A High-Resolution MRI Study of Regional Cortical Thickness in Professional Racing and Naïve Drivers

Authors:

Giulio Bernardi[1], Lorenzo Sani[1], Emiliano Ricciardi[1], Joel Reithler[2], Alessandra Papasogli[3], Riccardo Ceccarelli[3], Ferdinando Franzoni[4], Gino Santoro[4], Rainer Goebel[5], Pietro Pietrini[1]

Institutions:

[1]Laboratory of Clinical Biochemistry and Molecular Biology, University of Pisa, Pisa, Italy, [2]Maastricht University, Maastricht, Netherlands, [3]Formula Medicine, Viareggio, Italy, Viareggio, Italy, [4]Department of Internal Medicine, University of Pisa, Italy, Pisa, Italy, [5]Maastricht Brain Imaging Center, Maastricht University, Maastricht, Netherlands

Introduction:

A growing number of studies in both animals and humans indicate that functional and even anatomical modifications may occur in the brain as a consequence of learning and training in different cognitive domains (1). Recently, by using functional magnetic resonance imaging (fMRI), we showed in professional Formula 1 racing pilots a significantly lesser recruitment of task-relevant brain areas in response to visual-spatial tasks as compared to naïve car drivers (2). The aim of the present study was to determine whether the exceptional skills and intensive training in professional car pilots may be associated also to differences at an anatomical level in the regional cortical organization of the brain as compared to naïve control subjects.

Methods:

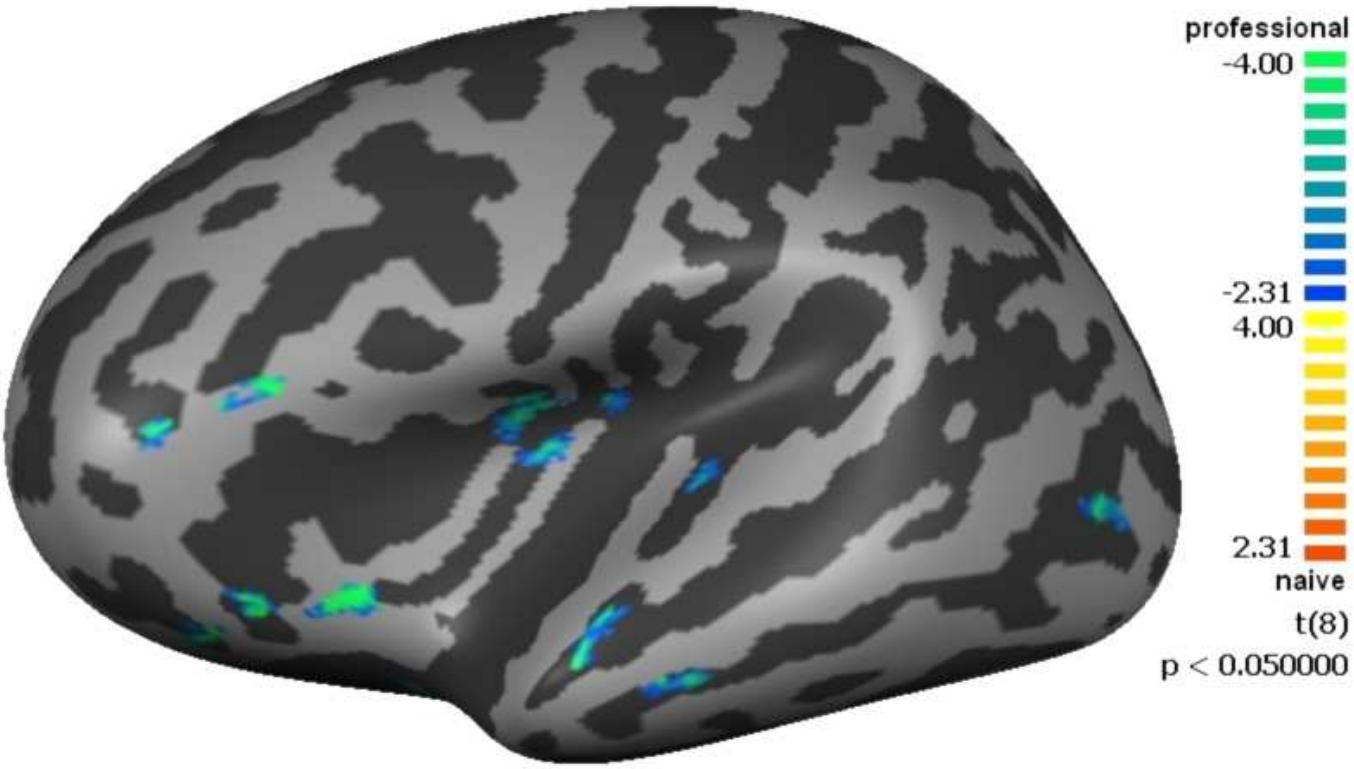
We used a GE Signa 1.5 Tesla MRI scanner (General Electric, Milwaukee, WI) to obtain high-resolution T1-weighted spoiled gradient recall images (1mm³ voxels) in 5 professional (mean age±s.d.=23±5 years) and 5 naïve (28±6 years) car drivers, all right-handed healthy males. Preprocessing and cortical thickness measurements were performed with BrainVoyager QX (Brain Innovation, Maastricht, The Netherlands). The procedure adopted by this software is based on the Laplace method as introduced by Jones et al. (3). Preprocessing phases for each subject included an automated white/gray matter segmentation and a manual correction of errors in white and gray matter classification (such as bridges or holes) performed by a blinded operator. Then, cortical thickness maps for each subject were calculated and reconstructed cortices were aligned using curvature information reflecting the gyral/sulcal folding pattern to gain an improved spatial correspondence across subjects. A t-test was used to determine differences between the two groups and to obtain cortical contrast maps for each brain hemisphere. We also applied a cluster threshold of 8mm² to filter smaller regions and so reduce noise. Statistical significance was set at $p<0.01$.

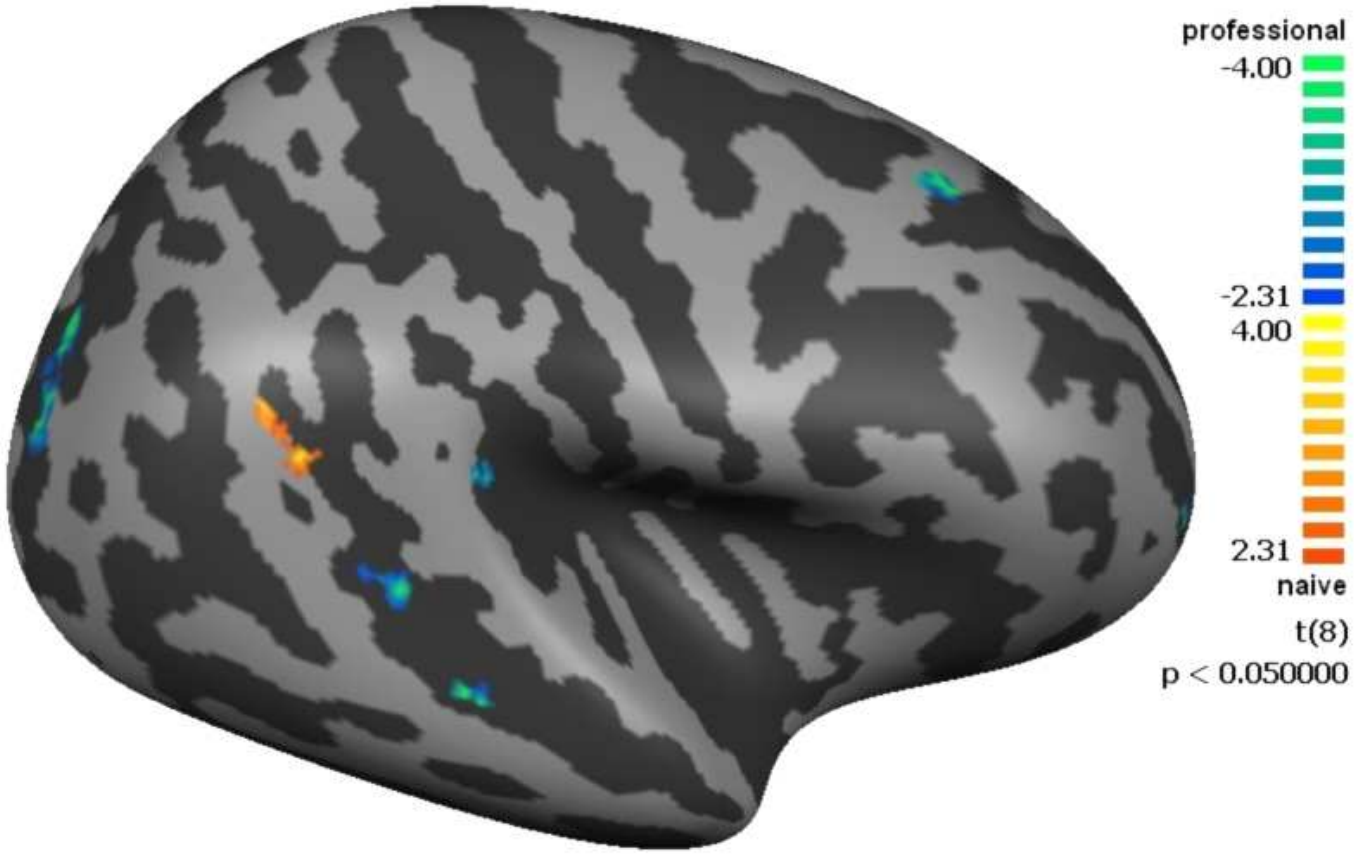
Results:

No significant differences in cortical thickness were detected between professional and naïve car drivers (uncorrected $p<0.01$). However, at a more liberal threshold (uncorrected $p<0.05$, 8mm² cluster threshold) several areas were found to have a greater cortical thickness in the professional car drivers than in the naïve group. These relatively small regions were located in the middle temporal/middle occipital gyrus, calcarine sulcus, superior and inferior temporal cortex, insula, orbital gyri and inferior frontal gyrus in the left hemisphere (Fig1); transverse occipital sulcus, intraparietal sulcus, superior temporal sulcus, lateral sulcus, orbital gyri and superior frontal sulcus and gyrus in the right hemisphere (Fig2). In contrast, regions located in the anterior part of cingulate gyrus bilaterally, and in the right inferior parietal lobe showed a greater cortical thickness in naïve than in professional drivers.

Conclusions:

With a conservative statistical threshold no differences in cortical thickness between professional and naïve car drivers reached significance. However, at a more liberal threshold, several brain areas, including areas primarily involved in visuo-spatial tasks, attention and planning, showed a greater cortical thickness in professional pilots as compared to naïve drivers. While these results obtained in a limited number of subjects must be considered preliminary, if confirmed in larger samples would support a relation between expertise and cortical thickness in task-related brain areas, in agreement with both our fMRI data in pilots and findings from studies in animals and in other high-skilled human groups (1, 2).





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