# Tool-use Training in Augmented Reality: Effects on tactile localization of tactile stimuli on the fingers and associated cortical processing as revealed with EEG

Amir Jahanian Najafabadi[1], Dennis Küster[2], Felix Putze[2], Ben Godde[1]

[1]Dept. of Psychology & Methods, Jacobs University Bremen, 28759 Bremen, Germany
[2]Dept. of Computer Science, University of Bremen, 28359 Bremen, Germany

## Abstract

We investigated whether virtual tool-use training combined with vibro-tactile feedback on the thumb and index finger changes localization of tactile stimuli on those fingers as well as associated cortical processing. Thirty young adult participants learned controlling a virtual gripper in augmented reality to grasp virtual objects at various locations in a horizontal plane. Vibrotactile feedback was applied to those fingers through a CyberTouch II cyber glove when the tool touched the object. Participants performed 4 blocks of training with 60 trials each. A tactile localization test (TLT) was applied to thumb and index finger at pre-test, mid-test and at post-test. The TLT consisted of 200 stimuli divided into 4 blocks. During TLT, stimulation amplitude was reduced on wrong trials and increased on correct trials. Herewith, mean amplitude served as performance measure as well as mean RT. Separate GLMs for percent changes in amplitude and RT with pre-test values as covariates and session (mid-test, post-test) as repeated measures revealed significant training effects for amplitude ($F(7,4886)=66.758$, $p<.001$, $pEta^2=0.074$) and for RT($F(7,4886)=12.812$, $p<.001$, $pEta^2=0.018$). Posthoc t-tests revealed that pre-test values for both amplitudes and reaction times were significantly higher in pre- as compared to mid- and post-test (all: $p < 0.05$). Analysis of event related potentials (ERP) during the TLT revealed no session effects on early (N100) sensory components over primary somatosensory cortex but greater longer latency activation (P300) over left frontal regions. This study confirms that virtual tool use training leads to changes in higher order somatosensory processing related to enhanced tactile localization performance.

**Keywords:** tool-use training, augmented reality, body representation, location, event related potential, primary somatosensory cortex, left frontal