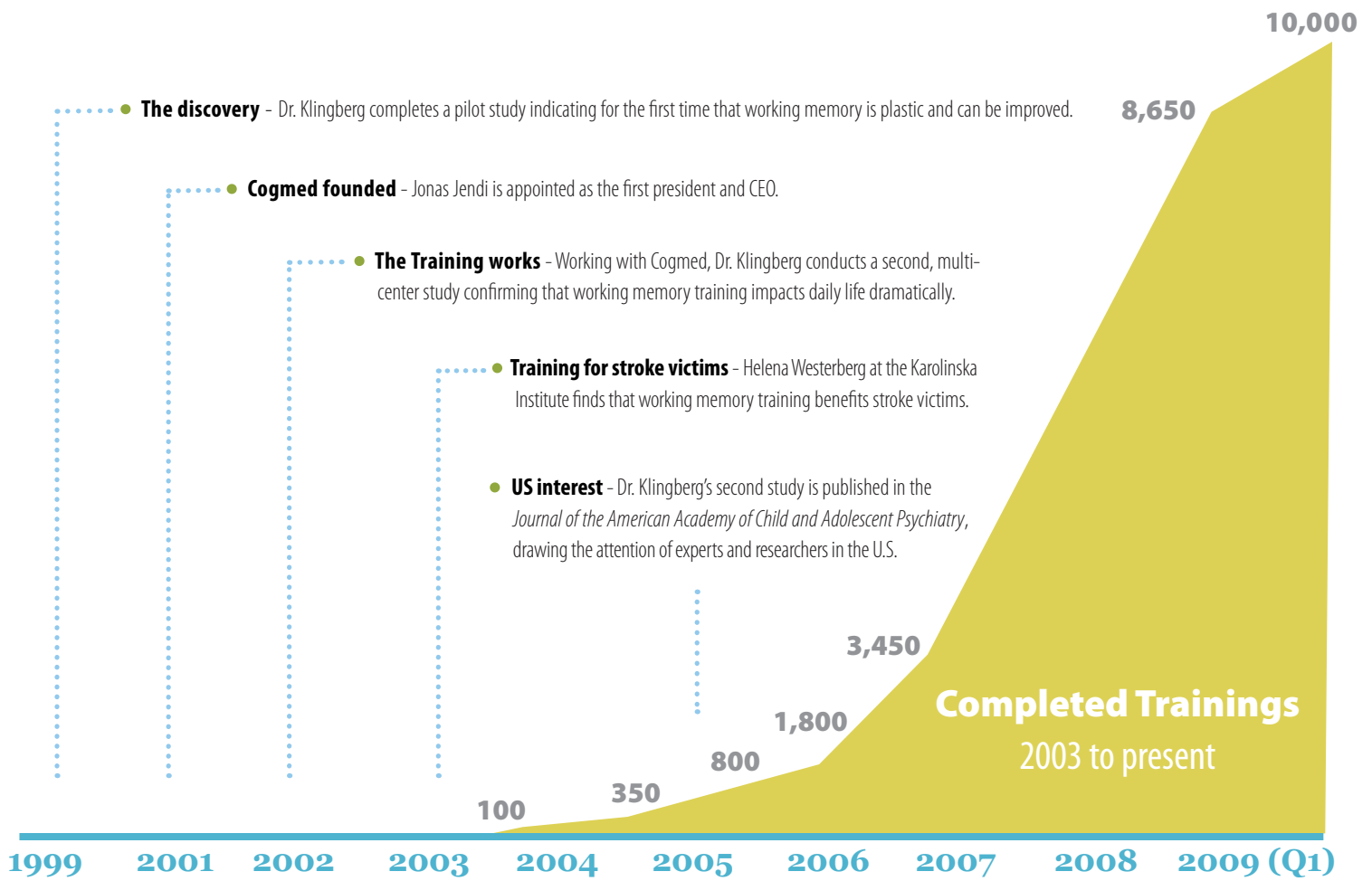


Moving beyond the brain's limits

Since its arrival in the scientific community, the concept of working memory has revealed new insights into the success and failure of the human mind in key circumstances. Working memory has been pushed into the mainstream as people begin to understand their performance in the context of this critical function. It is becoming an essential part of how we address questions like why can't I complete tasks at work? Why is my daughter struggling with math? Why is my father losing his mental edge?

But it is only during the past decade of intense research that the real impact of working memory has begun to be realized, most importantly, through the discovery that working memory can be substantially improved through training. This breakthrough changes the game for millions of people who are constrained by their working memory in one way or another. Thousands have embraced working memory training with dramatic success. Psychologists have begun to change the way they approach attention issues. Researchers are unlocking ways to help those with cognitive impairments regain control of their lives. Working memory training is helping move science and medicine into a new era in which the intricacies of the brain are better understood and addressed to improve quality of life on a broad scale.

The growth of working memory training



- **The discovery** - Dr. Klingberg completes a pilot study indicating for the first time that working memory is plastic and can be improved.

- **Cogmed founded** - Jonas Jendi is appointed as the first president and CEO.

- **The Training works** - Working with Cogmed, Dr. Klingberg conducts a second, multi-center study confirming that working memory training impacts daily life dramatically.

- **Training for stroke victims** - Helena Westerberg at the Karolinska Institute finds that working memory training benefits stroke victims.

- **US interest** - Dr. Klingberg's second study is published in the *Journal of the American Academy of Child and Adolescent Psychiatry*, drawing the attention of experts and researchers in the U.S.

- **North American launch** - Cogmed opens its North American headquarters in Naperville, IL and subsequently continues to expand across Europe, Asia and Australia

- **Early pioneers** - Drs. Lavin, Benninger, Katz and Ingersoll visit Cogmed's headquarters in Stockholm, becoming the first U.S. practitioners to offer the Cogmed Working Memory Training.

- **Research validation** - Dr. Bradley Gibson at the University of Notre Dame presents an independent study confirming the results of Dr. Klingberg's initial research.

- **A program for adults** - Cogmed announces Cogmed QM, a program designed especially for adults who want to improve working memory.

- **Training for professionals** - Westerberg shows that normal adults of all ages can dramatically improve their working memory through training.

- **Ongoing validation** - Dr. Chris Lucas at New York University replicates Klingberg's research, again showing the effectiveness of Cogmed training for students with ADHD.

- **Training for pre-schoolers** - Cogmed introduces Cogmed JM, a program for pre-school children to train their working memory.

- **Changing the brain** - Dr. Klingberg publishes a study in the prestigious journal *Science*, showing for the first time that training can impact the biochemistry of the brain.

- **Working memory and learning** - Dr. Joni Holmes, Darren Dunning and Dr. Susan Gathercole at the University of York publish research in *Developmental Science*, showing that Cogmed training improves academic performance.

References

- G.A. Miller, "The Magical Number Seven, Plus or Minus Two: Some Limits on our Capacity for Processing Information," *Psychological Review* 63 (1956): 81-97.
- Klingberg T, Forssberg H, Westerberg H (2002) Training of working memory in children with ADHD. *J Clin Exp Neuropsych* 24:781-791
- Olesen P, Westerberg H, Klingberg T (2004) Increased prefrontal and parietal brain activity after training of working memory. *Nature Neuroscience* 7:75-79
- Westerberg H, Hirvikoski T, Forssberg H, Klingberg T (2004) Visuo-spatial working memory: a sensitive measurement of cognitive deficits in ADHD. *Child Neuropsychology* 10 (3) 155-61.
- Mechelli, A., Crinion, J.T. Noppeney, U., O'Doherty, J., Ashburner, J., Frackowiack, R. S., et al. (2004). Structural plasticity in the bilingual brain. *Nature*, 431, 757.
- Klingberg T, Fernell E, Olesen P, Johnson M, Gustafsson P, Dahlström K, Gillberg CG, Forssberg H, Westerberg H (2005) Computerized Training of Working Memory in Children with ADHD – a Randomized, Controlled, Trial. *J American Academy of Child and Adolescent Psychiatry* 44 (2):177-186.
- H. Westerberg; H. Jacobaeus; T. Hirvikoski; P. Clevberger; M-L. Östensson; A Bartfai; T. Klingberg. Computerized working memory training after stroke – A pilot study. *Brain Injury*, (2007); 21(1): 21–29
- Beilock, S. L., Rydell, R. J., & McConnell, A. R. (2007). Stereotype threat and working memory: Mechanisms, alleviation, and spillover. *Journal of Experimental Psychology: General*, 136, 256-276.
- Thorell, L B, Lindqvist S, Bergman S, Bohlin G, Klingberg T (2008) Training and transfer effects of executive functions in preschool children. *Developmental Science*, 11(6): 969–976.
- McNab F, Varrone A, Farde V, Jucaite A, Bystritsky P, Forssberg H, Klingberg T. Changes in Cortical Dopamine D1 Receptor Binding Associated with Cognitive Training. *Science*, 323, 800 (2009)
- Holmes, J., Gathercole, S., Dunning, D. (2009). Adaptive training leads to sustained enhancement of poor working memory in children. *Developmental Science*.

Additional resources

About brain plasticity

Doidge, Norman *The Brain That Changes Itself: Stories of Personal Triumph from the Frontiers of the Brain Science*, by Norman Doidge

SharpBrains, a market research company focused on the brain fitness and cognitive health market, www.sharpbrains.com

About working memory

The Overflowing Brain: Information Overload and the Limits of Working Memory, by Torkel Klingberg

Baddeley A (2003) Working memory: looking back and looking forward. *Nat Rev Neurosci* 4:829-839.

Conway (ed) *Variation in working memory* (2007) Oxford Univ. Press.

www.aboutworkingmemory.com

Working memory and ADHD

Barkley RA (1997) Behavioral inhibition, sustained attention, and executive functions: constructing a unifying theory of ADHD. *Psychol Bull* 121:65-94.

Barkley RA, Murphy KR (2006) *Attention-deficit hyperactivity disorder: a clinical workbook*. New York: The Guilford Press.

Castellanos FX, Tannock R (2002) Neuroscience of attention-deficit/ hyperactivity disorder: the search for endophenotypes. *Nat Rev Neurosci* 3:617-628.

Martinussen R, Hayden J, Hogg-Johnson S, Tannock R (2005) A meta- analysis of working memory impairments in children with attention- deficit/hyperactivity disorder. *J Am Acad Child Adolesc Psychiatry* 44:377-384.

Westerberg H, Hirvikoski T, Forssberg H, Klingberg T (2004), Visuo- spatial working memory: a sensitive measurement of cognitive deficits in ADHD. *Child Neuropsychology* 10 (3) 155-61.

Attention Research Update, David Rabiner, www.helpforadd.com

About working memory and aging

Wilde NJ, Strauss E, Tulskey DS (2004). *J Clin Exp Neuropsychol*, 26.

About working memory and education

Gathercole SE, Pickering S (2003) Working memory deficits in children with low achievements in the national curriculum at 7 years of age. *British Journal of Educational Psychology* 70:177-194.

Gathercole, S, Alloway, T.P. (2009) *Working memory and learning – a practical guide for teachers*.



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