Auditioning for the brain

As we're learning, brain cells are "auditioned" and either hired or dismissed, based on their performance

by Elisabeth Wenger
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The long-held belief that "you can't teach an old dog new tricks" is probably wrong. Numerous studies of humans (and animals) have now shown time and again that both younger and older adults are indeed fully capable of learning new skills and information. Using magnetic resonance imaging, we can see that such learning is accompanied by an expansion of brain structure.

However, can the brain keep learning new skills without having to endlessly grow in size or volume? That question was first raised an incredible 123 years ago – by the ingenious Ramón y Cajal, considered by many to be the father of neuroscience – and is becoming ever more topical with the emerging field of "brain training." Endless expansion is certainly not nature's best solution to the phenomenon of lifelong learning, especially since the skull imposes quite definitive space restrictions.

Evidence suggests that the number of brain cells – such as neurons and glial cells – initially increases as we're learning, but decreases over time. We have observed this pattern of expansion and renormalization in a study in which right-handed people learned to write and draw with their left hand. After a month, their brain volume in motor-related brain areas had increased, but three weeks later these increases were barely detectable. If the subsequent contraction were due to people unlearning how to write with the left hand, this would not be surprising. However, we found that their task proficiency remained high or increased still further, although their brain had returned to (almost) its original size.

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In our most recent article in the journal *Trends in Cognitive Sciences*, my co-authors and I like to compare brain cells to actors auditioning for a movie, with the brain as the director: During learning, the brain holds an audition to find the cells best suited to the new job. To that end, it creates new cells, causing some brain regions to grow macroscopically in volume. The brain then tests these candidate cells to determine which are best at storing or carrying information.

The candidates that do this most efficiently are then kept, while the others are dismissed or cast in different roles. Such an auditioning process appears to be a quite natural way for the brain to remain efficient. Just as in other evolutionary processes, winnowing and selecting the best of several candidates has proved to be an immensely useful strategy. It is therefore conceivable that

the brain would adopt such a process to enable lifelong learning.

Our study is the first to demonstrate a pattern of expansion and renormalization of the brain in the course of skill acquisition in humans. This pattern has already been observed in animals, so we are by no means the first to propose or introduce the expansion–renormalization model. We are, however, the first to relate it to changes in the volume of human grey matter.

By doing this, we want to underscore the fact that the typical study design is simply insufficient to tell the full story of changes in the brain. We need designs that include more measurement time points in order to properly display plastic changes in brain volume — to "broadcast," so to speak, the brain's casting call in its full length.

Read more about this topic here:

Wenger, E., Kühn, S., Verrel, J., Mårtensson, J., Bodammer, N. C., Lindenberger, U., & Lövdén, M. (2017). Repeated structural imaging reveals non-linear progression of experience-dependent volume changes in human motor cortex. *Cerebral Cortex*, *27*, 2911-2925. doi:10.1093/cercor/bhw141

Wenger, E., Brozzoli, C., Lindenberger, U., & Lövdén, M. (2017). Expansion and renormalization of human brain structure during skill acquisition. *Trends in Cognitive Sciences,* 21(12), 930-939. doi:10.1016/j.tics.2017.09.008.