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Background

- Aphasia co-occurs with other types of different non-linguistic deficits one of which is executive functions (EF) impairments (Nicholasa & Connorb, 2016; Murray, 2017).
- Non-linguistic cognitive deficits, especially EF impairments, may influence language profiles, rehabilitation outcomes and chances for returning patients to normal life (Villard & Kiran, 2016; Murray, 2017).
- One of the EF that can influence the ability to readily and efficiently adopt rehabilitation programs and to influence outcomes is task switching (TS) (Nicholasa & Connorb, 2016; Murray, 2017).

Methods

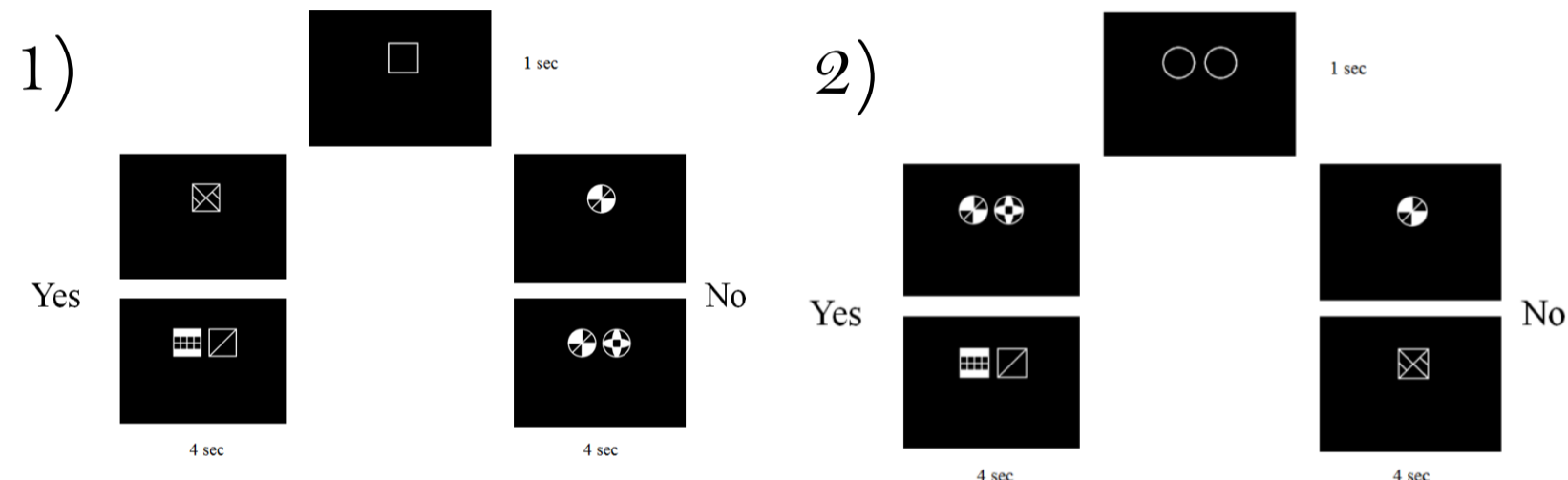
Participants

Twenty five healthy individuals (mean age: 38 ± 12.2 ; 6 men), out of which nineteen performed the same task after 1.5 months. Eighteen patients with aphasia and TS impairment (ten fluent and eight non-fluent; mean age: 45 ± 9.6 ; 8 men; 15 after left hemisphere CVA, 3 after TBI with left hemisphere damage; ranging from moderate to mild severity of aphasia). (All participants were right-handed native speakers of Russian).

1. TS task (for fMRI):

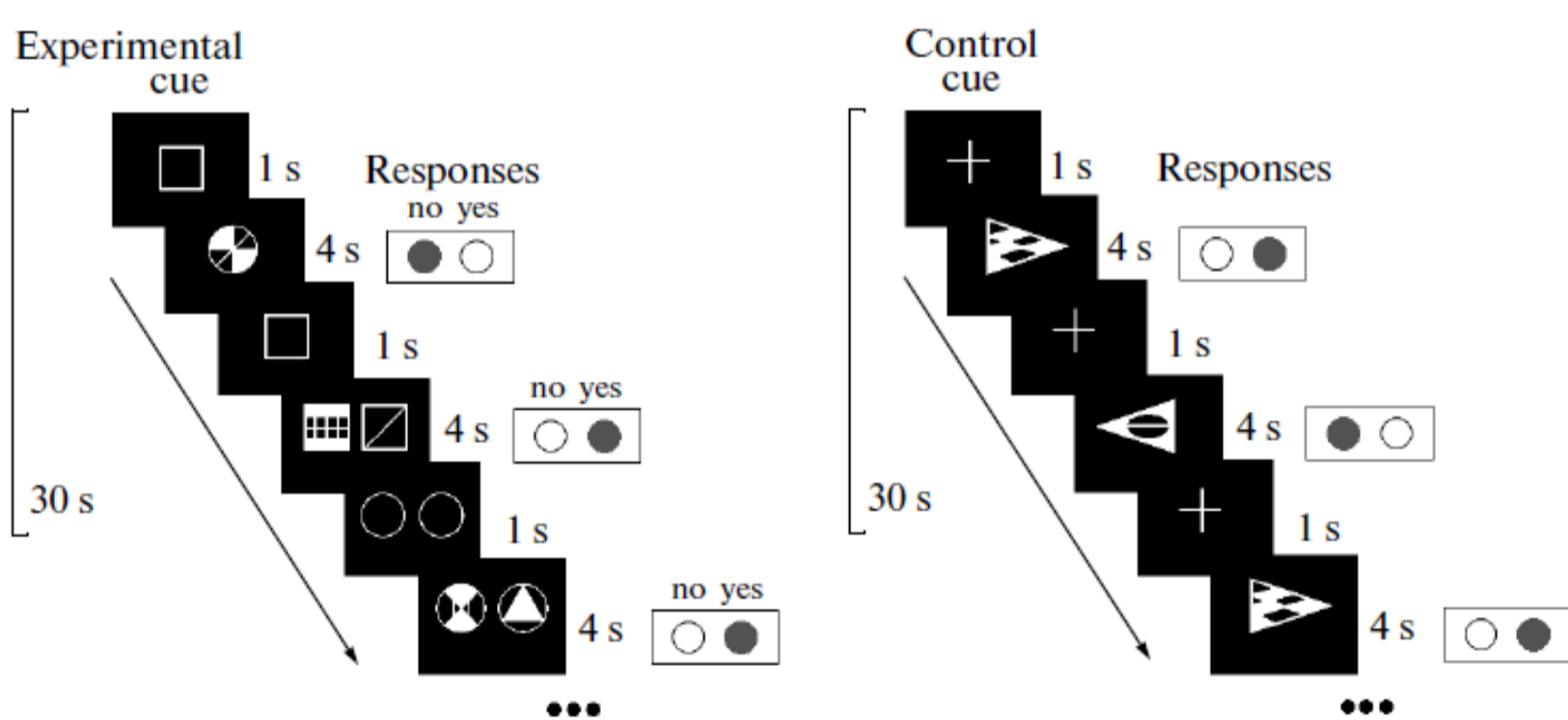
a. The experimental condition

the participants had to shift their attention between two objectives relying on the cues (classifying figures according to their form (circle/square) or number (one/two)) and press appropriate buttons.



b. The control condition

a triangle was presented, the participants had to press the button to which the angle of the triangle pointed



- fMRI session consisted of 16 blocks (8 experimental and 8 control)

- 1.5T Siemens Avanto scanner

BOLD: TE = 50 ms, TR = 3000 ms, FOV = 25 x 25 cm, 64 x 64 matrix, voxel dimension 3 x 3 x 3 mm high-resolution anatomical image: T1-weighted, MPRAGE; 0.98 x 0.98 x 1 mm; TE/TR 3/1900 ms

- fMRI data analysis was performed in SPM8 (for group level: $p < 0,001$, the threshold significance level of clusters $p(\text{FEW}) < 0,001$; for individual level: $p < 0,001$, the threshold significance level of clusters $p(\text{FEW}) < 0,01$)

2. Therapy for patients:

Each patient received two individual lessons with speech therapist and one with neuropsychologist five times a week for five weeks. After the intensive therapy targeting at recovery of language and executive functions, all the patients were discharged from the hospital with either good or pronounced improvements.

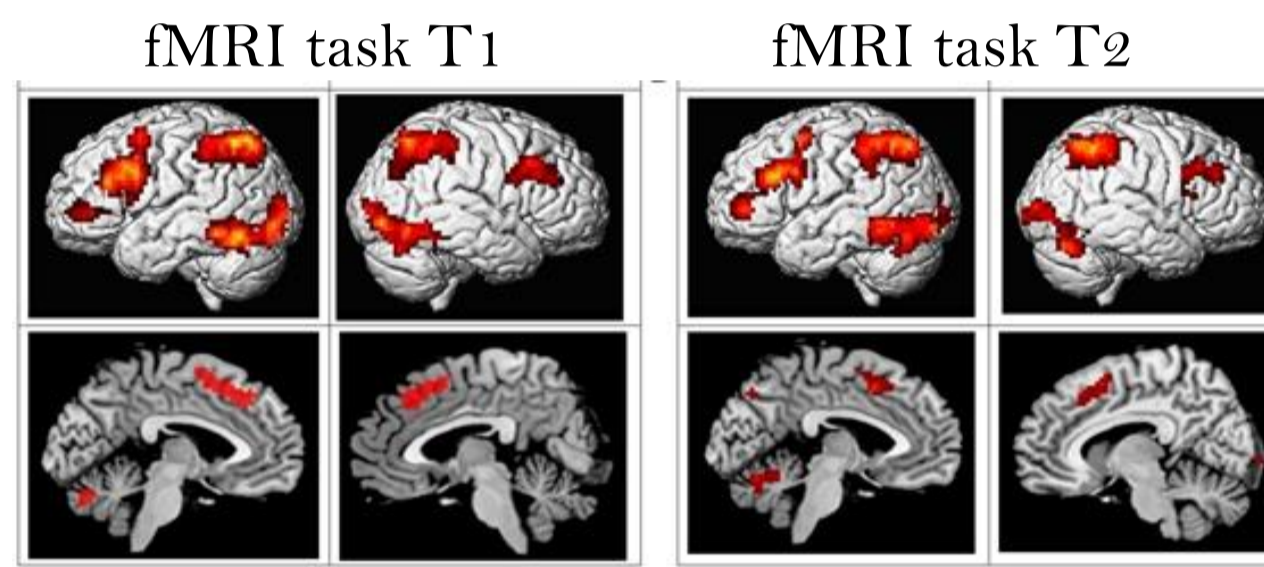
- All participants performed TS task for fMRI twice (T1 and T2, 1,5 month between sessions).
- Patients performed an fMRI task at the beginning (T1) and at the end (T2) of the rehabilitation.

Aims of the study

- Investigate how brain areas are reorganized after brain damage for performing of TS.
- Explore which brain areas take over the implementation of the impaired TS in patients with aphasia as well as functional cerebral reorganization of TS after intensive cognitive therapy.

Results

In healthy individuals the fMRI study revealed that a neuronal network controlling TS includes the dorsolateral prefrontal and inferior parietal cortical areas, as well as the secondary areas of the visual cortex, the supplementary motor area in the left hemisphere (LH) and the right hemisphere (RH) and cortical areas of the cerebellum bilateral.



No significant differences between first and second (after 1.5 month) fMRI test runs for healthy subjects were revealed.

Patients:

	fMRI task T1	fMRI task T2
Group 1. An asymmetric activation in frontal and parietal areas. At the end of the rehabilitation, there was a general decrease in activation but LH activation became more similar to that of healthy individuals.		
(four patients after LH CVA (two had fluent aphasia, three men), two with dominant activation in LH).		
Group 2. A very low activation of the brain, mainly in the frontal areas. After rehabilitation the activation primarily in frontal areas became more consistent with that of healthy subjects.		
(eight patients after LH CVA (four had fluent aphasia, three men)).		
Group 3. A very high and diffuse activation in most parts of brain. After rehabilitation a decrease of activation primarily in frontal areas was observed.		
(six patients: three after LH CVA and three after TBI (four had fluent aphasia, two men)).		

* All patients had additional activation in various brain areas (which was missing in healthy participants) at the beginning of the rehabilitation.

Discussion

➤ The repeated fMRI study of healthy individuals showed no significant difference which supports the reliability of an fMRI study and allows using this method to assess the impact of rehabilitation programs on patients with cerebral pathology.

➤ Comparison of fMRI data of each patient with a comparable norm group revealed three patterns of activation in patients with aphasia.

➤ These patterns didn't depend on localizations of brain damages, type of aphasia, age, the amount of brain damage time onset.

➤ The difference between the patients was only observed in the etiology of the disease which can be explained by the specificity and pathomorphological reactions of the brain typical for these disorders.

➤ Additional activation observed in patients (which non-existent in healthy subjects) can be due to: a) the TS task for patients is very difficult and additional brain resources are engaged; b) may reflect an unproductive brain work during performance of this task and can lead to impairment in this function and affect other functions.

➤ During positive rehabilitation the activation of brain became more consistent with that of healthy individuals. All this indicates that the brain has optimal and most functionally successful patterns of activations which are involved in performing the task.