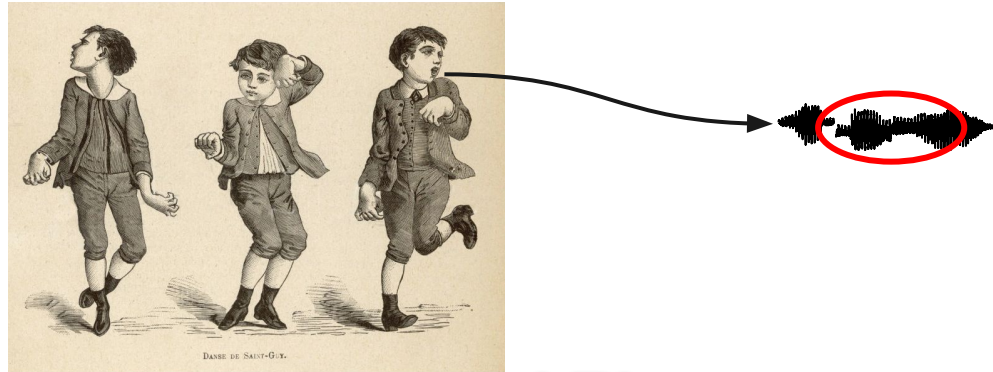


Measurements of turn-taking and linguistic behaviors in clinical settings

Rachid Riad, Lucas Gautheron, Emmanuel Dupoux, Anne-Catherine Bachoud-Levi, Alejandrina Cristia



LSCP Laboratoire de Sciences Cognitives et Psycholinguistique

NPI
NeuroPsychologie
Interventionnelle



DEC DÉPARTEMENT D'ÉTUDES COGNITIVES

PSL UNIVERSITÉ PARIS

Inria

Inserm
La science pour la santé
From science to health

IMRB INSTITUT MONDOR DE RECHERCHE BIOMÉDICALE

UPEC UNIVERSITÉ PARIS-EST CRETEIL VAL DE MARNE
Connaissance-Action

Overview

- 1) Introduction and motivations
- 2) Human expert annotation vs Crowdsourcing vs Automatic Methods
- 3) Conclusion

Overview

- 1) **Introduction and motivations**
- 2) Human expert annotation vs Crowdsourcing vs Automatic Methods
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Current follow-up in Neurodegenerative Diseases

Now at the **Hospital**



- Once/ Twice a year
- Specialized and fastidious tests
- Analysis by experts
- Wearisome and Expensive

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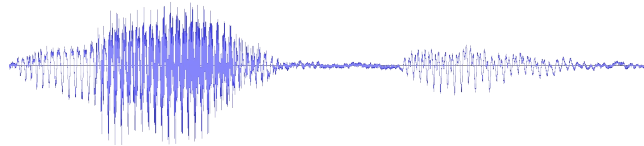
- Limitations in Clinical Trials
- Limited understanding of the disease
- Only reactions and not prevention of difficult life events

Clinical question

How to monitor the evolution of neurodegenerative diseases under less controlled conditions, more frequently and automatically?

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Clinical question

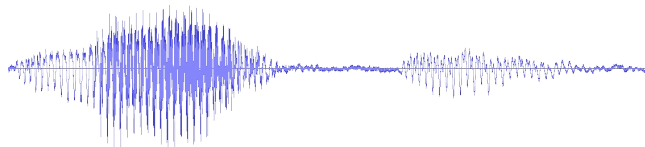
How to monitor the evolution of neurodegenerative diseases under less controlled conditions, more frequently and automatically?

Alzheimer's Disease

KC Fraser, JA Meltzer, F
Rudzicz 2016

Parkinson's Disease

A Tsanas, MA Little, PE
McSharry, LO Ramig
2010



Huntington's Disease

Riad et al. 2020

Multiple Sclerosis

J Rusz et al. 2018

Frontotemporal Dementia

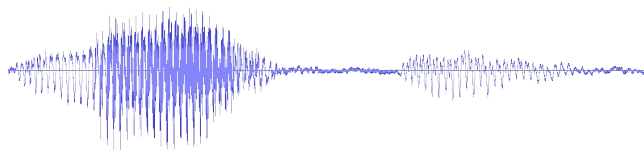
Zimerrer et al. 2020

Primary Progressive Aphasia

Wilson et al. 2010, Fraser et al. 2014

Researcher's/Engineer's problem

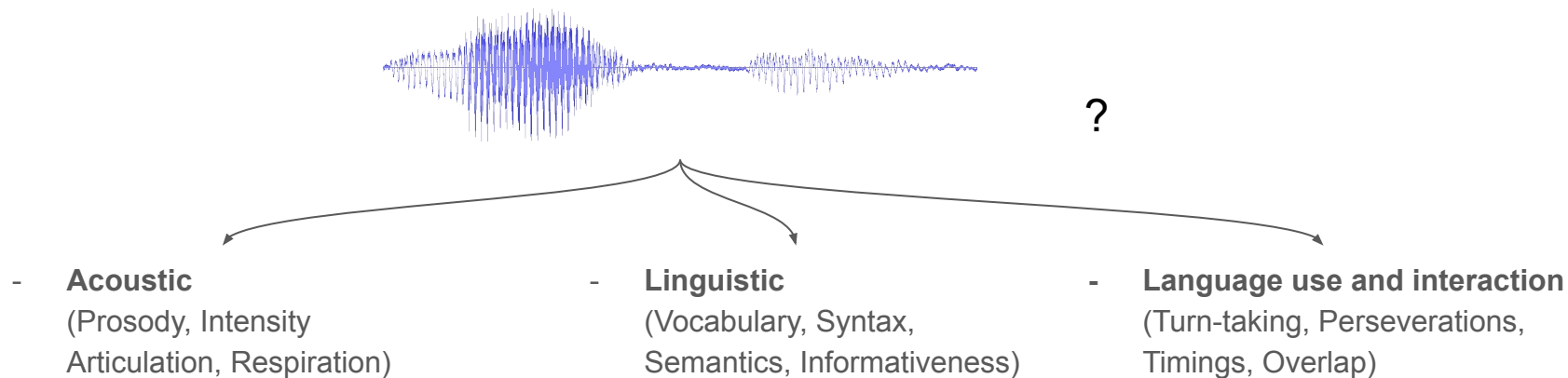
Then, how do we obtain measurements of naturalistic turn-taking and linguistic behaviors for clinical applications?



- **Acoustic**
(Prosody, Intensity
Articulation, Respiration)
- **Linguistic**
(Vocabulary, Syntax,
Semantics, Informativeness)
- **Language use and interaction**
(Turn-taking, Perseverations,
Timings, Overlap)

Researcher's/Engineer's problem

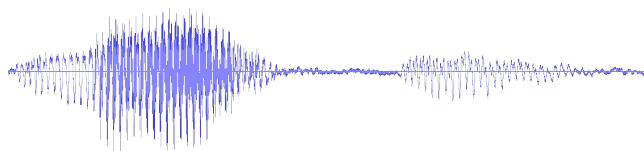
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Overview

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Human expert annotations



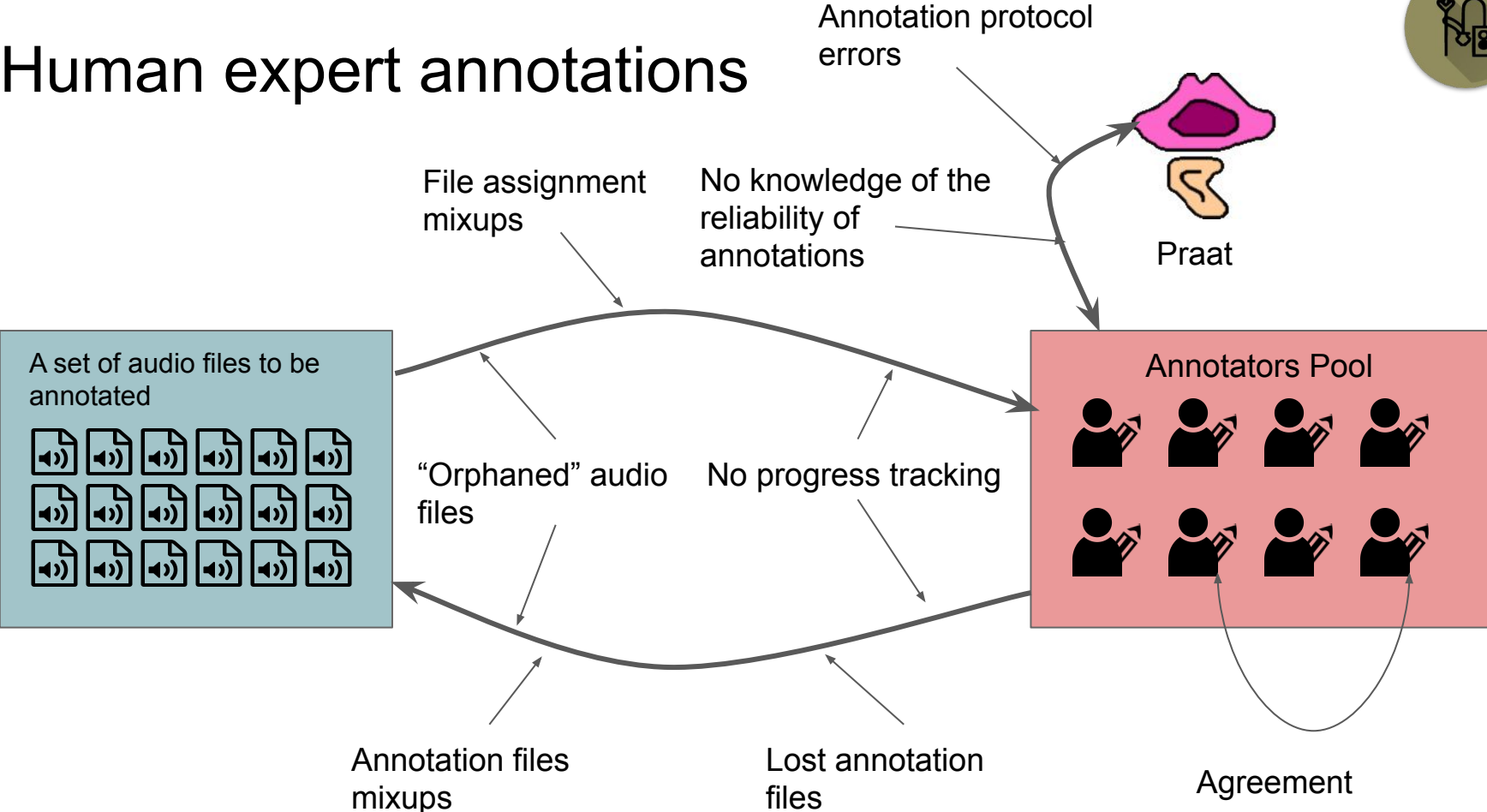
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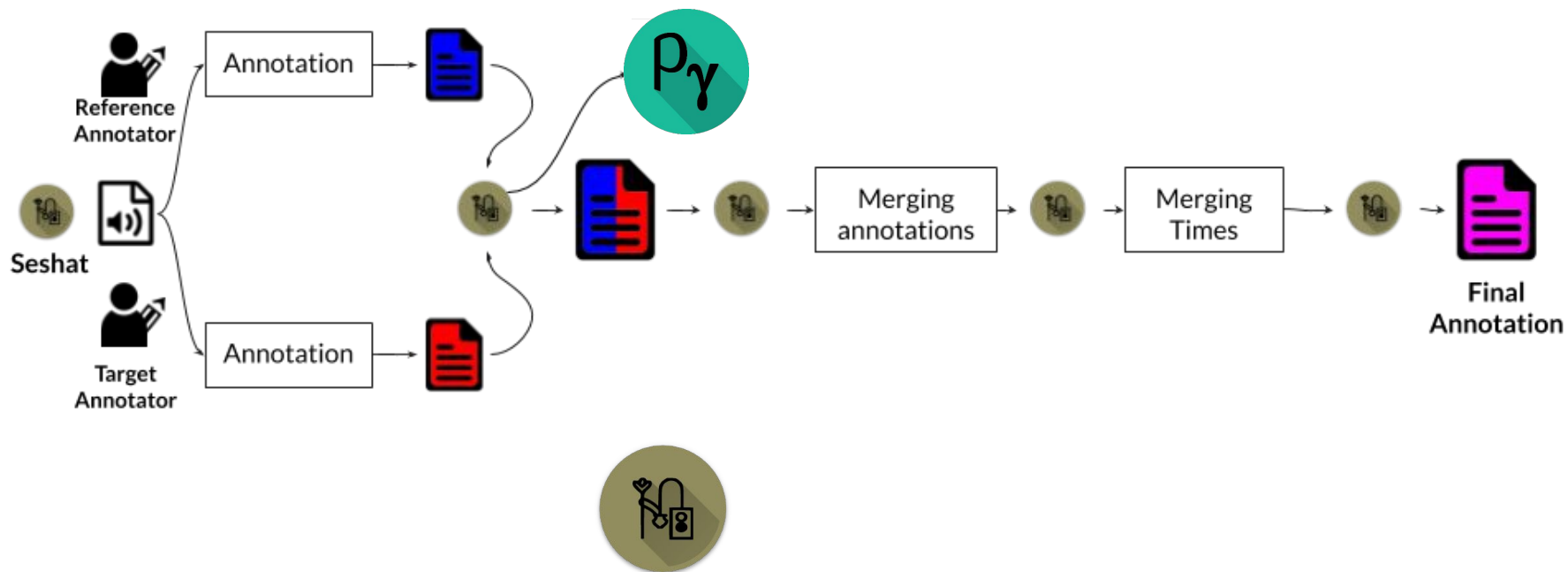
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Human expert annotations



Human expert annotations

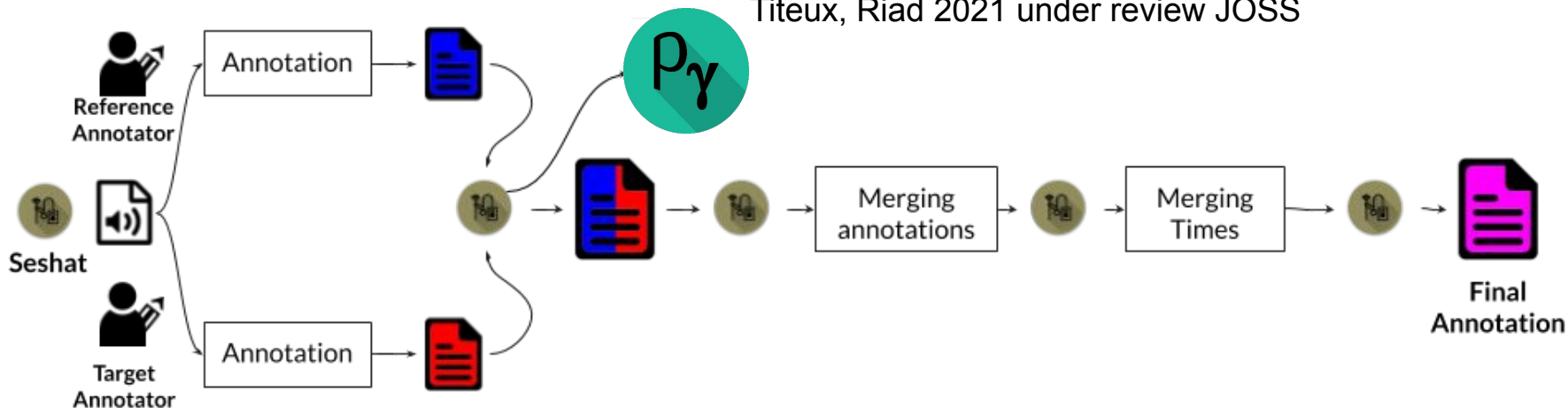


Human expert annotations

Huntington's Disease, Parkinson Disease,
Daylong recordings in Amazonia

<https://github.com/bootphon/pygamma-agreement>

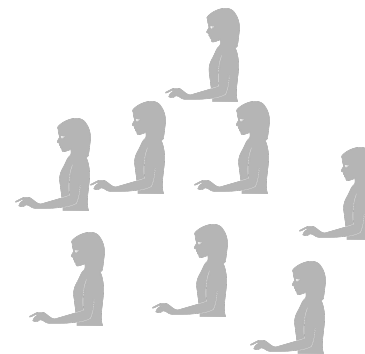
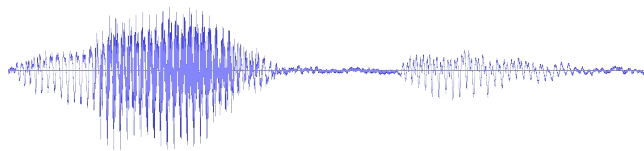
Titeux, Riad 2021 under review JOSS



<https://github.com/bootphon/seshat>

Titeux*, Riad* et al. LREC 2020

Crowdsourcing



- **Acoustic**
(Prosody, Intensity
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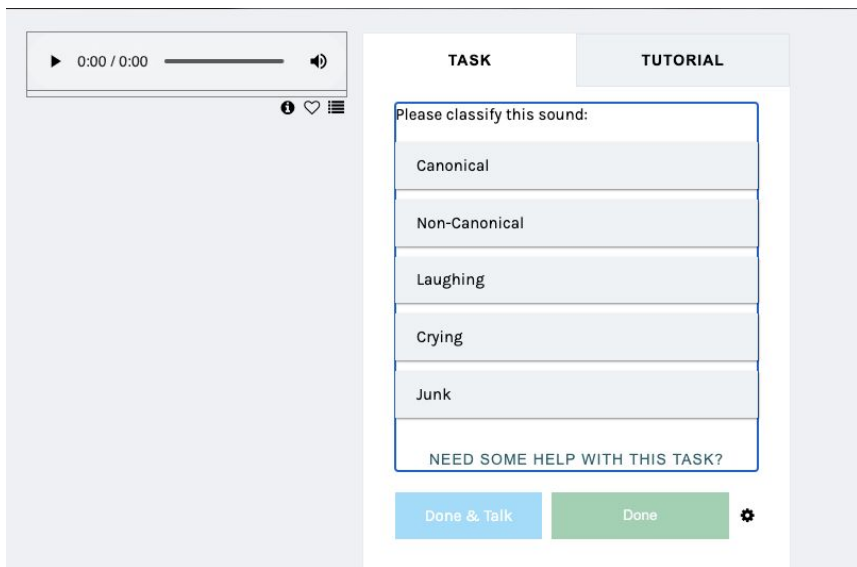
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Crowdsourcing

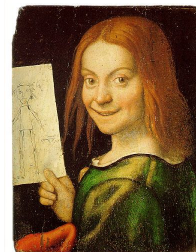
Semenzin, ..., Cristia. SLT 2021

<https://www.zooniverse.org/>



The screenshot shows a web interface for a crowdsourcing task. At the top left, there is a video player with a progress bar at 0:00 / 0:00 and a speaker icon. Below the player are icons for information, a heart, and a list. The main content area has two tabs: 'TASK' (selected) and 'TUTORIAL'. Under the 'TASK' tab, the instruction reads 'Please classify this sound:'. Below this are five radio button options: 'Canonical', 'Non-Canonical', 'Laughing', 'Crying', and 'Junk'. At the bottom of the task area is a link that says 'NEED SOME HELP WITH THIS TASK?'. At the very bottom, there are two buttons: 'Done & Talk' (blue) and 'Done' (green), followed by a gear icon for settings.

Angelman's Syndrome



Angleman's Syndrome:

10 children (6 males, 4 females; age range 11-53 months, mean=41.5 months)

Control:

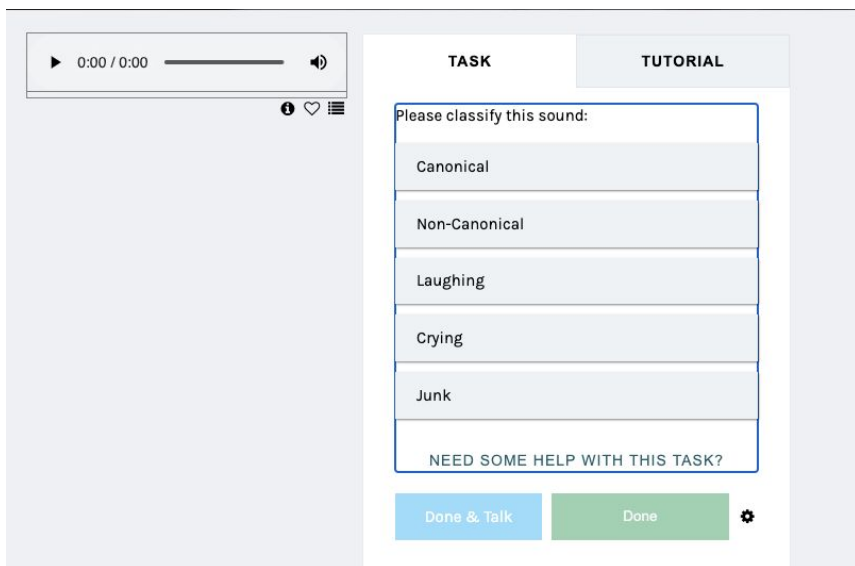
10 low-risk control children (6 males, 4 females; age range 4-18 months, mean=11.7 months)



Crowdsourcing

Semenzin, ..., Cristia. SLT 2021

<https://www.zooniverse.org/>



The screenshot shows the Zooniverse interface for a sound classification task. At the top, there is a media player with a play button, a progress bar at 0:00 / 0:00, and a speaker icon. Below the player are icons for help, heart, and list. The main area is divided into two tabs: 'TASK' and 'TUTORIAL'. Under the 'TASK' tab, the instruction reads 'Please classify this sound:'. Below this are five radio button options: 'Canonical', 'Non-Canonical', 'Laughing', 'Crying', and 'Junk'. At the bottom of the task area is a link that says 'NEED SOME HELP WITH THIS TASK?'. At the very bottom, there are two buttons: 'Done & Talk' (blue) and 'Done' (green), along with a gear icon for settings.

Angelman's Syndrome



$r=0.833$

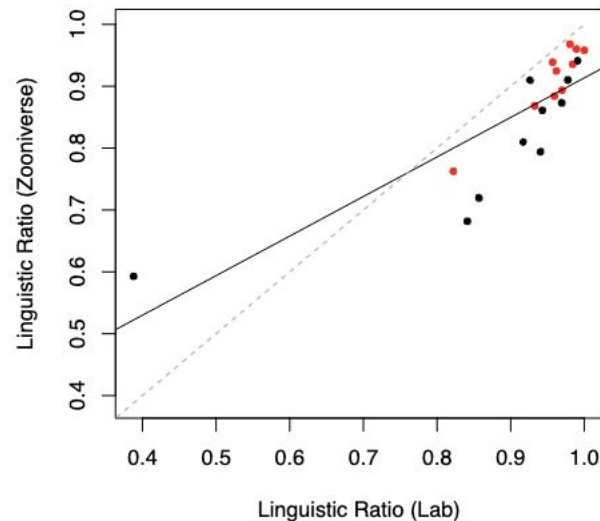
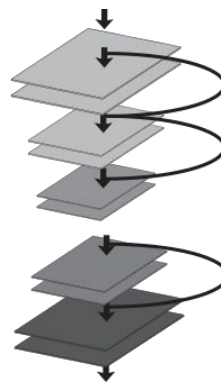
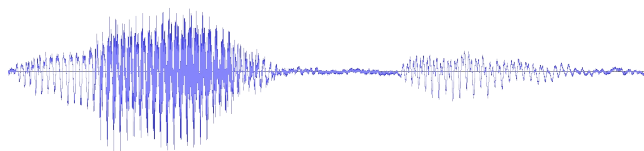


Fig. 3. Individual children's linguistic ratio according to Zooniverse versus Lab annotations. Black points correspond to children diagnosed with Angelman Syndrome, red for low-risk control.

Automatic methods



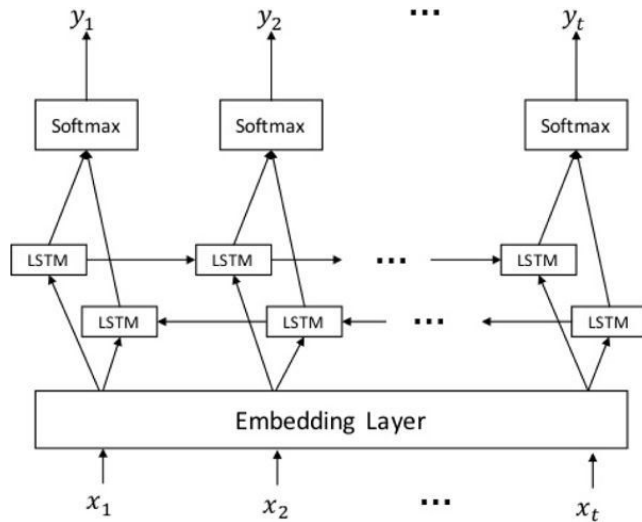
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Automatic methods

Riad et al. 2021



<https://github.com/MarvinLvn/voice-type-classifier>

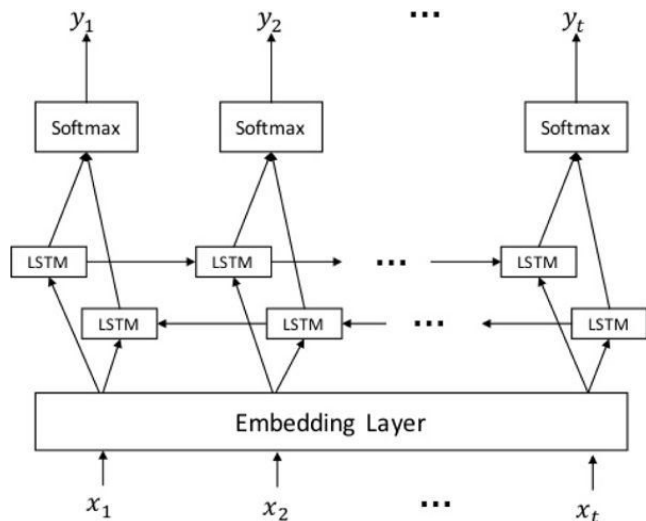
Table 1. Interviewee demographics and clinical scores

Sub-groups	Controls	Huntington's disease Gene carriers	
	C	PreHD	HD
N	22	18	54
Gender	10F/12M	10F/8M	32F/22M
Age (years)	54.1 (8.6)	50.1 (11.8)	53.5 (11.3)
CAG Triplets	≤ 35	41.5 (1.7)	44.2 (3.3)
TFC [20]	—	13.0 (0.0)	10.4 (2.1)
TMS	—	0.33 (1.0)	34.3 (15.6)



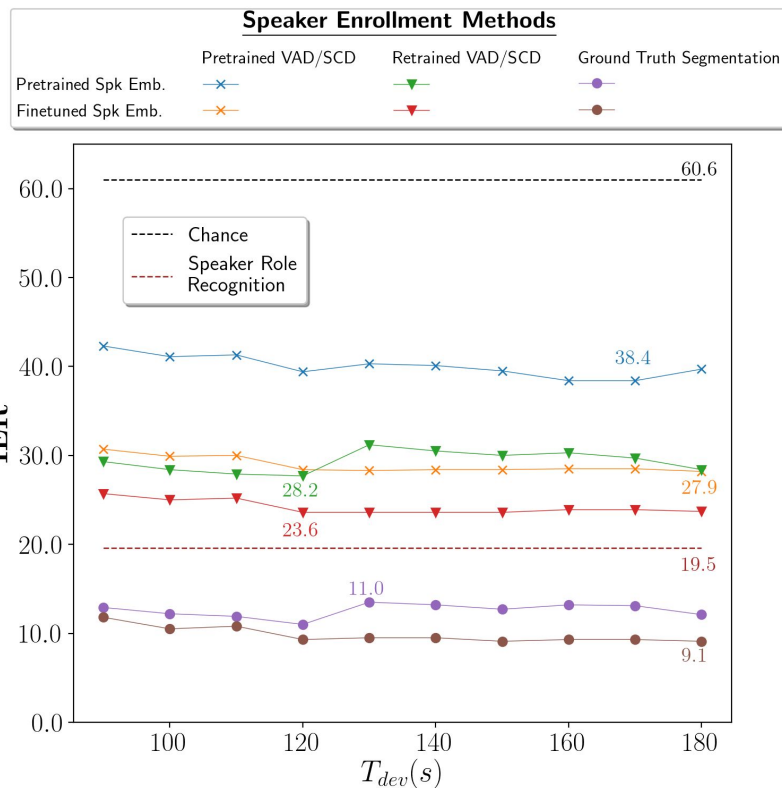
Automatic methods

Riad et al. 2021



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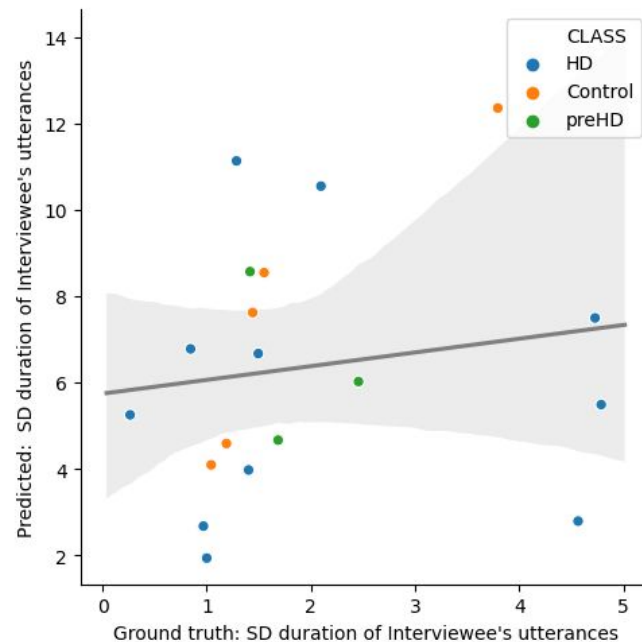
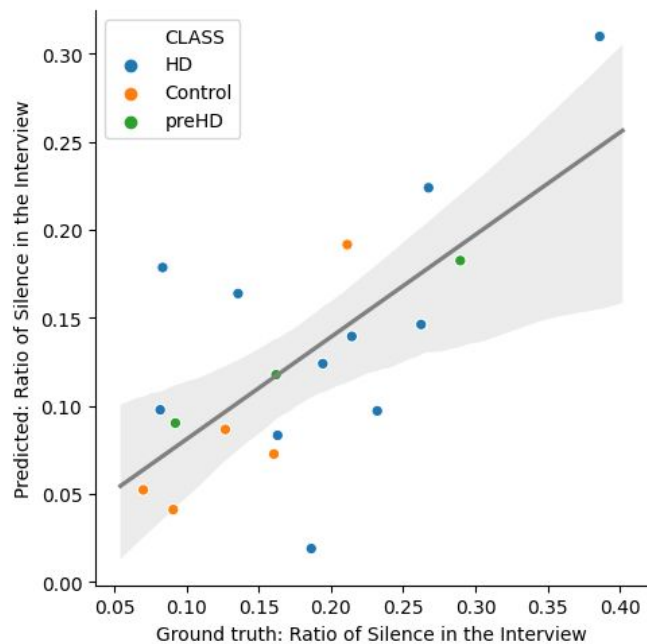
Huntington's Disease



Automatic methods

Huntington's Disease

Riad et al. 2021



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Comparison

	Human expert annotations
Reliability	+++
Cost	+++
Privacy	-
Scalability	---
Skills to launch such project	Organization, Data management

Comparison

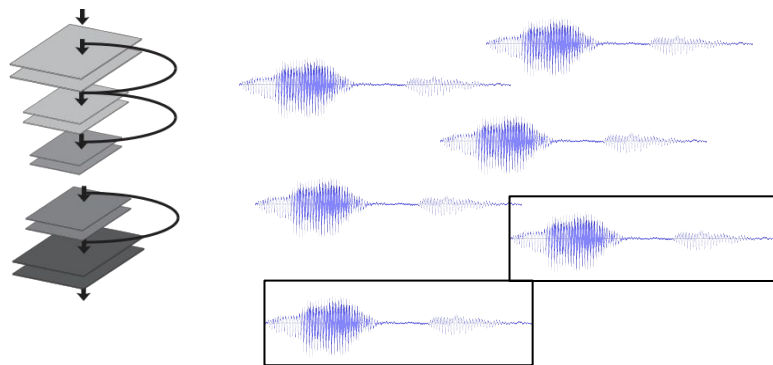
	Human expert annotations	Crowdsourcing
Reliability	+++	+(depends on how much can be shared)
Cost	+++	~ (depends)
Privacy	-	---
Scalability	---	+
Skills to launch such project	Organization, Data management	Organization, Data management

Comparison

	Human expert annotations	Crowdsourcing	Automatic methods
Reliability	+++	+(depends on how much can be shared)	+ (depends on training data)
Cost	+++	~ (depends)	+
Privacy	-	---	~ (models can leak training data)
Scalability	---	+	+++
Skills to launch such project	Organization, Data management	Organization, Data management	Engineering systems, Machine Learning

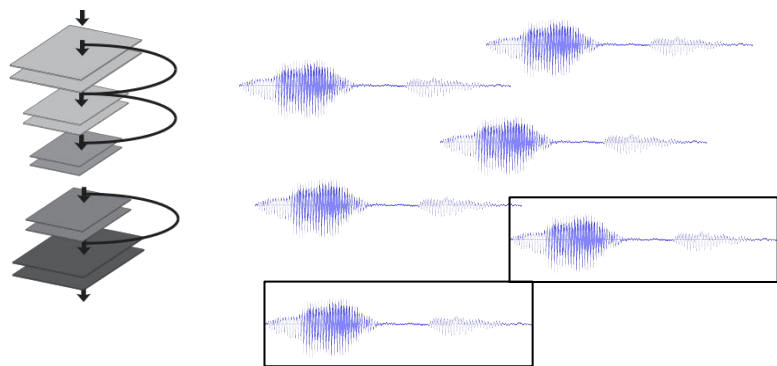
Future work

Self-supervised learning

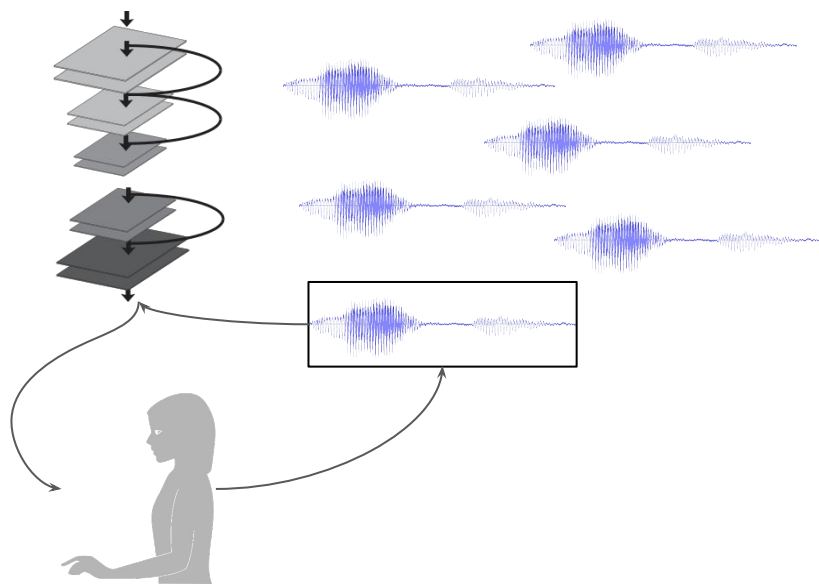


Future work

Self-supervised learning



Active learning



Thank you!



Hadrien Titeux



Marine Lunven



Laurent Cleret



Lorna Le Stanc



Agnes Sliwinski



Henri Vandendriessche



Elodie Idoux



Justine Montillot



Jennifer Hamet



Laurie Lemoine



Philippe Remy



Charlotte Jacquemot



Gilles Fenelon



Xuan Nga Cao



Emmanuel Dupoux



Hayet Salhi



Anne-Catherine Bachoud-Levi



Mathieu Bernard



Frank Rudzicz

and Lucie, Aurelie, Amina, Peixine, Alexandra, Coraline, Priscille, Jeanne, Clara, Tiffany



Alex Cristia



Lucas Gautheron



Alexis Gabadinho



Julien Karadayi

Lydie Lim

Cécile DiFolco

