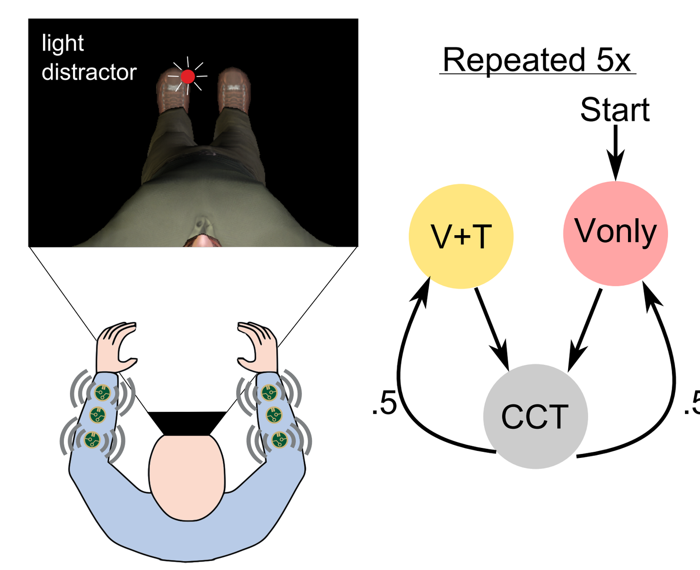
B. Crossmodal Congruency task (CCT) (Maravita 2003) :
CCT = Reaction time to visuo-tactile stimuli
CCE = Incongruent CCT - Congruent CCT

CCE is an indirect measurement of incorporation.



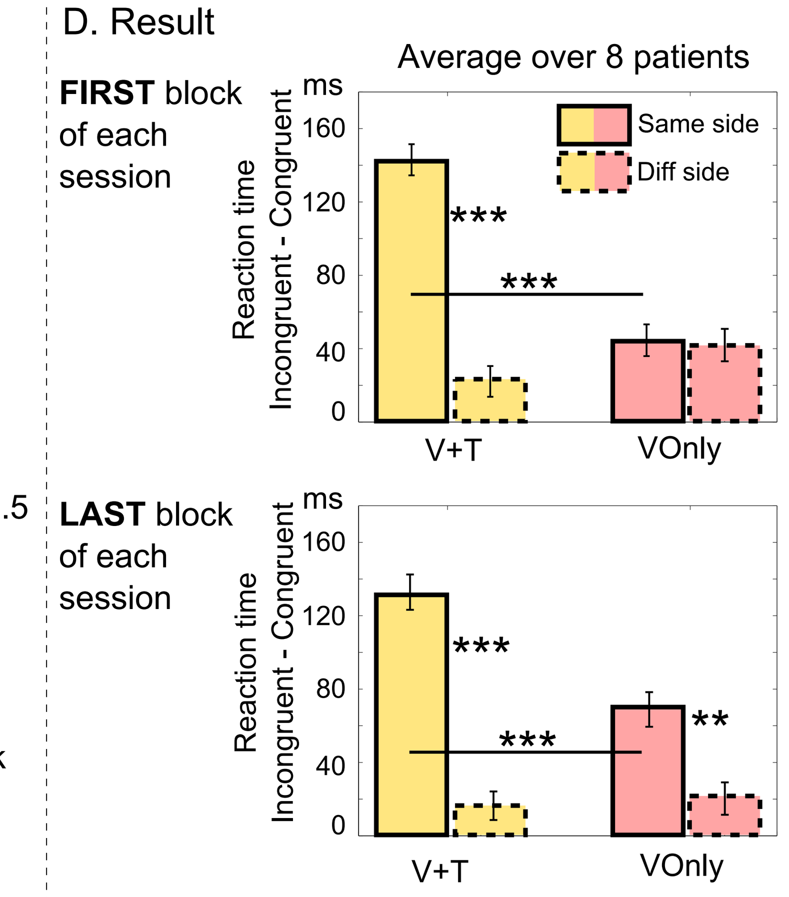
CCE (incorporation) is observed with a golf club only if subject uses it prior to the test.

C. Setup and experiment

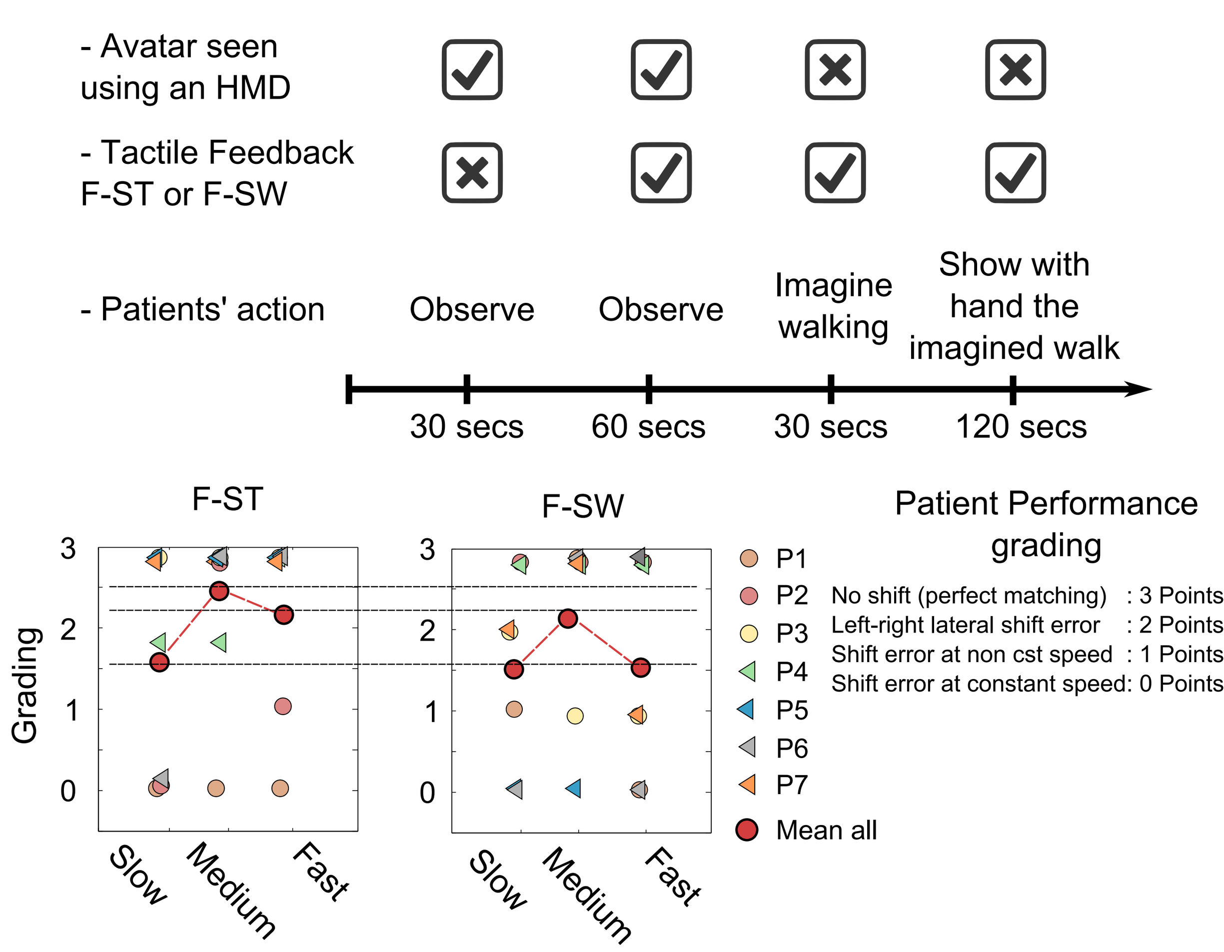


V+T: Visualize avatar's walk + tactile feedback
Vonly: Visualize the avatar's walk
CCT: Cross Congruency Task

D. Result



Leg position representation



Conclusion

- We proposed a simple yet powerfull tactile device for SCI patients.
- Using the apparent movement illusion it is possible to give the sensation of movement to patients using an array of vibrators.
- Thanks to the tactile feedback patients could feel where the virtual or robotic foot was. Feedback on stance leads to better results.
- We report evidence of incorporation of the avatar legs. This was true only after synchronous visuo-tactile stimulation.

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COLLABORATORS

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