THE NEURAL BASIS OF AGING: BRAIN ACTIVATION IN THE ELDERLY MOTOR SYSTEM
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Biomove session Maintaining mobility in health, disease and old age – From motor control perspectives

Introduction
Healthy aging is accompanied by changes in brain structure and function. Whereas age-related brain changes have been investigated intensively in the cognitive domain, less is known about changes within the motor system. Here we present two studies using functional magnetic resonance imaging (fMRI) to identify differential activation in elderly versus young participants while performing a hand-foot coordination task.

Methods
In total, 12 young (20-25 yrs) and 24 old subjects (62-71 yrs), all right-handed, participated in the experiments. FMRI scanning (Philips, Intera, 3 T) was applied while subjects performed metronome-paced, rhythmical hand and foot movements (either isolated or coordinated) with their right body side. Elderly executed the tasks at 1 Hz, whereas young subjects moved with a frequency of 1.5 Hz to match task difficulty. All functional images were preprocessed following a standard protocol and statistically analyzed by SPM2.

Results
In study 1 we compared the brain activation of 12 young and 12 elderly subjects while performing hand and/or foot movements. Our results revealed that elderly exhibited higher and more extended brain activation, so-called over-activation, than the young subjects in motor related areas (including the premotor cortex, parietal cortex and cerebellum), but, interestingly, also in areas involved in the cognitive monitoring of performance (anterior premotor areas and cingulate cortex). No brain regions were significantly more activated in the young than in the elderly subjects. In summary, study 1 revealed that seniors exhibit more elaborate brain activation than younger controls while performing motor tasks.

In study 2, we further investigated whether this age-related over-activation reflects compensation or dedifferentiation mechanisms. 'Compensation' refers to additional activation that supports successful performance, whereas 'dedifferentiation' described an unwanted activation spread which is not relevant to task performance. 24 elderly subjects performed the same tasks as in study 1 and performance scores were correlated with the brain activation. Our results indicate that over-activation on brain level is particularly found in good performers, whereas bad performers might even exhibit under-activation as compared to young controls.

Conclusion
In summary, our data indicate that the decline in brain structure and/or brain physiology, which is typically seen during aging, can be compensated by increased activation of various motor and even non-motor areas. This over-activation in the elderly appears to aid performance and motor functioning in seniors.

Keywords: Ageing, Biomove session, Brain Activity