

# BCI training to move a virtual hand reduces phantom limb pain

## A randomized crossover trial

Takufumi Yanagisawa, MD, PhD, Ryohei Fukuma, PhD, Ben Seymour, MD, PhD, et al.

Cite as: *Neurology*® 2020;95:e417-e426. doi:10.1212/WNL.0000000000009858

### Correspondence

Dr. Yanagisawa  
tyanagisawa@  
nsurg.med.osaka-u.ac.jp

### Study objective

To test whether training with a brain-computer interface (BCI) to control the movement of a phantom hand reduces phantom limb pain.

### Classification of evidence

Class III.

### What is known and what this paper adds

Studies suggest that BCI can be used to reduce phantom limb pain. This trial shows that 3 days of BCI training can reduce pain for a week.

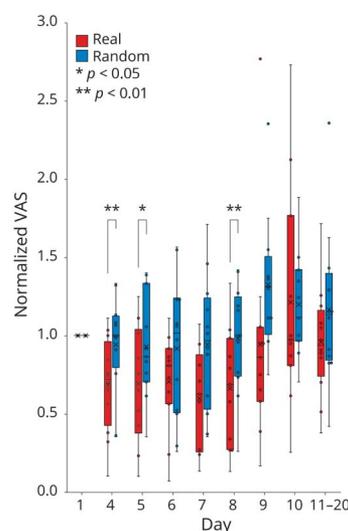
### Methods

This crossover trial included 12 men (age range, 37–68 years) with chronic phantom limb pain of the arm due to amputation or brachial plexus root avulsion. Patients were randomized to a sequence of 2 3-day training sessions (“real training” vs “random training”), with a  $\geq 3$ -week washout period between them. Before each session, participants opened and closed the intact hand on cue while 84 sensors collected magnetoencephalography signals corresponding to 126 cortical points contralateral to that hand. These data were used to construct a real decoder to estimate the likelihood of the intact hand opening. During “real training,” participants attempted to move a virtual phantom hand via the BCI system incorporating the real decoder. During “random training,” random values controlled the phantom hand’s movements. Pain intensity was blindly assessed on a 100-mm visual analogue scale (VAS) before and after each training session and by the patient on days 4–20.

### Main results and the role of chance

The primary outcome was pain intensity on a 100-mm VAS at day 4 (i.e. the day after training ended). Pain was reduced from baseline after real training (mean/100 mm [SDs], 45.3 [24.2] to 30.9 [20.6];  $p = 0.009$ ), but not after random training (36.6 [18.5] to 36.7 [25.0];  $p = 0.98$ ). The VAS scores on days 4 and 8 after real training were 32% and 36% lower, respectively, than the pre-training scores.

**Figure** Normalized VAS scores after training



### Harms

Increased pain occurred for 2 patients during real training and 7 patients during random training.

### Bias, confounding, and other reasons for caution

The small study sample came from a single center and all participants were men.

### Study funding/potential competing interests

This study was funded by the Japan Agency for Medical Research and Development, the Japan Science and Technology Agency, the Japan Society for the Promotion of Science, the TERUMO Foundation for Life Sciences and Arts, the Daiichi Sankyo Foundation of Life Science, vs Arthritis (UK) and IITP (SK). Some authors report additional competing interests. Go to [Neurology.org/N](https://www.neurology.org/N) for full disclosures.

### Trial registration number

UMIN000013608 in the University Hospital Medical Information Network Clinical Trials Registry.

A draft of the short-form article was written by M. Dalefield, a writer with Editage, a division of Cactus Communications. The corresponding author(s) of the full-length article and the journal editors edited and approved the final version.

# Neurology®

## **BCI training to move a virtual hand reduces phantom limb pain: A randomized crossover trial**

Takufumi Yanagisawa, Ryohei Fukuma, Ben Seymour, et al.  
*Neurology* 2020;95:e417-e426 Published Online before print July 16, 2020  
DOI 10.1212/WNL.0000000000009858

**This information is current as of July 16, 2020**

<b>Updated Information &amp; Services</b>	including high resolution figures, can be found at: <a href="http://n.neurology.org/content/95/4/e417.full">http://n.neurology.org/content/95/4/e417.full</a>
<b>References</b>	This article cites 21 articles, 0 of which you can access for free at: <a href="http://n.neurology.org/content/95/4/e417.full#ref-list-1">http://n.neurology.org/content/95/4/e417.full#ref-list-1</a>
<b>Permissions &amp; Licensing</b>	Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at: <a href="http://www.neurology.org/about/about_the_journal#permissions">http://www.neurology.org/about/about_the_journal#permissions</a>
<b>Reprints</b>	Information about ordering reprints can be found online: <a href="http://n.neurology.org/subscribers/advertise">http://n.neurology.org/subscribers/advertise</a>

*Neurology*® is the official journal of the American Academy of Neurology. Published continuously since 1951, it is now a weekly with 48 issues per year. Copyright © 2020 The Author(s). Published by Wolters Kluwer Health, Inc. on behalf of the American Academy of Neurology. All rights reserved. Print ISSN: 0028-3878. Online ISSN: 1526-632X.

