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How Computational Modeling Might Contribute to Neuropsychology

Dražen Domijan

ddomijan@ffri.hr
University of Rijeka

Hippocampus and memory

- Hippocampus has important role in memory, but it is not clear what precisely that role is
- Anterograde amnesia – lesion of the medial temporal lobe (deficit for learning new facts)
- Hippocampus is involved in declarative memory, but not in procedural learning (skills or habits)

Hippocampus and memory

- However, hippocampus is involved in more complex forms of classical conditioning (latent inhibition)

- Eyeblink conditioning:
- Unconditional stimulus (US) – air puff
- Conditional stimulus (CS) – tone

- If CS repeatedly precede US, the animal learns to respond to CS – eyeblink occurs after tone because air puff is expected

Hippocampus and memory

- Latent inhibition: prior exposure to the CS slows subsequent formation of US – CS association
- After hippocampal lesion, latent inhibition disappears
- Gluck et al. (2005): model of interaction between hippocampus and cerebellum

Gluck et al. (2005)

- Cerebellum is necessary and sufficient neural substrate for classical conditioning
- CS and US represent input to the neural network and CR is output signal
- Learning is implemented as a change in synaptic weights: Least Mean Square (LMS) algorithm

Gluck et al. (2005)

- LMS algorithm: learning by error correction
- Learning by comparison of CR (output signal) and US (input signal). Difference represents error which is minimized by LMS

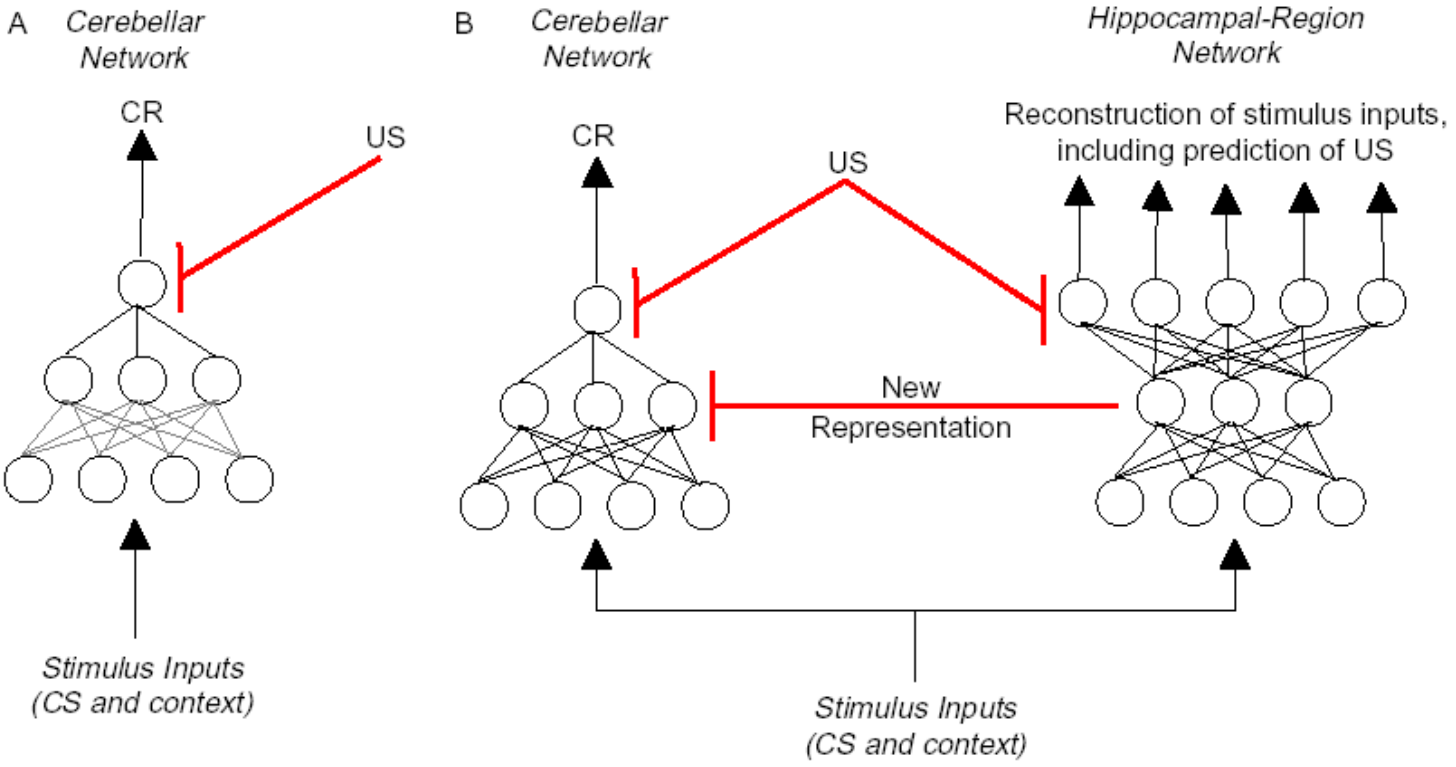
Gluck et al. (2005)

- Role of HC: development of new representations which encode important regularities in the environment
- If two CS often co-occur in the environment, their representations become more compact or more similar (compression)
- If two CS never occur together, their representations become more different (differentiation)

Gluck et al. (2005)

- The role of hippocampus: compression of redundancy and predictive differentiation
- Error back-propagation
- Hidden layer: compression and retaining information about difference in input patterns

Gluck et al. (2005)



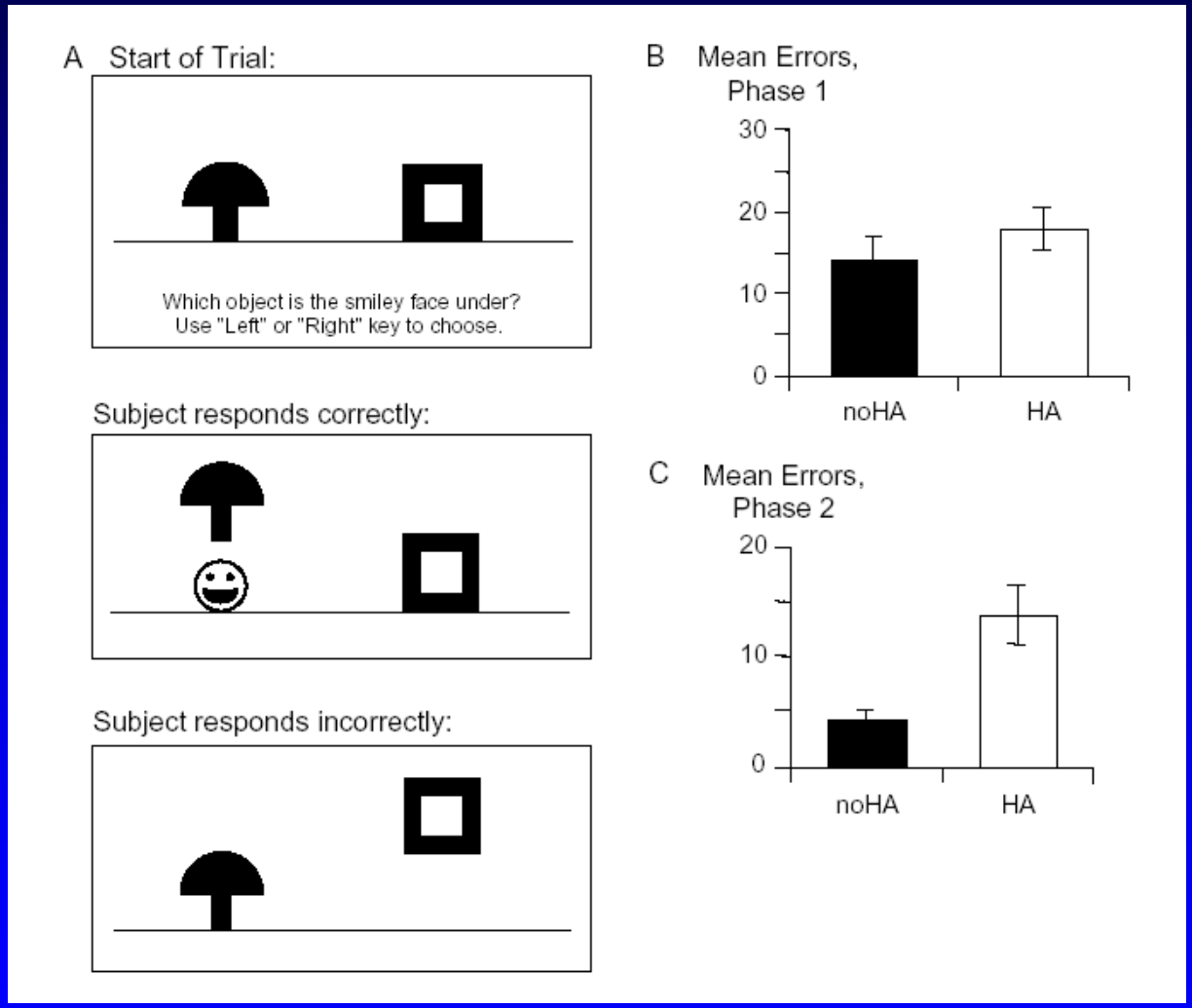
Application of the model

- Analysis of memory disorders in humans
- Lesion of HC disables latent inhibition in humans also
- Computer task similar to classical conditioning

Application of the model

- Concurrent discrimination task (i.e., color and shape)
- Task is divided in two phases. First phase is learning of association. Second phase is transfer of learned association to new situation
- 1st phase does not depend on the HC but 2nd phase depends. HC allows generalization
- Hippocampal atrophy (HA): 1st phase - yes. 2nd phase – no

Concurrent discrimination task

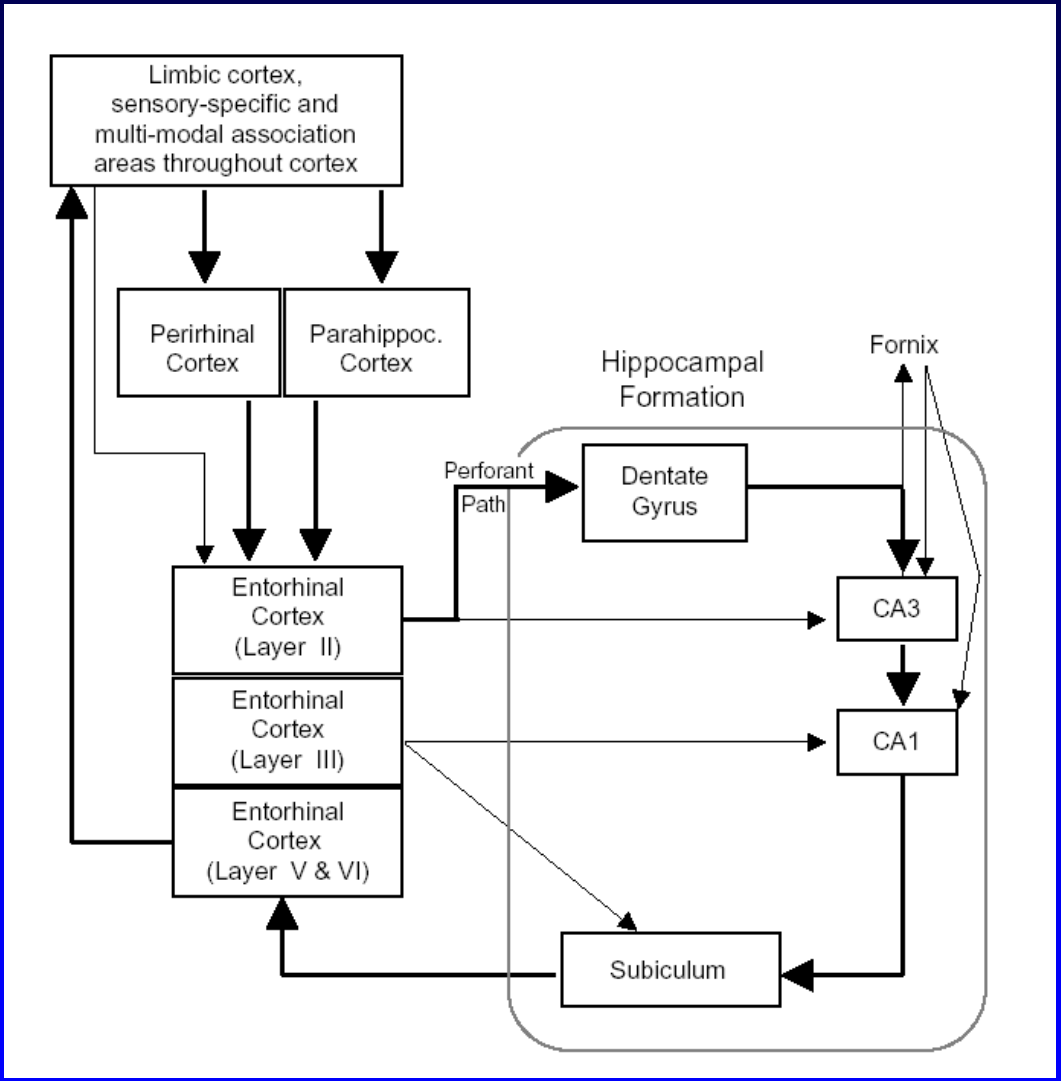


Clinical implications

- Concurrent discrimination task can be used as an indicator of reduced hippocampal volume which is a risk factor for subsequent development of Alzheimer's disease

- Clinical test. Good discrimination of older people with HA and people without HA when the results are compared with MRI

Detailed look at hippocampus



Conclusions

- Based on the theoretical arguments derived from the model, it is possible to develop a neuropsychological test

- Interesting example how theoretical and computational work in psychology and neuroscience might contribute to clinical practice, especially in developing new diagnostic tools