# Age-related motor and nociceptive cortical processing changes revealed with fMRI

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Healthy aging is often associated with declines in cognitive, motor, and sensory functions. This decline is attributable to neuroanatomical and neurophysiological changes in the brain with age. Several studies indicate that older subjects have greater fMRI activation in cognitive task-related cortical networks and recruit additional brain regions when performance is comparable.[1] Other studies have shown reduced fMRI activation in cortical regions involved in vision and olfaction.[2,3] However, there are no neuroimaging studies that have addressed the age-related changes in nociception. Increased prevalence of persistent pain with advancing age may be due to age-related changes in the nociceptive system. This study uses fMRI to compare cortical responses to painful heat in two age groups.

Methods: Healthy young subjects (mean age 27±2, range 25-30, n=7) and healthy older subjects (mean age 62±8, 56-75, n=7) were recruited for this study. All scans were performed on a 1.5 Tesla Philips Eclipse scanner. Subjects participated in 6 fMRI scans (3 sessions, 2 scans/session) in which two levels of painful heat stimuli were delivered to the left arm: 48°C (which was painful to all subjects, but variable in perceived intensity), and a subject-specific temperature that produced moderate pain (50±5 on a 0-100 visual analog scale). In addition each of the subjects performed a right-hand finger tapping task in each of the sessions and that scan was imposed between the two heat stimuli scans. An RF-spoiled volumetric scan covering the entire brain at 1.5mm slice thickness was obtained during each of the three sessions. These images were later segmented to obtain the gray matter and white matter volumes. For the heat stimuli, using a regression model, significant activation was identified in cortical regions of interest (ROI) known to be involved in nociceptive processing: primary and secondary somatosensory cortices (S1 & S2), anterior cingulate cortex (ACC), anterior and posterior insula (aINS & pINS), supplementary motor area, and inferior frontal gyrus (IFG). For the motor paradigm, significant activation was analyzed only for the regions of the left and right primary motor cortex (M1). For each ROI, two measures of activation were calculated: number of significantly active voxels (spatial extent) and signal change amplitude (amplitude). Age group differences were tested by comparing across-session means for each measure in each ROI.

Results: Spatial extent for the heat stimuli did not differ between groups for either stimulus level in any ROI. However, amplitude was significantly lower for older subjects in aINS (bilaterally) as shown in Fig 1. Analysis of coefficients of variation did not reveal systematic age group differences in variability for either measure. Spatial extent did not differ between the younger and older subjects for the motor paradigm. However there was a significant difference between the young and the old in the amplitude of activation with the younger subjects activating significantly higher than the old. The older subjects had significantly higher bilateral activation compared to the old as determined by the laterality index. The older subjects also showed a significant reduction in the gray matter volume in the anterior insula ($p<0.05$) and in the primary motor ($p<0.02$) regions, but no significant reduction in other ROIs..

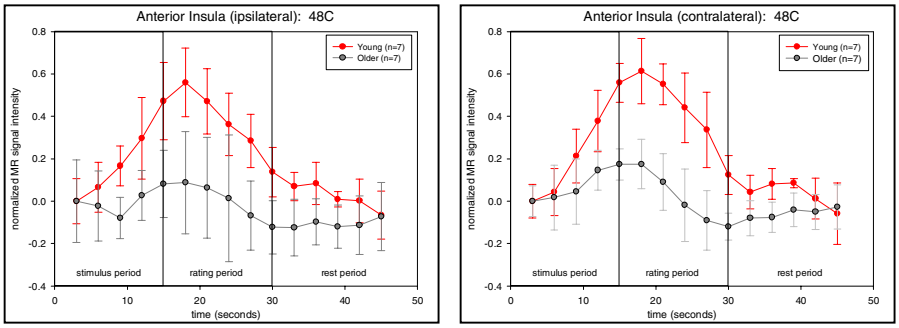


Figure 1. Time course of the pain-related fMRI response in the ipsilateral and contralateral insula.

Conclusion: Painful heat stimuli produce significantly smaller fMRI signal changes in older subjects in the anterior insula - despite producing comparable activation extent and pain intensity ratings. Our findings of reduced fMRI signal changes and the increased bilateral activation for the older subjects during the motor task confirm previously published results. The reduction in gray matter volume in these regions may explain the reduction in the fMRI signal in the older subjects.

References:

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