# AUTOMATED ANALYSIS OF DIGITIZED SPEECH ABNORMALITIES IN FRONTOTEMPORAL DEGENERATION

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# FRONTOTEMPORAL DEGENERATION

- Plan of talk
  - What is FTD?
    - Primary progressive aphasia
    - Behavioral variant FTD
  - Digitized speech analysis tools
    - Speech activity detector
    - Part-of-speech analysis
  - Application to FTD
    - Non-fluent/agrammatic primary progressive aphasia
    - Semantic variant primary progressive aphasia
    - Non-aphasic behavioral variant FTD



#### **Dementia with Pick Bodies**

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# FRONTOTEMPORAL DEGENERATION

- Early-onset neurodegenerative disease
- Two major clinical phenotypes
  - Primary progressive aphasia (45%)
    - Non-fluent/agrammatic variant
    - Semantic variant
  - Disorder of social comportment and executive functioning (55%)
    - Behavioral variant FTD
- Phenotypes are important because they are inexpensive screening markers of pathology



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# DIGITIZED SPEECH ANALYSIS

- Acoustic analysis
  - Automated speech activity detection
    - Timing of speech activity
      - Total speech time
      - Speech segment duration
      - Pause count
      - Pause duration
      - Pause rate
  - Automated pitch analysis
    - Fundamental frequency (f0)
    - Pitch contour
  - Forced alignment
    - Relate pitch to lexical content





# DIGITIZED SPEECH ANALYSIS

- Automated lexical analysis
  - Part of speech
    - Major grammatical subcategory
      - e.g. noun, verb, adjective, adverb, conjunction, determiner, pronoun, preposition
    - Speech errors/partial words, interjections
  - Lexical-semantic characteristics
    - Abstractness, frequency, ambiguity, familiarity, age of acquisition





## DIGITIZED SPEECH ANALYSIS

- Picture description task
  - Familiar
  - Brief
  - No training for administration





### NON-FLUENT/AGRAMMATIC PPA

- Nonfluent/agrammatic PPA
  - Criteria
    - Slow, effortful speech
    - Grammatical impairment
    - Apraxia of speech
  - Significant changes in speech
    - Reduced verbs and inflected verbs
    - Increased speech errors/partial words
    - Limited f0 range





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#### NON-FLUENT/AGRAMMATIC PPA



Courtesy John Q. Trojanowski MD, PhD



**Pick bodies** 



**Balloon cells** 

# 80% naPPA due to tauopathy such as Pick's disease



# **NON-FLUENT/AGRAMMATIC PPA**

- Nonfluent/agrammatic PPA ullet
  - Validation studies directly relating neurobiological measures to speech
    - MRI anatomy ٠
    - Cerebrospinal fluid
    - Pathology



- Parjane et al, under review Verb use and f0 related to CSF pTau
- particles/100 words Particle use related to Tau pathology burden in inferior frontal gyrus



Grammatical and speech deficit related to left frontal atrophy in naPPA



# SEMANTIC VARIANT PPA

- Semantic variant PPA
  - Criteria
    - Fluent, impaired word-finding
    - Impaired word meaning
    - Impaired object knowledge
  - Significant deficits in speech
    - Fewer nouns
      - Less concrete
      - More ambiguous
    - More pronouns





40

30.

20

10

nouns/100 words

SEMANTIC AMBIGUITY

**UNIQUE NOUNS** 







Cho et al, 2020

Contro

**bvFTD** 

naPPA

**svPPA** 

# TDP PATHOLOGY IN PPA

- Left temporal atrophy
- TDP-43 pathology



Courtesy John Q. Trojanowski MD, PhD





# SEMANTIC VARIANT PPA

- Semantic variant PPA
  - Validation studies directly relating speech to neurobiological measures
    - MRI



CSF neurofilament light elevated in TDP
Elevated NfL related to cognition



Concreteness and ambiguity related to left temporal atrophy



## **BEHAVIORAL VARIANT FTD**

- bvFTD clinical characteristics
  - Poor self-regulation, impulsive, disinhibited, impaired social conduct
  - Rigid, obsessive, rituals
    - Can co-occur with svPPA
  - Apathetic
  - Limited insight
  - Poor empathy
  - Executive deficits
    - Limited judgment
  - bvFTD without clinical aphasia
- Major challenge is establishing objective measures



#### **BEHAVIORAL VARIANT FTD**

- Speech and language disorder revealed in bvFTD patients
  - Acoustic features
    - Reduced f0 range
  - MRI atrophy in frontal regions bilaterally
    - Reduced f0 range related to frontal atrophy







# **BEHAVIORAL VARIANT FTD**

- Speech and language disorder revealed in bvFTD patients
  - Lexical features
    - Reduced adjective use
    - Related to apathy (r=0.32; p<.01)
  - MRI atrophy in frontal regions bilaterally
    - Reduced adjective use and apathy related to frontal atrophy



Cho et al, in press

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# DIGITIZED SPEECH IN FTD

- Digitized speech useful in FTD
  - Objective verification of clinical features
  - Useful for evaluating eligibility for treatment trials
  - Follow patients longitudinally for efficacy and safety during treatment trials
  - Enhance models of the neurobiology of language
  - Clinical marker of spreading pathology in progressive neurodegenerative diseases

# THANK YOU!

• Questions?

