Proprioceptive recalibration of multisensory processing in the human brain

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To successfully interact within the environment, we constantly integrate external multisensory stimuli by coding their position relatively to our body location1. It is well known that multisensory integration is enhanced when external stimuli occur inside the peripersonal space. However, no previous studies aimed at isolating the role of proprioception in determining the proximity of the external stimuli to the body. Here, we evaluate the role of proprioception in inducing a space-dependent modulation of multisensory processing, at both behavioral and neurophysiological levels.

Participants were asked to detect (Experiment 1: psychophysics; N=16) or passively attend (Experiment 2: electroencephalography; N=14) tactile (electrical) stimuli delivered to the left-hand dorsum, simultaneously with auditory stimuli delivered by a loudspeaker. Importantly, to manipulate the auditory stimuli proximity to the left hand, sound location was not modified, but participants had to perform a postural manipulation by moving their left hand (hidden from vision) either close to (~5cm) or far from (~90cm) the loudspeaker. Thus, the sound was always delivered at the same location, but proprioceptive input informed the subject about its distance from the hand. In Experiment 1, participants were asked to press a foot-pedal in response to tactile stimuli. In Experiment 2, we exploited a fast-periodic-auditory-stimulation2 paradigm during which participants were asked to attend audio-tactile stimuli delivered at a 5Hz-frequency, while performing the postural manipulation.

In both experiments, the postural manipulation induced a space-dependent modulation of multisensory processing. In Experiment 1, reaction times to tactile events were significantly faster in responses to near than far condition ($t= 3.095$; $p=0.0007$). In Experiment 2, summed responses at frequencies of interest, measured over frontocentral electrodes, were significantly higher in far than near condition ($t=2.56$; $p=0.02$).

Taken together, our findings provide new evidence about the role of proprioception in recalibrating multisensory processing. Indeed, the postural manipulation induced similar results as those found by other experimental paradigms manipulating sound location. At behavioural level, we found a performance facilitation with faster responses when multisensory processing occurred inside the peripersonal space3. At electrophysiological level, the frequency-domain analysis, showed larger responses when multisensory processing occurred outside the peripersonal space, a sort of crossmodal incongruency effect3, previously described only in time-domain analysis. Our novel electrophysiological paradigm elicited high signal-to-noise ratio responses within only few minutes of stimulation, thus posing as an ideal approach to evaluate when, during infancy, proprioception becomes informative in defining the peripersonal space boundaries.

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