Complex brain landscape controls speech

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Up to now, Broca's region in the brain has been thought to comprise two areas, since it was discovered in 1861, it has been regarded as one of the two regions in the cerebral cortex responsible for language. The conception of the neuroanatomical basis of our speech must be revised in its entirety according to researchers from Juelich, Aachen, Duesseldorf and Leipzig in the current edition of the journal *PLoS Biology*.

Broca's region is classically regarded as the motor centre for speech. Our ability to form phonemes and words is controlled here. According to the maps of the cerebral cortex developed by Korbinian Brodmann, which are still in use today, Broca's region is composed of two areas. Over the last few years, however, researchers have begun to question this subdivision as a result of experience gained in clinical studies and the findings of magnetic resonance imaging analyses. "Lesions in Broca's region could result in a dozen different language problems," says Professor Katrin Amunts, brain researcher at Forschungszentrum Jülich and first author of the study. "For example, in articulation but also in comprehension or in grammar, as linguistic studies have shown. This tends to suggest a much more complexly structured centre of language than was previously believed."

The scientists therefore decided to take a closer look at the cytoarchitecture and distribution of different receptors in Broca's region. Receptor molecules are the key to signal transduction between neurons - and can therefore help to further classify structurally similar regions. If the distribution of receptors is different in these regions, then the

functions of the brain at these locations must also be different. "We discovered that Broca's region does not just comprise two areas, but rather several - all of which form a highly differentiated mosaic," says Professor Karl Zilles, co-author of this study. "It's a complex world that's dedicated to our faculty of speech."

The study shows, for example, a clear difference in the distribution of one receptor between the Broca areas of the two cerebral hemispheres and slight differences in the case of the other receptors. Further studies are required to determine whether this is the molecular basis for the different clinical findings in patients with lesions in Broca's region either exclusively in the left or right brain hemisphere. Patients with lesions in the left brain hemisphere completely lose their ability to speak, while those with lesions in the right-hand side can still articulate correctly but lose their speech melody.

"One of the tasks for the future is to conduct a detailed functional analysis of the new organization of Broca's region and to investigate the interaction of the previously unknown areas," says Amunts. A new project has already begun on the analysis of the second region in the brain responsible for the faculty of speech - Wernicke's area. Classically, this area is thought to be involved in the understanding of language.

The discovery in question of several molecularly and cellularly different cortical areas in Broca's language region and in neighbouring areas shows that our faculty of speech is actually embedded in a much more differentially developed brain landscape than we have believed for the past 150 years. The findings are not just important for language research and the diagnosis and treatment of strokes. They also alter the neurobiological basis for current discussions on the evolutionary development of language, speech training and language disorders.

More information: Amunts K, Lenzen M, Friederici AD, Schleicher

A, Morosan P, et al. (2010) Broca's Region: Novel Organizational Principles and Multiple Receptor Mapping. *PLoS Biol* 8(9): e1000489. doi:10.1371/journal.pbio.1000489