Cholinergic Modulation Enhances Hippocampally-Dependent Spatial Relational Attention

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Background
Attention creates state-dependent patterns of activity in the human hippocampus (Aly & Turk-Browne 2016a,b). This might be occurring through cholinergic modulation:

- High levels of acetylcholine bias the hippocampus toward environmental input [ACh]
- Low levels of acetylcholine bias the hippocampus toward memory retrieval [ACh]

Acetylcholine enhances afferent input from entorhinal cortex to the hippocampus while simultaneously suppressing recurrent connections.

Hypotheses
- Given the importance of the hippocampus in relational processing, cholinergic modulation might improve relational attention.
- Alternatively, given the role of the hippocampus in spatial processing, cholinergic modulation might selectively improve spatial relational attention.

Study 1: Cholinergic Modulation

We recruited nicotine cigarette smokers (nicotine is a cholinergic agonist) for two sessions where they either:
- ingested nicotine within past hour, or
- abstained from smoking for at least 12 hours

Smoking abstinence was confirmed with a CO PPM monitor:
- Smoking day: 8.13 ± 1.02
- Non-smoking day: 3.75 ± 0.45
  \[ t = 5.22, p < 0.001 \]

N=24; 10 females
Mean age: 24.3 ± 0.75 years
Mean education: 16.5 ± 0.42 years
Mean cigs/day: 5.2 ± 0.69

- Nicotine improved performance on the spatial relational task and had no effect on any other trial type.

Study 2: Hippocampal Lesion

A hippocampal lesion patient was tested against age- and education-matched controls.

The hippocampal patient was a 19 year old male with 12 years of education. A hypoxic brain injury lead to volume loss in the left hippocampus and parahippocampal area.

Control group N=11; 7 females
Mean age: 21.1 ± 0.42 years old
Mean education: 15 ± 0.40 years

- The hippocampus is necessary for spatial relational attention.

Discussion
Cholinergic modulation selectively improves spatial relational attention.

Hippocampal damage selectively impairs spatial relational attention.

Nicotine may be enhancing spatial relational attention via the hippocampus.

One way in which this enhancement might occur is through increasing the strength of input from entorhinal cortex to the hippocampus.

References