Brain plasticity: effects of judo practice on gray matter volume

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Rationale

- Experimental studies have shown that physical exercise, planning and execution of complex movements are associated with changes in brain structure.
- The changes possibly reflect plastic alterations of the cortical mantle in response to an enhanced demand imposed by motor task and/or physical exercise.
- In humans, cortical plasticity in relation to physical exercise is yet to be fully determined and quantified.

Introduction

Physical Exercises Increases Liberation of Tropic Factors: Nerve Growth Factor (NGF), Brain Derived Neurotrophic Factor (BDNF) and Fibroblast Growth Factor (FGF) (Cotman and Berchtold, 2002)

The main action of local trophic factor is cell surviving, improving resistance of nervous system to insults and also increasing neuronal connections (Mattson, 2000)

Introduction

- Animal Model X Human Model
- Non-Invasive Method
- MRI

Introduction

- Study with Basketball Players (Park et al, 2006)
- Senescent Person and Aerobic Exercises (Colcombe et al, 2006)

Objective

- To investigate changes on gray matter volume in judo players using voxel-based-morphometry (VBM) of high resolution Magnetic Ressonance Image (MRI).

Methods

Characteristics of judo players and control health groups

	Judo Players	Control
Time of practice	>10 year	–
Age	25,2 year (± 1,8 year)	25,3 year (± 2,9 year)
Limit of age	20 to 40 year	20 to 40 year
Number of Subjects	8	18

MRI Scanning Protocol

- 2 T Scanner Elscint Prestige
- Volumetric (3D) T1, 1mm isotropic voxels
- T1 best anatomic 3D resolution

Image Processing

- Voxel-based Morphometry (VBM)

- Software Matlab 6.5, MRIcro, SPM2 e NPM

- All results were obtained with Wilcoxon test (voxel by voxel)

Normalization and Modulation

Image

Templ

Normalization

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

Image Normalized

Segmentation

Image Smoothed

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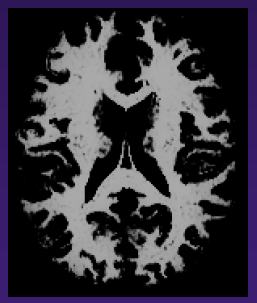
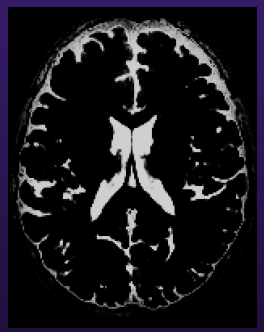
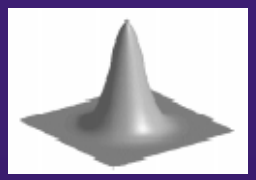
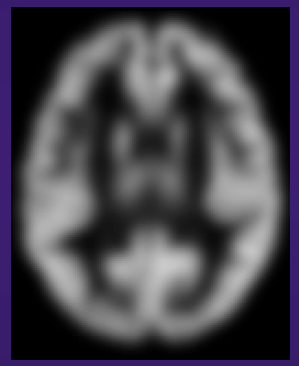




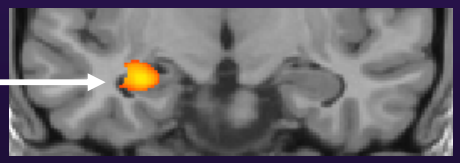
Gaussian Kernel



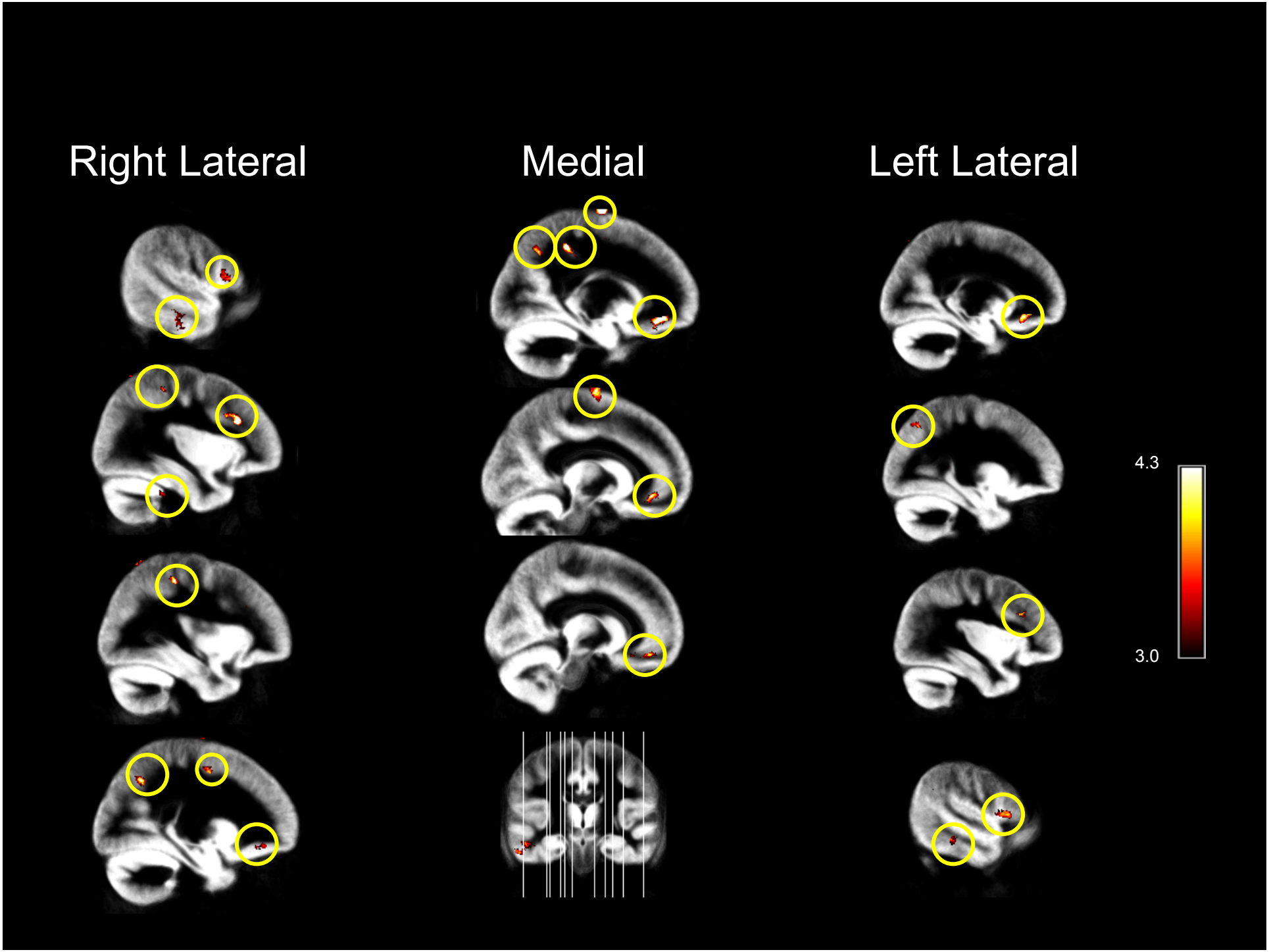


NPM or SPM 2

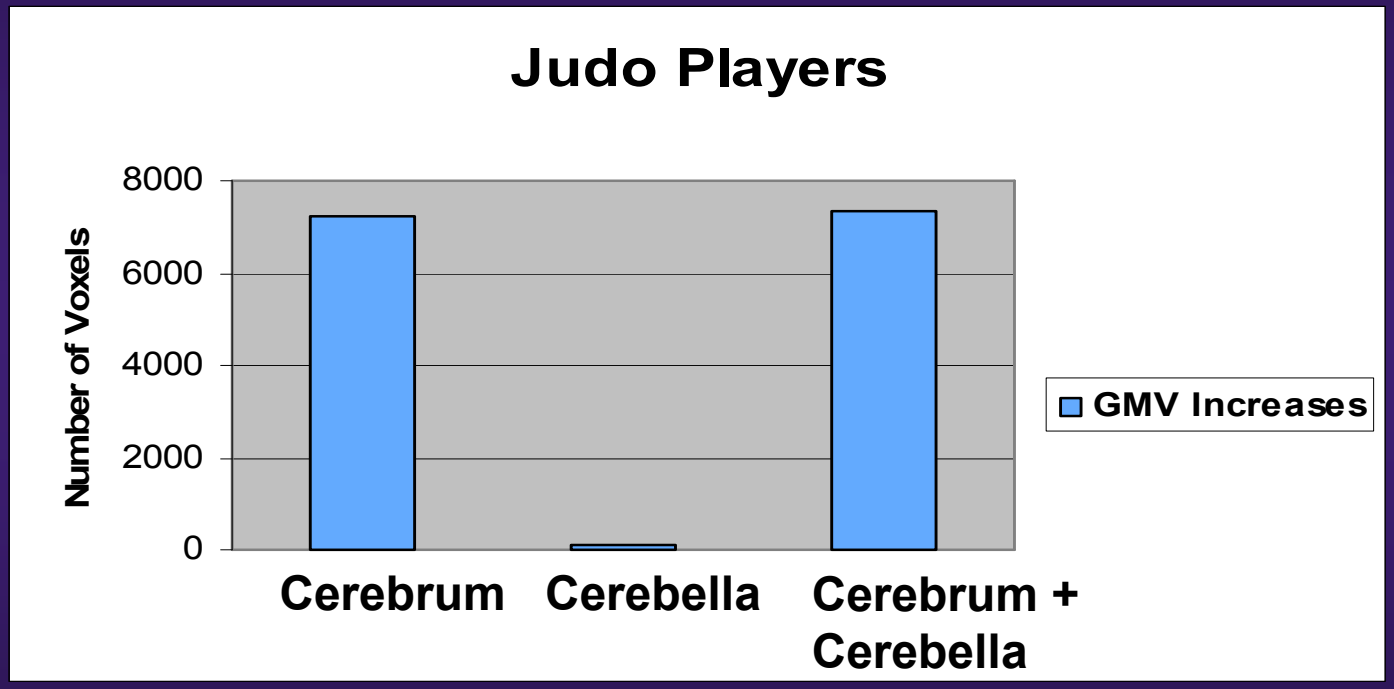
$P < 0.05$



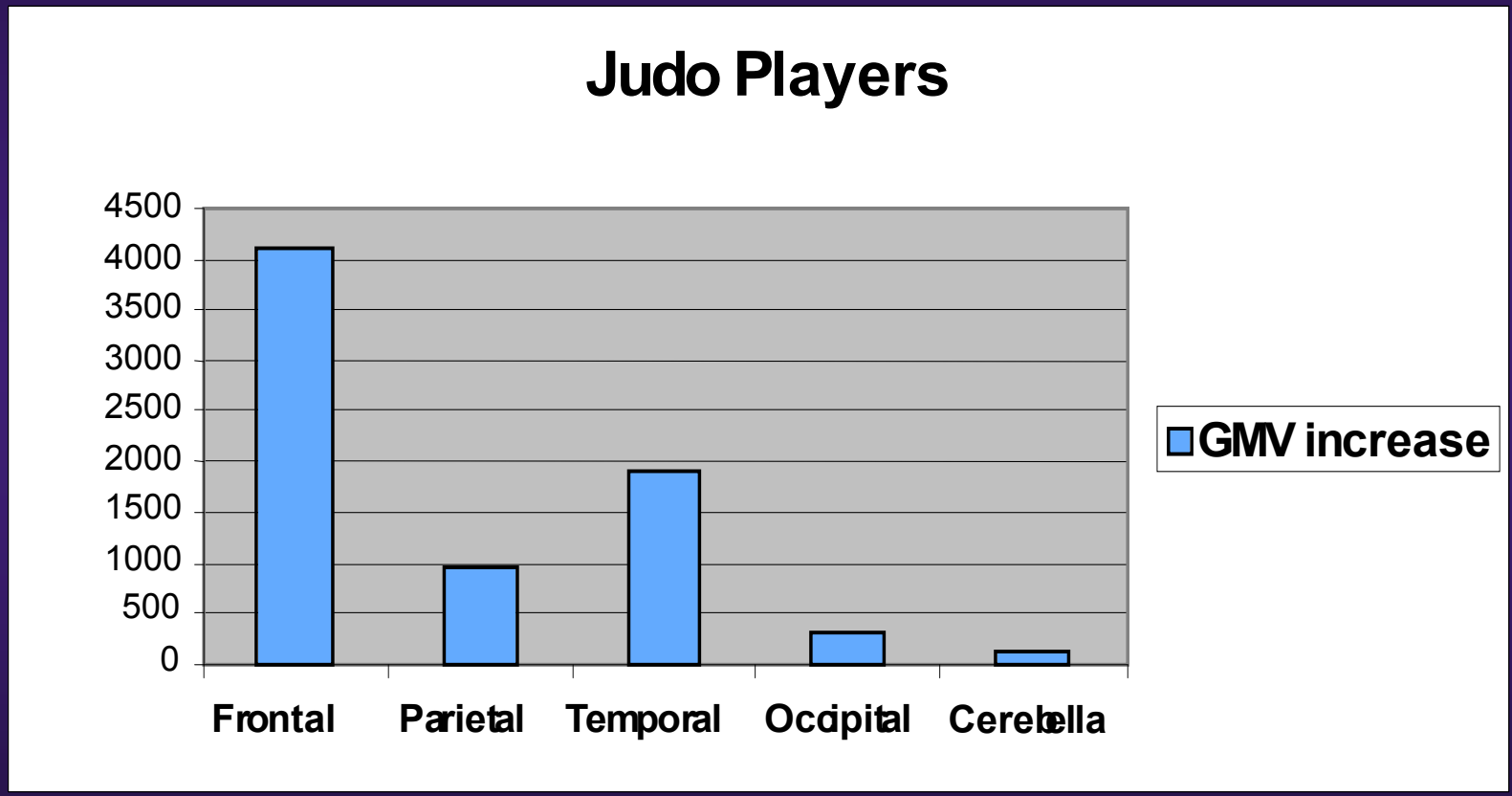
Results


Right Lateral
Medial
Left Lateral
4.3
3.0

Brain GMV Increase

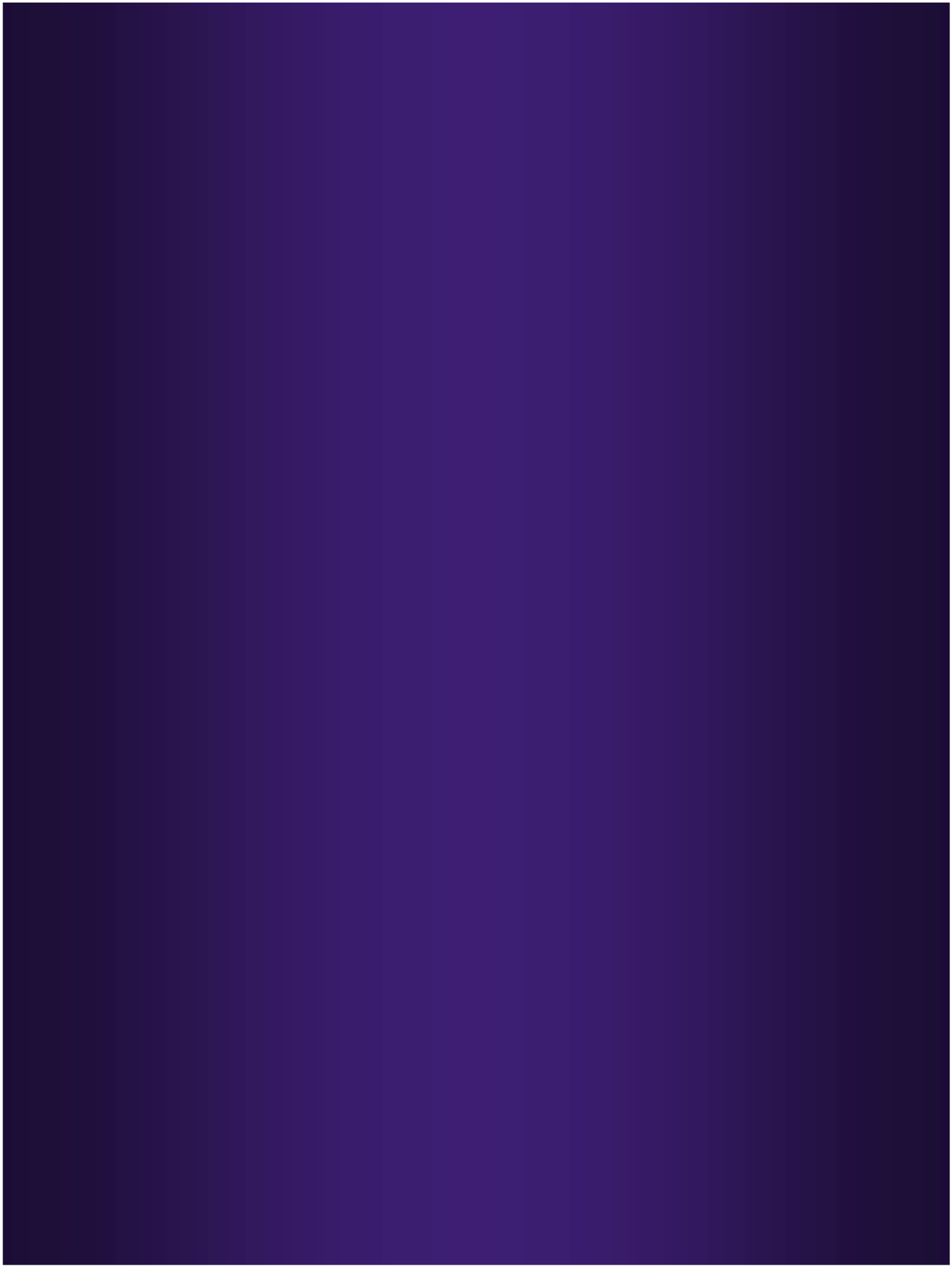


Brain GMV Increase



Conclusion

- Increased gray matter volume in judo players is possibly induced by the practice of a complex motor task.
- More specifically, the gray matter volume within the primary motor cortex, memory and associative areas are particularly affected by the practice of judo.
- Our findings suggest that motor planning and execution, embedded in sport practice, including judo, can induce specific plasticity related changes in the brain.



Frontal lobe increased cortical gray matter volume ($p < 0,01$)

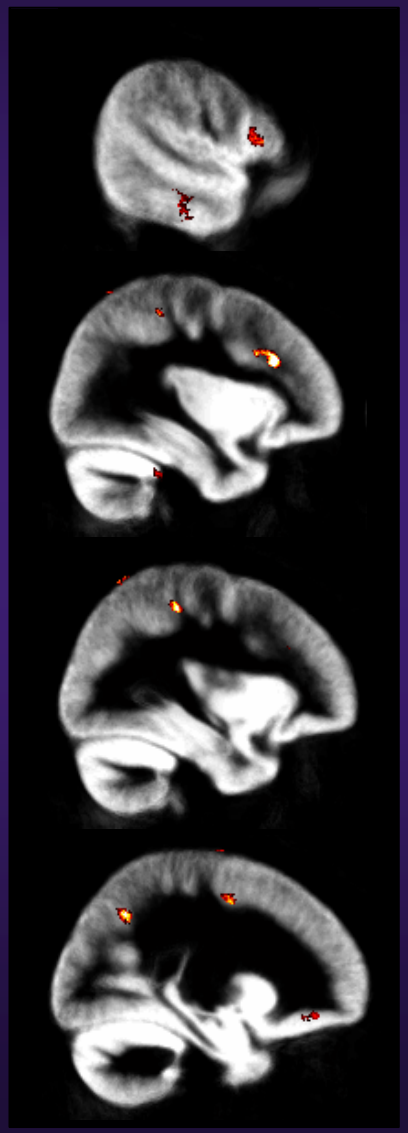
Anatomical Region	Number of Voxels	
	Right Hemisphere	Left Hemisphere
Pre-central Gyrus	-	227
Frontal Superior Gyrus	-	398
Frontal Superior Orbital Gyrus	283	357
Frontal Middle Gyrus	-	34
Frontal Middle Orbital Gyrus	-	305
Frontal Inferior Opercular Gyrus	472	530
Frontal Inferior Triangular Gyrus	162	418
Rolandic Opercular	-	62
Supplementary Motor Area	51	196

Parietal, temporal and occipital lobe increased cortical GMV ($p < 0,01$)

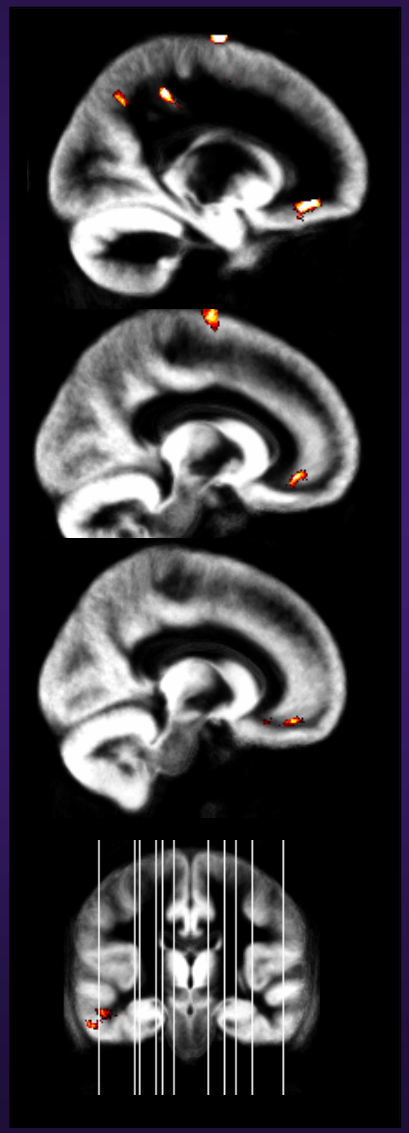
Anatomical Region	Number of Voxels	
	Right Hemisphere	Left Hemisphere
Rectus Gyrus	517	69
Paracentral	-	55
Postcentral	-	234
Parietal Superior Gyrus	114	435
Parietal Inferior Gyrus	-	46
Precuneus	-	37
Temporal Middle Gyrus	122	326
Temporal Inferior Gyrus	398	1040
Occipital Superior Gyrus	169	-
Occipital Middle Gyrus	-	133

JUDO PLAYERS x CONTROLS

Right Lateral



Medial



Left Lateral

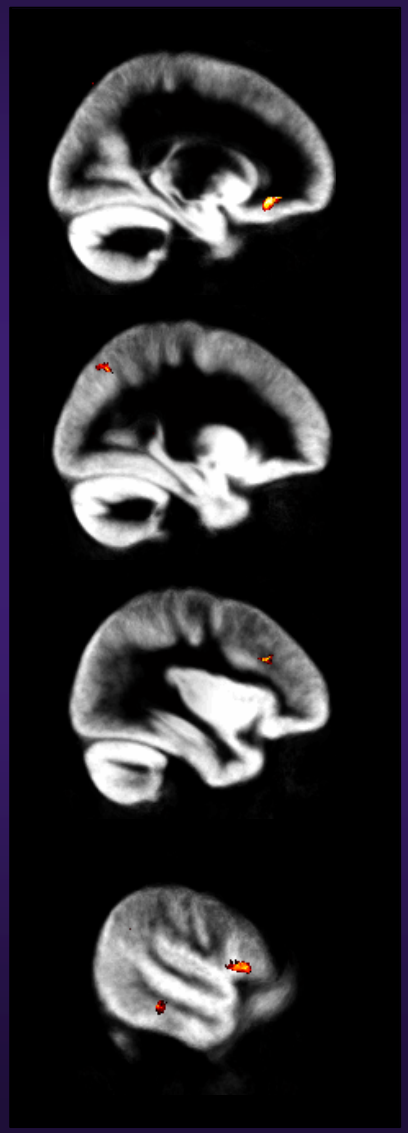


Image Pre-processing