Two brain regions join forces for absolute pitch

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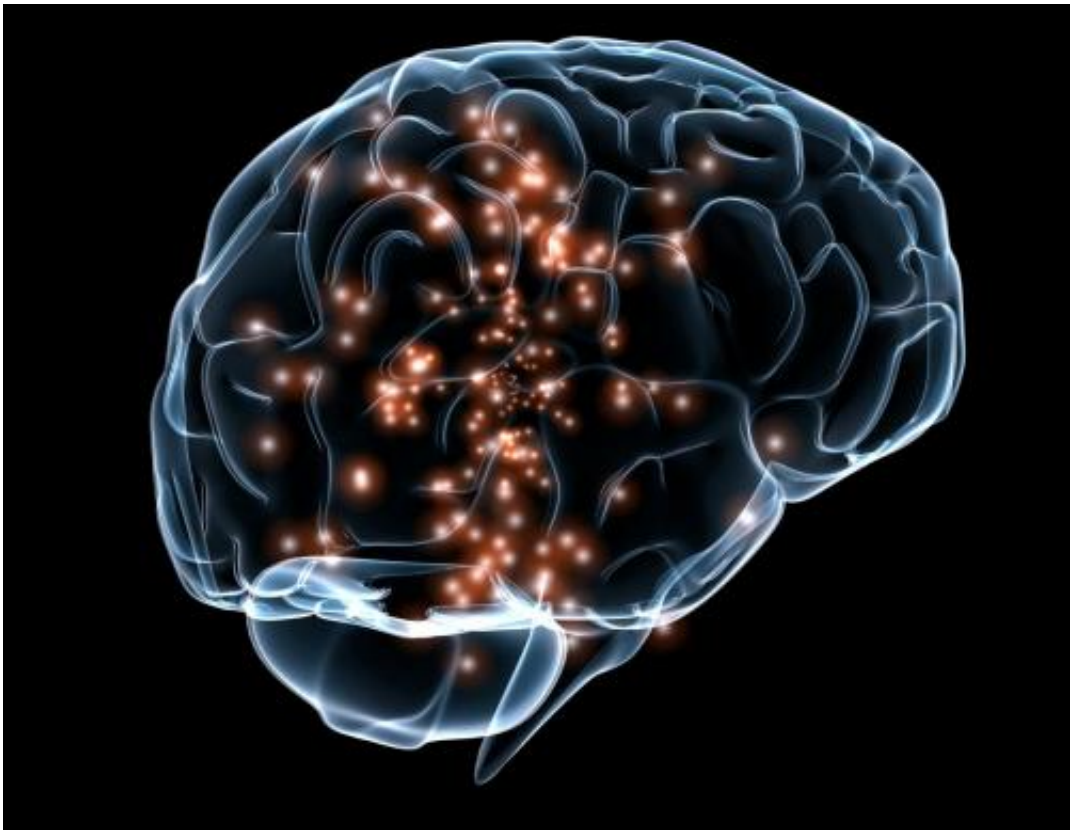

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People who have "absolute pitch" can identify notes immediately without relying on a reference tone. Intensive research is being conducted into the neuronal basis of this extraordinary ability at the University of Zurich's Department of Neuropsychology. The researchers

have now detected a close functional link between the auditory cortex in the brain and the frontal lobe in these extraordinary people – a discovery that is not only important in theory, but also in practice.

Mozart, Bach and Beethoven are all supposed to have had it: "absolute pitch" – the ability to identify and categorize a note without having to rely on any reference tones. People with absolute pitch perceive a note and can identify it accurately as C sharp, A or F sharp, for instance. Most other people are only able to distinguish between notes relatively. While, with a prevalence of one percent in the normal population, the remarkable ability is relatively rare, it is observed twenty percent more frequently in professional musicians. It is often suspected that this special hearing skill is a key aspect of extraordinary musical talent.

A team headed by Professor Lutz Jäncke has already been conducting intensive research into this phenomenon in the Music Lab at UZH's Department of Neuropsychology for many years. In a current study involving musicians with absolute pitch, there is now evidence that, according to first author Stefan Elmer, opens up a new view on the underlying psychological and neurophysiological processes involved in absolute pitch: "Our study shows how two brain regions, namely the auditory cortex and the dorsal frontal lobe, work together for absolute pitch. In the process, we combine two essentially conflicting explanatory approaches for the phenomenon."

Two theories on absolute pitch

One explanation assumes that people with absolute pitch already categorize the notes at a very early stage of sound processing. In other words, they process tones in the same way as speech sounds and assign them to particular categories, which is referred to as the categorical perception of tones. This theory assumes that the tones are already processed in the primary and secondary auditory cortex in the brain in

people with absolute pitch.

Another theory suggests that people with absolute pitch only process the notes later on and associate them with memory information. People with this gift supposedly master the subconscious allocation of the tones to memory information particularly well. These allocations primarily take place in the upper frontal lobe, in the dorsal frontal cortex. "Therefore, both theories make completely different statements regarding the moment and the anatomical location of the special processing and there is evidence to support both theories," explains Jäncke.

Connected brain regions explain the phenomenon

In his study, Stefan Elmer is now able to show that functionally the left-hand auditory cortex and the left-hand dorsal frontal cortex are already strongly linked in a dormant state – in other words, when there are no tasks to be performed. This functional coupling could be estimated based on a mathematical technique, which uses surface electroencephalography to extrapolate the brain activity inside the brain. In people with absolute pitch, the neurophysiological activity in the frontal and auditory cortex are synchronized, which suggests a close functional connection.

This means that the brain regions that control early perception functions (auditory cortex) or late memory functions (dorsal frontal cortex) are already tightly interwoven in a dormant state. "This coupling enables an especially efficient exchange of information between the auditory cortex and the dorsal frontal cortex in people with absolute pitch, which means that the perception and memory information can be exchanged quickly and efficiently," explains Elmer.

Training auditory perception

The results are not only important to understand absolute pitch, but also efficient auditory processing: "Auditory perception doesn't only depend on the integrity of the auditory cortex, but also especially on the linking of the auditory cortex with superordinate brain structures that process memory information," sums up Jäncke. Based on these results, it might be possible to develop training measures, which would improve the auditory skills in old age, but also in connection with different hearing impairments.

More information: Stefan Elmer, Lars Rogenmoser, Jürg Kühnis und Lutz Jäncke. "Bridging the gap between perceptual and cognitive perspectives on absolute pitch." The *Journal of Neuroscience*, 6. Januar, 2015. DOI: 10.1523/JNEUROSCI.3009-14.2015

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