Organization for
Human Brain Mapping

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HBM2010
BARCELONA, SPAIN

16th Annual Meeting of the Organization for Human Brain Mapping

abstracts

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BARCELONA, SPAIN

16th Annual Meeting of the Organization for Human Brain Mapping

June 6-10, 2010 • Catalonia Palace of Congresses

1

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1446 WTh-PM
Improved Assessment of Brainstem Neuroanatomy with High Resolution MRI and DTI
Guadalupe Soria, Matteo de Notaris, Raúl Tudela, Gerard Blasco, Josep Puig, Anna Planas, Salvador Pedraza, Alberto Prats-Galino, Experimental MRI 7T Unit, IDIBAPS, IIBB-CSIC, Barcelona, Spain

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1448 WTh-PM
The Right Amygdala and Adolescent Male Substance Use
Rebecca Blanton, Marc Potenza, Rajita Sinha, Linda Mayes, Yale University, New Haven, United States

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1450 WTh-PM
Studying structural human brain networks using cortical surface area as morphometric descriptor
Gretel Sanabria-Diaz, Lester Melie-García, Yasser Iturria-Medina, Yasser Alemán-Gómez, Gertrudis Hernández-González, Lourdes Valdés-Urrutia, Lídice Galán, Pedro Valdés-Sosa, Cuban Neuroscience Center, Havana, Cuba

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1452 WTh-PM
Sex effects on small-world organization of structural brain networks in young healthy individuals
Kai Wu, Yasuyuki Taki, Kazunori Sato, Ken Okada, Ryoi Goto, Ryuta Kawashima, Hiroshi Fukuda, Department of Nuclear Medicine and Radiology, IDAC, Tohoku University, Sendai, Japan

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1454 WTh-PM
Generational differences of head shape and brain shape of Japanese
Kazunori Sato, Shigeo Kinomura, Yasuyuki Taki, Ryoi Goto, Ken Okada, Ryuta Kawashima, Hiroshi Fukuda, IDAC, Tohoku University, Sendai, Japan

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1456 WTh-PM
Brain size and gender effects on the development of inter-hemispheric connectivity
John Lewis, Junki Lee, Alan Evans, The Brain Development Cooperative Group, Montreal Neurological Institute, McGill University, Montreal, Canada

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1458 WTh-PM
Brain Tissue Thickness Estimation using a Projection Scheme
Robert Dahnke, Rachel Aine Yotter, Gabriel Ziegler, Christian Gaser, Structural Brain Mapping Group, Department of Psychiatry, University of Jena, Jena, Germany

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1460 WTh-PM
Almost nothing is left in the association between corpus callosum size and handedness
Eileen Luders, Nicolas Cherbuin, Paul Thompson, Boris Gutman, Kaarin Anstey, Perminder Sachdev, Arthur Toga, UCLA, Los Angeles, United States

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1462 WTh-PM*
The Human Connectome: Exploring Nerve Fiber Tracts at a Micrometer Scale by Means of Polarized Light (O-T1)
Markus Axer, Uwe Pietrzyk, David Graessel, Jürgen Dammers, Björn Eiben, Kurt Hoffmann, Philipp Schloemer, Karl Zilles, Katrin Amunts, Institute of Neuroscience and Medicine (INM-1), Research Centre, Jülich, Germany

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1464 WTh-PM
MorphoConnect: Toolbox for studying structural brain networks using morphometric descriptors
Lester Melie-García, Gretel Sanabria-Diaz, Yasser Iturria Medina, Yasser Alemán-Gómez, Cuban Neuroscience Center, Havana, Cuba

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1466 WTh-PM
White matter asymmetries in the human brain: an in vivo diffusion tractography study
Michel Thiebaut de Schotten, Flavio Dell'Acqua, Dominic ffytche, Matt Allin, Muriel Walshe, Robin Murray, Williams Steven, Declan Murphy, Marco Catani, Institute of Psychiatry, London, United Kingdom

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1468 WTh-PM
Semi-automated in-vivo segmentation of visual area V1 based on structural 7 Tesla MRI
Marcel Weiss, Gabriele Lohmann, Gerik Scheuermann, Robert Turner, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany

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1470 WTh-PM
Thalamic Volume, Shape and White Matter Integrity in First-Episode Schizophrenia
Anqi Qiu, Kang Sim, National University of Singapore, Singapore, Singapore

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1472 WTh-PM
The frequency of sulcal pits and intellectual ability in the adult human brain
Kiho Im, Yu Yong Choi, Kun Ho Lee, Sun I. Kim, Lee Jong-Min, Children's Hospital Boston, Harvard Medical School, Boston, United States

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1474 WTh-PM
On alignment techniques for statistical shape analysis of brain structures using landmark coordinate
Matias Bossa, Ernesto Zacur, Salvador Olmos, University of Zaragoza, Zaragoza, Spain

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1476 WTh-PM
Mental Toughness and Brain Structure
Peter Clough, Samuel Newton, Peita Bruen, Earle Keith, Earle Fiona, Francesca Benuzzi, Simona Gardini, Alexa Huber, Fausta Lui, Annalena Venneri, University of Hull, Hull, United Kingdom

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On alignment techniques for statistical shape analysis of brain structures using landmark coordinate

Abstract No:

2641

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Introduction:

The goal of many previous morphometry studies was to localize anatomical brain differences between patient groups. A common approach is to perform local hypothesis tests on shape features, such as Student's t or Hotelling's T2 test on the coordinates of labeled landmarks. Statistical maps are used to show regions with statistically significant differences. A preprocessing stage is required in order to align all instances to a common reference space. Some works use the coordinates of specific anatomical landmarks, such as anterior and posterior commisures, while other strategies use information from all available landmarks, such as Procrustes alignment. Even though not much attention is usually devoted to the alignment stage, it really has a strong influence in the statistical maps.

The aim of this work is to analyze two alignment strategies in the context of multi-object shape analysis, i.e., when several brain structures are jointly analyzed.

Methods:

A subset of 405 elderly subjects from ADNI study [1] was used in this work: 188 normals and 216 AD patients sex- and age-matched. Baseline T1 MRI images were analyzed with the FIRST tool [2], for automatic segmentation of subcortical structures (caudate, putamen, globus pallidus, hippocampus, amygdala and thalamus). Coordinates of the nodes defining the surface mesh were used as shape features.
Two different alignment strategies were analyzed: global alignment, i.e. Procrustes alignment of the landmarks from all structures together, and structure-wise alignment, i.e. Procrustes alignment of each individual structure. Statistical shape analysis was performed on the coordinates of the nodes after alignment. Hotelling T2 test was used to assess mean difference between patient groups and to provide statistical maps. P-value correction due to multiple comparison was not considered in this work because we are more interested in the location of the most significant regions rather than the significance level.
When using structure-wise alignment, which is the most common approach, the information of the relative pose among structures (location, orientation and size) is disregarded. However, this information may be very valuable. The pose information can be encoded by a transformation matrix. The set of these matrices form a Lie group and a Riemannian manifold that can be parameterized is several ways, including Euler angles plus scale and translation, matrix group logarithm, Riemannian tangent space. In all cases, a set of 7 parameters is required: 3 for translation, 3 for rotation and 1 for scale. Hypothesis testing was performed on these parameters to assess for statistical differences in the relative pose among structures. Student's t-test was performed on the scale parameter and Hotelling T2 test on the subsets of rotation/translation parameters. Statistical significance was assessed with a permutation test with 1e5 permutations and Bonferroni correction.

Results:

Figures 1 and 2 show the maps of the square root of Hotelling T2 statistic for global and structure-wise alignment respectively. Although significant regions were found in both cases, the location of the most significant regions is completely different. The reasons of these differences can be the following ones: if a given structure suffers a disease-related displacement without deformation, significant differences would be observed in the maps with global alignment, but not in the structure-wise case because the location information is exclusively in the pose parameters; on the other hand, a local shape difference between groups (for example, an atrophy of the hippocampus tail) could be partially compensated by the structure-wise alignment yielding a significant atrophy at the opposite extreme of the structure.
Statistical analysis of the pose information was performed using the following parameterization: the 3 independent parameters of the rotation matrix logarithm, the translation vector and log of the

scale parameter. Values of Student's t- and Hotelling T2-statistic are given in Fig. 3 for each structure. Significant differences (p-value of 0.05 after correction) are highlighted.
The scale parameter was found significant at all selected structures except both caudate nuclei. The most significant volume differences were found at hippocampi, thalami and right amygdala. The subset of translation parameters was significant for all subcortical structures except for both amygdalae. The most significant displacement was found in both caudate nuclei. Regarding to rotation parameters, the structures with the most significant rotation were both amygdalae.
The number of comparisons using landmark coordinates is much higher than in the case of pose parameters. Accordingly, the multiple comparisons correction will be more severe in the former case and the differences in pose parameters (Fig. 3) will be much more significant than in landmark coordinates (Fig. 1-2).

Conclusions:

Statistical shape analysis performed on landmark coordinates is very sensitive to the alignment procedure because the coordinates are not a pose invariant feature. Very different patterns of shape differences were found between AD patients and normal elderly subjects from ADNI study when using global and structure-wise alignment. In addition, the Procrustes alignment depends on the spatial distribution of landmarks on the structure. Therefore, the interpretation of these statistical maps must be done very carefully. It may be argued that the conclusions found in many previous brain shape studies should be reformulated.
Most previous brain shape studies are focused on a single structure and disregard the information of relative pose within the brain. In this study significant differences were found at some pose parameters of subcortical nuclei when comparing AD patients and controls. In our opinion, this information, which includes volumetry, deserve more attention in future studies.

Left	Accu	Amyg	Caud	Hipp	Pal	Puta	Thal
Rot	2.8	9.2 *	4.1 *	7.7 *	1.9	3.3	2.5
Trans	5.4 *	3.2	7.1 *	5.0 *	5.2 *	4.4 *	4.9 *
Scale	4.0 *	5.5 *	2.5	7.4 *	4.4 *	5.1 *	6.3 *
Right	Accu	Amyg	Caud	Hipp	Pal	Puta	Thal
Rot	2.6	9.3 *	4.8 *	4.2 *	2.5	3.2	2.7
Trans	5.1 *	2.6	6.8 *	4.6 *	3.8 *	5.1 *	4.1 *
Scale	5.6 *	7.2 *	2.6	7.3 *	4.4 *	4.5 *	6.3 *

References:

Mueller, S. (2005), 'The Alzheimer's disease neuroimaging initiative', *Neuroimaging Clin N Am*, vol. 15, no. 4, pp. 869-77.
Smith, S. (2004), 'Advances in functional and structural MR image analysis and implementation as FSL', *NeuroImage*, vol. 23, no. Suppl 1, pp. S208-19.

Categories

- Anatomical Studies (Neuroanatomy)