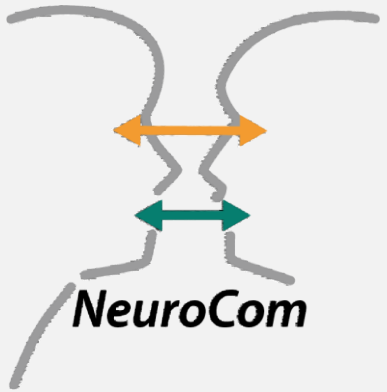
Neuroanatomy of Memory

Part 2

Derek Ott

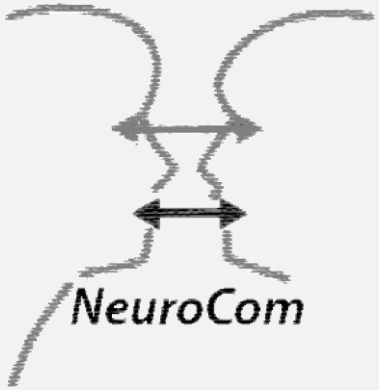
Max Planck School of Cognition
Unfallkrankenhaus Berlin

Oct 9, 2020



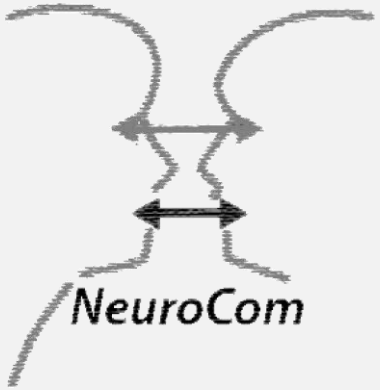
Improvement of declarative memory

- normal memory span is seven to nine items
- with association (assigning meaning) the span can be tremendously expanded (e.g. record for memorizing π: over 70,000 decimal places)
- motivation important for memory acquisition
- emotional link can improve memory consolidation significantly (e.g. choose mnemonics that are absurd or sexually explicit)
- mental training in the elderly with measurable effects, yet no transfer and no proven benefit in the prevention of dementia
- several pharmaceutics are available to improve memory and prevent dementia, but none have proven to be effective
- most commonly used anti-dementive drug in Germany: extracts from Gingko



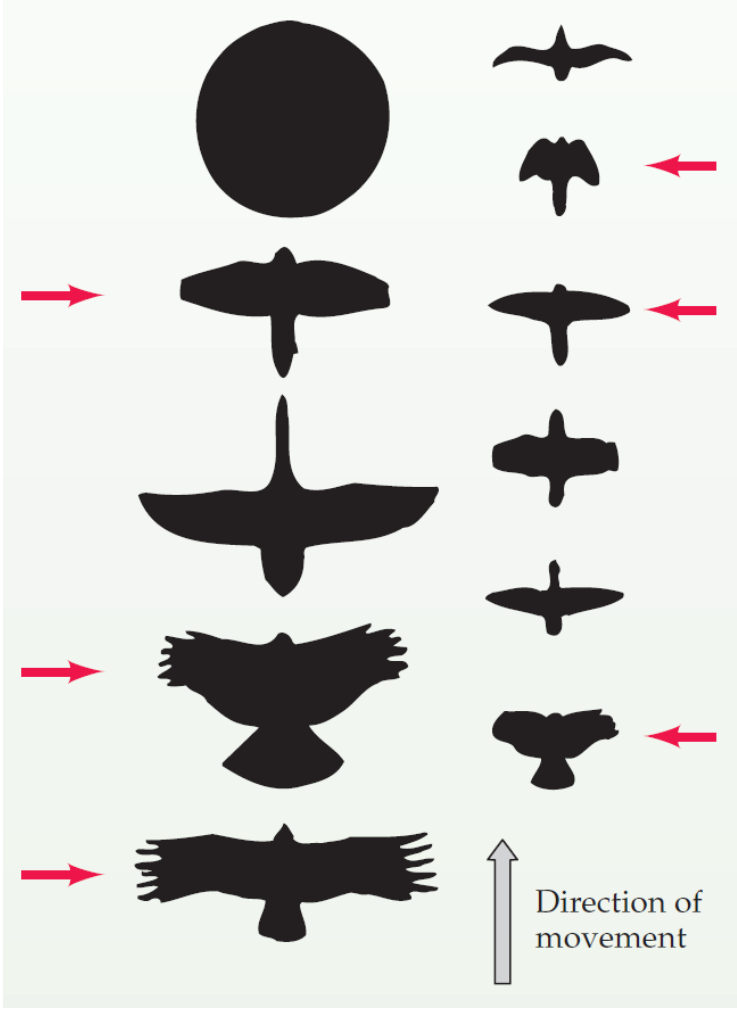
Nondeclarative memory

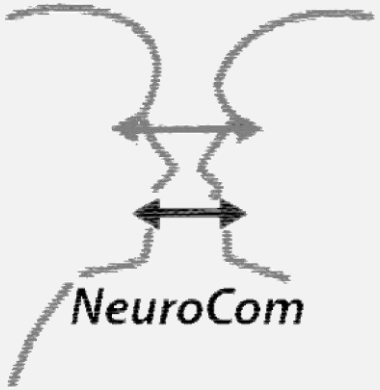
- aka “procedural memory”
- umbrella term including skills, associations and “adaptive responses”
- not available to consciousness (at least not in any detail)
- difficult (or impossible) to convey using language (e.g. teach a piano piece by explaining finger movements)
- experimentally often accessible by measuring response times or accuracy in a test setting
- reliant on different parts of the brain, depending on the nature of the stimulus-response bind



Phylogenetic memory

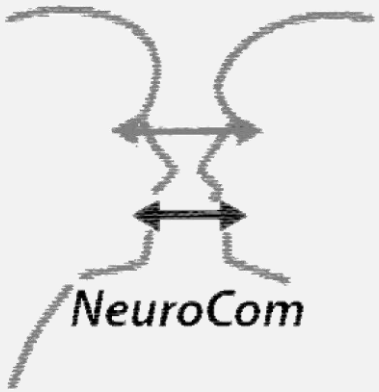
- innate action and response pattern, i.e. genetically encoded
- shaped by evolution
  - chimps: innate fear response of spiders and snakes
  - birds: hatchlings crouch when seeing a silhouette resembling a predator bird
  - many animals “know” how to walk, find the teat, vocalize, etc., at birth
  - “the most important […] stored information” for survival
- “hard-wired” in little-understood sensory-motor connections



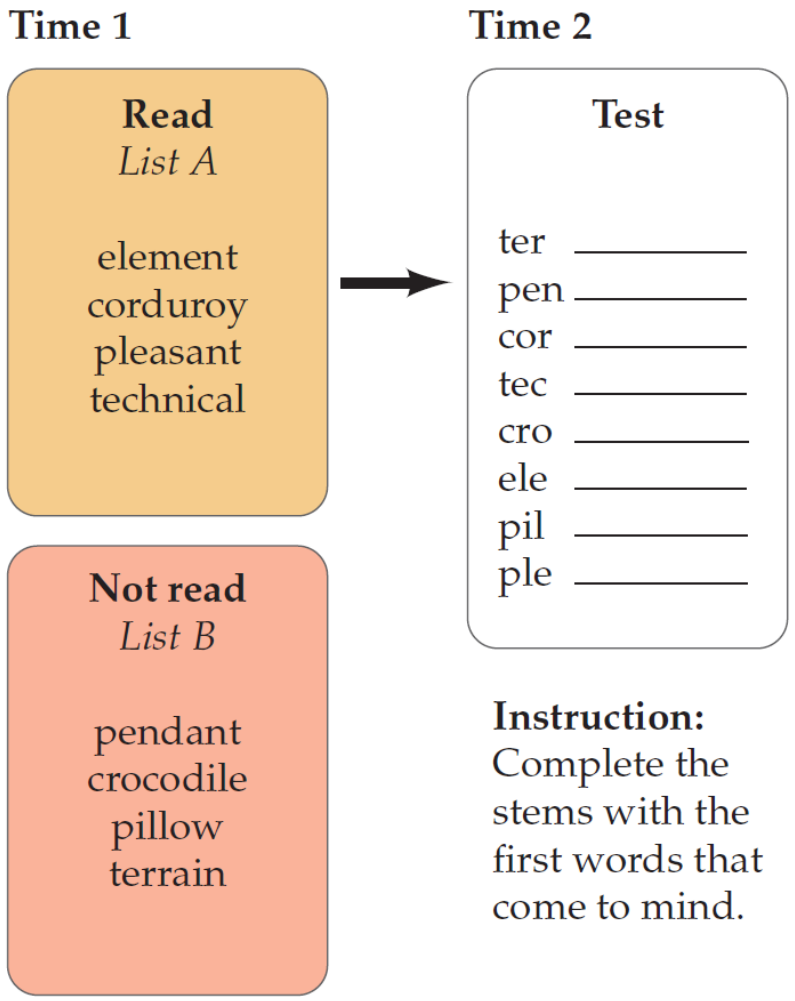


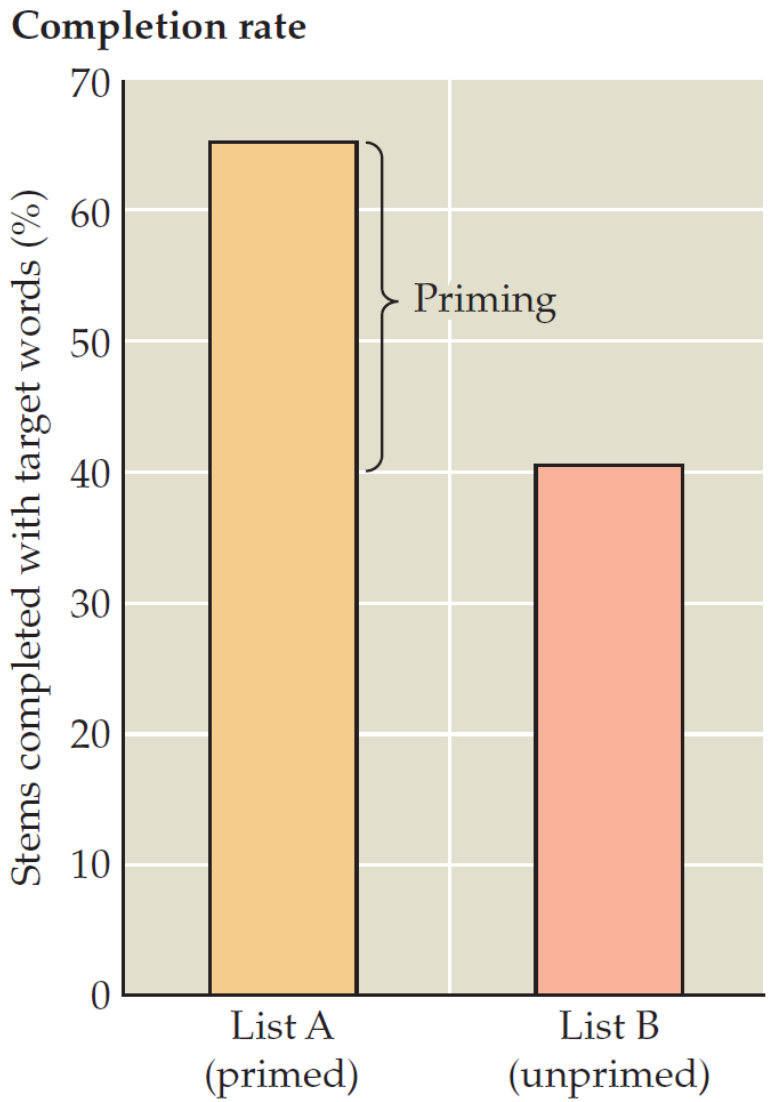
Priming

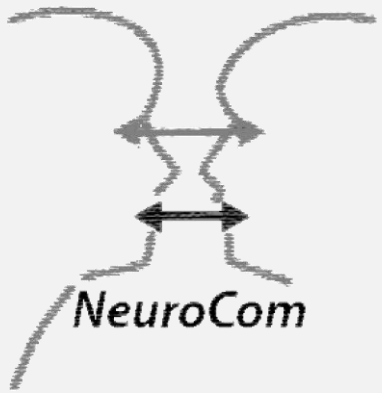
- change in stimulus processing due to experience, with or without conscious awareness
- e.g. read a list of words on day 1, complete “unrelated” words on day 2 – “intrusion” of words from day 1 list *(see next slide)*
- however, not very reliable (sorry, advertising industry!)
- contextualizing increases error tolerance (e.g. words with ambiguous meanings or distracting ambient noise)
- relies on basal ganglia, especially dopaminergic input (substantia nigra and ventral tegmental area in the midbrain) and sensory areas in the case of perceptual priming
- resistant to brain injury, aging, or dementia (but not Parkinson’s disease)



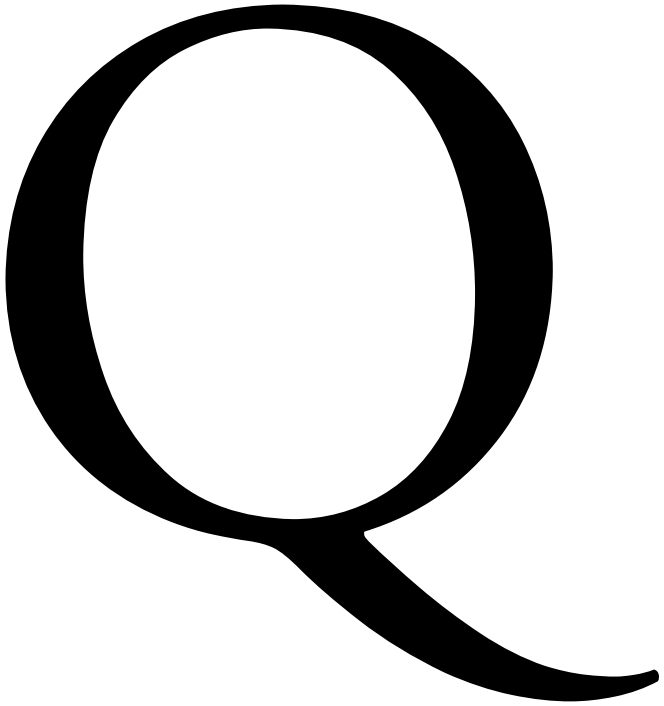
Word list priming







Questions?

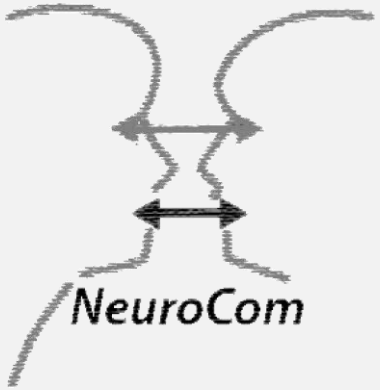


"Judge a man* by his questions rather than by his answers."

[* woman / person / camera / TV]

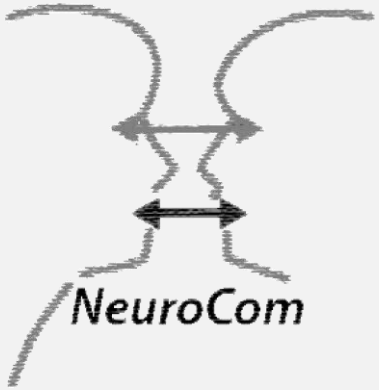
Conditioned learning

- the process of tying a response tendency to a stimulus that does not innately trigger the response
- classical conditioning (Pavlovian learning): innate reflex ("unconditioned" stimulus-response pattern) is tied to unrelated stimulus ("conditioned" stimulus-response)
- operant conditioning: altered probability of behavioral response after reward (or punishment), e.g. Skinner box
- extinction, if reward is no longer provided
- "reinforcement learning": very similar to operant conditioning, but broader in its use
- important in habit formation (adaptive and maladaptive, e.g. addiction or OCD)
- depends on cortices involved in stimulus and response, prefrontal cortex, basal ganglia (dopamine), amygdala (esp. fear conditioning)



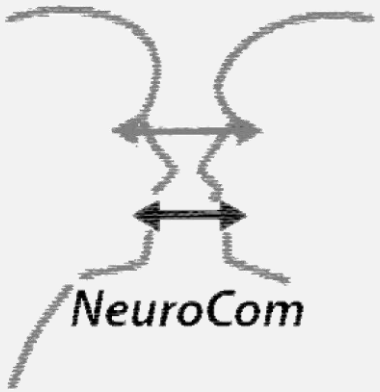
Complex motor learning

- can include non-sequential (e.g. handstand, balance on a bicycle, hit a piano key to produce the desired attack) and sequential elements (learn a dance, a tongue twister, to play a piano song)
- most everyday activities include both
- relies on the same structures as operant conditioning / reinforcement learning (mental representation serves as reinforcer)
- with more required motor precision, more initial involvement of cerebellum
- with longer sequences, more initial prefrontal involvement
- as proficiency increases with training, cerebellar and prefrontal activity subside (action becomes more robust against errors, but also corrections)



Summary part 2

- memory capacity can be expanded by several strategies, most efficiently (arguably) by assign emotional meaning to items
- nondeclarative memory is an umbrella term including phylogenetic learning, priming, conditioned and complex motor learning
- these processes depend on a number of brain structures (basal ganglia with dopaminergic reinforcement, prefrontal cortex, cerebellum, sensory cortices) with the notable exception of Papez circuit elements, e.g. hippocampus
- double dissociation: declarative memory can be impaired and nondeclarative preserved – and vice versa



I completely forgot about the ceremony…