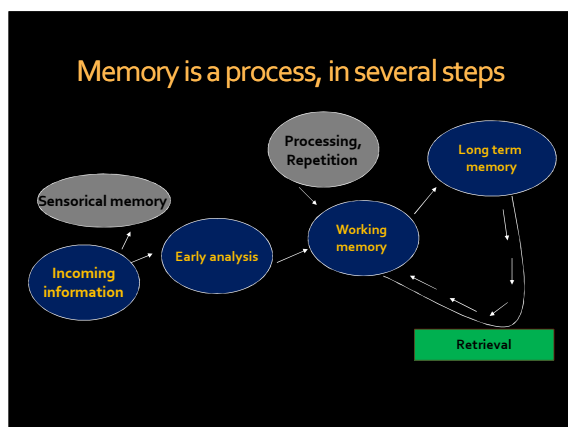
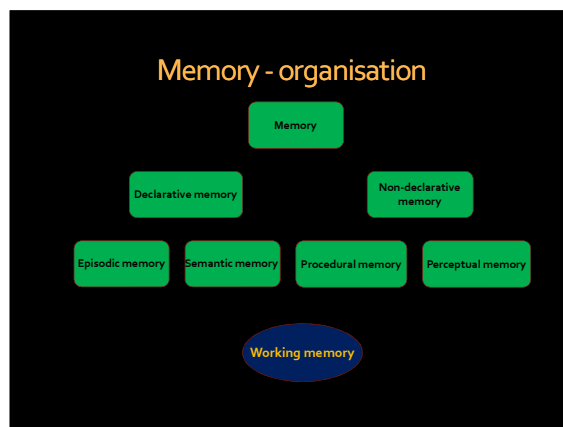




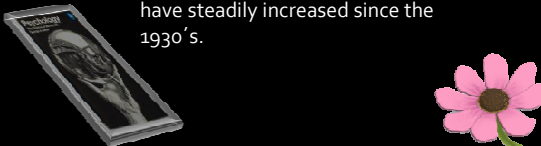
Working Memory Training

– in Theory & Practice



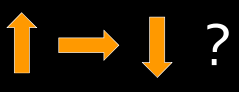

History: Memory & the brain

- The human brain has a limited capacity for processing information.
- Miller – 1956 The Magical number 7 +/- 2.
- Scientists discovered that the brain is plastic
-The environment is important! IQ levels have steadily increased since the 1930's.



Fluid intelligence


Which of the arrows in the lower right corner best completes the series of arrows below?

Working memory

- Alan Baddeley defined the term in the beginning of the 1970's
- "The term working memory refers to a brain system that provides temporary storage and manipulation of the information necessary for such complex cognitive tasks as language comprehension, learning, and reasoning"

(Baddeley A. Science, 1992 Jan 331:255, 256-9.)



The episodic buffer

- Information from long term memory is integrated with information from the fonological and visuo-spatial systems.
- Example: solve a mathematical problem.
*- A candy bar costs 80 cents. Michael has 6 euros.
 How many candy bars can he buy?*



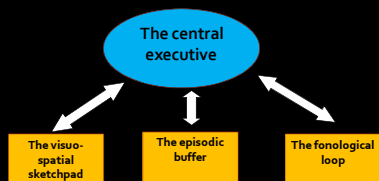
The central executive

- Controls the activities of the working memory system
- Is connected to the direction of attention
- Is still being investigated and further defined



Baddeley's model

The four components of Working memory:



Working memory

- Helps us control and use our attention, as well as manage distracters
- A fundamental function for the execution of a number of mental tasks
- Working Memory capacity strongly correlates with gF (= fluid intelligence)
- Working Memory capacity correlates strongly with tests that measure scholastic performance such as mathematics and reading



Increased focus on working memory

- WISC (Wechsler Intelligence Scale for Children) is the most commonly used intelligence measure in diagnostic evaluation. In the latest version focus has shifted towards fluid intelligence (working memory and processing speed index) in relation to cristallized intelligence.

Children with attention difficulties



Children with attention difficulties

- Prevalance of ADHD is 3-6%
- Commonly also exhibit working memory deficit



Children with poor working memory

- Constant low working memory capacity
- Difficulties with group activities
- Easily distracted
- Can't keep up with learning goals in school

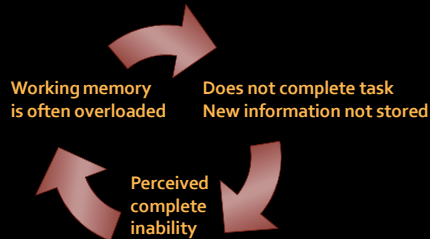


Children with poor working memory

- Difficulties remembering and following instructions, especially long instructions with several steps
- Difficulties monitoring their own work
- Mind often wanders



Risk for negative circle



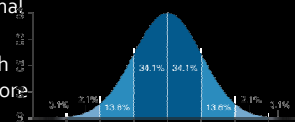
Development of working memory

- Working memory develops the most between 4 and 15 years of age.
- Children of 4 years have a relatively undeveloped working memory and can on average repeat approximately 2 digits backwards.



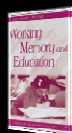
Development of working memory

- Working memory capacity follows normal distribution
- A 7-year old child with low ability can therefore perform equal to the average 4-year old.



Literature

- Working Memory and Learning (2008)
av Gathercole & Alloway
- Working Memory and Education (2006)
Red: Pickering
- The Centre for Working Memory and Learning
at York University: <http://www.york.ac.uk/res/wml/> (2009-4-08)



Interventions



Interventions

- Distinct connection between ADHD and working memory difficulties.

Possible interventions:

1. Medicine – e.g. methylphenidate
2. CBT – Cope (Parental Management Training)
3. Adapted pedagogical strategies
4. Working memory training



Working memory training

Working memory training

- Different types of exercises where the aim is to continuously increase the number of objects one can memorize



Working memory training

- Different types of exercises where the aim is to continuously increase the number of objects one can memorize
- The order of stimuli must be continuously changed
- Immediate feedback
- Demands inhibition of automatic responses



Research about working memory training



"Correct resistance"

- In a randomized controlled trial (Klingberg et al., 2005) the effects of working memory training for children 7-12 years with ADHD were explored. Children in both treatment and control group trained about 40 minutes a day, five days a week, for a total of five weeks.
- The study showed that the treatment group significantly improved their performance on tests measuring verbal and visual working memory, response inhibition and problem solving.



"Correct tools"

- In a study Lisa Thorell et al. (2009) inhibition training was compared to working memory training in preschool children. In both groups the level of difficulty of the exercises was adapted based on the performance of the child.
- The results showed that working memory training led to improvements in working memory tests (including non-verbal trained) and attention. No improvement was seen, however, as a result of inhibition training.



"Sufficient time"

- In a study from 2009, led by the Swiss researcher Susanne Jaeggi it was shown that working memory training can improve adults performance on intelligence tests.
- The study also showed that the improvement on the tests appears to be dose dependent, ie. more days (19 days) of working memory training resulted in greater improvements in intelligence tests than fewer (8 days).



Optimal conditions

- Quiet environment
- Motivated student and trainer!
- Maximum challenge
- Regularity
- Long period of training



How can training have effect?

- Plasticity – The neuronal systems ability to adapt
- *Functional: Memory training*
- *Structural: "Taxi drivers in London"*

(Maguire et al. PNAS, 2000)



How can training have effect?

- Hypothesis of transfer effects:
 - Multi modality of nerve cells
 - Training and "transfer tasks" use overlapping systems



What are the possible consequences?

- Improved ability to concentrate
- Improvements on working memory and working memory related tasks
- Spin-off effects



Memory training – much left to be discovered!

- How does training effect different groups: Asperger syndrome, Schizophrenia, Downs syndrome etc.
- What are the long term effects?



Experiences of Memory Games

- Children with ADHD often exhibit a reduced working memory capacity and difficulties in mathematics and reading/writing. In the autumn of 2009 and spring 2010 an evaluation of Memory Games Senior was conducted with children aged 7-11 years with ADHD .
- The children were randomly divided into an active control group (that trained vocabulary) and a training group (that used Memory Games Senior).



Experiences of Memory Games

- All children who participated in the evaluation trained at home with their parents as training supervisors. The training took place at least 20 times during a 5-8 week period.
- The children in the training group improved their performance significantly, in comparison to the control group, on tests measuring verbal working memory and arithmetic ability upon completion of training.



Experiences of Memory games

- During fall 2007 and spring 2008 Memory games was evaluated in a randomized controlled study in Lund and Stockholm, Truedsson et. al. (2008)
- 55 school children age 7-9 were included in the study
- The children trained with Memory games for circa 5 weeks in groups of different sizes
- Results showed an improvement on a backward digit span task, and of visuospatial WM, on the visuospatial span task.