Cerebral networks involved in internal scaling of spatial dimensions.

Published: 10-12-2013
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Primary goal: Identification with fMRI of specific cerebral activations during drawing of figures in different conditions.

Ethical review	Approved WMO
Status	Recruitment stopped
Health condition type	Other condition
Study type	Observational invasive

Summary

ID

NL-OMON38588

Source
ToetsingOnline

Brief title
Internal scaling of spatial dimensions.

Condition

- Other condition

Synonym
Healthy population

Health condition

Gezonde populatie

Research involving
Human

Sponsors and support

Primary sponsor: Universitair Medisch Centrum Groningen
Source(s) of monetary or material Support: Ministerie van OC&W

Intervention

Keyword: Drawing, fMRI, Premotor cortex

Outcome measures

Primary outcome

Localisation of condition-related increase in cerebral activation in the medial and lateral premotor cortex. A voxel-based analysis of task-related cerebral activation (increased BOLD responses) will be performed using 'Statistical Parametric Mapping' (SPM8). In this way differences in medial and lateral premotor cortex activation between the different experimental conditions will be quantified. The number of 16 subjects is enough for a random effects analysis of the fMRI data.

Secondary outcome

Not applicable.

Study description

Background summary

Motor information needs to be coupled to visual information of an object to grasp that object. Apart from spatial information about the location of the object, it is necessary to make an estimation about the size of the object to grasp it. To do this, sensory input and motor output must be integrated. The parietal cortex is involved in both the processing of spatial information and the generation of task-related movements. Furthermore the parietal cortex is part of the so-called 'dorsal stream', positioned between the primary and secondary visual areas and the premotor cortex. This network supports visually-guided actions, spatial navigation and spatial working memory. In a previous experiment we created selective dyscongruence in axial orientation, which showed that there is perceptual and executive specialization of visuomotor control in movements. During the transformation with dominance of motor information there was activation of the left premotor cortex, while during transformation of dominant visual information there was activation of

the right dorsal premotor cortex and the right posterior parietal cortex. In a behavioural experiment patients with Parkinson's disease (PD) were not able to perform these tasks. They followed the visual example instead of the instructed direction of drawing, which suggests a disturbance in maintaining the own internal spatial system in PD. An other component of visuomotor transformation is the scaling of the size of objects. It is reasonable to assume that there is an internal reference system for scaling of size of subjects. Prediction of size of an object without holding it is based on visual information about the distance of the object with reference to other objects in the direct environment and/or the size with reference to one's own body. The underlying cerebral mechanisms, in which premotor and parietal cortex undoubtedly have a clear role are currently unknown.

In our earlier experiment patients with PD drew figures with the same orientation bigger, after leaving out direct visual feedback on their own drawings. This points to a problem with the maintenance of an internal reference system of spatial dimensions, This also seems to play a role in micrographia, which is an early symptom in this disease, with a prevalence varying from 15% to 50%. Micrographia is characterized by a decrease in the movement amplitude during writing. Different explanations have been given for this phenomenon. Van Gemmert et al. proposed that micrographia in PD is caused by an increased complexity of the task at cerebral level. Apart from that, there is a strong correlation between micrographia and hypophonia and bradykinesia, although this does not have to be a causal relation because all three factors are influenced by the severity of the disease. PD patients can increase their size of writing when encouraged to do so, but this persists only for a short time. Furthermore, it has been shown that PD patients write bigger without visual feedback, which is consistent with the observation of de Jong et al. (1999). It can be questioned which cortical mechanisms are responsible for the fact that the size of writing is seemingly easily changeable. The possibility to change the size of writing with external stimuli suggests that there is a problem with internal scaling of size in PD. We hypothesize that there is a shift from medial to lateral premotor cortex involvement when an external stimulus is presented. This can explain the improvement in size of writing in the presence of an external stimulus or by an increase in attention. From functional imaging studies it is known that there is dysfunction of the medial premotor cortex in PD patients, while the lateral premotor cortex is spared. The lateral premotor cortex is activated during the selection of movements evoked by external stimuli, while the supplementary motor area (SMA) is activated in the absence of external stimuli. A comparable dichotomy between these areas is created during motor learning with SMA activation during learned motor sequences, while the lateral premotor cortex is activated during learning of new motor sequences. This shift can explain why patients change the size of writing when reminded to write bigger, because a different (attention-related) neuronal network is used with activation of the lateral premotor cortex.

It is necessary to gain insight in the cerebral networks involved in internal

scaling of size at a more basal level. To do so we will do a functional MRI (fMRI) study with 16 healthy volunteers. We expect that copying of figures causes activation of the cerebral network involving the medial premotor cortex, apart from visual and parietal areas. When presenting the same reference object with the task to draw it two times bigger or smaller, this extern object causes a change in the use of the internal defined spatial system. The expectation is that more lateral premotor cortex areas will be activated, in particular the left dorsal premotor cortex, and also the left ventral premotor cortex together with activation of the antero-inferior parietal cortex. We expect that drawing the original reference object at presentation of the same object of a different size causes activation of the right lateral premotor cortex and postero-superior parietal cortex. This is comparable to the earlier described executive and perceptual specialization of visuomotor control of movements. Apart from these specific effect in the lateral premotor cortex we expect a general effect of increased activation in the SMA in every dyscongruence between stimuli and motor action, in comparison with exact copying of the example. By gaining insight in the functional balance between medial and lateral premotor areas in the described tasks, we expect to gain more insight in the fundamental organization of motor actions and visuomotor disturbances in PD.

Study objective

Primary goal: Identification with fMRI of specific cerebral activations during drawing of figures in different conditions.

Study design

3T fMRI is used to measure task-induced blood oxygen level dependent (BOLD) responses, that are caused by an increase in regional perfusion. This measure gives an index of the distribution of local neuronal activations. Before scanning handedness is quantified using the Edinburgh Handedness Inventory. During the fMRI measurements subjects are presented with 6 different conditions via a beamer. The following experimental conditions are distinguished: (1: total visuomotor congruence) drawing the reference figure (square, circle, diamond or triangle), with variations in the figures to keep one's attention, (2: total visuomotor congruence, different sizes) the reference figure is presented in different sizes and must be copied, (3: visual dyscongruence, but also motor memory) the reference figure is presented in different sizes, but subjects must draw the original reference figure, (4: motor dyscongruence) A: the reference figure is presented in different sizes and must be copied two times bigger, B:the reference figure is presented in different sizes and must be copied two times smaller, (5: visuomotor congruence, different sizes, control for motor memory) the reference figure is shown and needs to be drawn in different sizes, but the presented figures are a different figure than the reference figure (6) a rest condition during which subjects will fixate on a

point on the screen.
A condition takes 20 seconds (2 seconds instruction and 6 times 3 seconds drawing), the rest condition takes 17 seconds (2 seconds instruction, 15 seconds fixating on the screen). A block consists of 3 times the 6 conditions (about 6 minutes). A run consists of 4 blocks (total 23.4 minutes). Two runs of experimental conditions will be performed by the subjects. Between the two runs an anatomical (T1-weighted) scan will be made. Each condition is thus presented 24 times. A subject lies in the scanner for about 50 minutes.
Subjects draw on a specially designed writing case which lies in their lap. This writing case has also been used during a previous fMRI experiment investigating writing in healthy subjects.
A voxel-based analysis of differences between task-related cerebral activations will be performed using 'Statistical Parametric Mapping' (version SPM8). The differences between the experimental conditions will be quantified.

Study burden and risks

Use of MRI is very safe, especially when precaution is taken to evaluate contraindications for the MRI scan. Subjects will be asked for contraindications during a telephone conversation. Before the MRI scan this will be checked again.The risks are nihil and the burden is considered small (1 hour time), which is why we think this study can be justified.

Contacts

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Trial sites

Listed location countries

Netherlands

Eligibility criteria

Age
Adults (18-64 years)
Elderly (65 years and older)

Inclusion criteria

Healthy right-handed persons aged 18-65 years.

Exclusion criteria

Subjects who suffer from specific neurological or psychiatric disorders or injury to the upper extremities will be excluded. Subjects who cannot go in the MRI scanner are also excluded. With neurological disorders we mean disorders for which the consult of a medical specialist was necessary: epilepsia, severe brain injury and temporary paralysis. Exclusion criteria for the MRI are for example the presence of ferromagnetic material in or on the body, pregnancy or claustrophobia. (specifief in the questionnaire) Furthermore, subjects who are right-handed, but draw with their left hand are excluded. Also, subjects with an uncorrectable abnormality in visual acuity will be excluded.

Study design

Design

Study type: Observational invasive

Masking:	Open (masking not used)
Control:	Uncontrolled
Primary purpose:	Basic science

Recruitment

NL

Recruitment status:	Recruitment stopped

Start date (anticipated):	11-12-2013
Enrollment:	16
Type:	Actual

Ethics review

Approved WMO Date:	10-12-2013
Application type:	First submission
Review commission:	METC Universitair Medisch Centrum Groningen (Groningen)

Study registrations

Followed up by the following (possibly more current) registration

No registrations found.

Other (possibly less up-to-date) registrations in this register

No registrations found.

In other registers

Register	ID
CCMO	NL46359.042.13