

On the necessity of hippocampus in lexical-semantic mapping in language processing.

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Background

- Hippocampus contributes to the online processing of language.¹
- Semantic knowledge is grounded in experiences that give rise to meaning.²
- Some evidence for a role for hippocampus in semantic processing:
 - Direct hippocampal recordings -> increased hippocampal theta oscillations for semantically constraining sentences³
 - fMRI -> left-hippocampal engagement during a semantic interference naming paradigm⁴
 - Patients with bilateral hippocampal damage -> Impairments in semantic feature generation⁵
- **Question: Is hippocampus necessary for lexical-semantic mapping in online sentence processing?**
 - **Experiment 1:** Tests lexical-semantic mapping in single word processing^{6,7}
 - **Experiment 2:** Tests lexical-semantic mapping in sentences⁸

Dynamic GLMM (dGLMM)⁹

- Analyze fixation data on a ms-by-ms and trial-by-trial basis in binary form⁹ using glmer in R.
- Identify order of autoregression (AR) and include AR as a fixed effect to handle autocorrelation between time-points.
- Include crossed random effects structures (random effects varying across persons and items).
- Extensions of this model include a spatial covariate, defined as the distance between the *prior* fixation point and the centroid of the critical interest area.¹⁰

Experiment 1

Single words

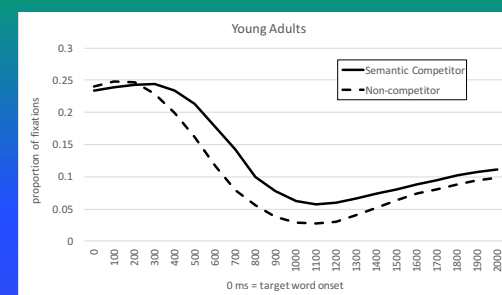


Pictures -> 1000ms -> "candle" -> Participant clicks [candle]

Condition	Target	Critical object	Other	Other
Semantic-competition	candle	lightbulb	peacock	shoe
Unrelated target (competitors present)	shoe	lightbulb	candle	peacock
Unrelated target (competitors absent)	mailbox	lightbulb	peacock	bear

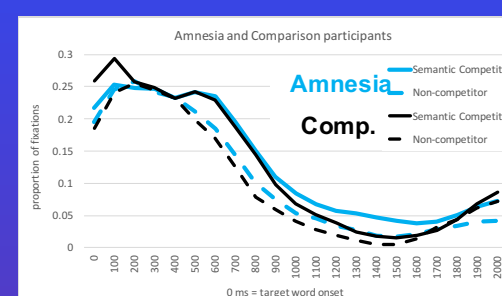
Data analysis using Dynamic GLMM (dGLMM)⁹:

- Young adults (N=18)



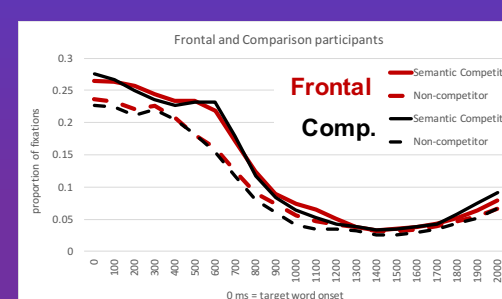
Critical object fixations in Competition condition >> Unrelated target cond.

- Amnesia patients with bilateral hippocampal damage (N=5) + Matched comparisons (N=5)



Critical object fixations in Competition condition > Unrelated target cond. No interaction with group.

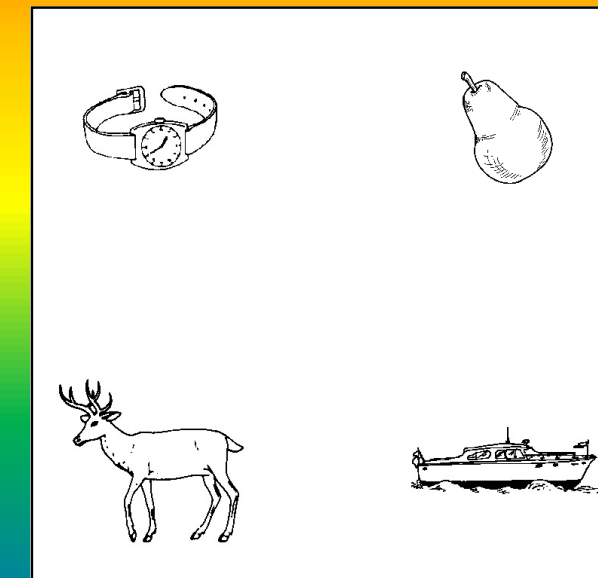
- Brain damaged controls (BDC) with frontal damage (N=5) + Matched comparisons (N=5)



Critical object fixations in Competition condition > Unrelated target cond. No interaction with group.

Experiment 2

Sentences

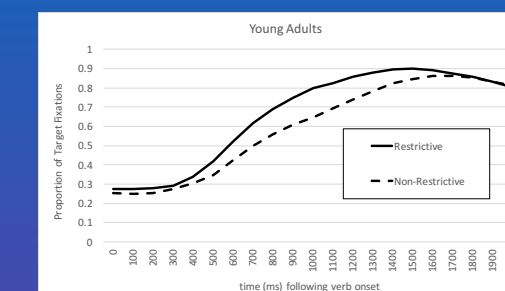


Pictures -> 1000ms -> "She will hunt the deer" -> Participant clicks [deer]

Condition	Target	Other	Other	Other	Target Selected in Norming
Restrictive verb (e.g. hunt)	deer	watch	pear	boat	98%
Unrestrictive verb (e.g. paint)	deer	watch	pear	boat	28%

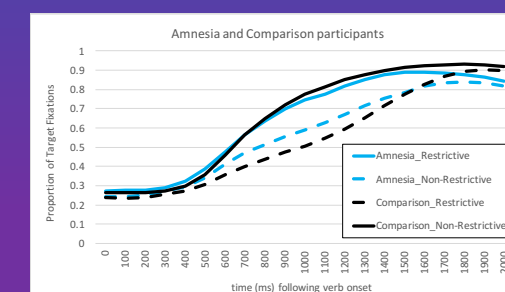
Data analysis using Dynamic GLMM (dGLMM)⁹:

- Young adults (N=16)



Target fixations in Restrictive >> Non-restrictive condition.

- Amnesia patients with bilateral hippocampal damage (N=5) + Matched comparisons (N=10)



Target fixations in Restrictive >> Non-restrictive condition. No interaction with group.

Conclusions

- No evidence for impaired lexical-semantic mapping in spoken language processing following bilateral hippocampal damage.
- Hippocampus may contribute to lifelong tuning of lexical-semantic knowledge, predicting graded effects, with close and frequent semantic relations remaining intact.
- **Bottom line:** At least for relatively common words and concepts, hippocampus is not necessary for engaging the lexical-semantic network in online sentence processing.

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