Recognition memory associated with hippocampal pattern completion in young and older adults

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Background

- Accurate memory retrieval from partial or degraded input requires the reactivation of memory traces, a hippocampal mechanism termed pattern completion (PC). Given its extensive recurrent excitatory connections, CA3 likely executes this auto-associative process [1].
- Age-related changes in hippocampal integrity have been hypothesized to shift memory processes in favour of retrieval of already stored information (pattern completion), to the detriment of encoding new events (pattern separation), i.e. the aged brain should show CA3 hyperactivity and a bias towards pattern completion [2].

Aims

(1) Behavioural Study: Can we identify age-related memory differences specifically associated with PC?
(2) Patient Study: Is the dentate gyrus involved in PC?
(3) Eyetracking Study: Does viewing behaviour influence age-related PC differences?
(4) T7-fMRI Study: What are the underlying neural mechanisms of PC and the related age differences?

Methods

(1) Behavioural

- Stimuli: 10 young (5 female, 20-35 years, MoCA score: 28.1) and 20 older adults (15 female, 62-78 years, MoCA score: 27.3)
- Design: 20 items from 2 lists, for which an item from list 1 was presented before each item from list 2.

(2) Patient

- Patient & L.: (male, 54 years, bilateral DG lesions)
- 20 healthy controls (10 female, mean age 52 years)

(3) Eyetracking

- Eyetracking paradigm: 12 items from 2 lists, 1 stimulus repeated, novel stimuli are shown either after or before the repeated stimulus.
- 26 young (13 female, 22-35 years, MoCA score: 28.4) and 24 older adults (12 female, 62-77 years, MoCA score: 27.6)

(4) T7-fMRI

- Functional: 0.8 mm iso EPI-slab (TR = 2s)
- Structural: 0.4 × 0.4 × 1.0 mm T2-slab
- Automatic segmentation of hippocampus on T2 (ASHS) + manual correction following [6]
- Coregistration of T2 to EPI via 1.6 mm iso full-brain EPI

Results

Behavioural results

Recognition ability declines with reduced stimulus completeness, more so in aging, and older adults are biased towards pattern completion

Eyetracking results

Viewing patterns are stimulus-driven rather than response choice-driven, but the overlap of fixation heatmaps is predictive of the age-related pattern completion bias

Neuroimaging results

Older adults show hyper-activity in CA3 and decreased activity in PhC

Conclusion

- Aging is associated with a strong pattern completion bias and CA3-hyperactivity confirming existing computational models; and patient data emphasizes the interplay of hippocampal subfields CA3 and DG.
- Paradigm provides base for development of clinical tool (life-span, pathological ageing...)

References