Universitat Pompeu Fabra Barcelona
Department of Translation and Language Sciences

Computational Modeling of Language and Memory Decline in Alzheimer's Disease

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CONTENTS

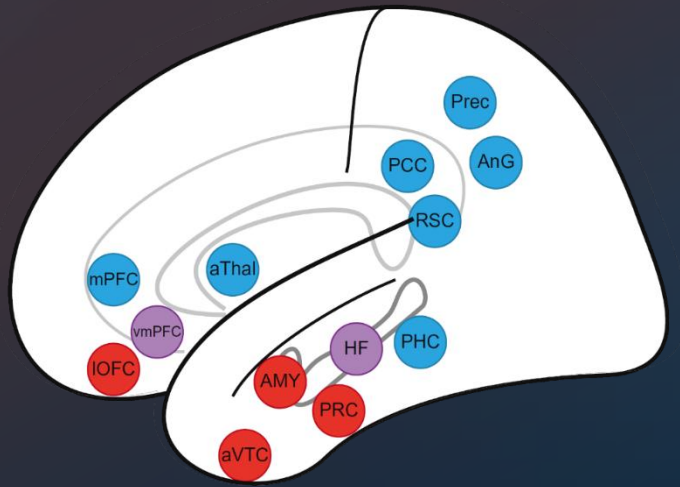
PART I

INTRODUCTION TO RESERCH TOPIC

Alzheimer's disease (AD)

- The most common cause of dementia
- No available treatment or drugs
- Early intervention could help
- Develop automated tools

Memory Decline in AD



- Decline in episodic memory (EM): central & early
- EM: the specific occurrence of an event in space, time, and as personally witnessed (Tulving, 2002)
- hippocampus and cortical pathways to & from it:
  - a posterior medial network
  - a anterior temporal network

Language Decline in AD

- Language impairment: very early & progressive
- Language and memory shares underlying neural mechanisms (Covington & Duff, 2016)
- Spontaneous speech: the most common data type
- Trustworthy model for AD

PART II

RELATED STUDIES & FRAMEWORK

What has been done?

- Started in the 2000s and flourished since 2011
- Fast development thanks to the open source data and codes, especially ADReSS(o) challenges and DementiaBank.

What has been done?

- Paralinguistic features
  - Spectral/cepstral
  - Voice quality
- Prosody features

VS

- Morpho-lexical: richness
- Syntactic: complexity
- Semantic: idea density/embedding
- Pragmatic: turn-taking

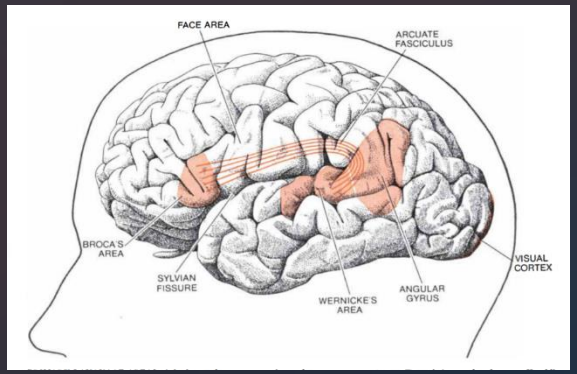
Episodicity & EM

- Extractable from EM
- Episodicity:
  - Dynamic
  - First-person perspective
  - Specific
- Episodicity declines in AD (Chapin et al, 2022)

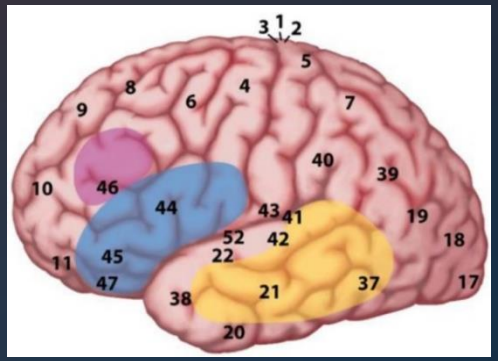
What has NOT been done?

- not early
- little interpretability
- Not hypothesis-driven
- overfitting (esp. big DL models)
- NLP for episodicity

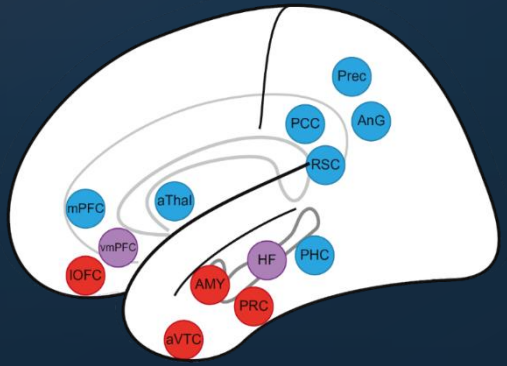
Models of Language



Geschwind's version of the Wernicke-Lichtheim-Geschwind (WLG) model



Hagoort (2013)'s Memory-Unification-Control (MUC) model of language



Ritchey (2019)'s PM-AT episodic network

PART III

AIMS & QUESTIONS

Aims

Whether, how and why

ML models can model the language and memory decline concerning AD

Predict the probability and severity of cognitive impairment in a trustworthy manner

Research Questions

What acoustic-prosodic and textual features best perform in detecting preclinical and MCI?

What are the linguistic analogs of EM, and how can we model them linguistically and computationally?

To what extent can a language-based model match with and get improved by MRI images?

... ...

PART IV

DESIGN & METHODOLOGY

Datasets

ACE Data

- 5 groups, from health to AD
- 18HC+31SCD+MCI(16/23)+31AD
- 4 tasks
- Spanish/Catalan
- Speech + neuropsy

Maragall Data

- 2 groups, biomarker +/-
- 111 + / 101 -
- Telephone interview
- Spanish/Catalan
- Speech + neuropsy + MRI

English Data

- 2 groups, control/AD
- Publicly available
- Speech + demographic

Chinese Data

- 2 groups, control/AD
- Speech + neuropsy + MRI
- To be collected if grant approved

Classification & Trustworthy Check

cross-validation using extracted features,

check performance and over/underfitting,

interpret the results with *cognitive tests and neural images*.

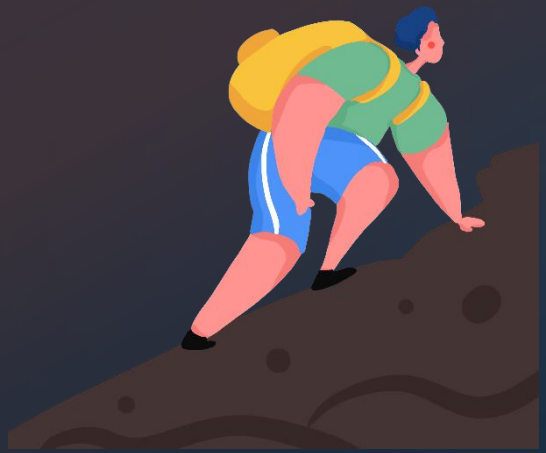
PART V

WORK PLAN

Current Work

- ✓ Random forest on ACE study (esp. scene construction data)
- ✓ Same experiments on Maragall data
- ✓ Initial evaluation on language-related cognitive task results from Maragall data
- ✓ Annotating an episodicity dataset
- ✓ Grant application for Chinese data collection

Work in Next Years



ACE

→ Advance current work into a paper

→ Speech augmentation trial

→ Task effect investigation

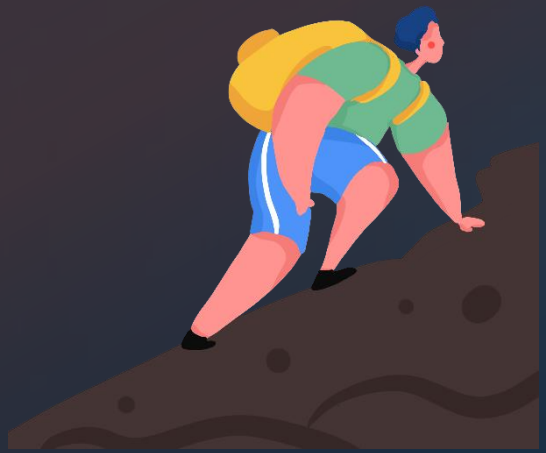
Episodicity

→ Dataset building and publishing

→ Linguistic analysis

→ Computational modelling

Work in Next Years



Maragall

→ Try similar experiments

→ Investigate the MRI data

→ Special focus on episodicity in language and episodic network

Others

→ Chinese study if grant approved

→ Potential collaborations and work …

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Thank you!