Age-related Brain Activity Difference during Arithmetic Testing: An fMRI Investigation

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PURPOSE

To investigate the neural basis for aging effect on single-digit multiplication using functional magnetic resonance imaging (fMRI).

METHOD AND MATERIALS

Nineteen younger and twenty aged subjects were required to perform single-digit multiplication and control tasks in magnetic resonance (MR) scanner.

RESULTS

For behavioral measures, our results revealed no differences in two age groups in accuracy and reaction time (RT) performance. For fMRI analysis, single-digit multiplication, relative to detecting-zero, yielded multiple frontal, temporal and parietal activations for both younger and aged participants, however, aged adults exhibited more extensive activation in medial frontal areas and less extensive activation in temporal and parietal lobes as compared with younger adults. Direct group comparisons showed that aged adults exhibited greater activity in right and left supplementary motor area (SMA), and weaker activity in bilateral parahippocampal gyri together with a cluster in right middle temporal gyrus.

CONCLUSION

Our findings indicate that, healthy aged adults enhance control of fact retrieval in SMA to compensate the deficits in temporal lobe memory system. Moreover, our findings provide supportive evidence for posterior-anterior shift in aging (PASA) pattern in arithmetic problem solving domain.

CLINICAL RELEVANCE/APPLICATION

fMRI can demonstrate the neural basis of cognitive alteration in normal aging and patient. It has the potential to diagnose neurodegenerative disease in early stage.
frontotemporal dementia: 17 patients with C9ORF72 mutation and 10 patient with PGRN mutation. The severity of FLAIR hyperintensity was rated using the Fazekas & Schmidt score. The type of FLAIR hyperintensities was rated using a 3-level score: A- vascular type; B- vascular type predominating in the areas of atrophy; C-non vascular type. The presence of regional atrophy was scored as follow: presence or absence of an anteroposterior gradient of atrophy; presence or absence of a left-to-right or right-to-left gradient of atrophy.

RESULTS

Interrater agreement was moderate for Fazekas & Schmidt score (0.50 {0.16-0.68}) and was high for the type of FLAIR intensities (0.79 {0.56-0.91}), the presence of anteroposterior gradient of atrophy (0.78 {0.61-1}) and the presence of left-to-right or right-to-left gradient of atrophy (0.73 {0.52-0.94}) (weighted kappa tests). Atypical FLAIR hyperintensities (type B-C) were present in 90% of patients with PGRN mutation, while only 12% with C9ORF72 mutation. Asymmetrical anterior atrophy, characteristic of frontotemporal dementia, was present in 70% of patients with PGRN mutation, while only 18% of patients with C9ORF72 mutation.

CONCLUSION

Major phenotypic differences distinguish on brain MRI C9ORF72 and PGRN mutations, which are both related to frontotemporal dementia with TDP-43 inclusions. This result demonstrates that gene-related effects can overpass lesion-related effects in the phenotypic expression of frontotemporal dementias.

CLINICAL RELEVANCE/APPLICATION

In patients presenting with frontotemporal dementia, neuroradiologists should raise the possibility of a genetic form linked to PGRN mutation when atrophy is particularly marked, and associated with atypical FLAIR hyperintensities, predominating in the areas of atrophy.

Cognitive Dysfunctional in Patients with Early Type 2 Diabetes: A Preliminary BOLD fMRI and MR Spectroscopy and DTI Study

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PURPOSE

There are few studies about cognitive impairment in early type 2 diabetes using fMRI technique. To evaluate cognitive dysfunction in early type 2 Diabetes patients with psychological tests and BOLD fMRI. To analyze MR spectroscopy change in prefrontal cortex (PFC) and white matter abnormal by DTI.

METHOD AND MATERIALS

Twenty-five patients with early type 2 diabetes mellitus and 15 demographically similar, healthy subjects were enrolled. A series cognitive function tests including Wechsler memory scale-revised(WMS-R) were assessed; DTI, Bold fMRI (using nback working memory task) and single-voxel MRS with TE 30 on bilateral PFC were performed. The statistic differences of psychological tests and MRS result between the two groups were evaluated by SPSS. The fMRI data were analyzed by SPM2. DTI data were processed using FSL package, Tract-Based Spatial Statistics(TBSS) to detect the FA/MD group difference.

RESULTS

(1) psychological tests showed that the scores of cognitive tests in diabetes group were significantly lower than those in control group. (2) fMRI examinations revealed that the activation pattern in diabetes group was similar with the control group, but less activation in prefrontal, parietal lobe. There was additional activation in right temporal lobe (including inferior temporal gyrus and parahippocampus gyrus) and anterior cingulate cortex in diabetes group. (3) MRS data showed that comparing with control group, Glx/Cho,Cr were significantly elevated in bilateral PFC; NAA/Cho,Glx/Cho,Glx/Cr were significantly elevated in the right PFC. Transit memory was negatively correlated with Glx/Cho (F=-0.546, P value =0.013) and Glx/(Cr+Cho) (F=-0.471, P value =0.036). 4) DTI: patients group showed significant MD increase in right temporal WM and right superior longitudinal fasciculus (SLF) and right anterior internal capsule , FA showed decrease trend in those area in patients group.

CONCLUSION

Advanced neuroimaging techniques could detect microstructure and functional abnormalities in type 2 diabetic patients with normal appearing on conventional MR. The hypofunction in PFC in fMRI, abnormal white matter connectivity in DTI, and Glx elevation in MRS correlated with cognitive memory dysfunction, and may reveal early pathophysiological process and corresponding compensation.

CLINICAL RELEVANCE/APPLICATION

Advance functional MRI technique could detect early brain cognitive damage in patient with type 2 diabetes.
METHOD AND MATERIALS

Our sample was composed by n=85 individuals distributed in three groups: 1) SLE with episodic memory deficits (SLE+) (n=17); 2) SLE without episodic memory deficits (SLE-) (n=34); 3) controls without episodic memory deficits (n=34). Groups were matched on age, education, sex, MMSE, and SLICC. Episodic memory deficits were defined by performance on Rey Auditory Verbal Learning Test. All the participants were examined on a 1.5 Tesla MRI scanner. The protocol of image acquisition was: FLAIR sequence with axial and sagittal T1 3D MPRAGE. The FreeSurfer software was used to perform the cortical volumetric reconstruction and segmentation. One-way ANOVA and ANCOVA (time of diagnosis as a co-variate) analysis were performed in SPSS software.

RESULTS

Results indicated significant differences between SLE+>SLE- and SLE+>controls in the volume of the third ventricle. Co-variance analysis showed significant minor volume of right and left thalamus in SLE+ when compared to SLE-. No differences among groups were found in focused attention performance.

CONCLUSION

Our findings indicated group effects on right and left thalamus and on the third ventricle volumes. These findings are consistent with evidences of hippocampal-diencephalic interactions associated to episodic memory performance in SLE.

CLINICAL RELEVANCE/APPLICATION

Findings presented here suggest that thalamus may be the first episodic memory-related structure to be affected in the volumetric-anatomical level in SLE when the hippocampus is intact. An additional hypothesis would be that thalamus connections have a critical role in disrupting several neuropsychological processes in SLE.

SSG11-05

Right Arcuate Fasciculus Disruption in Chronic Fatigue Syndrome


PURPOSE

(1) Detect microstructural abnormalities underlying chronic fatigue syndrome (CFS) using diffusion tensor imaging (DTI), (2) assess if gray and/or white matter volumes are abnormal utilizing T1-weighted volumetric analysis, and (3) detect suspected global alterations in brain perfusion using pseudo-continuous arterial spin labeling (ASL).

METHOD AND MATERIALS

15 CFS patients and 14 controls provided informed consent in accordance with Stanford’s Institutional Review Board and HIPAA. Subjects underwent 3.0T volumetric T1 and T2-weighted imaging, two DTI acquisitions, and ASL. Segmentations of supratentorial gray and white matter and cerebrospinal fluid were used to compare gray and white matter volume fractions and cortical thickness. DTI was processed with automated fiber quantification (AFQ), which compares piecewise fractional anisotropy (FA) along 20 tracks. The FreeSurfer segmentation was used to compare cerebral blood flow.

RESULTS

Bilateral white matter volume and right thalamic volumes were reduced in the CFS population. In CFS, FA was increased in the right arcuate fasciculus, and cortical thickness increased in both of its endpoints: the right middle temporal and right precentral gyrus. In right-handers, FA was also increased in the right inferior longitudinal fasciculus, and thickness increased in one endpoint, the right occipital lobe. Within CFS patients, right anterior arcuate FA as well as basal ganglial volumes increased with disease severity. ASL showed no significant differences.

CONCLUSION

Bilateral white matter and right thalamic atrophy are present in CFS. Right hemispheric increased FA and cortical thickness are present, suggestive of a compensatory or pathological network. Right anterior arcuate FA may serve as a biomarker for CFS.

CLINICAL RELEVANCE/APPLICATION

Automated tractography can be useful for studying the microstructure underlying neurological disorders.

SSG11-06

Intrinsic Functional Connectivity of the Default Mode Network is Associated with Symptom Severity in Schizophrenia

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PURPOSE
Chronic schizophrenia (SCZ) is characterized by decreased intrinsic functional connectivity of the default mode network (DMN) as compared to healthy controls. The purpose of the present study was to investigate if intrinsic functional connectivity of the DMN is associated with symptom severity as estimated by the positive and negative symptom scale (PANSS).

METHOD AND MATERIALS
Resting state functional connectivity data was obtained from 23 SCZ patients (mean age 37.9 +/- 11.8 yrs, 8 female). Functional EPI sequences and a high-resolution MPRAGE sequence were acquired at 3.0 Tesla (Magnetom VERIO, Siemens, Germany). Preprocessing was performed using FSL 4.16. The DMN of each individual was extracted applying dual regression independent component analysis. Voxel-wise regression coefficients for the psychological test items PANSS (subscales total, positive symptoms and negative symptoms) and trait anxiety were estimated by using a mixed-effects general linear model. Significantly correlated voxels are reported at a threshold of p < 0.005.

RESULTS
Within the DMN connectivity of the medial prefrontal cortex was negatively correlated with severity of positive symptoms and anxiety. Connectivity between the DMN and the right striatum was negatively correlated with general symptom severity as measured by the PANSS total score. No correlation between severity of negative symptoms and DMN connectivity was detected.

CONCLUSION
Intrinsic functional connectivity of the DMN as measured by resting state functional MRI is not only capable of detecting group differences between SCZ patients and healthy controls but can also provide an imaging correlate for differential symptom severity in SCZ patients.

CLINICAL RELEVANCE/APPLICATION
As an imaging correlate of symptom severity in SCZ, DMN connectivity might serve as an imaging marker to monitor treatment effects and as a potential intermediate phenotype for schizophrenia risk genes.

SSG11-07
Appropriate Imaging Utilization: A Meta-analysis of Neurological Imaging in First Episode Psychosis
Wilfred Dang BS (Presenter): Nothing to Disclose, Sabina Imran Khan MBBS: Nothing to Disclose, James P. Ross BSc: Nothing to Disclose, Santanu Chakraborty FRCR, DMRD: Speakers Bureau, Merck KGaA Speakers Bureau, Novartis AG Grant, Bayer AG

PURPOSE
The low diagnostic yield associated with the usage of CT/MRI imaging in first episode psychosis (FEP) has caused a change in British guidelines to decrease redundant neuroimaging. However, imaging for FEP is still common in North America and remains a point of controversy. The purpose of this study is to assess current literature regarding the diagnostic value for FEP neuroimaging. This will help us determine the necessity of head CTs/MRIs in clinical practice for FEP patients.

METHOD AND MATERIALS
Electronic searches were performed in MEDLINE, PSYCHINFO and EMBASE in November 2013. Search criteria consisted of: "Psychotic Disorders", "Psychosis", "MRI", "CT", "Predictive Value of Tests", "Differential Diagnosis", "Biomedical Technological Assessment" and syntax derivatives of these search terms. After duplicates were removed, two reviewers screened 545 articles for inclusion. Studies included needed to meet the following: a) Patients must be presenting with FEP, b) Patients had a CT or MRI at the time of presentation, c) Studies must have reported abnormal or normal image results, and d) The rationale of the scan must be reported. Disputed articles between reviewers were resolved by a senior neuro-radiologist. All statistical analyses were performed using the Comprehensive Meta-Analysis Software. The event rate was computed as the number of patients with abnormal radiological findings possibly accountable for psychosis over the total number of patients that underwent imaging. Event rates for CT and MRI were summarized in separate forest plots, with the corresponding 95% confidence interval for each study.

RESULTS
Preliminary results from 8 abstracted studies show that, out of 1,019 CT/MRI scans, 838 scans were completely normal, whereas some abnormalities were observed in only 181 scans. Most abnormalities seen were either benign or incidental and did not have any impact on patient management. The calculated overall rate of abnormal findings that accounted for psychosis was 0.9% (95% CI: 0.5%-1.9%).

CONCLUSION
Given the low diagnostic yield of neuroimaging for FEP, more consideration needs to be given to ordering a head CT/MRI for FEP due to radiation and resource utilization concerns.

CLINICAL RELEVANCE/APPLICATION
Neuroimaging for FEP has very little value in determining the cause for psychosis and should be re-evaluated in psychiatric guidelines.

SSG11-08
Investigating the Predictive Value of Whole-brain Structural Neuroimaging in Obsessive Compulsive Disorder: A Multivariate Pattern Classification Approach
Disorder: A Multivariate Pattern Classification Approach

PURPOSE

Obsessive-compulsive disorder (OCD) is one of the most common disabling psychiatric disorders. Many magnetic resonance imaging (MRI) studies have already revealed brain structural abnormalities in OCD patients involving both gray matter (GM) and white matter (WM). However, results of those publications were based on average differences between groups, which limited their usages in clinical practice. Multivariate pattern analysis (MVPA) approach is a promising analytical technique which allows the classification of individual observations into distinct groups. Therefore, the aim of this study was to examine whether the application of MVPA to high-dimensional structural MR images would allow accurate discrimination between OCD patients and healthy control subjects (HCS).

METHOD AND MATERIALS

High-resolution T1-weighted volumetric 3D MR images were acquired for 33 OCD patients and 33 demographically matched HCS using a 3.0 T MRI system. Structural images were preprocessed with the Diffeomorphic Anatomical Registration using the Exponentiated Lie algebra (DARTEL) toolbox. Differences in GM volume and WM volume between OCD and HCS were examined respectively using two sorts of well-established MVPA techniques, namely, Support Vector Machine (SVM) and Gaussian Process Classifier (GPC). We also drew a receiver operating characteristic (ROC) curve to help evaluate the performance of each classifier.

RESULTS

Results of SVM and GPC classification between OCD patients and HCS utilizing both GM and WM were shown in the figure. Overall, the classification accuracies for both classifiers regarding GM and WM anatomy were all above 75% and the highest classification accuracy (81.82%, \( P < 0.001 \)) was achieved with SVM classifier using WM information.

CONCLUSION

The current study illustrated that both GM and WM anatomical features might be used to classify OCD patients from HCS. WM volume with SVM approach showed the highest accuracy in current population to reveal group differences, which indicated its potential diagnostic role in helping detecting OCD.

CLINICAL RELEVANCE/APPLICATION

Using multivariate pattern analysis approach, we revealed structural MR images might be used to classify obsessive compulsive disorder from controls and provided supports for its potential role as a diagnostic tool.

Abnormal Functional Connectivity of the Default Mode Network in First-episode, Drug-naive Major Depressive Disorder: A Resting-state fMRI Study

PURPOSE

Dysconnectivity hypothesis posits that major depressive disorder (MDD) relates to abnormal resting-state connectivity within the default-mode network (DMN). Posterior cingulate cortex (PCC) is believed to have a key role in DMN and be involved in the pathophysiology of MDD. The goal of this study is to investigate whole-brain functional connectivity of PCC during resting state in subjects with MDD.

METHOD AND MATERIALS

A total of 17 patients with first-episode, drug-naive MDD patients and 30 healthy well-matched volunteers were prospectively examined. Resting-state brain functional connectivity analysis was used to examine the correlation between the PCC and whole-brain regions.

RESULTS

Compared with healthy controls, MDD patients showed significantly decreased functional connectivity of the PCC in the left middle temporal gyrus and right superior frontal gyrus. Increased functional connectivity of the PCC was detected in the right insula, right transverse temporal gyrus, left precuneus, right lingual gyrus, left posterior cingulate, left superior/middle frontal gyrus, right cuneus, and right precuneus.

CONCLUSION

Our findings suggested that abnormal functional connectivity of the DMN exist in first-episode, drug-naive MDD and further highlight the importance of the DMN in the pathophysiology of MDD.

CLINICAL RELEVANCE/APPLICATION
Resting-state fMRI can demonstrate functional connectivity of the default mode network in MDD and further highlight the importance of the DMN in the pathophysiology of MDD.