UNIVERSIDAD NACIONAL DE EDUCACIÓN A DISTANCIA (UNED)

UCA Universidad de Cádiz

Instituto Universitario de Investigación en Linguística Aplicada - ILA

CONGRESO INTERNACIONAL LINGÜÍSTICA CLÍNICA

RESEARCH GROUP SECONDS AND FUNGRAMKB

UNED MADRID

SECONDS

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FunGram KB

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Scope of our research

Linguistic

- Meaning construction model
- Cognitive operations
- Functional grammar and ontological semantics

lexicom

www.lexicom.es

Computation

- Natural Language Processing (NLP)
- Computational Linguistics
- Text Mining
- Machine Learning

FunGramKB NLP Lab

NLP LAB

Clinical

- Plastic nature of the brain
- Semantic memory

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Computation: NLP

Browsing lexico-conceptual data

NAVIGATOR

Automatically **R**epresenting **TE**xt **M**eaning via an **I**nterlingua-based **S**ystem

ARTEMIS

Discovering and **EX**tracting **TER**minology

DEXTER

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Computation: Text mining and machine learning

DAta **MI**ning **EN**countered

DAMIEN

RecOgniziNg Domains with IATE

RONDA

CAtegory- and **S**entiment-based **P**roblem Find**ER**

CASPER

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Clinical: Neurolinguistics

The Neuroscience Brain Project using Linguistic and Computational tools

Can we move our research into this field? If so, how?
What are the problems and the research questions?
What type of projects?

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Scope of our research

Neurodegenerative diseases	Primary Progressive Aphasia Alzheimer's Disease Mild Cognitive Impairment: Prodromic Alz Parkinson's Disease with Dementia Dementia with Lewy Body Hutington's Disease Corticobasal syndrome Amyotrophic Lateral Sclerosis
Oncological interventions	Brain tumors Tumor resection
Psyachiatric disorders	Depression Schizophrenia

Scope of our research

Neuroscience

Neurolinguistics

NLP

- Neurodegenerative diseases (ND), e.g. Alzheimer and Parkinson, where mild cognitive impairment is one of the most notorious manifestations (Obeso et. al., 2013; Rábano, 2015; Pérez Cabello de Alba, 2016; Boschi et. al., 2017; Mortamisa, 2017)

- Oncological brain tumor resection in eloquent areas of the brain, e.g. Brocca's area (Barcia et. al., 2012; Rivero-Rivero et. al. 2016), where the linguistic faculty is lost;

- Detection and early prevention of psychiatric disorders (depression, schizophrenia etc.) through natural language processing.

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Neurodegenerative diseases: AD and PD

Semantic memory

Can semantic memory loss be quantified?
Can we identify regular patterns in this cognitive decline?

On the linguistic tests

How can we improve standard techniques to evaluate linguistic deficits and cognitive impairment?
Can we automate the procedures so as to obtain more consistent and unified scoring results? (e.g. The Hayling test)

Mapping data

Moreover, can this gradual decline be mapped and correlated with *fMRI* (*functional magnetic resonance imaging*)? Can we correlate linguistic impairments and image distortions?

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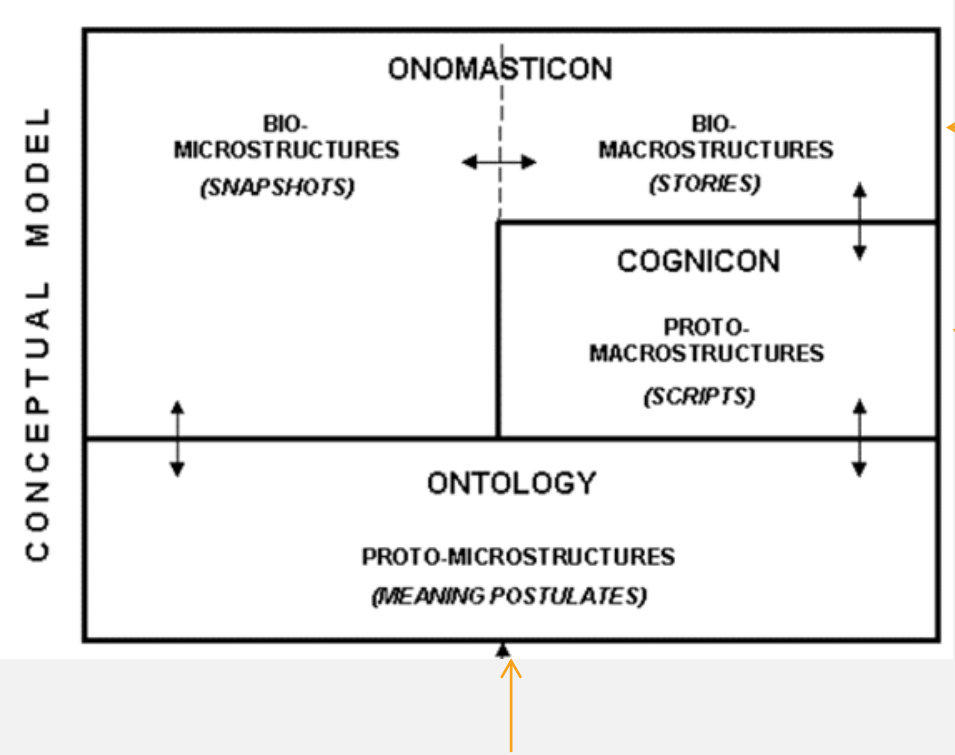
Semantic memory: finding patterns

Compared to episodic memory, there has been little exploration of semantic memory, this being restricted principally to tasks of category fluency and naming. Cross-sectional studies have not reported an association between performance on category fluency tasks and amyloid load, and longitudinal studies have detected only minimal impairment over time on the Boston naming test in association with increasing amyloid levels. (Mortamaisa et. al., 2017)

- Ontological semantic representation
- Identifying the conceptual routes using computational techniques

How?

Knowledge representation and semantic memory



1. *Episodic memory* (stores information about entities and events…)

2. *Procedural memory* (stores information on how we perceive events that we perform in our daily lives, how to ride a bicycle)

3. *Semantic memory* (stores information about words and it functions as a mental thesaurus)

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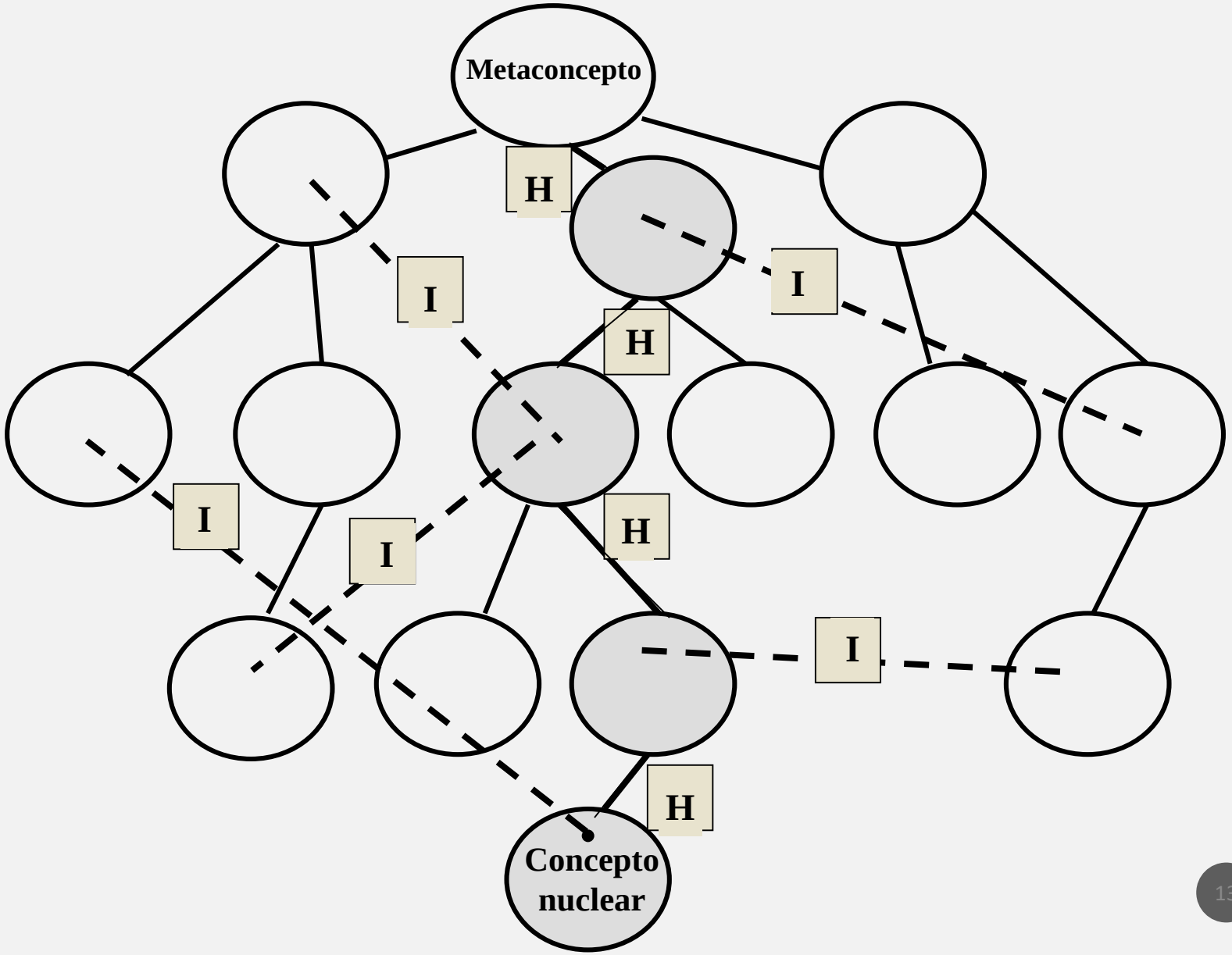
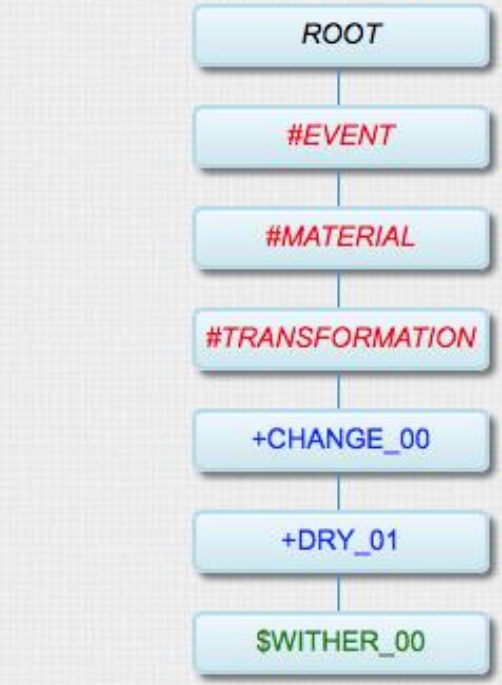
Natural Language Processing Lab

Microsoft Concept Graph for short text understanding
https://concept.research.microsoft.com/Home/Introduction

Reasoning: MicroKnowing



ONTOLOGICAL HIERARCHY



CONCEPTUAL ENTRY

CONCEPT:
$WITHER_00

THEMATIC FRAME:
(x1)Theme
(x2: +PLANT_00 ^ +FLOWER_00 ^ +LEAF_00)Referent

MEANING POSTULATE:
+(e1: +DRY_01 (x1)Theme (x2)Referent (f1: (e2: +BECOME_00 (x2)Theme (x3: +SMALL_00 | +WEAK_00)Attribute))Result (f2: (e3: ing +DIE_00 (x2)Theme))Result)

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Semantic data

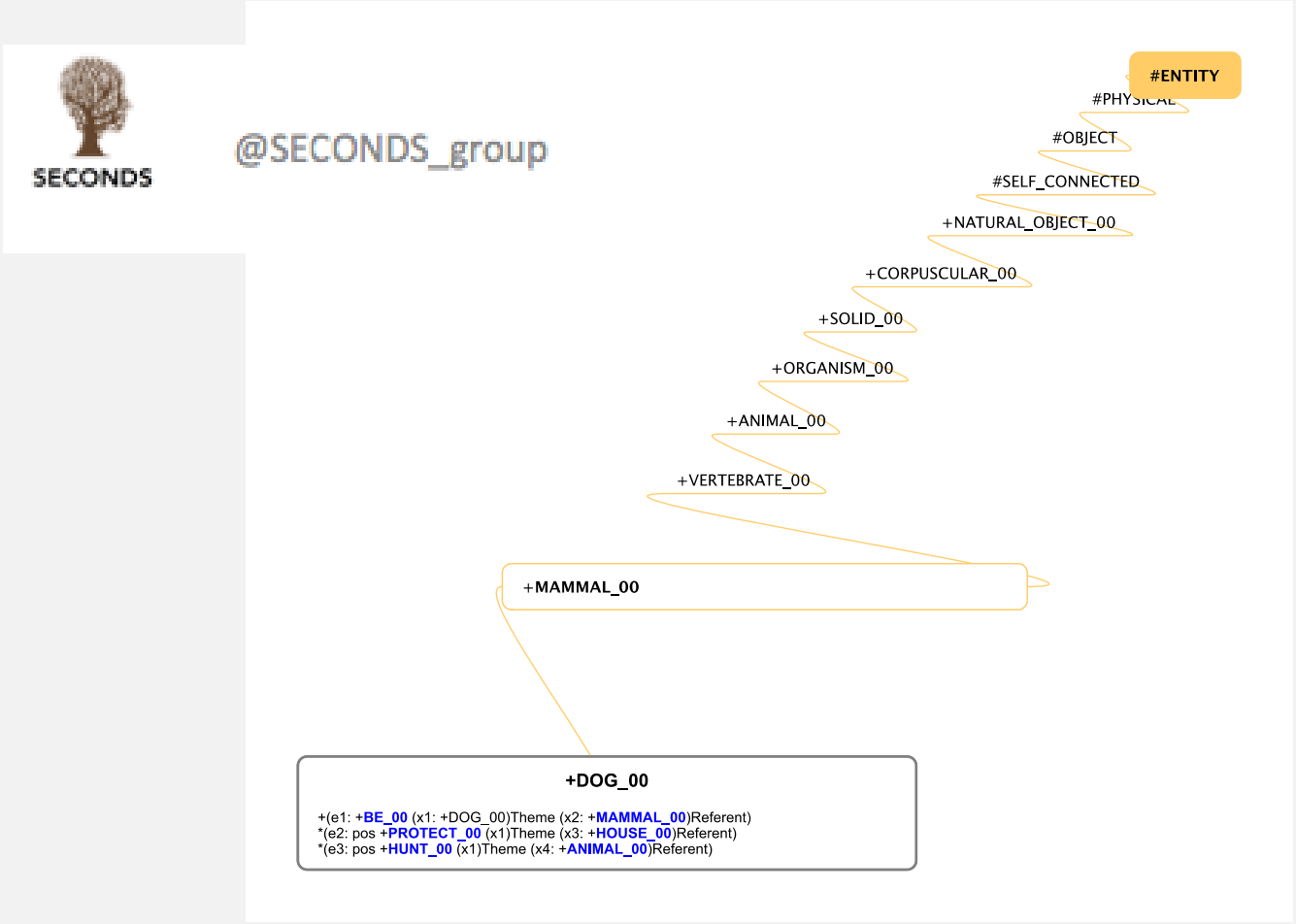
Semantic verbal fluency tasks involve the exploration and retrieval of words based on semantic criteria (Baldo et al., 2006).

According to Peter et. al. (2016), two cognitive components are required for successful retrieval [e.g. Shao et al., 2014]:

1. Executive component is related to strategic search and retrieval processes and requires frontal lobe functioning;

2. Semantic component is associated with the integrity of lexico-semantic networks and temporal brain regions (cf. Peraita and Graso, 2010; Pérez, 2016; Mairal and Pérez, 2017)

Finding patterns for conceptual route impairment using ontological semantic representation



Pérez y Teomiro (2014), Pérez (2016), Mairal y Pérez (2017)

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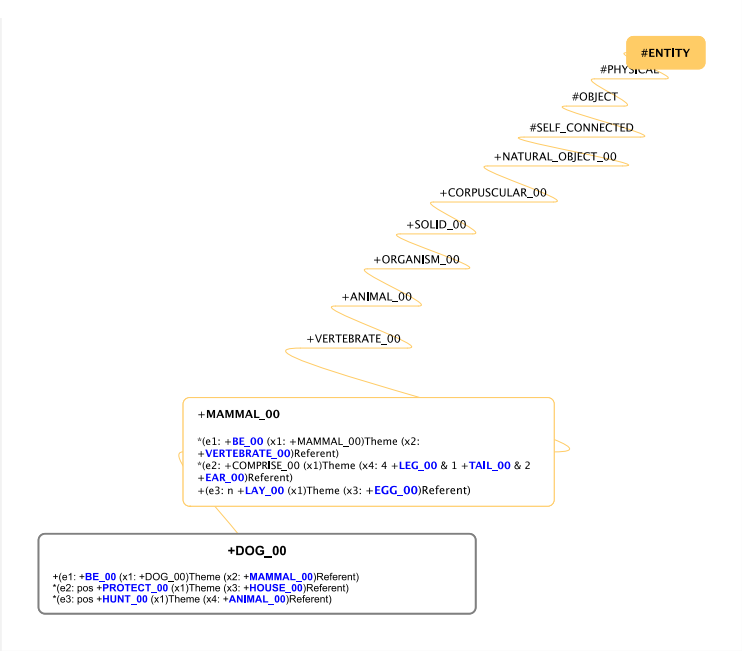

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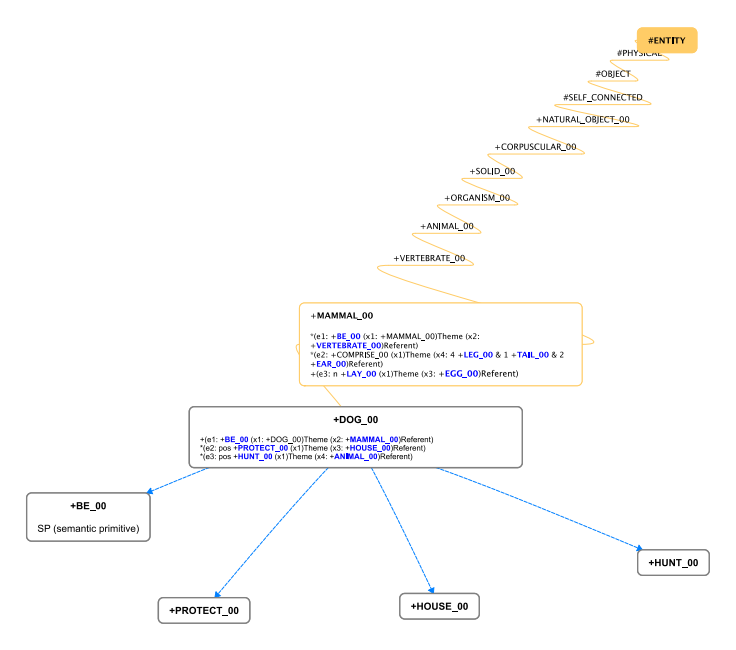

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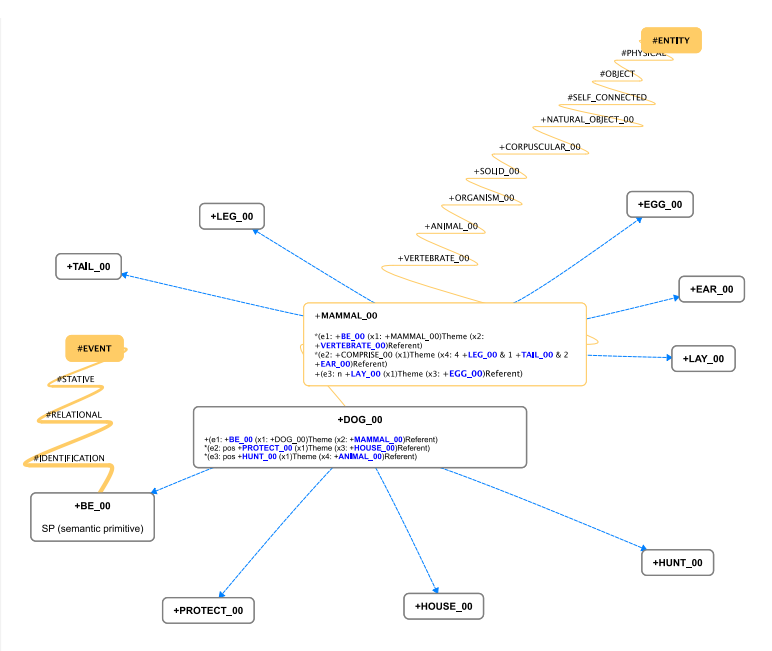

On the linguistic tests

- Decontextualized: Traditional language tasks based on single word or isolated sentence processing

- Connected Speech

Often neglected, or performed according to non-standardized procedures.

The analysis of connected speech is a very useful tool, providing detailed data about all linguistic levels: phonetic, phonological, lexicosemantic, morpho-syntactic, syntactic and discourse-pragmatic (Boschi et. al., 2017)

On the linguistic tests: challenges

(…) the need of further work, including the development of automated methods, to take advantage of the richness of connected speech analysis for both research and clinical purposes (Boschi et. al., 2017)

Automating the data

Is it posible to automate the results and thus avoid subjective scores?

If we want to quantify semantic memory loss, we need more robust computational tools that can provide exact data over language: machine learning and text mining.

How?

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Automating the tests: a computer platform for patient tracking

- Computer platform that automatically assigns scores for each of the ítems of the tests involved; Hayling and Burguess (Parkinson), Boston (Alzheimer), Mini Mental State Examination (MMSE)
- A uniform protocol for the different tests so that the variable used will be shared by the different research centers and moreover the scores will obey to the same principle thus avoiding subjective measures depending on the criteria of the researcher administering the test;
- Data visualization in terms of graphs for patient tracking

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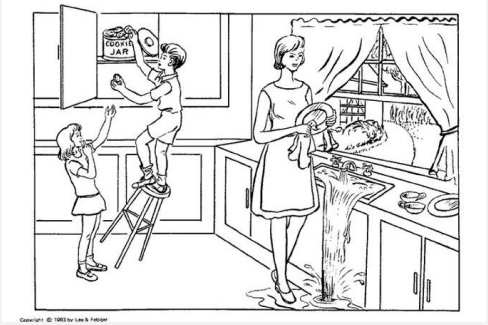
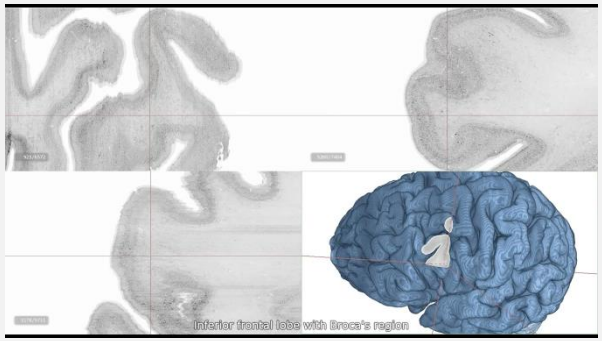
Mapping the data

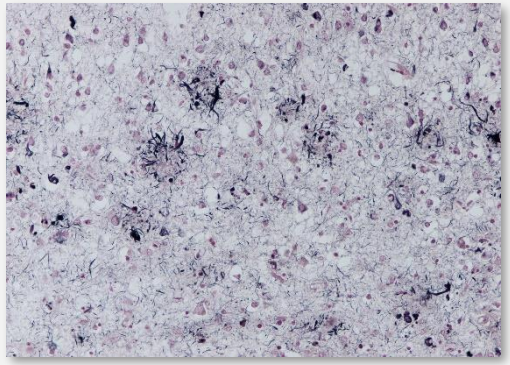
Combination of tests + neuroimaging + biological markers:

Can we correlate the three?

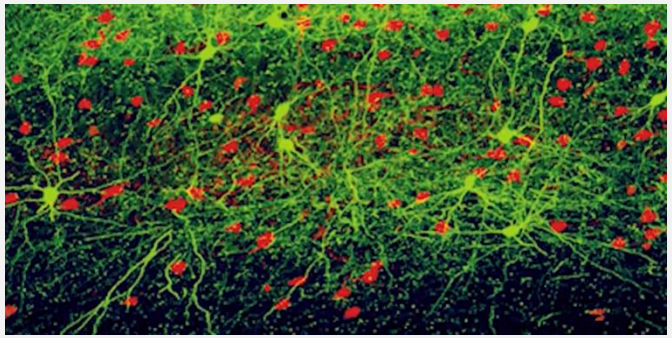
The 'cookie-theft' picture





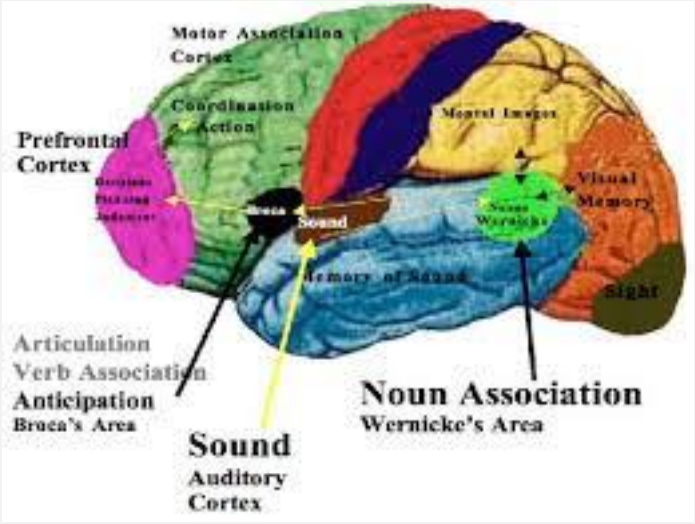


Deficits

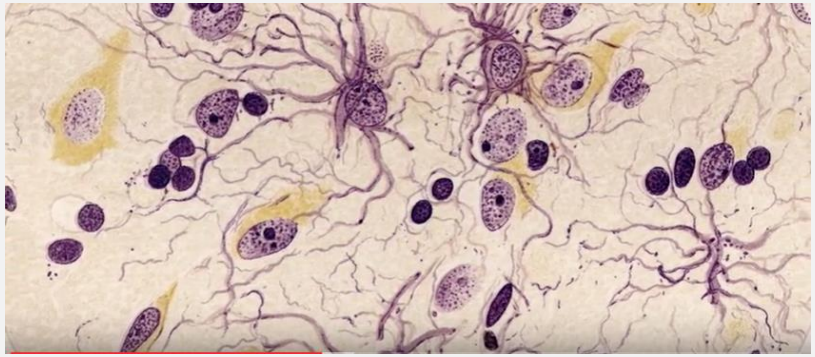


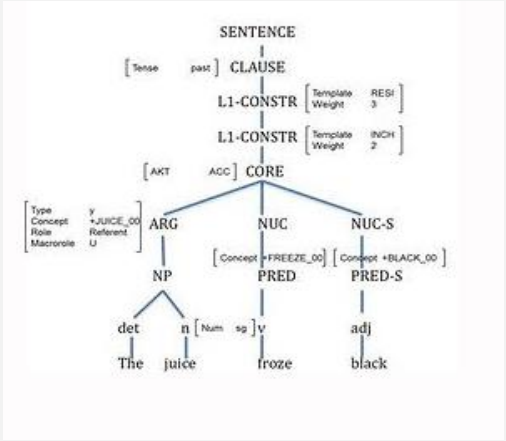
Histological representation

Thesis, methodology and aims



Linguistic deficits





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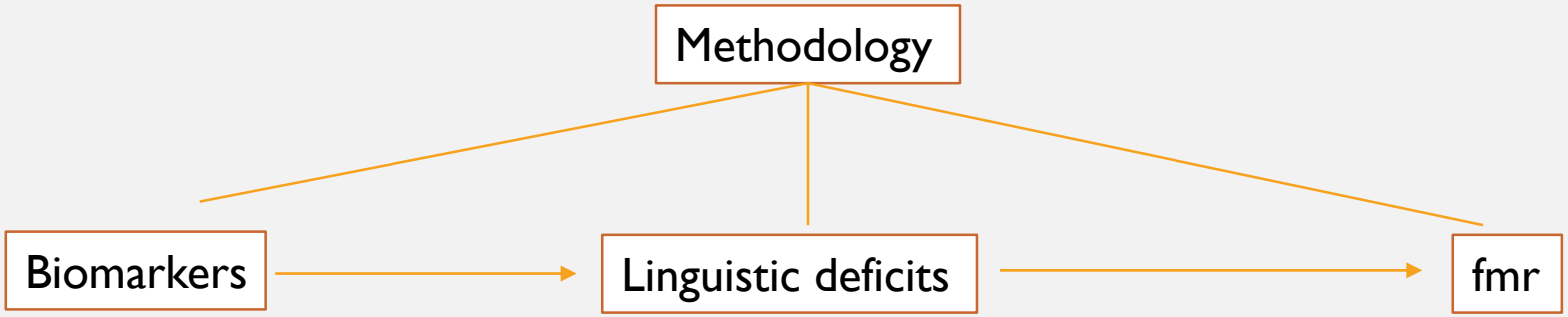
Towards a linguistic, neural atlas of the brain



An increasing number of studies are combining biological, neuroimaging, and cognitive biomarkers in large cohorts to determine whether sequentially cognitive changes follow on from biomarker changes or whether they may be detected at an earlier and parallel stage using conventional testing. (Mortamaisa et. al., 2017)

Towards a linguistic, neural atlas of the brain

- Correlation

  Neurolinguistic tests: linguistic deficits

  Fmr: alterations in the morphology of the brain

  Biomarkers: presence of amyloid and tau protein

- Precise identification of patterns at a preclinical or prodromal stage

ATLAS OF THE BRAIN

MUCHAS GRACIAS

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