Practice Makes Permanent

Barbara Oakley, PhD, PE











COW



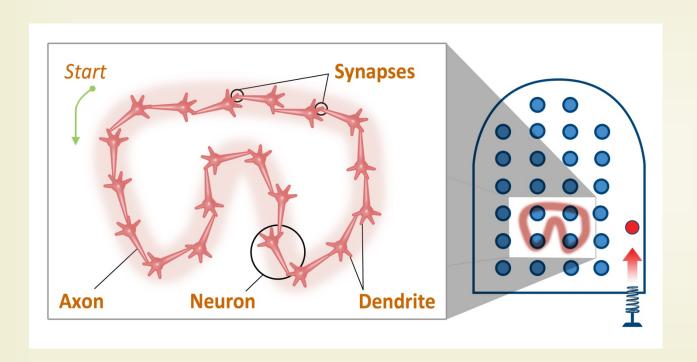
love, zest, hope?

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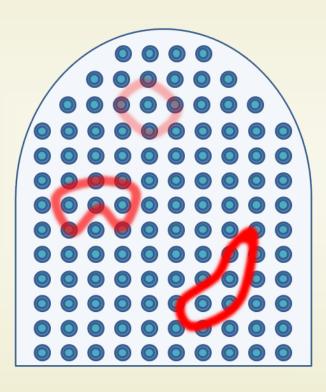
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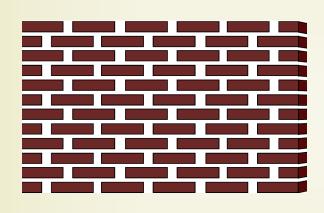
Creating a neural pattern



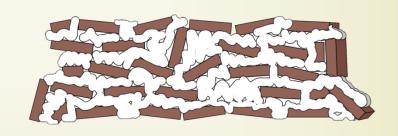
Practice makes permanent



Building strong neural structures



A little every day



All at once

Relevant Readings

- Brown, J.S., A. Collins, and P. Duguid. "Situated Cognition and the Culture of Learning." Educational Researcher 18, no. 1 (1989): 32-42.
- Dunlosky, John, Katherine A Rawson, Elizabeth J Marsh, Mitchell J Nathan, and Daniel T Willingham. "Improving Students' Learning with Effective Learning Techniques: Promising Directions from Cognitive and Educational Psychology." Psychological Science in the Public Interest 14, no. 1 (2013): 4-58.
- Ericsson, Karl Anders. Development of Professional Expertise. NY: Cambridge University Press, 2009.
- Geary, David C. The Origin of Mind. Washington, DC: American Psychological Association, 2005.
- Geary, David C, A Wade Boykin, Susan Embretson, Valerie Reyna, Robert Siegler, Daniel B Berch, and J Graban. "Task Group Reports of the National Mathematics Advisory Panel; Chapter 4: Report of the Task Group on Learning Processes." In, (2008): 2008. http://www2.ed.gov/about/bdscomm/list/mathpanel/report/learning-processes.pdf.
- Guida, A., F. Gobet, H. Tardieu, and S. Nicolas. "How Chunks, Long-Term Working Memory and Templates Offer a Cognitive Explanation for Neuroimaging Data on Expertise Acquisition: A Two-Stage Framework." Brain and Cognition 79, no. 3 (Aug 2012): 221-44.
- Karpicke, J effrey D. "Retrieval-Based Learning Active Retrieval Promotes Meaningful Learning." Current Directions in Psychological Science 21, no. 3 (2012): 157-63.
- Karpicke, J effrey D, and Phillip J Grimaldi. "Retrieval-Based Learning: A Perspective for Enhancing Meaningful Learning." Educational Psychology Review 24, no. 3 (2012): 401-18.
- Karpicke, J effrey D, and Henry L Roediger. "The Critical Importance of Retrieval for Learning." Science 319, no. 5865 (2008): 966-68.
- Karpicke, J effrey D, Andrew C Butler, and Henry L Roediger III. "Metacognitive Strategies in Student Learning: Do Students Practice Retrieval When They Study on Their Own?". Memory 17, no. 4 (2009): 471-79.

Relevant Readings (continued)

- Karpicke, J. D., and J. R. Blunt. "Retrieval Practice Produces More Learning Than Elaborative Studying with Concept Mapping." Science 331, no. 6018 (Feb 11 2011): 772-5.
- Karpicke, J.D., and J.R. Blunt. "Response to Comment on 'Retrieval Practice Produces More Learning Than Elaborative Studying with Concept Mapping'." Science 334, no. 6055 (2011): 453-53.
- Kornell, Nate, Matthew J ensen Hays, and Robert A Bjork. "Unsuccessful Retrieval Attempts Enhance Subsequent Learning." Journal of Experimental Psychology: Learning, Memory, and Cognition 35, no. 4 (2009): 989.
- Komell, N., A. D. Castel, T. S. Eich, and R. A. Bjork. "Spacing as the Friend of Both Memory and Induction in Young and Older Adults." Psychology and Aging 25, no. 2 (J un 2010): 498-503.
- McDaniel, M. A., and A. A. Callender. "Cognition, Memory, and Education." In Cognitive Psychology of Memory, Vol 2 of Learning and Memory, edited by Henry L Roediger. 819-43. Oxford, UK: Elsevier, 2008.
- Roediger, Henry L., and Mary A. Pyc. "Inexpensive Techniques to Improve Education: Applying Cognitive Psychology to Enhance Educational Practice." *Journal of Applied Research in Memory and Cognition* 1, no. 4 (2012): 242-48.
- Roediger, Henry L, and Andrew C Butler. "The Critical Role of Retrieval Practice in Long-Term Retention." Trends in Cognitive Sciences 15, no. 1 (2011): 20-27.
- Roediger, Henry L, and J effrey D Karpicke. "The Power of Testing Memory: Basic Research and Implications for Educational Practice." *Perspectives on Psychological Science* 1, no. 3 (2006): 181-210.
- Rohrer, Doug, and Harold Pashler. "Increasing Retention without Increasing Study Time." *Current Directions in Psychological Science* 16, no. 4 (2007): 183-86.
- Taylor, Kelli, and Doug Rohrer. "The Effects of Interleaved Practice." Applied Cognitive Psychology 24, no. 6 (2010): 837-48.
- See also extensive endnote references and discussions in Chapters 2 and 3, A Mind for Numbers, Barbara Oakley, Penguin, 2014.

Image credits

- Barbara Oakley, age 10, with Earl the lamb.
- Barbara Oakley, age 18, in the US Army.
- Barbara Oakley, on the Soviet trawler "Tigil" on the Bering Sea, 1983.
- Barbara Oakley at South Pole Station in Antarctica, 1983.
- Philip Oakley, Siple Station, Antarctica, 1982.
- http://en.wikipedia.org/wiki/File:Cow_female_black_white.jpg
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