Long-term recovery in chronic nonfluent aphasia and apraxia of speech

3 single case studies over a period of five years

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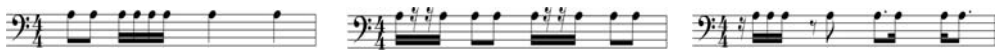
Introduction

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).

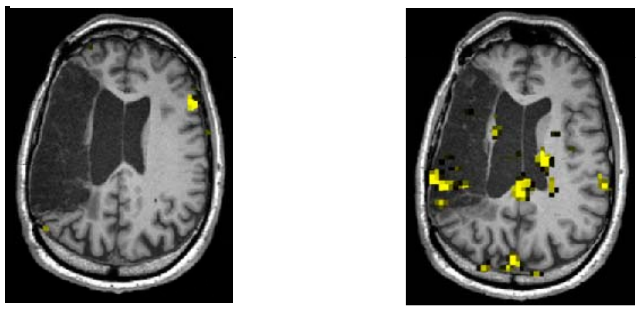


(1) regular (2) regular with rests (3) irregular

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.

Results

Mr. U



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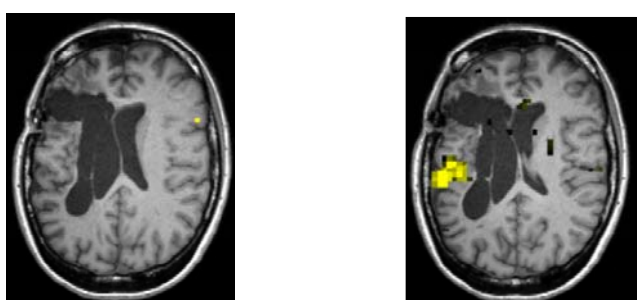
Mrs. A



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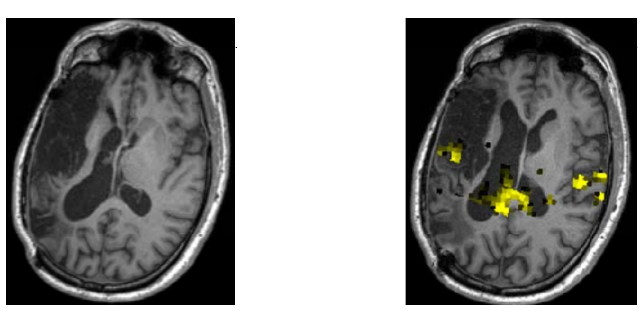
Mr. H



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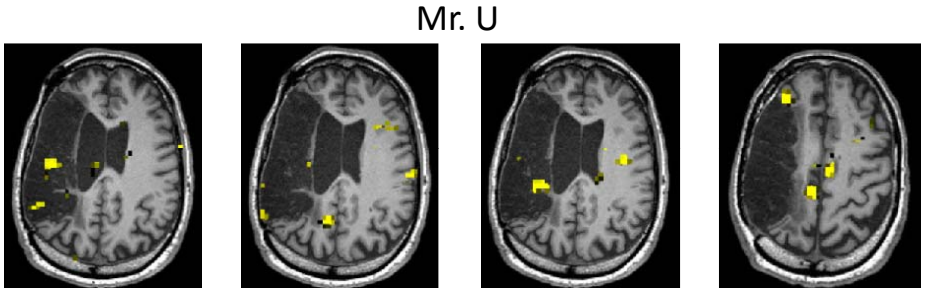
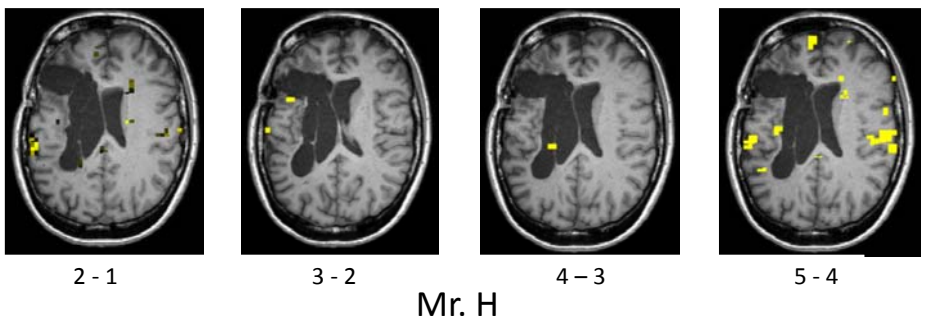


2 - 1 3 - 2 4 – 3 5 - 4

Mrs. A



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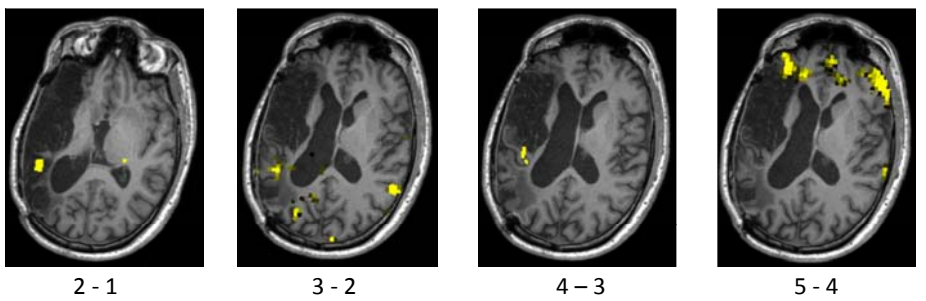
Mr. H



2 - 1 3 - 2 4 – 3 5 - 4

For each follow-up assessment, post-minus pre- imaging data yielded further additional peri-lesional activation in all patients, particularly in the left middle and superior temporal gyri.
Especially the last post-minus pre-imaging data analyses (4-5) showed additional peri-lesional activation in frontal regions.
Post- and pre-test comparisons revealed clinically significant improvements for all patients in each follow-up language and motor-speech test.
A continuous significant increase in profile level, an overall and clinically relevant measure of the severity of aphasia, finally resulted in an improvement of the aphasia syndrome in two of the patients (from Broca's to anomic aphasia, from global to Broca's aphasia).
Significant motor-speech improvements were assessed concerning phonetic and phonemic structure of words and speech fluency.
Follow-up analyses of the recorded data demonstrated that with increasing therapy duration patients improved significantly in their temporal sequencing performance.

Discussion

Based on our findings, we assume that an improvement of short-term storage of sublexical phonological material and, as a result of this, improved temporal sequencing possibly represents a basis for improved speech-motor processing but also for significant improvements of language capabilities.
In this connection, functional reintegration of the left superior temporal gyrus seems to be decisive. Concerning language improvement, corresponding reports, although referring to language therapy interventions, emphasize its' auditory-motor integration function by translating acoustic speech signals into articulatory representations of the frontal lobe.
Our results suggest that 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.
As far as we know, comparable long-term studies are not available as yet, neither from the field of language therapy nor from the field of music therapy and from voice training in particular.

References

Bradt, J., Magee, W.L., Dileo, C., Wheeler, B.L. & McGilloway, E. et al. (2010), 'Music therapy for acquired brain injury' [Review], *Cochrane Database of Systematic Reviews*, 7, 1-42.
Breier, J.I., Juranek, J., Maher, L.M., Schmadeke, S., Men, D. & Papanicolaou, A.C. (2009), 'Behavioral and neurophysiologic response to therapy of chronic aphasia,' *Archives of Physical Medicine and Rehabilitation,* 90 (12), 2026-2033.
Crosson, B., McGregor, K., Gopinath, K.S., Conway, T.W., Benjamin, M., Chang, Y.L., Bacon Moore, A., Raymer, A.M., Briggs, R.W., Sherod, M.G., Wierenga, C.E. & White, K.D. (2007), 'Functional MRI of language in aphasia: a review of the literature and the methodological challenges,' *Neuropsychology Review,* 17, 157-177.
Jungblut, M. (2009), 'SIPARI® A music therapy intervention for patients suffering with chronic, nonfluent aphasia', *Music and Medicine*, 1 (2), 102-106.
Jungblut, M., Huber, W., Pustelniak, M., Schnitker, R. (2012), 'The impact of rhythm complexity on brain activation during simple singing - an event-related fMRI study,' *Restorative Neurology and Neuroscience*, 30 (1), 39-53.
Jungblut, M., Huber, W., Mais, C., Schnitker, R. (2014): Paving the way for speech: voice-training-induced plasticity in chronic aphasia and apraxia of speech – three single cases. *Neural Plasticity* Vol. 2014, Article ID 841982, 14 pages. doi:10.1155/2014/841982
Jungblut, M., Huber, W. Schnitker, R.(2016): Rhythm structure influences auditory-motor interaction during anticipatory listening to simple singing. *Journal of Speech Pathology and Therapy* 1: 108. doi:10.4172/jspt.1000108

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