A Collection of Pragmatic-Similarity Judgments over Spoken Dialog Utterances

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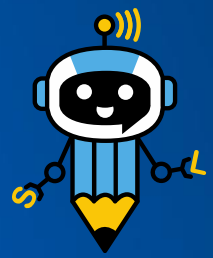
Linguistic Resources and Evaluation Conference

(LREC) 2024



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Human Spoken Language is Multifaceted

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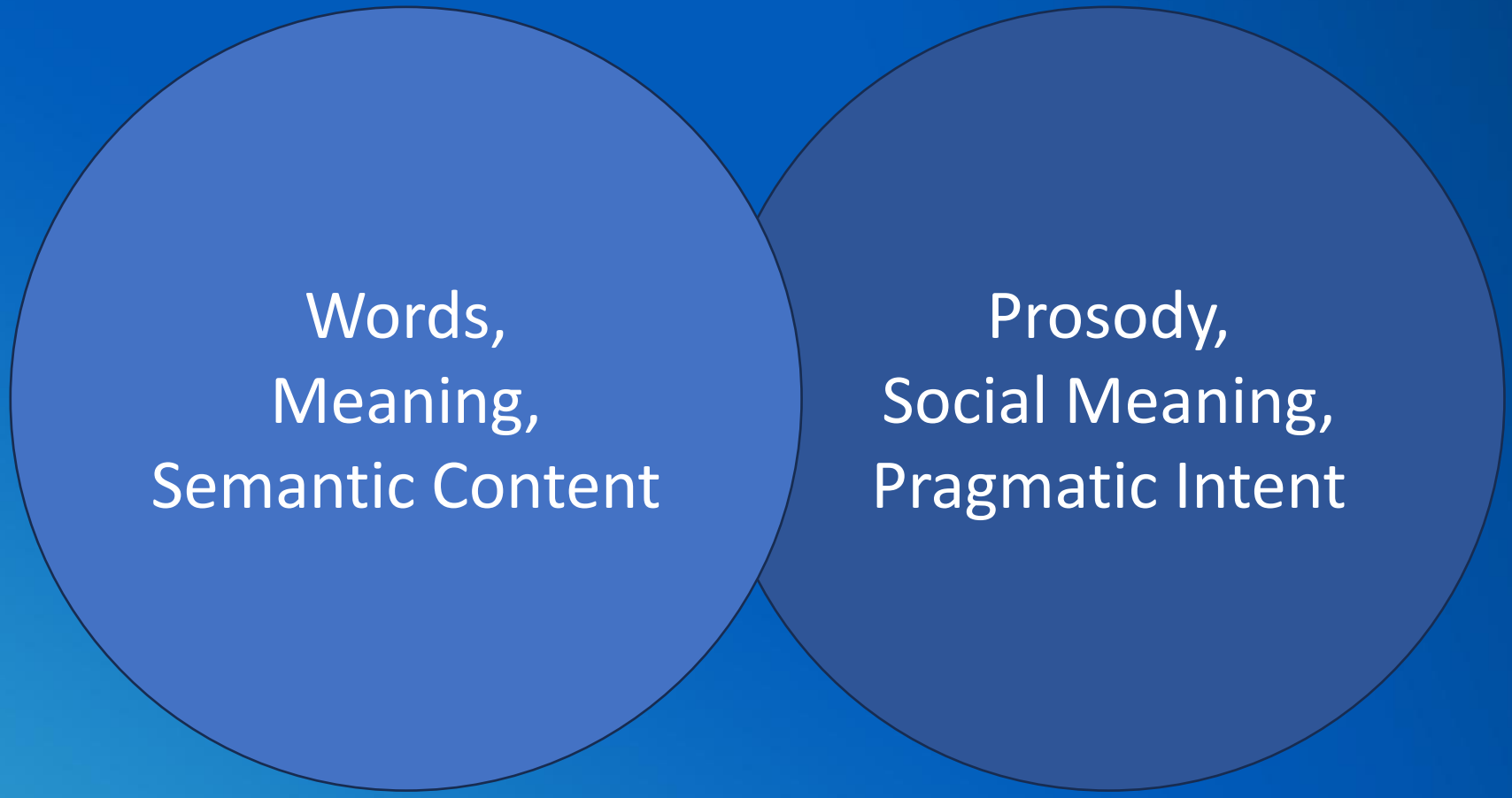

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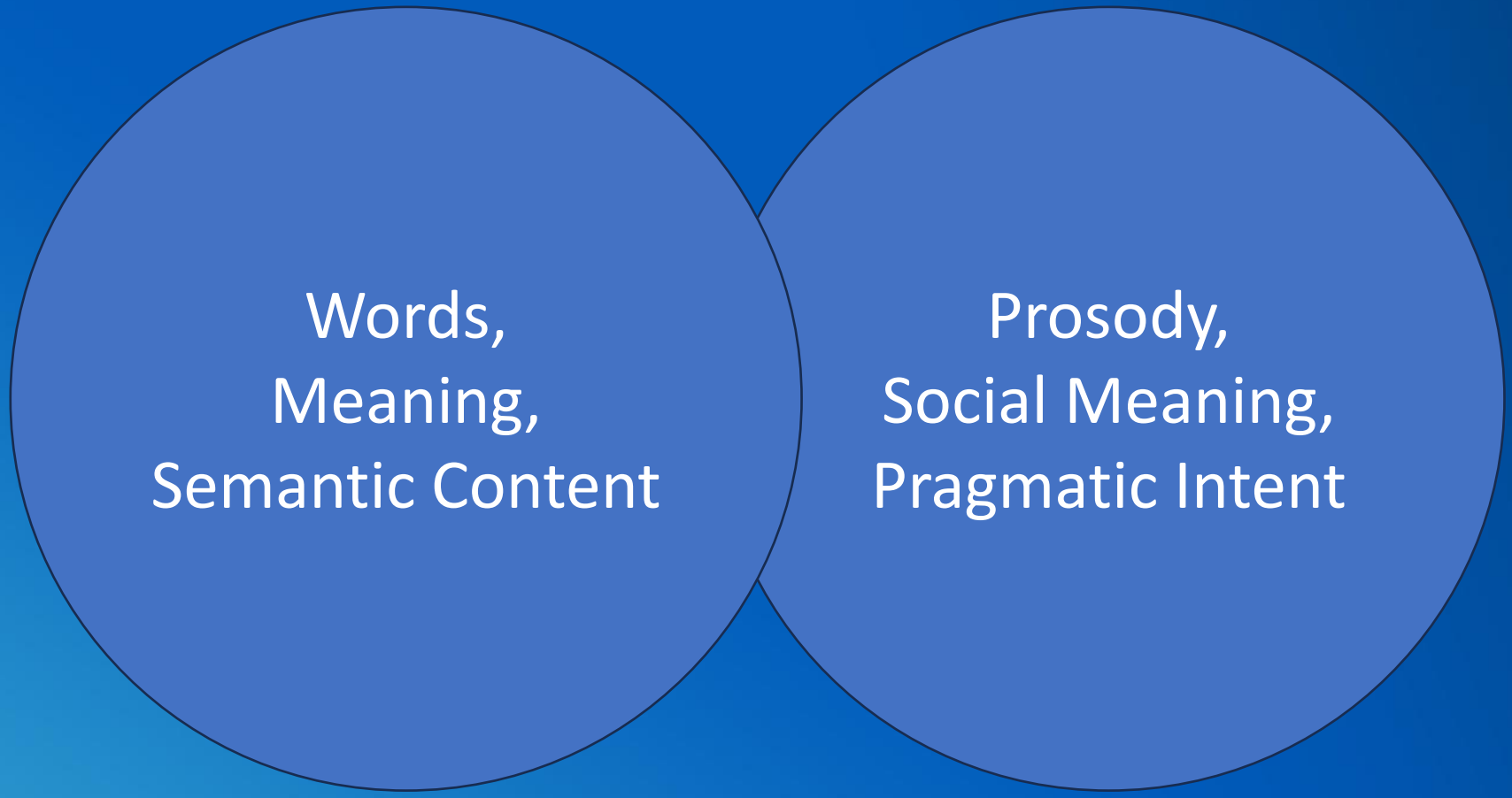

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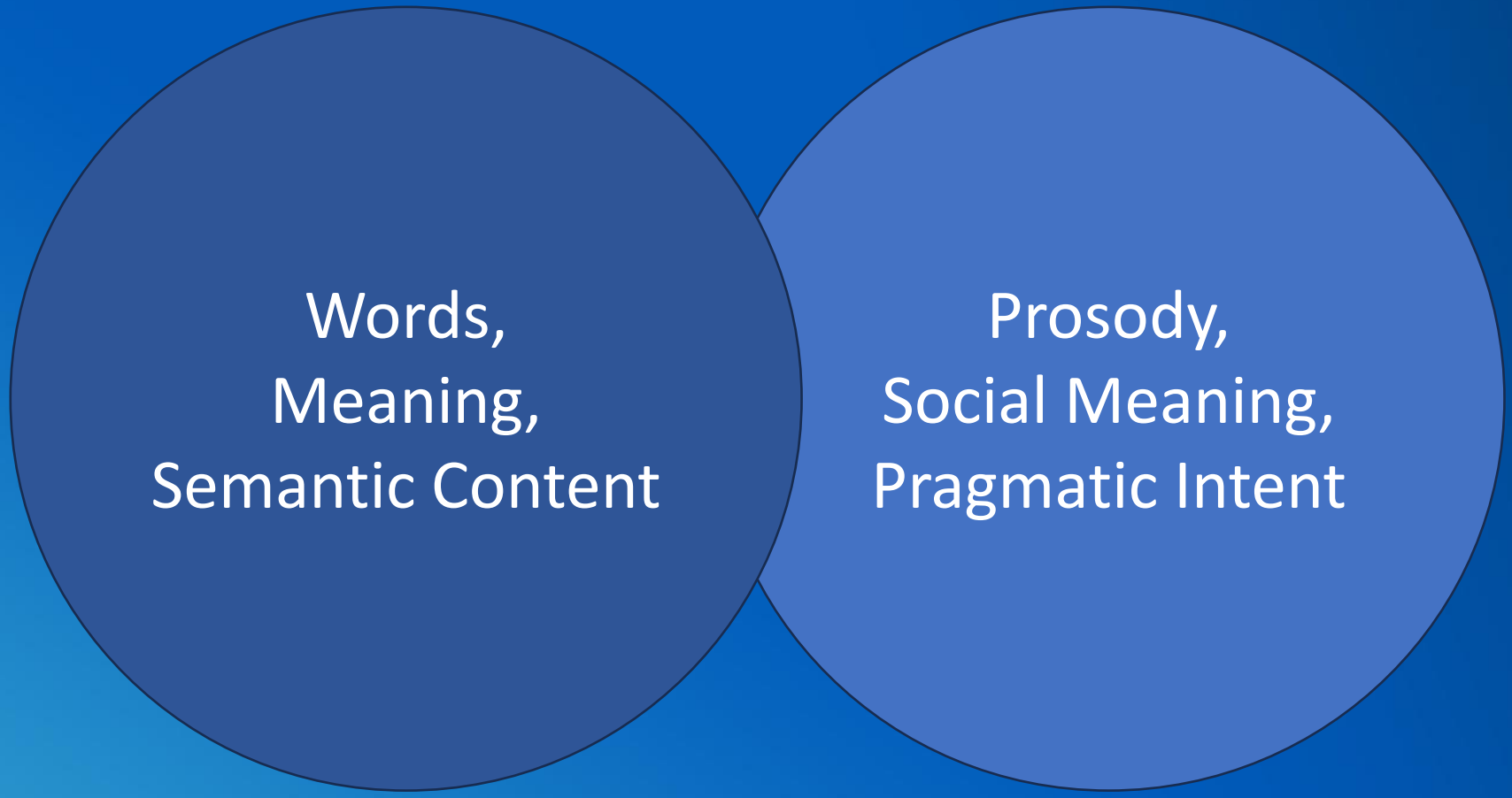

Speech Synthesis

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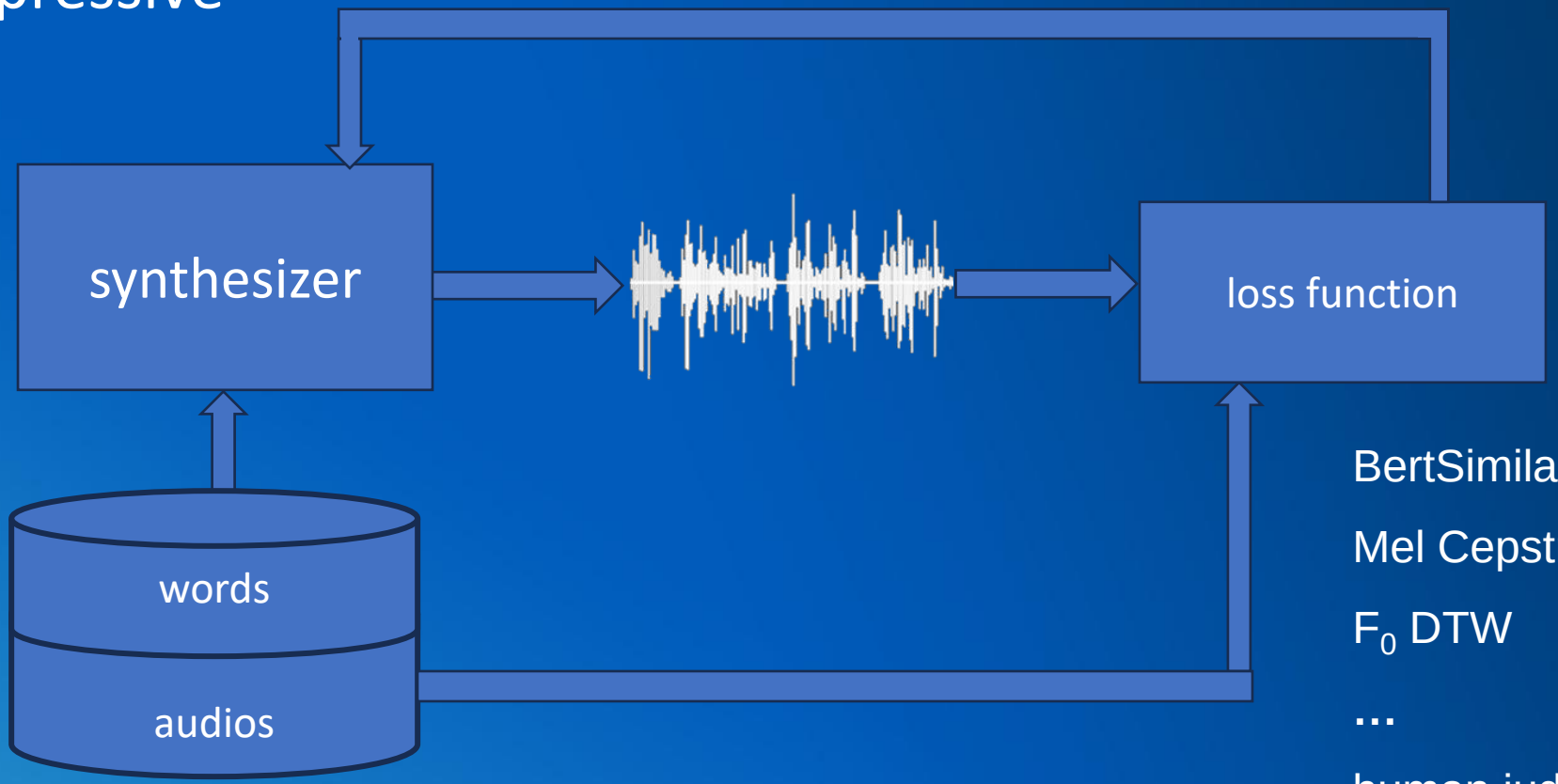
- Already highly intelligible
- Not very expressive



Uses for a Pragmatic Similarity Measure

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- For Speech Synthesis:

  How close is an utterance to the target?

- For Second-Language Training:

  How close is a learner utterance to a target?



- For Diagnosis:

  Are the two utterances close enough to infer that the speakers have the same medical condition?

- For Retrieval-based Chatbots:

  . . .

Related Work

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- Semantic-similarity models
  - address a different problem
- Prosodic-similarity models
  - designed only for read speech
- Same-speech-act models (Pragst 2022)
  - inadequate for nuanced or multifaceted utterances

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A Collection of Pragmatic-Similarity Judgments over Spoken Dialog Utterances

Data is needed

- To train models
- To evaluate models

A Collection of Pragmatic-Similarity Judgments over Spoken Dialog Utterances

Data is needed

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Outline

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- The need
- The data we collected
- Cleverness and weakness in the data collection
- A model trained using this data

Session Statistics

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	English 1	English 2	Spanish
Stimuli (clip pairs)	220	233	235
Judges	9	9	6
Total judgments	1980	2098	1410
Agreement*	0.45	0.72	0.66

*average inter-judge correlation, Pearson's

https://github.com/divettemarco/PragSim

Judgment Examples

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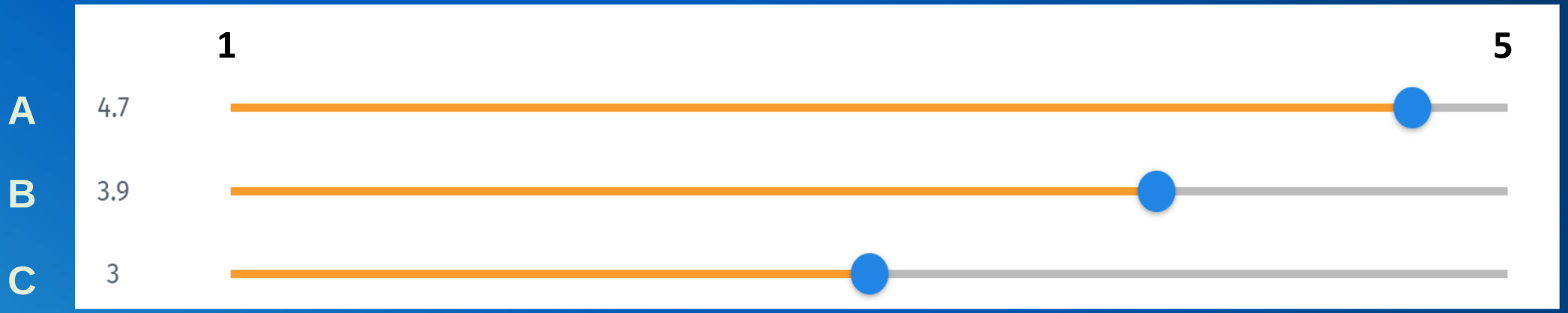
A

B

C



"How pragmatically similar are these, in terms of the overall feeling, tone, and intent?"

Judges, Procedure

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2nd Session, October 7, 2023

Other Design Choices

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- Dialog data

- Rating (vs ranking, ABX, etc.)
- Continuous rating 1 – 5 (vs discrete)
- Minimal delay between presentation
- Context-free presentation

Design Choices: The Instrument

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"How pragmatically similar are the two clips, in terms of the overall feeling, tone, and intent.

- Try to ignore:
  - speaker differences,
  - differences in the words said
  - insignificant differences in pitch, rate, pausing, etc.

- Maybe consider: • Similarity in the contexts where they would likely appear • Similarity in how a listener would likely respond • Similarity in how the speaker may have felt (confident, positive, offended, enthusiastic, etc.) • Similarity in the dialog activity (correcting a misconception, teasing, holding the floor, asking a question, implying something, etc.)"

Stimulus Creation

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Each pair has

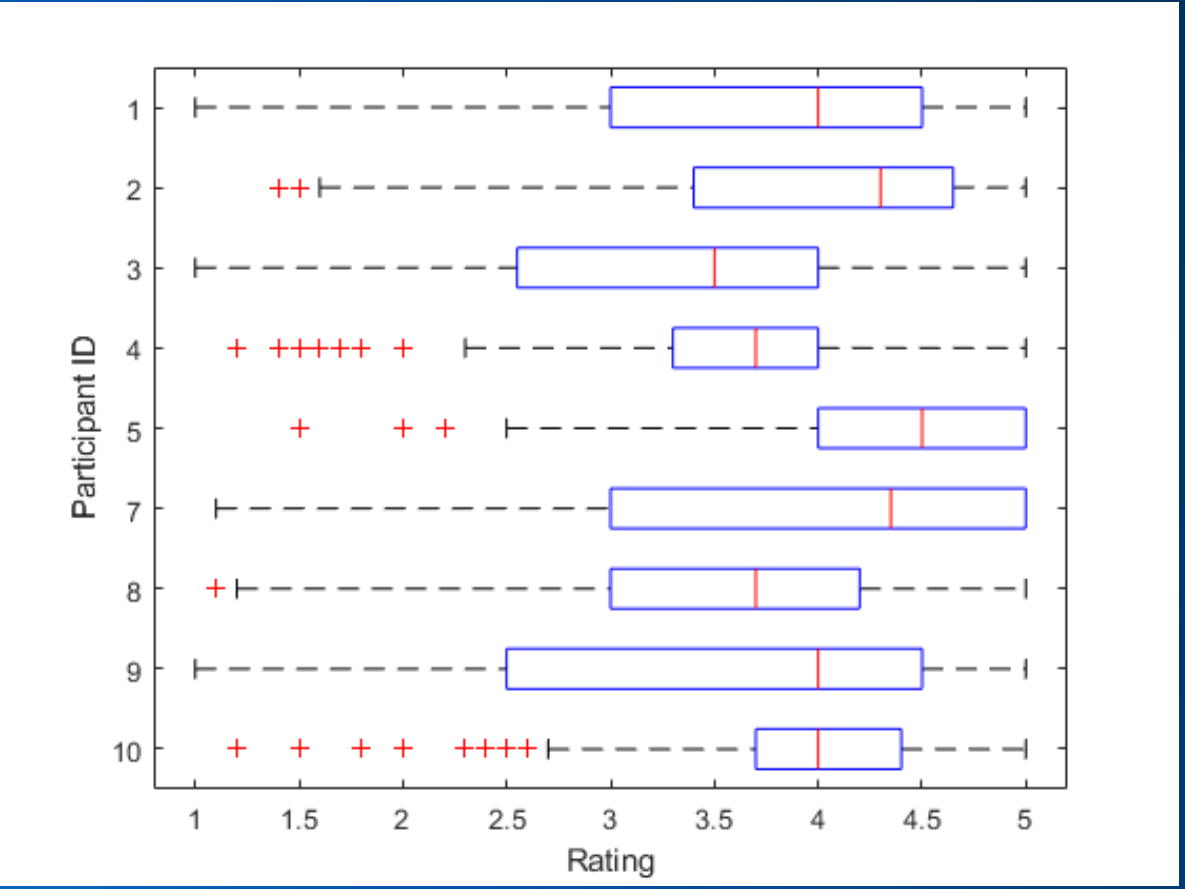
- An utterance from a real dialog, chosen for interestingness
- A re-enactment, done under various conditions:
  - Mimic the audio
  - See the words
  - Reproduce audio with different words
  - See the words and the context
  - Hear only the context
  - Speech synthesizer

very similar

moderately similar

Factors Affecting Ratings

- Judges varied
- Judges got slightly more generous over time
- Judges learned to use more of the scale



Factors Affecting Agreement

- Judge identity

Inter-Annotator Agreement (correlations), Session 1

judge	1	2	3	4	5	7	8	9	10
1									
2	0.40								
3	0.38	0.61							
4	0.37	0.59	0.59						
5	0.19	0.30	0.31	0.49					
7	0.41	0.67	0.66	0.54	0.33				
8	0.39	0.64	0.60	0.80	0.40	0.54			
9	0.21	0.40	0.36	0.18	0.19	0.51	0.20		
10	0.42	0.62	0.50	0.59	0.29	0.52	0.63	0.27	
Per-Judge Means									
	0.34	0.53	0.50	0.52	0.31	0.52	0.52	0.29	0.48

Session 2
average agreement: 0.72

Other Factors Affecting Agreement

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Poor agreement

Generally better agreement

- For blandly-spoken pairs

  i.e., without laughter, ingressive fillers, breathiness, falsetto …

- For similar-personality speakers

- For judges with more experience
- Near the top of the scale
- For pairs with same lexical content
- For pairs similar in duration

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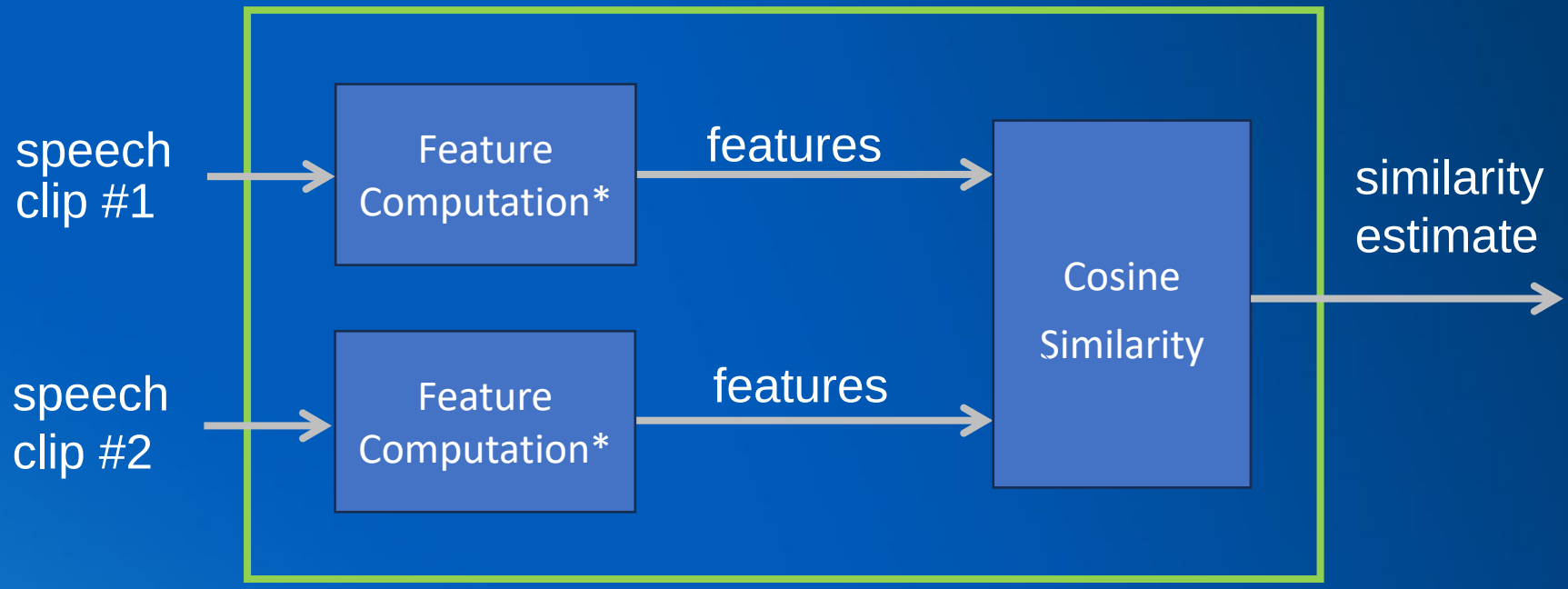
Bonus Topic

A Similarity-Prediction Model



*Features:

- 103 features from the HuBert pretrained model
- selected to optimize performance on a training set of 1980 human judgments of similarity
- averaged over each entire clip

Comparison to human agreement

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Average of Correlations* with Every Human Judge

	English 1	English 2	Spanish 1
Wav2Vec 2.0	.31	.41	.24
HuBert	.45	.41	.40
Selected HuBert	.50	.64	.45
Worst Human	.29	.68	.62
Average Human	.45	.72	.66
Best Human	.53	.78	.70

* Not correlations with the human average, like before

Utility for Finding Most-Similar Utterances

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- An utterance from a conversation last week
  I drive a Hyundae Elantra, it's a gray color. Um, I chose it

- The most similar utterance out of 5000+ Switchboard utterances
  I use, 1-2-3, a lot. It's a Lotus product. It has a spreadsheet and I have, I use a

Notes:

- Talking about a product choice
- Early in the conversation
- Surprised by the question, disfluent
- Unsure whether the listener will recognize the name
- Satisfied with the product
- Intending to explain why they chose it

Pragmatic Similarity Demo

Contributions

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- A protocol to collect pragmatic-similarity perceptions
- Observations of factors affecting ratings and agreement
- A set of 5000+ ratings of pragmatic similarity, for use in:
  - Speech-to-speech translation
  - Assessment of speaking skills
  - Dialog systems
  - Diagnosis

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Common Pragmatic Functions

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- Positive assessment
- Cueing action
- Marking a shift in activity
- Showing empathy
- Yielding the turn vs Holding the floor

and many more, often nuanced, often in combination

A Conversation

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Utility for Classifying Speech Disorders

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Challenge: given data from a new, unknown speaker, is he/she autistic or not?

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Utility for Classifying Speech Disorders

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Challenge: given data from a new, unknown speaker, is he/she autistic or not?

We used the NMSU ASD-NT dataset (thanks to Dr. Lehnert-LeHouillier)

- 28 Participants
  - 14 Neurotypical
  - 14 Autism spectrum disorder

- 789 ASD audio clips
- 702 NT audio clips

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The Problem

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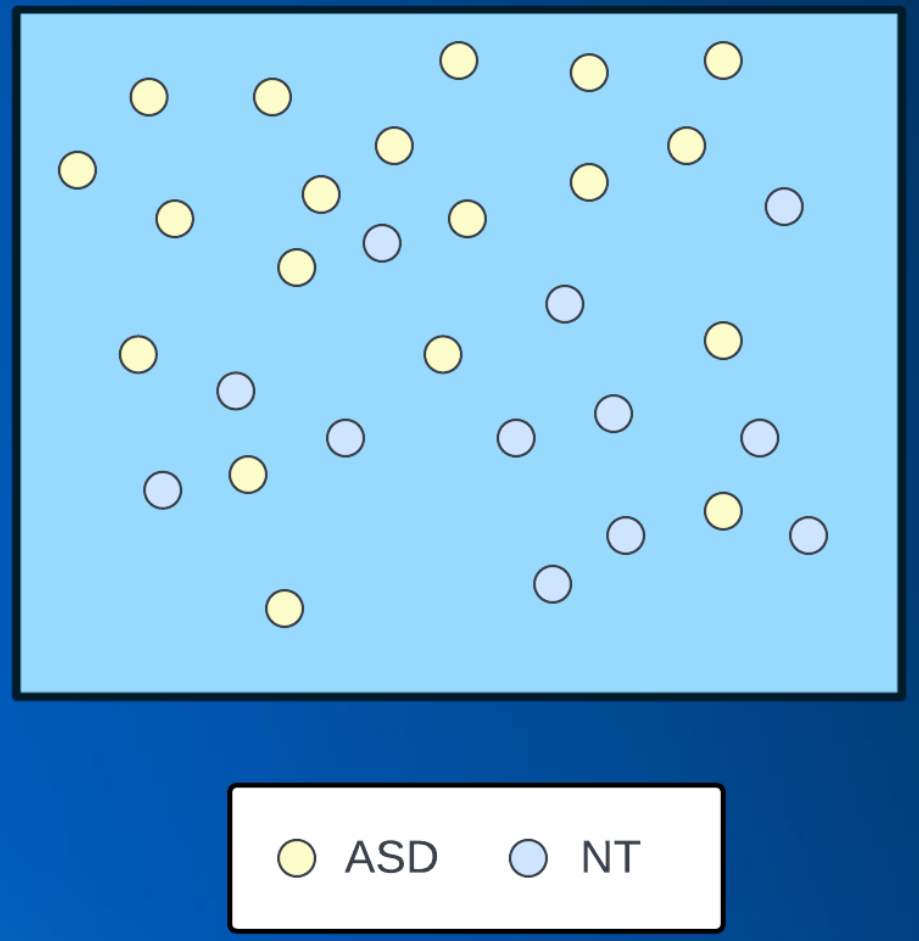
Known-Clip Representations



The Problem

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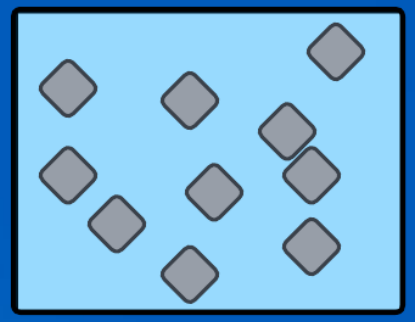
Child X and some of his Speech Clips



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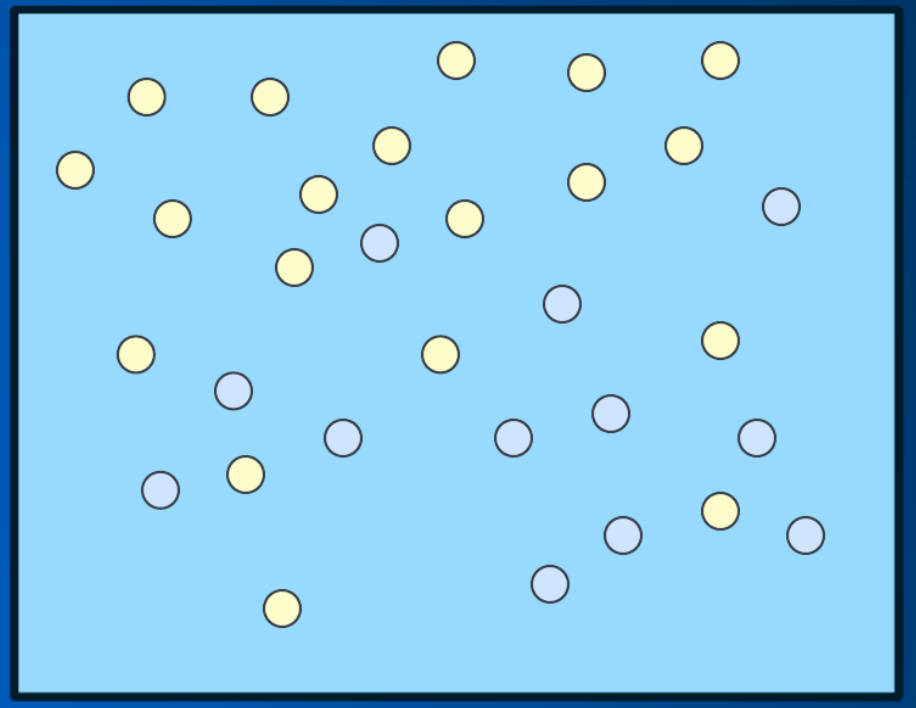
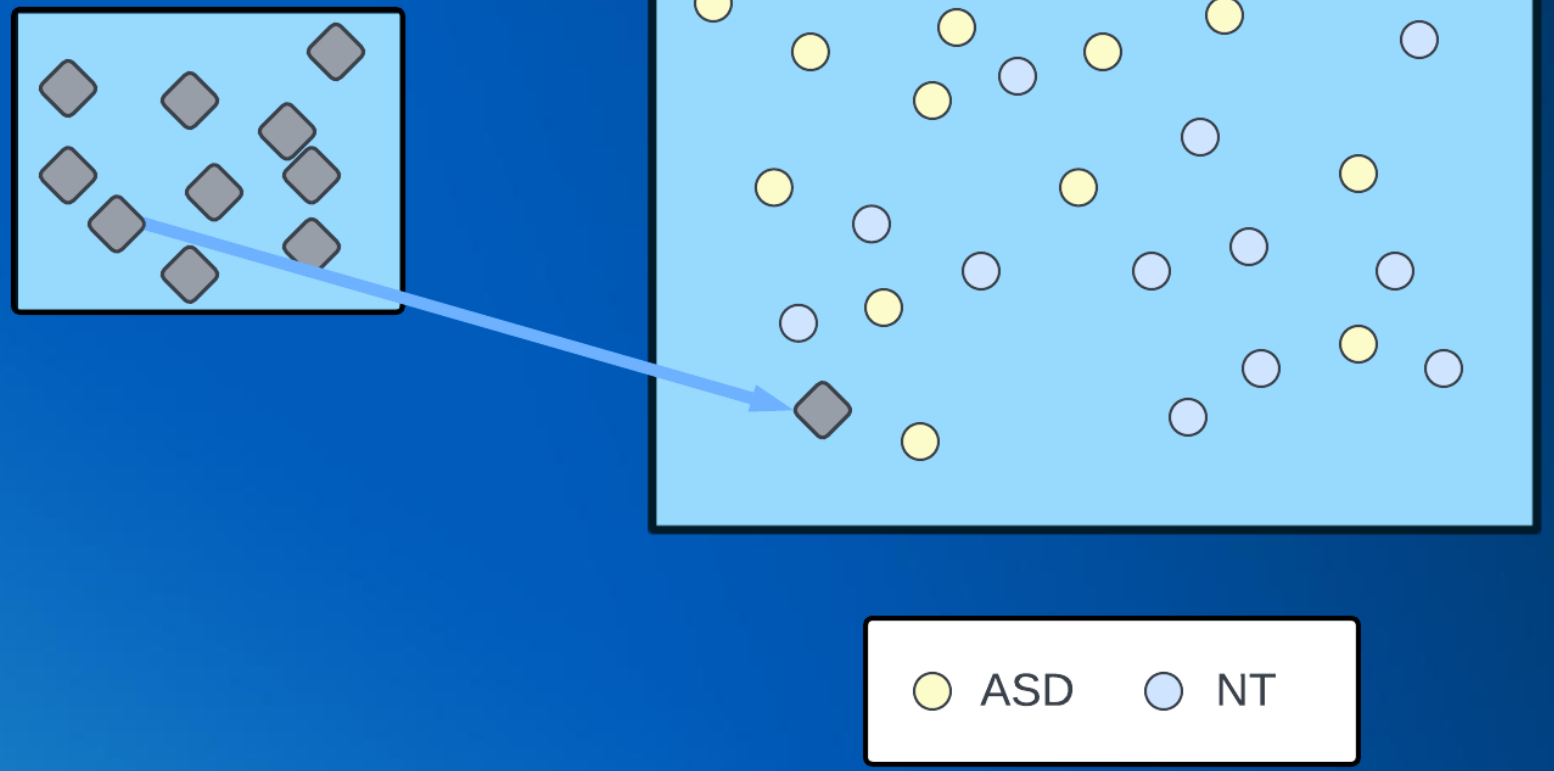


Classification by kNN



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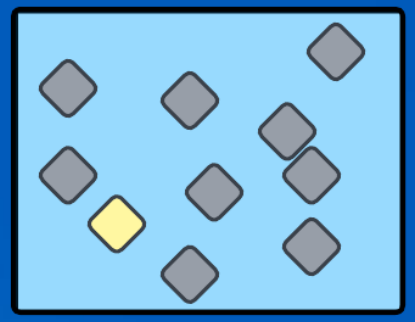

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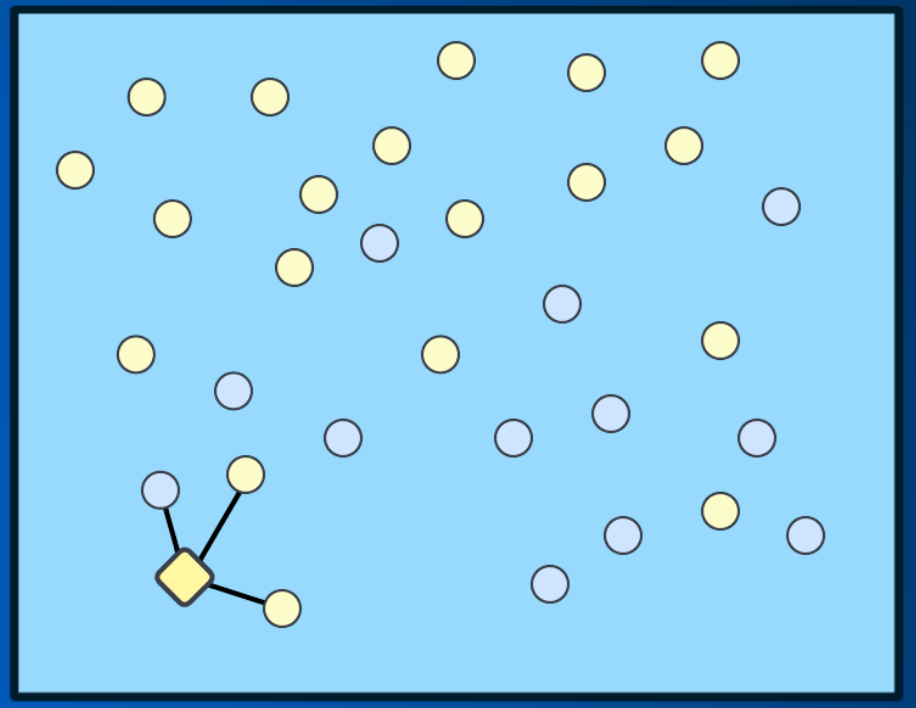

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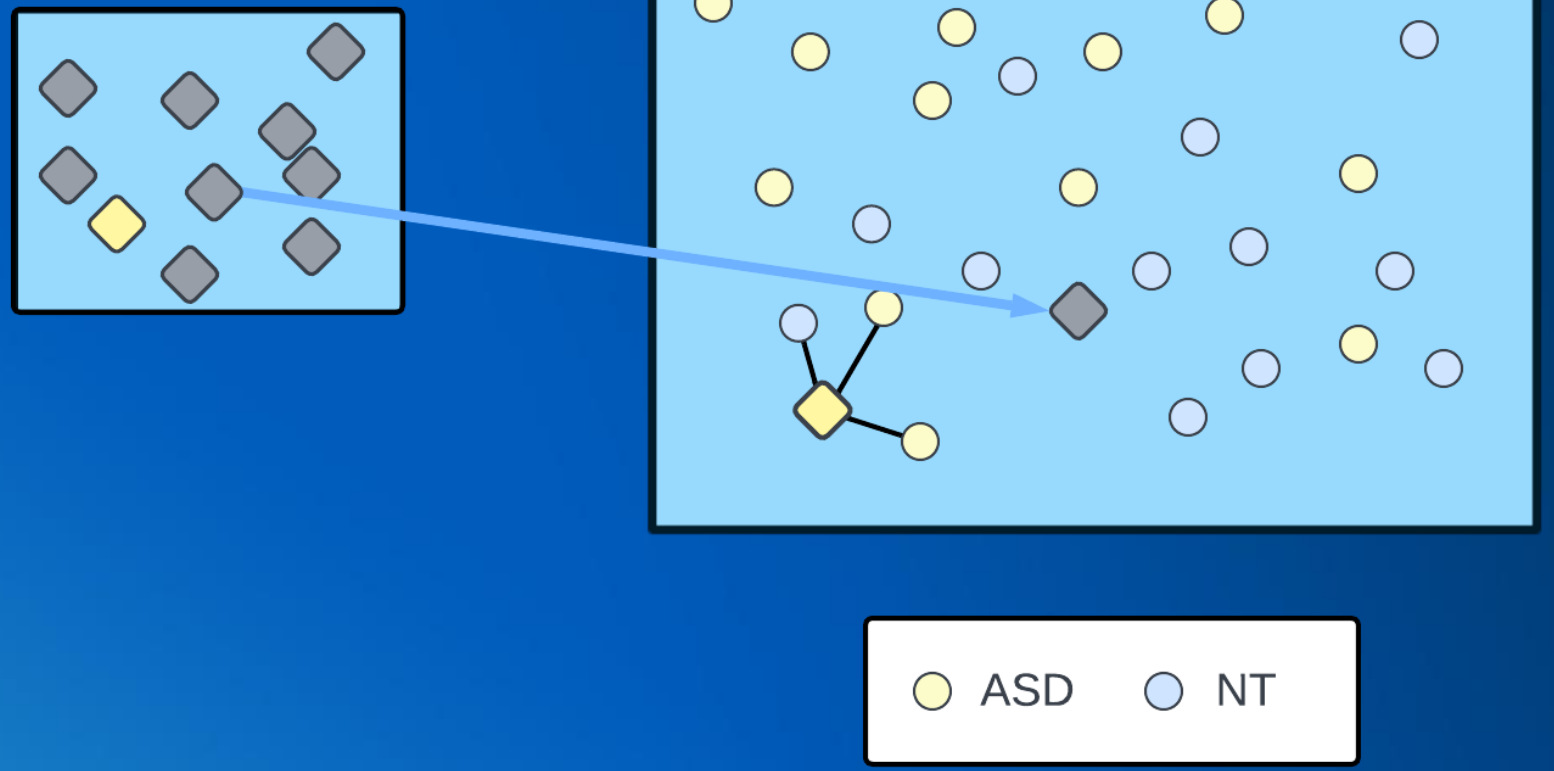

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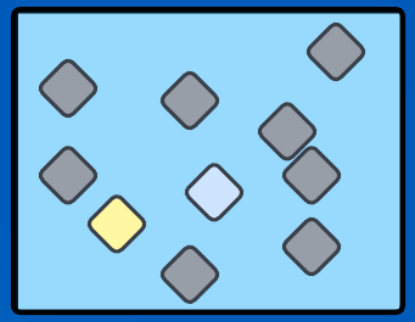

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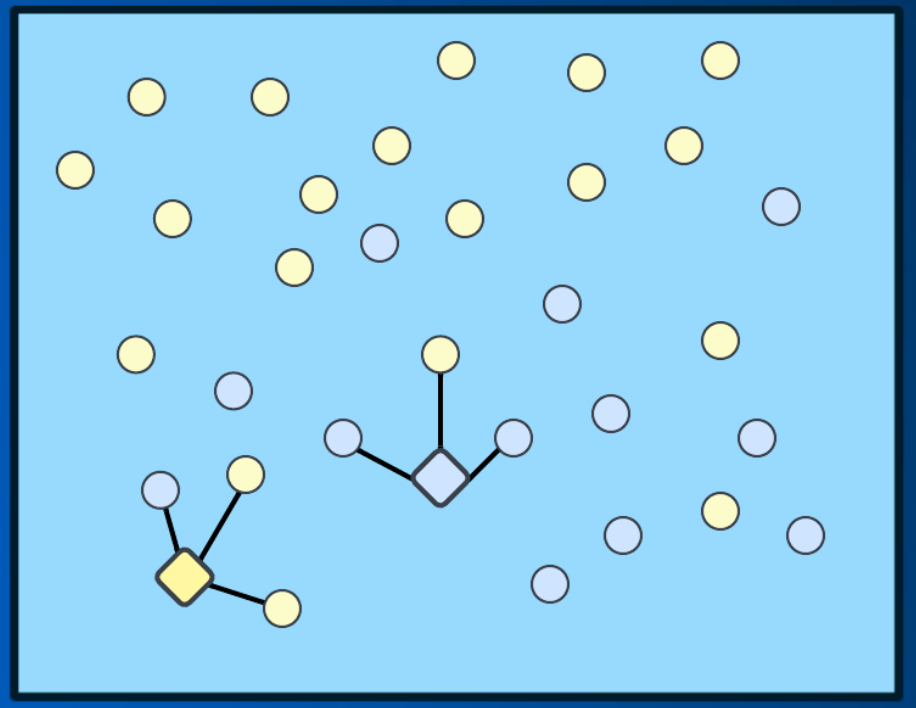

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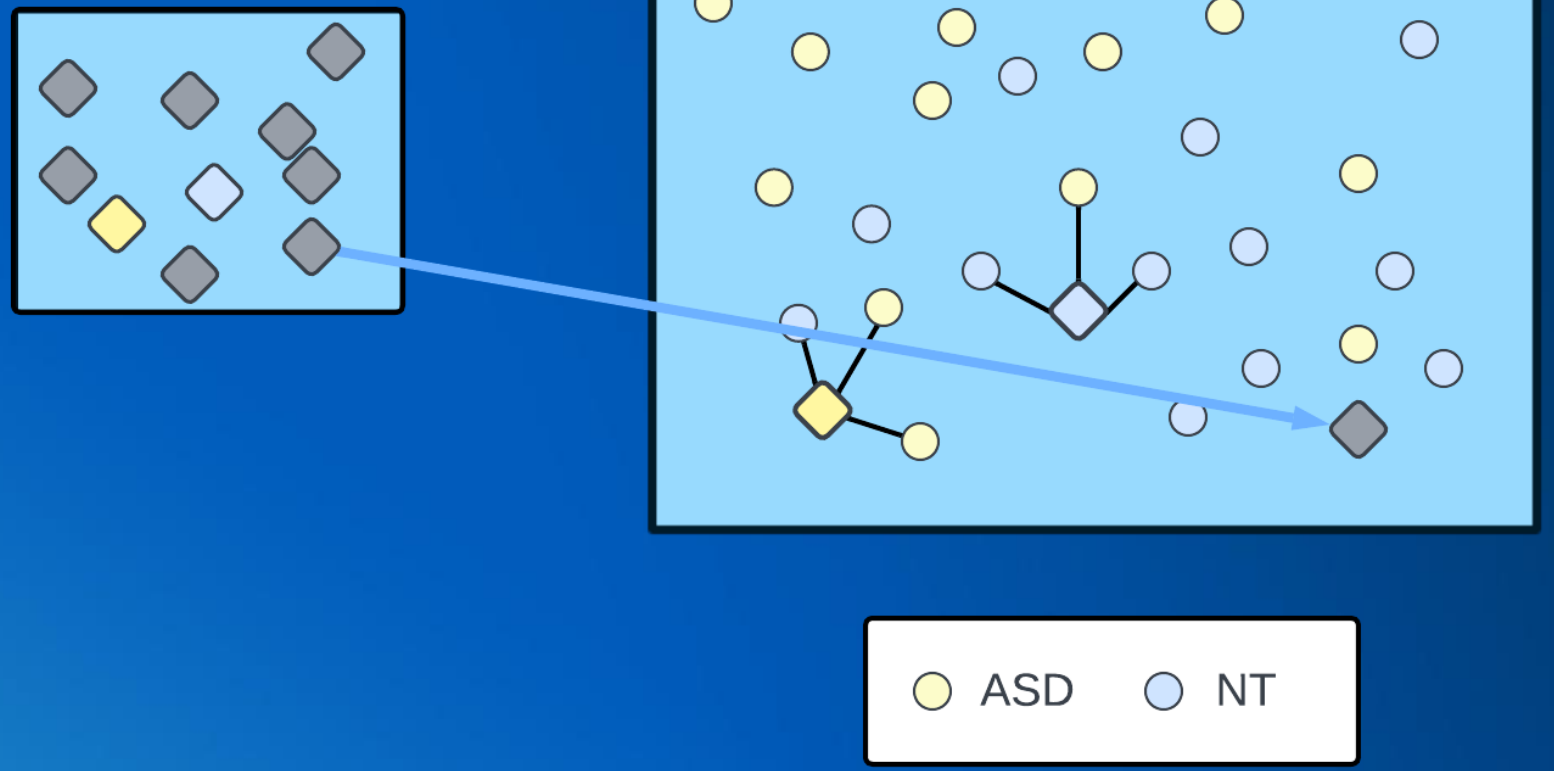

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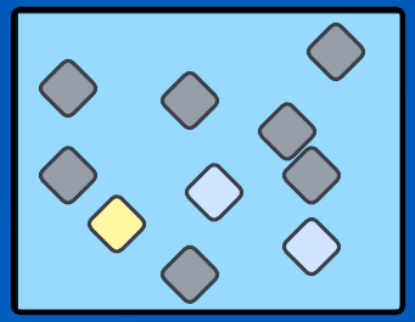

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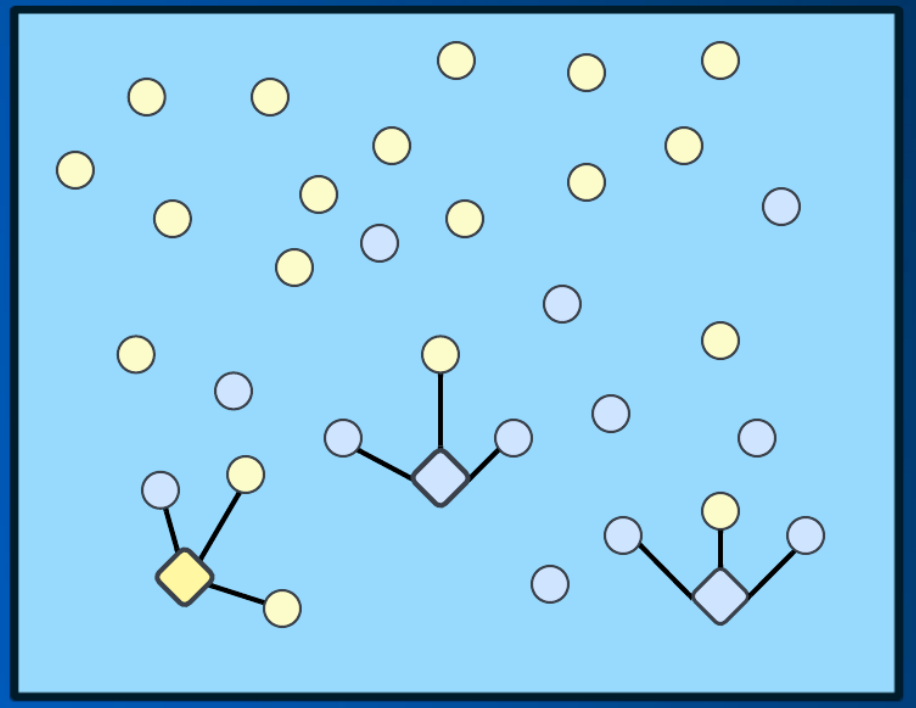

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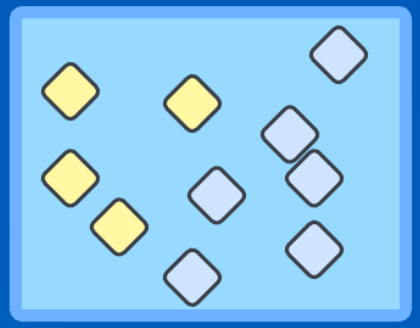


We classify the child by their most frequent clip label

Results

	Autistic	not
Predicted Autistic	10	1
Predicted not	4	13

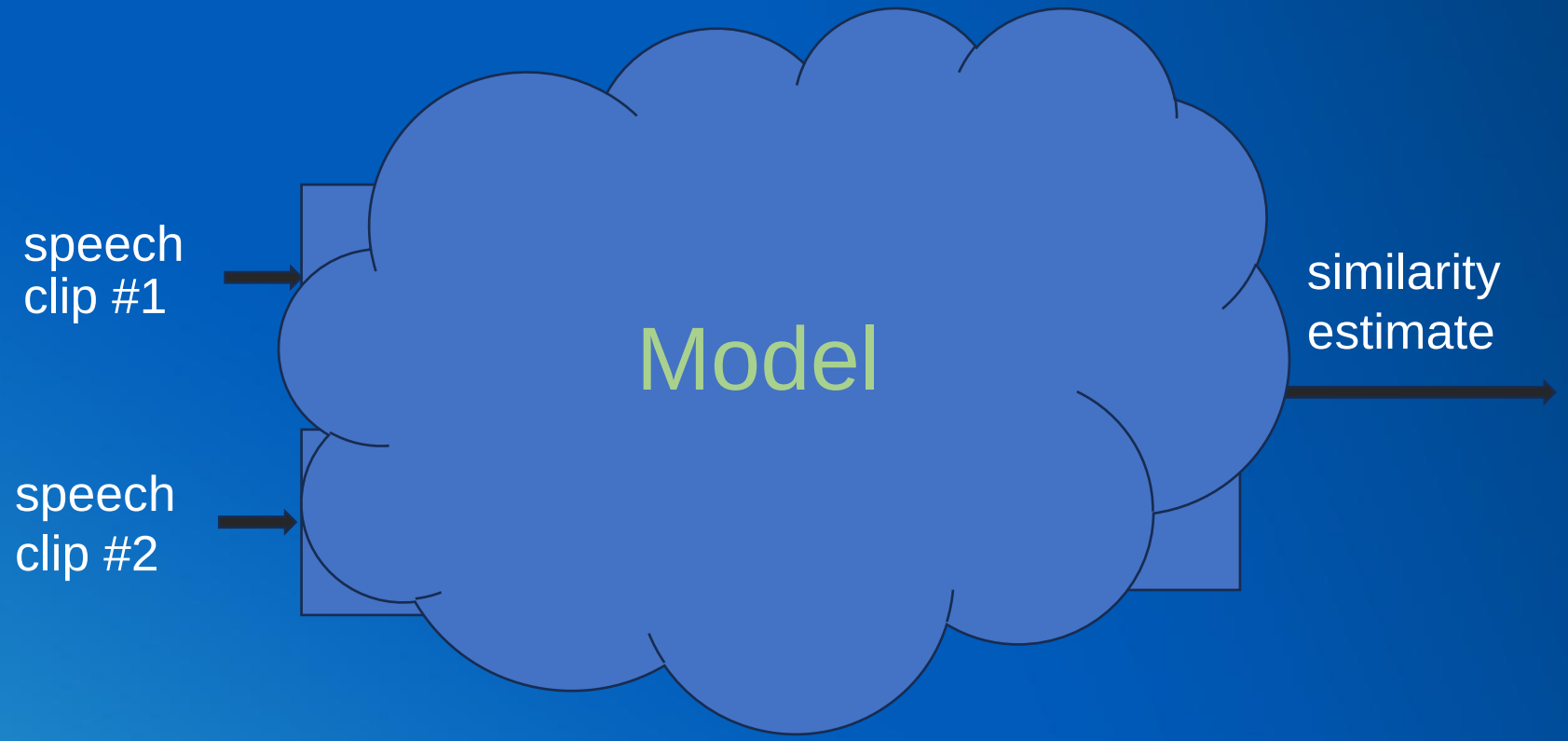
81% accuracy

Exculpatory factors

- the misclassified NT speaker was one of the youngest
- 3 of the misclassified autistic speakers had lower ADOS scores
- 2 of them had very few audio clips to go on

Note: best performance with k=7, but not highly sensitive

Problem (restated)



Results

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Correlation with Human Judges' Averages

	English 1	English 2	Spanish 1
Cepstral distance	.09	.24	.22
F0 DTW	.08	.11	.07
Mel-cepstral DTW	.16	.23	.22
Duration	.24	.05	.20
WavLM	.12	.17	.06
Wav2Vec 2.0	.31	.41	.24
HuBert	.45	.41	.40

Language Dependencies

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Correlation with human judgment averages

	English 1	English 2	Spanish 1
Original HuBert	.45	.41	.40
English-tuned HuBert	.69	**.74**	**.53**
Spanish-tuned HuBert	.59	**.63**	**.72**

- Feature selection helps
- Language-specific features selection helps more

Comparison to BERTSimilarity

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Correlation with average human judgments on the lexically-distinct subset*

	English 1	English 2	Spanish
selected HuBert	0.31	0.20	0.38
duration	0.49	0.11	0.20
BertSimilarity	0.57	0.50	0.38

* for the rest, BertSimilarity performance is of course 0.0

Demo Procedure

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- An undergraduate, native English speaker volunteers
- He/she has a short conversation with Andy
- The system extracts their utterances.
- For each, it finds utterances in the corpus that it thinks are very similar, less similar, etc.
- We listen and see if we agree

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After this point is just spare slides

Other Use Cases, with Healthcare Utility

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A similarity metric can support

- Detecting atypical speakers
- Finding similar speakers
- Finding representative utterances
- Finding atypical/outlier utterances
- Finding comparable utterances (as in the demo)

What are Prosody and Pragmatics?

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- Prosody is the patterns of rhythm, stress, and intonation in speech.
- Pragmatics is the study of how context contributes to meaning.
- Prosodic features convey pragmatic meaning.
- Pragmatic Similarity defines how closely the meaning of two utterances are to each other.

Shallow Modeling Options

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- Supervised learning (requires labeled data)
- Unsupervised learning
- Self-supervised learning

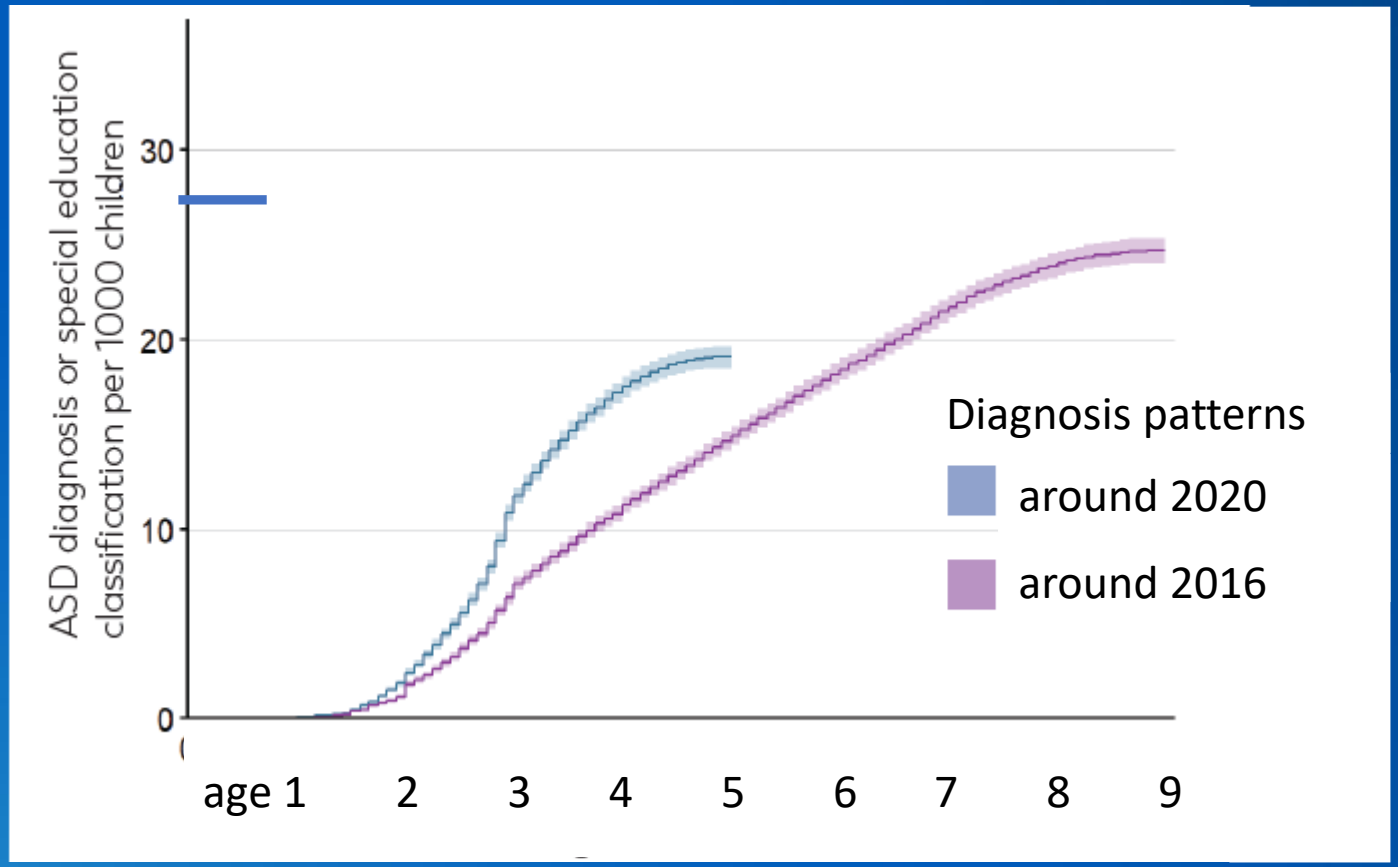
Childhood Communication Disorders

- Apraxia
- Dysarthria
- Articulation disorders
- Stuttering
- Specific language impairment
- Autism (1 in 36 children)

  etc.

Early intervention can help … but this requires early screening

Early Diagnosis is Hard



https://www.cdc.gov/ncbddd/autism/addm-community-report/spotlight-on-COVID-disruption.html

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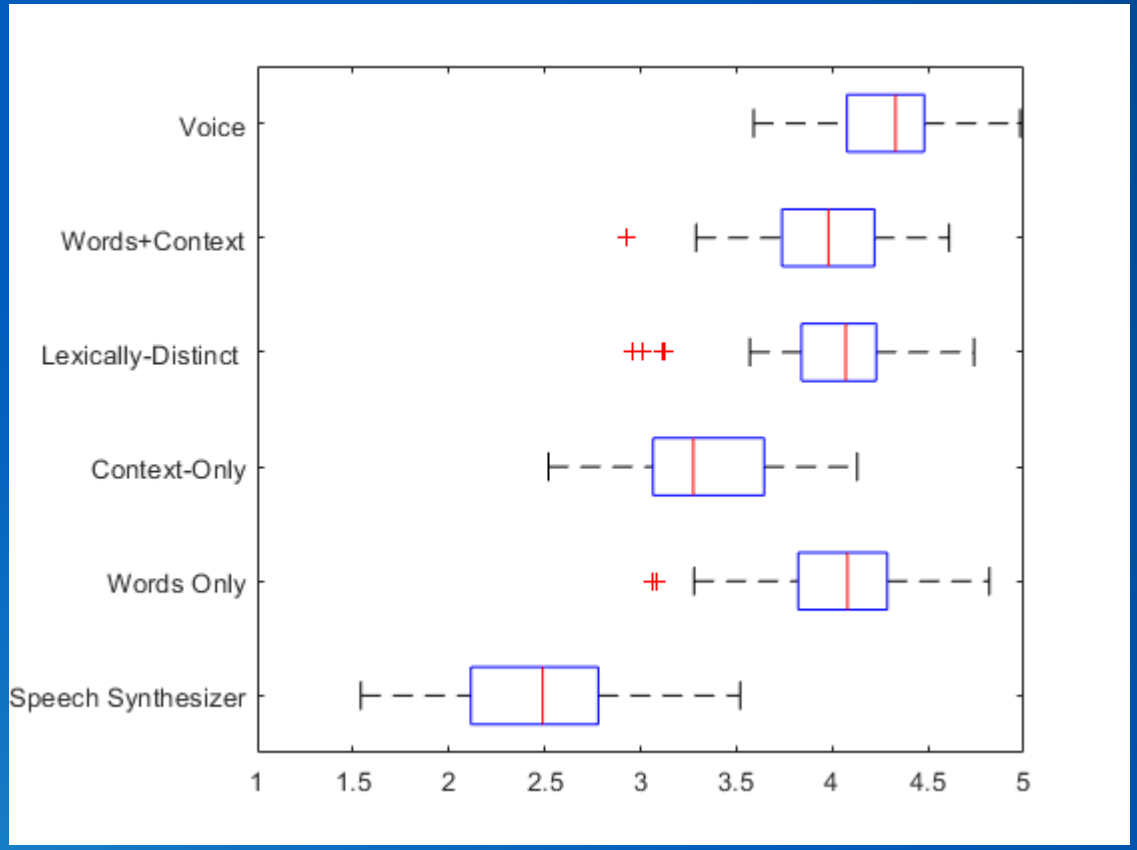

Common Pragmatic Functions

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- Cueing action
- Positive assessment
- Marking a shift in activity
- Showing empathy
- Yielding the turn vs Holding the floor



All of these are mostly conveyed with prosody non-trivially