Critical role of right inferior frontoparietal network in kinaesthetic illusory movement

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Résumé

Background and aim: Under optimal frequency characteristic, vibratory stimulation of muscle tendon commonly evokes illusory limb movements, conveying kinaesthetic information to the cerebral cortex. Although the neural network underlying kinaesthetic processing is well-known, the neural basis responsible for the illusory feeling of movement, labelled kinaesthetic conscious perception, remains to be understood. Interestingly, certain subjects are insensitive to illusory movements despite optimal tendon stimulation. In the present fMRI study, we sought to uncover the neural basis of kinaesthetic conscious perception by examining differences in central processing of kinaesthetic information between subjects who did experience illusory movements and those who did not.
Methods: Fifteen subjects underwent a muscle tendon vibration protocol, supine into a 3-Tesla fMRI scanner. Pneumatic vibration devices were placed on the right and left tendons of the tibialis anterior muscles, providing low- (30 Hz) and high-frequency (100 Hz) stimulations. These parameters were so selected as 30 Hz stimulation drives weak discharges of the primary endings without kinaesthetic illusions and 100 Hz frequency optimally activates primary endings and usually provides consistent illusory movements. fMRI time series were analyzed using leave-one-subject-out general linear models and region of interest analyses.

Results: Among the fifteen subjects, nine felt systematic illusory movement in the high-frequency condition, reporting ankle plantar-flexion movement, whereas the six other subjects did not experience illusions in any of the conditions. A non-limb-specific associative network, including the opercular part of the right inferior frontal gyrus and the right inferior parietal lobule, was more active in subjects with kinaesthetic illusions. Inversely, levels of activation in the other brain areas involved in kinaesthetic processing were rather similar between the two subsamples of subjects.
Conclusions: The results suggest that activation of the right inferior frontoparietal areas, once passed a certain threshold, forms the basis of illusory movements, likely recruiting circuitries usually responsible for movement monitoring through forward computations.

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