Visuomotor adaptation changes tactile discrimination: an ERP study

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Alterations of processing of tactile stimuli induced by multisensory stimulation suggest a high degree of neuroplasticity in the primary somatosensory cortex (SI) [1]. These alterations have been shown to depend on the way in which we represent our body depending on *passively* sensed and *explicitly* experienced visuo-tactile contingencies. Tactile sensitivity is enhanced when: (a) the stimulated skin region is *explicitly* viewed during *passive* touch [2-5]; (b) an explicitly magnified forearm is *passively* observed through a magnifying lens [6, 7, 3]; and (c) the arm is physically extended via a mechanical grabber [8]. Tactile resolution can also be altered through intra-modal contingencies: e.g., by vibrating the biceps tendon that induces the perception of an elongated body portion [9]. However, in natural conditions, inter- and intra-modal contingencies do not manifest themselves in a passive and explicit way. Instead, they occur *implicitly*, through the *active* interaction with the environment (e.g., body growth). Importantly, [10] demonstrated that visuomotor contingencies based on these ecological properties (i.e., *actively* determined; *implicitly* experienced) quickly impact our representation of the body that, in turn, affects tactile sensitivity; two point tactile discrimination (2PTD) was improved by a brief *visuomotor adaptation* in which participants executed reaching movements with the visual feedback of their reaching finger displaced farther in depth, as if they had a longer arm. Our EEG study provides the first evidence concerning the neural basis of this phenomenon. We recorded brain activity in SI, elicited by the electrical stimulation of the right forearm during a 2PTD task (the two point distance selected according to the individual threshold) after visuomotor adaptation sessions used by [10]. These sessions included *normal reaches* (visual feedback coincident with the actual position of the finger) and *extended reaches* (visual feedback 150 mm further away from the actual finger position). A reliable increase in brain activity was observed after the visuomotor adaptation with extended but not normal reaches (as signalled by the voltage amplitudes of ERPs' components gained by the two-point vs. one-point tactile stimulation). This brain activity modulation was first observed at mid-latency (N140) and consolidated at later stages of somatosensory information processing (LPC-1, P300).

Visuomotor adaptation changes body representation and preset the tactile circuits involved in the 2TPD task, via top-down links from multisensory areas (in the Posterior Parietal Cortex) into the somatosensory cortex.

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1. Gallace A, Spence C. (2010). Touch and the body: The role of the somatosensory cortex in tactile awareness. *Psyche, 16:* 30-67.

2. Tipper SP, Lloyd D, Shorland B, Dancer C, Howard LA, McGlone F. (1998). Vision influences tactile perception without proprioceptive orienting. *Neuroreport, 9*: 1741-1744.

3. Kennett S, Taylor-Clarke M, Haggard P. (2001). Noninformative vision improves the spatial resolution of touch in humans. *Current Biology, 11:* 1188–1191.

4. Taylor-Clarke M, Kennett S, Haggard P. (2002). Vision modulates somatosensory cortical processing. *Current Biology, 12:* 233–236.

5. Schaefer M, Heinze HJ, Rotte M. (2005). Viewing touch improves tactile sensory threshold. *Neuroreport, 16*: 367-370.

6. Schaefer M, Heinze HJ, Rotte M. (2008). Observing the touched body magnified alters somatosensory homunculus. *Neuroreport, 19*: 901-905.

7. Taylor-Clarke M, Jacobsen P, Haggard P (2004). Keeping the world a constant size: object constancy in human touch. *Nature Neuroscience, 7*: 219 –220.

8. Cardinali L, Frassinetti F, Brozzoli C, Urquizar C, Roy AC, Farne` A. (2009). Tool-use induces morphological updating of the body schema. *Current Biology, 19*: R478 –R479.

9. de Vignemont F, Ehrsson HH, Haggard P. (2005). Bodily illusions modulate tactile perception. *Current Biology, 16*: 1286 –1290.

10. Volcic R, Fantoni C, Caudek C, Assad JA, Domini F. (2013). Visuomotor adaptation changes stereoscopic depth perception and tactile discrimination. *Journal of Neuroscience, 33*: 17081–17088.