



Title	Unconscious learning of auditory discrimination using mismatch negativity (MMN) neurofeedback
Author(s)	Chang, Ming; Iizuka, Hiroyuki; Naruse, Yasushi; Ando, Hideyuki; Maeda, Taro
Citation	Scientific Reports, 4, 6729 https://doi.org/10.1038/srep06729
Issue Date	2014-10-24
Doc URL	http://hdl.handle.net/2115/57626
Rights(URL)	http://creativecommons.org/licenses/by-nc-sa/4.0/
Type	article
Additional Information	There are other files related to this item in HUSCAP. Check the above URL.
File Information	srep06729-s1.pdf (Supplementary Information)



[Instructions for use](#)

Supplementary Information for

Unconscious learning of auditory discrimination using mismatch negativity neurofeedback

Ming Chang^{1,2,*}, Hiroyuki Iizuka^{3,*}, Yasushi Naruse², Hideyuki Ando^{1,2}& Taro Maeda^{1,2}

¹Graduate School of Information Science and Technology, Osaka University, 2-1 Yamadaoka, Suita, Osaka 565-0871, Japan

²Center for Information and Neural Networks (CiNet), National Institute of Information and Communications Technology and Osaka University, 588-2, Iwaoka, Iwaoka-cho, Nishi-ku, Kobe, Hyogo 651-2492, Japan

³Graduate School of Information Science and Technology, Hokkaido University, Nishi 9-Chome, Kita 14-Jo, Kita-ku, Sapporo, Hokkaido 060-0814, Japan

*Correspondence and requests for materials should be addressed to Ming Chang (chang.ming@ist.osaka-u.ac.jp) or Hiroyuki Iizuka (iizuka@complex.ist.hokudai.ac.jp).

Cognitive strategies

When the participants were asked how they made the disc size change after the BAD test on the last training day. The strategies each participant in the neurofeedback group reported to use were as follows:

Participant 1: "I tried to imagine that the solid green disc comes near to my eyes."

Participant 2: "I tried to imagine putting air in the green balloon (solid green disc)."

Participant 3: "I prayed that the solid green disc would enlarge all the time."

Participant 4: "I prayed that the solid green disc would enlarge all the time."

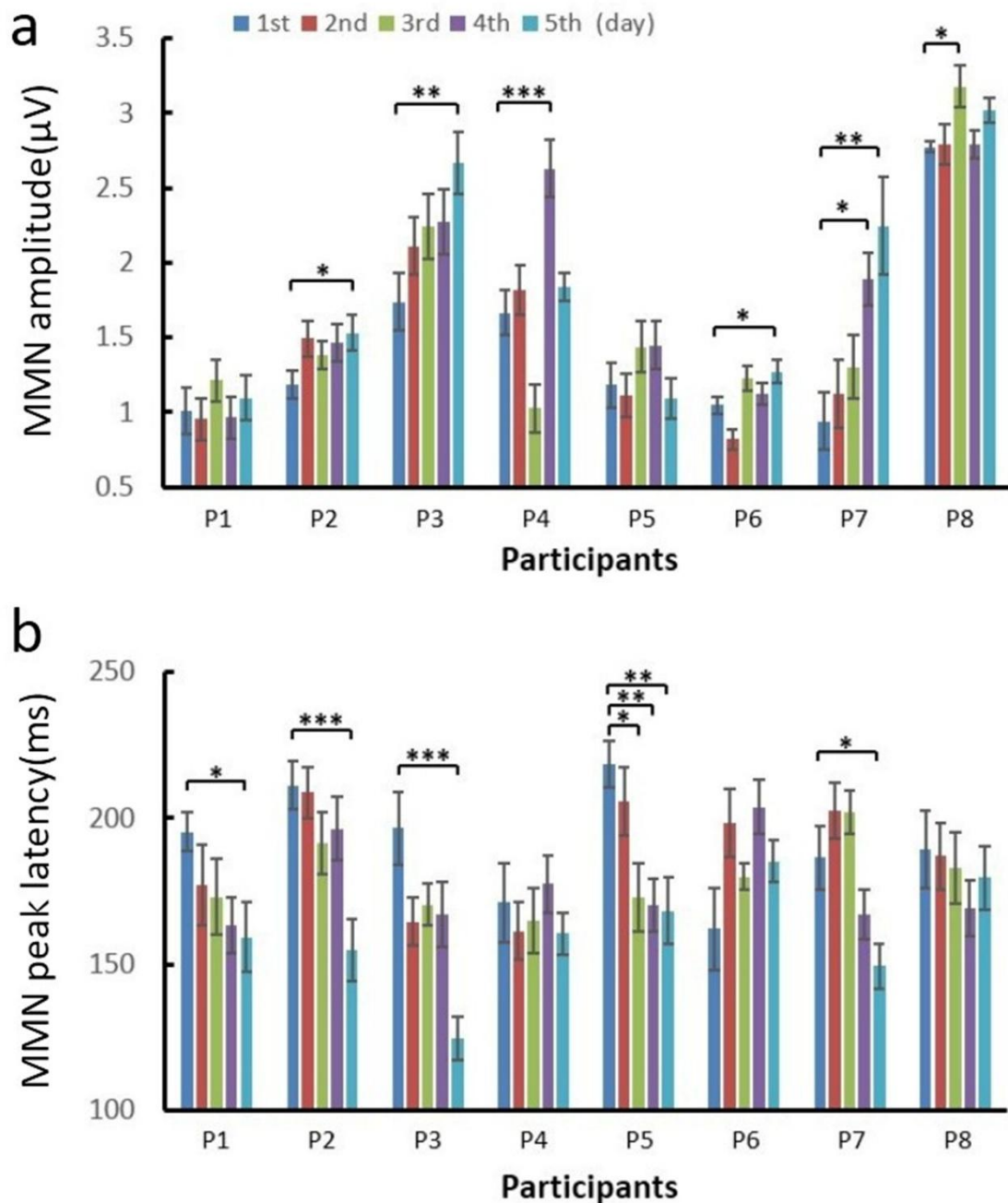
Participant 5: "I tried to imagine a bigger green disc than what I saw just now."

Participant 6: "I tried to imagine that enlarging the solid green disc was like pinching out on a smart phone."

Participant 7: "I tried to remember old memories or one scene about sports."

Participant 8: "I tried to focus my attention on the solid green disc and put energy into enlarging it."

Supplementary Figure S1



Supplementary Figure S1: MMN changes for individual participants in the neurofeedback group. (a) The MMN amplitude on each training day is shown for individual participants in the neurofeedback group. EEG data from 12 sessions on each training day were recorded to compute the MMN for each participant. Significant differences in amplitude between days were evaluated using a one-way analysis of variance (ANOVA) followed by Dunnett's test for multiple comparisons. Six of the eight participants exhibited a significant rise in MMN amplitude. (b) 5 of the 8 participants demonstrated a significant decrease in MMN peak latency. The error bars represent s.e.m. * $P < 0.01$, ** $P < 0.01$ and *** $P < 0.001$, based on Dunnett's test in comparison with the first day. MMN, mismatch negativity.