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## **The plastic brain: Better connectivity of brain regions with training**

**Researchers at the Leibniz-Institutes für Wissensmedien (IWM) and of the Graduate School and Research Network LEAD at the University of Tübingen now found out: Short and intensive arithmetic training strengthens the neuronal connections between brain regions in adults. This neuronal plasticity through numerical learning was already detectable after only five training sessions.**

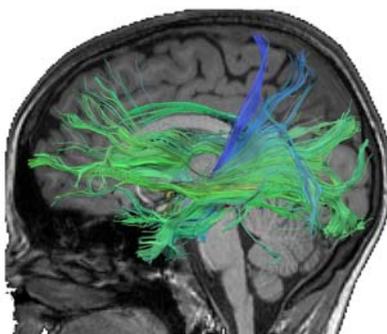
Tübingen, 02. July 2018. No matter whether a person learns new knowledge or a new body movement – synapses, nerve cell connections and entire brain areas, i.e. the function and structure of the brain, do always change. The human brain remains “plastic” for a lifetime, i.e. it is able to change. Researchers led by Dr. Dr. Elise Klein at the Leibniz-Institut für Wissensmedien (IWM) have investigated functional and structural changes of the brain as consequence of media-based numerical learning. It seems obvious that arithmetic training has an impact on our ability to calculate. The study demonstrated this on a neuronal level: The calculation training changed the network of brain areas that was activated when solving math calculations. However, the study has now also revealed structural changes in the brain as a result of calculation training - and thus anatomical changes in the neuronal network.

**The findings indicate how learning processes manifest themselves in the brain and show the potential of neurocognitive plasticity in adulthood.**

The calculation training not only successfully improved the performance of the participants, the researchers from Tübingen also succeeded in determining how this

learning process takes place on a neuronal level. In a previous study, they had already observed that training increases functional activation in brain areas associated with the retrieval of arithmetic facts from long-term memory (e.g. hippocampus). By using diffusion-weighted magnetic resonance imaging, the researchers have now been able to show that the training also strengthened the structural connection between these areas which led to a successful learning process. "The neuronal plasticity following media-based training was already evident after only five training units," says Elise Klein from the IWM. "This change at the neuronal level indicates that even short cognitive training sessions can induce plastic processes in the brain. The selectivity of the neurostructural changes, in turn, gives insight into the processing of arithmetical facts in the brain." The findings not only indicate how learning processes manifest themselves in the brain, but also show the potential of neurocognitive plasticity in adulthood.

Korbinian Moeller, head of the Junior Research Group Neuro-cognitive Plasticity, comments on the results of the study: "The study improves our understanding of the neuronal foundations of numerical learning and of the possibilities of neuronal reorganisation in the brain. The results can be used to develop interventions for children with learning disabilities and for patients with arithmetic difficulties after brain damage."



**Figure:**

Fiber connections of the brain passing through the Hippocampus and associated with the retrieval of numeric facts. Media-based training strengthened the conductivity of the fibers connected to long-term memory.

Results of the study have been published in the renowned journal "Cortex".



**Study:** <https://doi.org/10.1016/j.cortex.2018.05.017>

**More Information:**

Dr. Dr. Elise Klein  
NG Neuro-cognitive Plasticity  
Phone: +49 7071 979-205  
Email: e.klein@iwm-tuebingen.de

**Press:**

Mira Keßler  
Press Department  
Phone: +49 (0) 7071 979-222  
Email: presse@iwm-tuebingen.de

Since April 2015, Elise Klein has been working at the IWM in the junior research lab Neuro-cognitive Plasticity within the Wrangell Habilitation Programme. The researchers of the lab are particularly interested in the neural foundations of knowledge acquisition and knowledge application. The topical focus of the junior research group is on numerical cognition with particular interest being paid to the neural correlates of number processing as well as its development during childhood.



**The Leibniz-Institut für Wissensmedien**

The Leibniz-Institut für Wissensmedien (IWM) analyses how digital technologies can be used to improve knowledge processes. The psychological basic research of the 110 scientists is concerned with practical fields like school and university, knowledge work with digital media, knowledge-based internet use and knowledge transfer in museums. From 2009 till 2016, the IWM together with the University of Tuebingen organised the first Leibniz-ScienceCampus on the topic “Informational Environments” which has been running as follow-up project under the heading “Cognitive Interfaces” since 2017

**The Leibniz Association**

The Leibniz Association connects 93 independent research institutions that range in focus from the natural, engineering and environmental sciences via economics, spatial and social sciences to the humanities. Leibniz institutes address issues of



social, economic and ecological relevance. They conduct knowledge-driven and applied basic research, maintain scientific infrastructure and provide research-based services. The Leibniz Association identifies focus areas for knowledge transfer, especially in cooperation with the Leibniz museums, and informs policy-makers, academia, business and the public. Leibniz institutions collaborate intensively with universities – in form of “Leibniz ScienceCampi” (thematic partnerships between university and non-university research institutes), for example – as well as with industry and other partners at home and abroad. They are subject to an independent evaluation procedure that is unparalleled in its transparency.

### **About LEAD**

The LEAD Graduate School & Research Network features an integrated interdisciplinary research and training program for doctoral students and postdocs on Learning, Educational Achievement, and Life Course Development. Its aim is to contribute to the evidence-based approach in educational policy by securing empirical data on "what works" in education and to train highly qualified experts for research and practice. LEAD is funded by the Excellence Initiative of the German Research Foundation.