Effects of sex and age on regional frontal lobe gray matter distribution

V. A. Sluming[1,2], A. Mayes[3], I. D. Wilkinson[4], C. Romanowski[4], E. Cezayirli[5], and P. E. Cowell[6]
[1]School of Health Sciences, University of Liverpool, Liverpool, Merseyside, United Kingdom, [2]Magnetic Resonance and Image Analysis Research Centre, University of Liverpool, Liverpool, Merseyside, United Kingdom, [3]School of Psychology, University of Manchester, Manchester, United Kingdom, [4]Academic Department of Radiology, University of Sheffield, United Kingdom, [5]Department of Anatomy, University of Celal Bayar, Turkey, [6]Department of Human Communication Sciences, University of Sheffield, United Kingdom

In a previous study of prefrontal ageing, we showed regional sex differences in two independent cohorts of healthy adults (Cowell et al., 2007). In men, age effects were greatest in medial prefrontal volumes, with decreases in dorsal and orbital subregions. In women, changes were found in dorsomedial prefrontal volume with additional decreases in lateral prefrontal regions. This initial study used stereologically derived volume estimates which did not differentiate between gray matter (GM) and white matter (WM) contributions. The current study reports voxel based morphometric (VBM) analyses of MRI scans from the same cohort to investigate sex differences in ageing in relation to GM distribution, with a particular focus on frontal regions.

Sixty-six healthy men (n=31) and women (n=35), aged 20-72 years, from the original cohort of 68 participants were included. High resolution T_1 weighted structural MRI scans were acquired with two standard clinical 1.5T MR imaging systems from Sheffield (Eclipse, Philips Medical Systems, Cleveland, Ohio, USA) and Liverpool (GE Signa, General Electric, Milwaukee, Wisconsin, USA). Details of scanning protocols are given in Cowell et al., 2007. Data were processed using the VBM5 Toolbox (Gaser, 2009) within SPM5 (implemented in Matlab2008, running on an Apple Mac). All brain datasets were normalized to the ICBM space template (European), bias corrected, segmented and smoothed with 12mm FWHM kernel. Significant regions were localized using probabilistic maps within Anatomy Toolbox v1.6 (Eickoff, 2008)

Factorial analyses comparing participants above and below age 50 showed GM decrements in the left and right putamen in both sexes. There were no significant Sex x Age effects. However, within-sex regression analyses to investigate GM distribution as a function of age showed different patterns of change for women and men. In frontal structures, men showed aging related GM decreases in the right and left IFG (BA44/45) (Figure 1). Women showed GM decreases in several frontal cortical regions including right superior orbital, left middle orbital, left and right middle frontal gyri (Figure 2).

Right and left putamen GM was affected by age in men and women. This may be related to the significant level of medial prefrontal brain volume loss previously observed in both sexes (Cowell et al., 2007) as the putamen receives important projections from medial prefrontal cortex (Öngur and Price, 2000). In men, there were no obvious parallels between the previous volume results and current VBM findings. However in women, regional overlap between volume changes and VBM results was observed. Previously reported decreases in women's lateral prefrontal brain volume (Cowell et al., 2007) may be related to the current study's finding of decreased GM distribution throughout the frontal cortices. These combined effects are consistent with changes in neuroanatomy, neurotransmitter and neurocognitive function found in frontal cortical systems of postmenopausal women (Craig and Murphy, 2007).

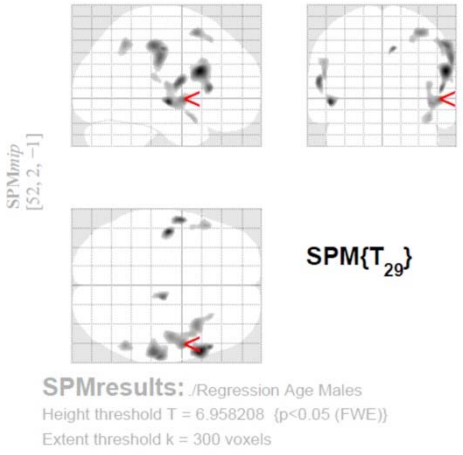

Figure 1 Significant regions of negative correlation in Males

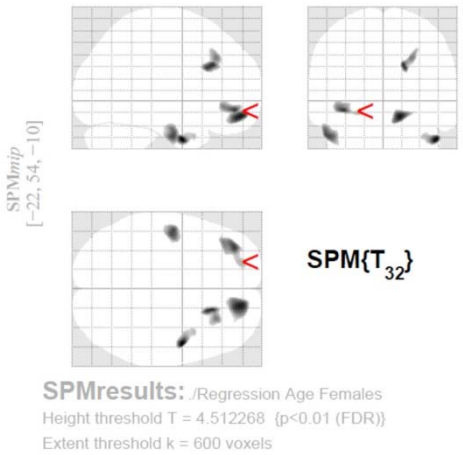

Figure 2 Significant regions of negative correlation in Females

References

Craig, M.C. and Murphy, D.G. 2007. Journal of Neuroendocrinology, 19:1-6.
Cowell, P.E., Sluming, V.A., Wilkinson, I.D., Cezayirli, E., Romanowski, C.A.J., Webb, J.A., Keller, S.S., Mayes, A., and Roberts, N. 2007. European Journal of Neuroscience, 25:307-318.
Eickoff S, Anatomy Toolbox v1.6 , http://www.fz-juelich.de/inm//spm_anatomy_toolbox
Gaser, C. VBM Toolbox, http://dbm.neuro.uni-jena.de/vbm/
Öngur, D. and Price, J.L. 2000. Cerebral Cortex, 10:206-219.