Voice-training-induced plasticity in chronic nonfluent aphasia and apraxia of speech over a period of 5 years

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Introduction

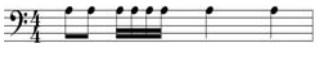
Difficulties with temporal coordination or sequencing of speech movements are frequently reported in aphasia patients with concomitant apraxia of speech (AOS). Evidence-based rhythmic-melodic voice training SIPARI® which was developed for language rehabilitation aims specifically at improving these capabilities.

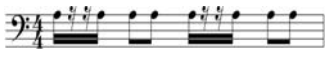
In our first fMRI study with patients, post- minus pre-treatment imaging data yielded significant peri-lesional activation in all patients particularly in the left superior temporal gyrus after a treatment period of six months. These activation changes correlated with significant improvements of patients' vocal rhythm production as well as their language, and speech motor performance (Jungblut et al., 2014). Our present objective was to investigate if and how this process continues over a period of five years.

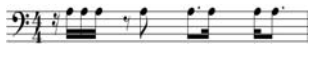
Methods

Patients:
3 patients with severe chronic nonfluent aphasia and AOS (1 Broca's, 2 global aphasia patients) were included in this long-term therapy study. Changes in language and speech-motor performance were examined 5 times by combining cognitive and neural methods.

Stimuli:
Patients underwent the same fMRI-procedure as 30 healthy control subjects in our pre-study (Jungblut et al. 2012) in order to investigate if changes in brain activation occur due to improved temporal sequencing. Stimuli consisted of chanted vowel changes with differing rhythm structure (see below). Stimuli were presented by fMRI compatible headphones (Resonance Technology).


(1) regular


(2) regular with rests


(3) irregular

Task:
The experiment was conducted in an event-related design. Stimuli were presented in a pseudo-randomized order and jittered around an interstimulus interval (ISI) of 9 sec.
Patients had to immediately repeat the heard stimuli after the presentation had stopped. Their vocal production was recorded and analyzed.

Data Acquisition:
The study was performed on a 3T Siemens Trio MRI-system. We used a T2*-weighted EPI sequence (TR 2200ms, TE 30ms, FA 90°); 41 transversal slices with a thickness of 3.4 mm were acquired covering the whole brain.

Data Analysis:
Imaging data were analyzed using SPM 12. Functional data were derived from subject specific, fixed-effect analyses with an FWE-corrected p-value of p=0.05 and an extend threshold of 5 voxel for each single subject.

References

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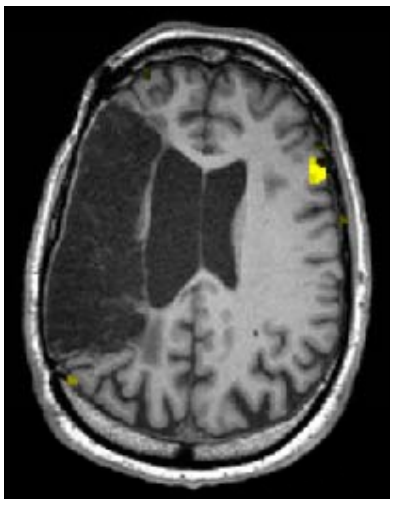
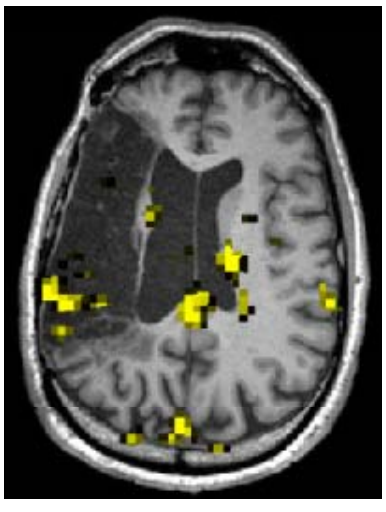
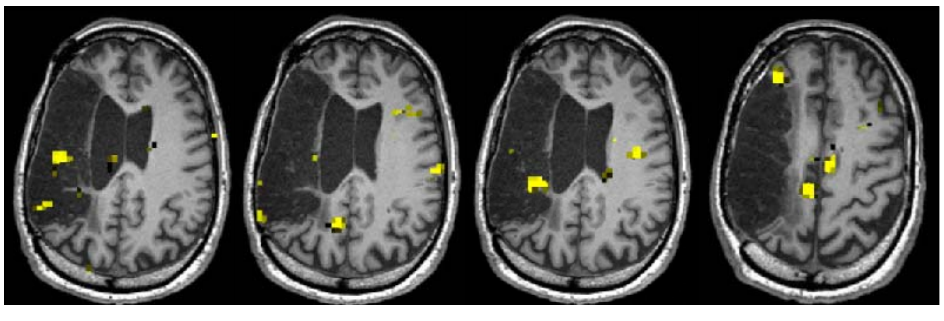
Results

Please see the results of one patient (5 scans over a period of 5 years)


1 – 5


5 - 1


2 - 1 3 - 2 4 – 3 5 - 4

For each follow-up assessment, post-minus pre- imaging data yielded further additional peri-lesional activations in all patients primarily in the left superior temporal gyrus.
Likewise, clinically significant improvements could be assessed in each follow-up language and motor-speech test, resulting in an overall change of the aphasia syndrome in two of the patients. Only the last post-minus pre- imaging data analysis (5 – 4) yielded additional peri-lesional activation in the middle frontal gyrus. Follow-up analyses of the recorded data demonstrated that with increasing therapy duration patients also improved significantly in their temporal sequencing performance.

Discussion

Based on our findings, we assume that an improvement of phonological short-term memory and, as a result of this, improved temporal sequencing of sublexical material possibly represents a basis for improved speech-motor processing but also for significant improvements of language capabilities.
Functional reintegration of the left superior temporal gyrus is mentioned in the literature in connection with language improvement. However, these research reports refer to language therapy interventions.
Our results suggest that especially in the treatment of severely impaired chronic aphasia patients with concomitant AOS the applied rhythmic-melodic voice training SIPARI® can be very effective because it targets specific language deficits but also cognitive function. The fact that even over a period of five years significant improvements could be achieved continuously and substantiated by underlying mechanisms of reorganization should give rise to further research.

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