

Research Area: Clinical and Cognitive Neuropsychology

(Head: Prof. Dr. Bettina Mohr-Pulvermüller)

Area of research and current research projects

- Neurorehabilitation and cortical reorganisation in post stroke aphasia
- Post Stroke Depression
- Cognitive and motor processing in autism spectrum disorders
- Functional lateralisation in healthy individuals and in neuropsychiatric disorders
- Neuroimaging (EEG, MEG, fMRI) of language

I Aphasia therapy, Neurorehabilitation and Cortical Reorganisation after stroke

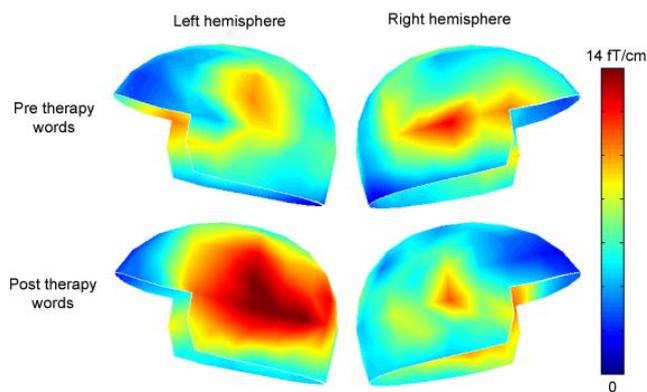


The functional restitution of language in aphasia patients with chronic language and communication disabilities is the focus of this research. We have developed a highly effective method for treating language problems in stroke patients. This method, called **Intensive Language Action Therapy (ILAT)**, an extension of **Constraint-Induced Aphasia Therapy (CIAT)** is based on neuroscientific principles. ILAT comprises language training, delivered in a highly intensive fashion, usually 3 hours per day over a period of two weeks. ILAT is usually delivered in a group setting of three patients and one therapist.

Findings from our most recent randomized-controlled clinical trials showed that:

- ILAT leads to significant language improvements, even in patients with chronic aphasia, several years after stroke onset
- ILAT is more effective than intensive naming therapy or conventional aphasia treatment
- Already two hours of ILAT per day over the course of two weeks improves language functions
- ILAT is effective in reducing depressive symptoms in chronic aphasia patients

Neuroimaging data demonstrate that brain reorganisation after ILAT occurs in perilesional brain regions in the left hemisphere and in frontal areas in the right hemisphere. These neuroplastic changes correlate with clinical language improvements after treatment.



Neuroplastic changes to words before and after ILAT-therapy in patients with chronic non-fluent aphasia.

Magnetencephalography (MEG) results: Topographical MEG field gradient maps showing distribution of the auditory magnetic mismatch negativity (MMNm) responses to words for the pre- and post-therapy session over the left and right hemisphere (170-210 ms after word onset). from Mohr et al. (2016). *Neuropsychologia*

II Post stroke depression in chronic aphasia

Post-stroke depression (PSD) is among the most frequent neuropsychiatric consequences of stroke, affecting ca. 40% of stroke sufferers. Negative consequences of depression include increased morbidity, mortality and poorer functional recovery. So far, the causes of PSD are largely unknown and translational research on PSD is rather limited.

The aim of our research is to investigate a variety of neuropsychological, biological and social factors that contribute to PSD in patients with chronic aphasia. Moreover, we address the effects of therapeutic interventions in this patient group. Our most recent data show that Intensive Language Action Therapy (ILAT) leads to a significant reduction of symptoms of depression in patients with chronic aphasia (Mohr et al., in revision). This clinical improvement can be explained by the positive effects of behaviourally relevant training of verbal communication and associated positive social interactions in small group settings characteristic of ILAT.

Both research projects on aphasia are conducted in close collaboration with researchers at the Freie Universität Berlin and the University of Malaga, Spain.

Selected recent publications:

- Mohr, B., Stahl, B., Berthier, M., & Pulvermüller, F. (2017). Intensive communicative therapy reduces symptoms of depression in chronic non-fluent aphasia. (in revision)
- Mohr, B. 2017. Neuroplasticity, functional recovery and intensive language therapy in chronic post stroke aphasia: Which factors are relevant? *Frontiers in Human Neuroscience*, 11:332. doi.org/10.3389/fnhum.2017.00332
- Stahl, B., Mohr, B., Dreyer, F.R., Lucchese, G., & Pulvermüller, F. 2017. Communicative-pragmatic assessment is sensitive and time-effective in measuring the outcome of aphasia therapy. *Frontiers in Human Neuroscience*, 11:223, doi: 10.3389/fnhum.2017.00223
- Lucchese, G., Stahl, B., Dreyer, F., Pulvermüller, F. & Mohr, B. 2016. Therapy-Induced Neuroplasticity of Language in Chronic Post Stroke Aphasia: A Mismatch Negativity Study of (A) Grammatical and Meaningful/less Mini-Constructions. *Frontiers in Human Neuroscience*, 10:669. doi: 10.3389/fnhum.2016.00669
- Stahl, B., Mohr, B., Dreyer, F., Lucchese, G., Pulvermüller, F. 2016. Language therapy in social interaction: Communication mechanisms promote recovery from chronic

aphasia. *Cortex*, 85, 90-99.

Mohr, B., MacGregor, L.J., Difrancesco, S., Pulvermüller, F., Shtyrov, Y. 2016. Therapy induced left-hemispheric changes in word-specific brain activation in aphasia: Evidence from magnetoencephalography. *Neuropsychologia*, 93, 413-424.

MacGregor, L., Difrancesco, S., Pulvermüller, F., Shtyrov, Y., Mohr, B. 2015. Ultra-rapid access to words in chronic aphasia: The effects of intensive language action therapy (ILAT) *Brain Topography*, 28, 279-291.

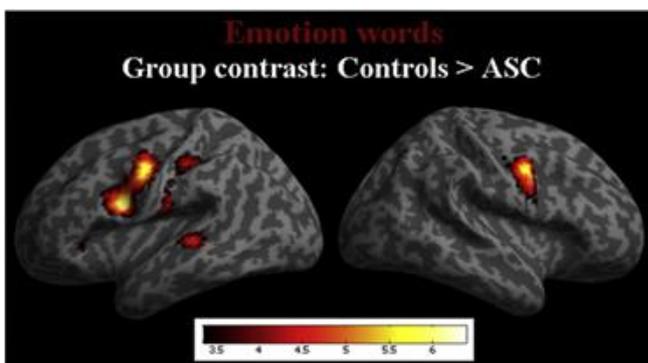
Mohr, B., Difrancesco, S., Harrington, K., Evans, S., Pulvermüller, F. 2014. Increase of right-hemispheric activation after intensive language action therapy (ILAT) in chronic aphasia: fMRI evidence from auditory semantic processing. *Frontiers in Human Neuroscience*, 14, doi: 10.3389/fnhum.2014.00919.

III Cognitive and motor processing in Autism Spectrum Disorders

Autism spectrum conditions (ASC) are neurodevelopmental disorders associated with deficits in language, sensory perception, motor skills and social interaction. This clinical condition often leads to chronic and devastating impairments in daily life. However, the underlying cause of ASC is still unknown. Our research aims at investigating the neuropsychological, neurophysiological and motor correlates of action-semantic processing in ASC to gain insight into the neuronal mechanisms underlying this condition. Neuropsychological profiles and electrophysiological signs are mapped on to clinical symptoms to identify specific markers that are of diagnostic and prognostic value.

Our previous findings indicate that individuals with ASC show reduced brain activation in the motor cortex and in limbic brain structures specifically when processing emotion words. This hypoactivity does not occur in brain areas unrelated to emotion processing and correlates with severity of clinical symptoms. The data suggest that sensory-motor deficits may help to explain problems in emotion processing and other clinical symptoms in ASC.

This research is conducted in close cooperation with researchers at Charité, Department of Psychiatry, CBF and the University of Bournemouth, UK.



Differences in brain activation (measured with fMRI) between individuals with autism spectrum conditions (ASC) and neurotypical controls (Controls). Statistical group contrast (controls > ASC) for emotion words (red). from Moseley et al. (2015). Neuroimage.

Selected recent publications:

- Moseley, R.L., Correia, M.M., Baron-Cohen, S., Shtyrov, Y., Pulvermüller, F. Mohr, B. 2016. Reduced volume of the arcuate fasciculus in adults with high-functioning autism spectrum conditions. *Frontiers in Human Neuroscience*, 10:214. doi: 10.3389/fnhum.2016.00214.
- Moseley, R., Shtyrov, Y., Mohr, B., Lombardo, M.V., Baron-Cohen, S., Pulvermüller, F. 2015. Lost for emotion words: What motor and limbic brain activations reveal about autism and about semantics in general. *Neuroimage*, 104, 413-422.
- Moseley R., Pulvermüller F., Mohr B., Lombardo M., Baron-Cohen S., Shtyrov Y. 2014. Brain routes for reading in adults with and without autism: EMEG Evidence. *Journal of Autism and Developmental Disorders*, 44, 137-153.
- Ludlow, A., Mohr, B., Whitmore, A., Garagnani, M., Pulvermüller, F., Gutierrez, R. 2014. Auditory processing and sensory behaviours in children with Autism Spectrum Disorders as revealed by mismatch negativity. *Brain and Cognition*, 86, 55-63.
- Moseley, R. L., Mohr, B., Lombardo, M. V., Baron-Cohen, S., Pulvermüller, F. 2013. Action-semantic deficit in autism: behavioural and brain manifestation. *Frontiers in Human Neuroscience*, 7, doi:10.3389/fnhum.2013.00725

IV Neuroimaging (EEG, MEG, fMRI) of language and functional lateralisation in healthy individuals and in neuropsychiatric patients

The focus of this research area is on the neuropsychology and neurophysiology of language processing and on the functional connection between the two cerebral hemispheres. Neuroimaging data have shown that patterns of brain activation are strongly dependent on the semantic content of words. For example, action-related words elicit brain activation in language areas of the brain and in the motor cortex in both hemispheres. In contrast, function words without semantic content are strongly lateralised to the left hemisphere. We are investigating under which experimental conditions the two hemispheres exchange information and activate interhemispheric neuronal networks. There is evidence that in some psychiatric conditions (e.g. in schizophrenia, autism spectrum disorders, etc.), the functional connection within or across the two cerebral hemispheres might be impaired, which could be associated with specific clinical symptoms or neuropsychological deficits.

Selected publications:

- Moseley, R., Carota, F., Hauk, O., Mohr, B., Pulvermüller, F. 2012. A Role for the Motor System in Binding Abstract Emotional Meaning. *Cerebral Cortex*, 22, 1634-1647.
- Pulvermüller, F., Kherif, F., Hauk, O., Mohr, B., Nimmo-Smith, I. 2009. Cortical cell assemblies for lexical and category-specific semantic processing as revealed by fMRI cluster analysis. *Human Brain Mapping*, 30 (12), 3837-3850.
- Mohr, B., Pulvermüller, F., Rockstroh, B., Endrass, T. 2008: Hemispheric cooperation –A crucial factor in schizophrenia? Neurophysiological evidence. *Neuroimage*, 41, 1102-1110.

Mohr, B., Endrass, T., Pulvermüller, F., 2007: Neurophysiological correlates of the bilateral redundancy gain for words: An ERP study. *Neuropsychologia*, 45, 2114-2124.

Information for students:

If you are interested in undertaking research in any of these research areas, please contact me at: bettina.mohr@charite.de or Tel.: 030 450 517564

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