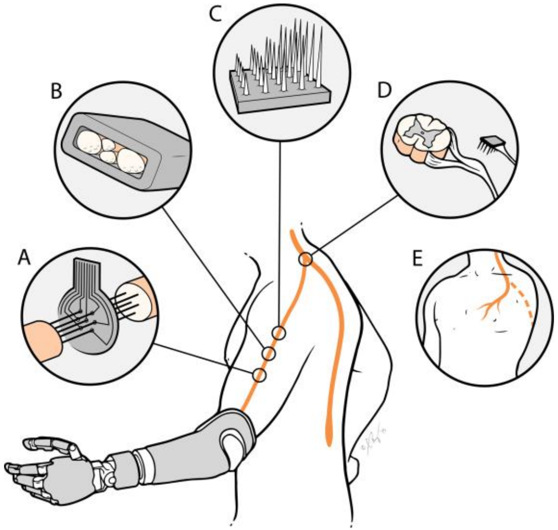
Journal Club



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Translational Neural Engineering Laboratory,

Neuro-X, EPFL

Rules of the journal club

- Groups of 4 students
- We will propose you a list of papers
- Papers will be in pairs <u>on a similar subject</u>
- We have chosen 12 pairs of papers
- You can choose 1 pair
- In 1 month, you should present both papers and be able to compare them

11	6	25/03/2025	Lab 2- Simulation and position control		
12	7	01/04/2025	Advanced Modeling and Control [Bouri]: Z-width	Lab 3 - impedance control and Z - width	
	8	08/04/2025	Romain Baud (Simulation of visco elastic effects)	LabS- distribution of projects + distribution of literature review papers	Lab 3 - impedance control and Z - width
14	9	15/04/2025	Lab 3 - impedance control and Z - width		
15	10	22/04/2025	Holiday		
16	11	29/04/2025	How we perceive the world [Shokur]	Lab Specialization	
	12	06/05/2025	Journal club presentation		

Outline

- What is a research paper
- How to read a paper
- Full example on one paper and expected exercise
- Presentation of all the pairs of papers
- Each group chooses 1 pair of papers

What is a research paper

- Articles are the main means of communication in science
- Publication type
  - Specialized journals (peer review)
  - Proceedings of a conference (generally peer-review)
  - Pre-prints archives (e.g. arXiv, biorXiv, MedrXiv)
- Different editorial groups with - generally- one main journal and various specialized ones (Nature, Nature Communication, Nature Neuroscience, Scientific Reports, Spinal Cord, …)
- What is a **peer review:** experts (generally between 2 and 5) in a field evaluate the quality and validity of scholarly work before it is published. The reviewers recommend:
  - **Minor Revision, Major Revision, Rejection, accepted as it is (very, very, very rare)**

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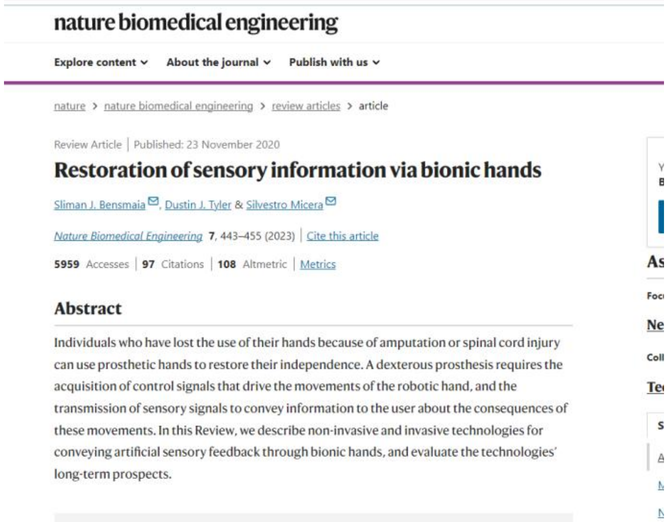
What is a research article

- Categories of articles (there are more…)
  - Original Research/Research article: primary and unpublished studies that advance the state-of-the-art
  - Review papers: written for a general audience and provide insightful coverage of topics and trends of high interest.
  - Perspective papers: emerging ideas written by experts in the field (generally invited by the editor)
  - Case reports: a study that reports the results from a very small cohort of participants, for example, a clinical condition with 1 patient.



nature biomedical engineering

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Review Article | Published: 23 November 2020

Restoration of sensory information via bionic hands

Sliman J. Bensmaia, Dustin J. Tyler & Silvestro Micera

Nature Biomedical Engineering 7, 443–455 (2023) | Cite this article

5959 Accesses | 97 Citations | 108 Altmetric | Metrics

Abstract

Individuals who have lost the use of their hands because of amputation or spinal cord injury can use prosthetic hands to restore their independence. A dexterous prosthesis requires the acquisition of control signals that drive the movements of the robotic hand, and the transmission of sensory signals to convey information to the user about the consequences of these movements. In this Review, we describe non-invasive and invasive technologies for conveying artificial sensory feedback through bionic hands, and evaluate the technologies' long-term prospects.

NEUROSCIENCE

A brain-computer interface that evokes tactile sensations improves robotic arm control

Sharlene N. Flesher[1,2,3], John E. Downey[1,2,3,4], Jeffrey M. Weiss[1,5], Christopher L. Hughes[1,2,3], Angelica J. Herrera[1,2,3], Elizabeth C. Tyler-Kabara[6], Michael L. Boninger[1,2,5,7,8], Jennifer L. Collinger[1,2,3,5,8]†*, Robert A. Gaunt[1,2,3,5]†*

- **First author**: the one that provided the most relevant original contribution and did the practical work for the study
- **Last author**: the source of the funding for the project, came-up with the main idea behind the project, provided guidance
- Corresponding author: the primary point of contact, responsible for handling communication with the journal editors, reviewers, and readers
- Others - generally - in order of importance
- Co-authorship is more and more common

How to read a paper

A first quick read

1. Read the title
2. Read the abstract carefully
3. Check the Figures + captions

More in deep

4. Read Introduction (▶motivation)
5. Read the figures + results text (▶ contribution)
6. If something is not clear - > check the methods
   - If still not clear -> check the supplementary materials
7. Discussion (▶ Interpretation of the results, consequence for the field, limitations)

How to read a paper

NEUROSCIENCE

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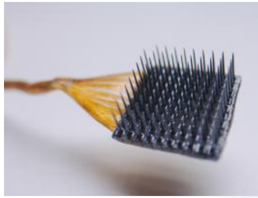
Prosthetic arms controlled by a brain-computer interface can enable people with tetraplegia to perform functional movements. However, vision provides limited feedback because information about grasping objects is best relayed through tactile feedback. We supplemented vision with tactile percepts evoked using a bidirectional brain-computer interface that records neural activity from the motor cortex and generates tactile sensations through intracortical microstimulation of the somatosensory cortex. This enabled a person with tetraplegia to substantially improve performance with a robotic limb; trial times on a clinical upper-limb assessment were reduced by half, from a median time of 20.9 to 10.2 seconds. Faster times were primarily due to less time spent attempting to grasp objects, revealing that mimicking known biological control principles results in task performance that is closer to able-bodied human abilities.

- Intro
- Problematic
- Methods
- Results
- Conclusions
- Outlook

Methods



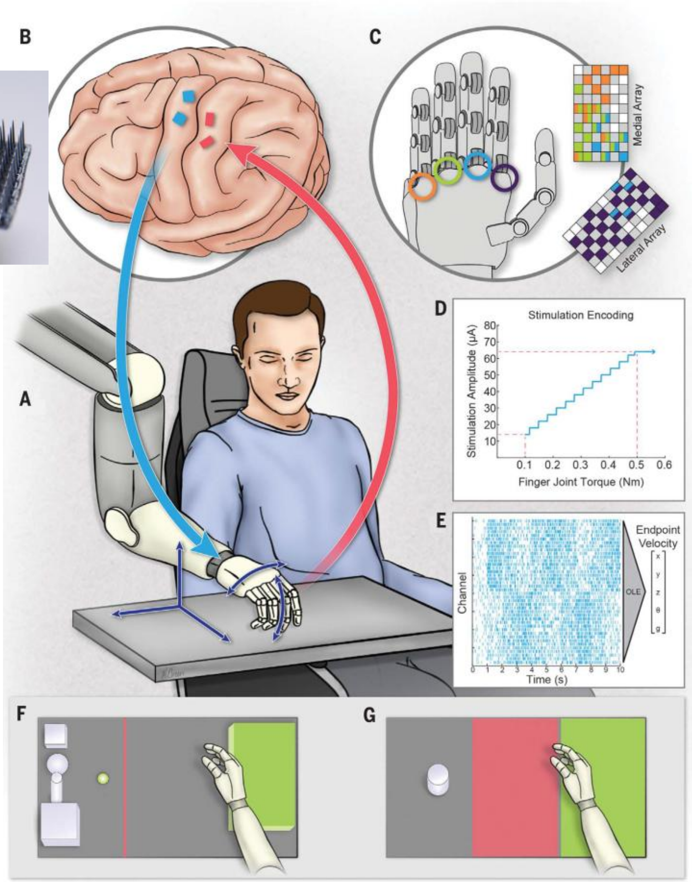


Figure 1 presents an overview of the bidirectional brain-computer interface (BCI) system. (**A**) The participant used an intracortical BCI to continuously control a robotic arm in five movement dimensions during each trial.

(**B**) Electrode Array Placement

(**C**) Torque-Driven Sensory Feedback – Torque from robotic finger movements controlled electrical stimulation, with different finger torques mapped to evoke sensations in specific finger regions.

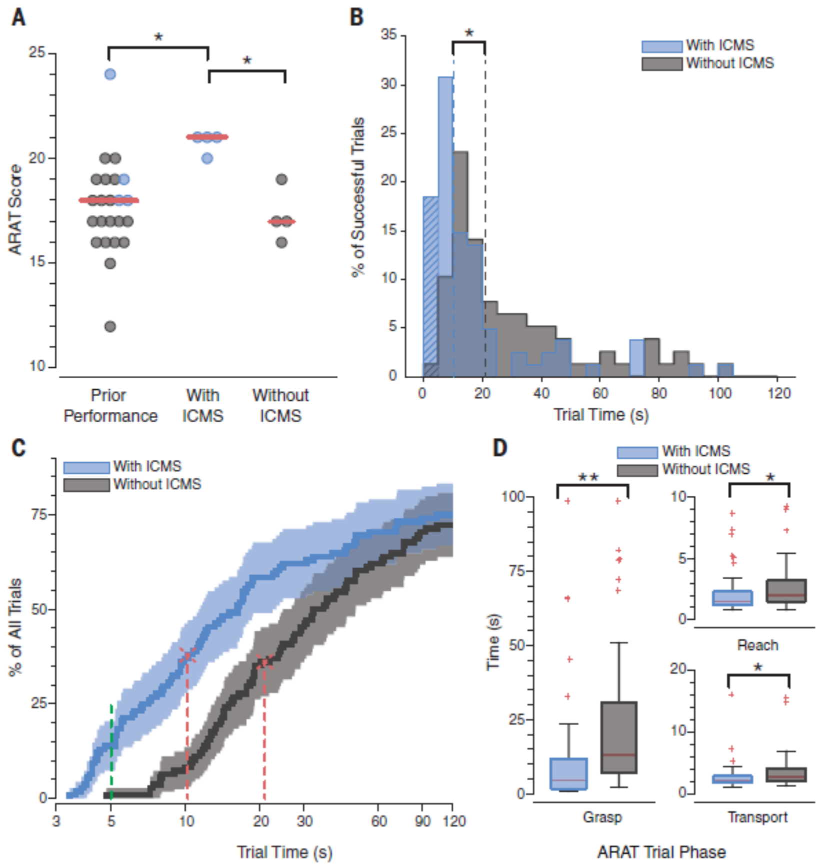
(**D**) Stimulation Modulation – The strength of the stimulation current increased in proportion to the torque, using a linear mapping method.

(**E**) **Neural Decoding** – Neural signals from the motor cortex were shown as a raster plot and decoded into movement commands using an optimal linear estimator.

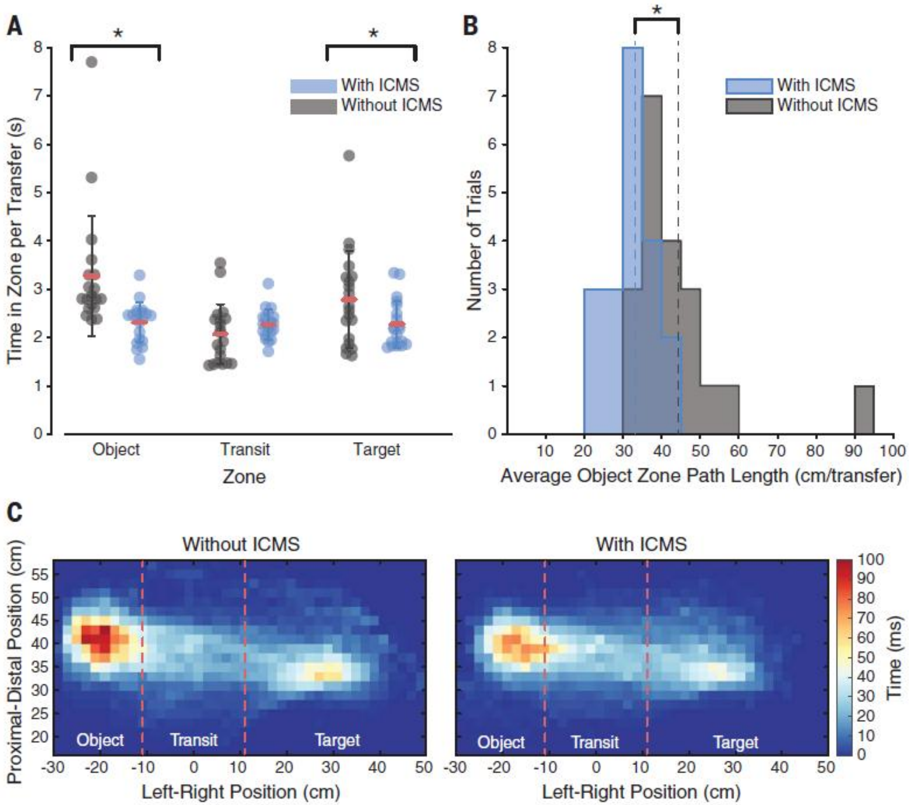
(**F**): ARAT Task View – An overhead view of the Action Research Arm Test, where objects were moved from a starting point (green dot) to a platform (green box).

(**G**): Object-Transfer Task View

Results


A
ARAT Score
Prior Performance
With ICMS
Without ICMS
B
% of Successful Trials
With ICMS
Without ICMS
Trial Time (s)
C
% of All Trials
With ICMS
Without ICMS
Trial Time (s)
D
With ICMS
Without ICMS
Time (s)
Grasp
Reach
Transport
ARAT Trial Phase

Results


A
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*
With ICMS
Without ICMS
Time in Zone per Transfer (s)
Object
Transit
Target
Zone
B
*
With ICMS
Without ICMS
Number of Trials
Average Object Zone Path Length (cm/transfer)
C
Without ICMS
With ICMS
Proximal-Distal Position (cm)
Object
Transit
Target
Left-Right Position (cm)
Time (ms)

What we want you to do

- **Motivation**

What was the rational of this research?

- **Contribution**

Key findings? What was new compared to existing literature?

- **Discussion and outlook**

Consequences for the field? Future applications?

Limitations?

What we want you to do

- **Motivation**
- Sensory feedback is important
  - For motor tasks
  - To not rely on visual feedback
- **Technological Gap:** Bidirectional prosthetic was shown via nerve stimulation but cannot work for people with spinal cord injuries (-> connection with the Central nervous system is necessary)
- **Contribution & Discussion**
  - It is possible to provide sensory feedback via Intracortical stimulation and motor decoding at the same time
  - This improves patient ability in functional tasks
  - Patients spent less time on the reaching and releasing zone than when relying on vision alone
- **Limitation:** Only one subject; nonrigid objects? Other Sensory modalities?

1. Sensory feedback, electrical, and mechanical stimulation

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12. kinematics-based or emg-based control for upper limbs

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