

Perceiving and Producing Emotions in Israeli Sign Language

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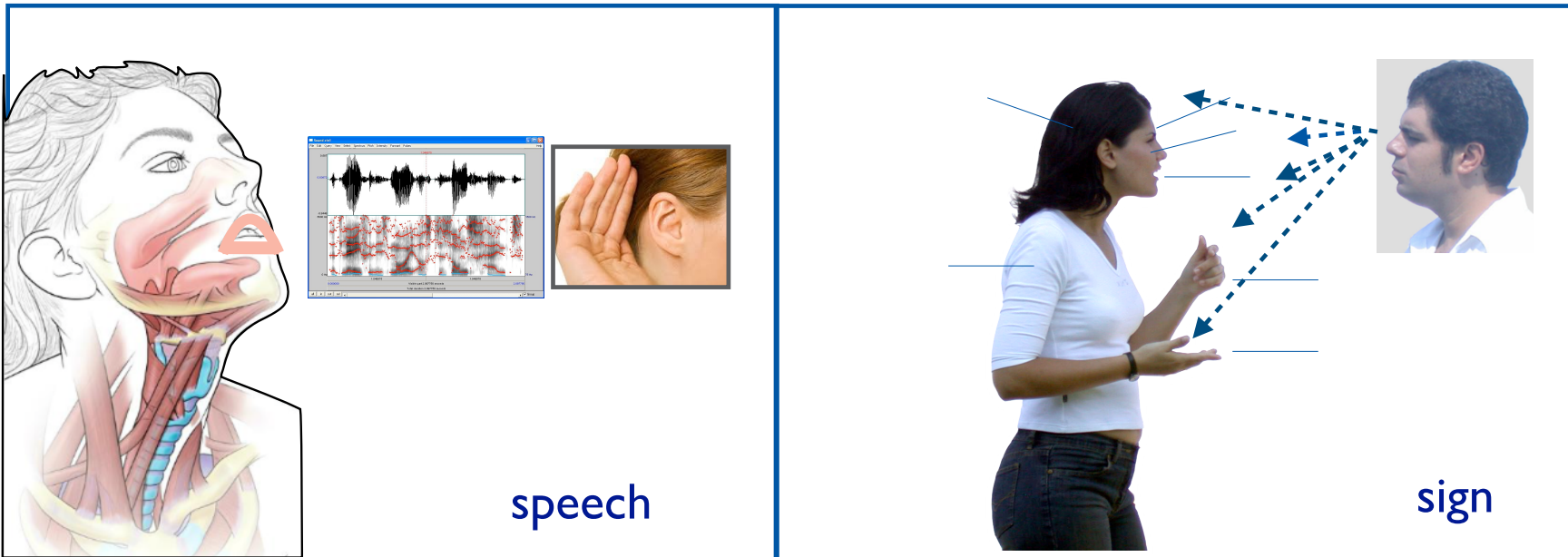
*Expressing Emotions in Sign Languages
2024 Workshop, University of Hamburg*



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HUMAN LANGUAGE: AN ANOMALY OF NATURE

Humans are the only species with language
WE HAVE TWO KINDS



- **Spoken and signed languages are equally natural to humans (e.g, CODA acquisition (Newport & Meier 1985))**
- **Many crucial grammatical similarities between the two types (Sandler in press)**
- **Key, pervasive, and type-universal differences as well (e.g, arbitrariness vs. iconicity) (Sandler in press)**
- Where does the expression of emotion come in?
 - not considered part of linguistic structure (Ladd 2008)
 - intuition: universally understood (foreign movies)
 - **is expression of emotion the same in the two natural language types?**

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Sign Language and Spoken Language: The Dual System Hypothesis

Wendy Sandler



Cambridge University Press

Emotions in the auditory and visual modalities

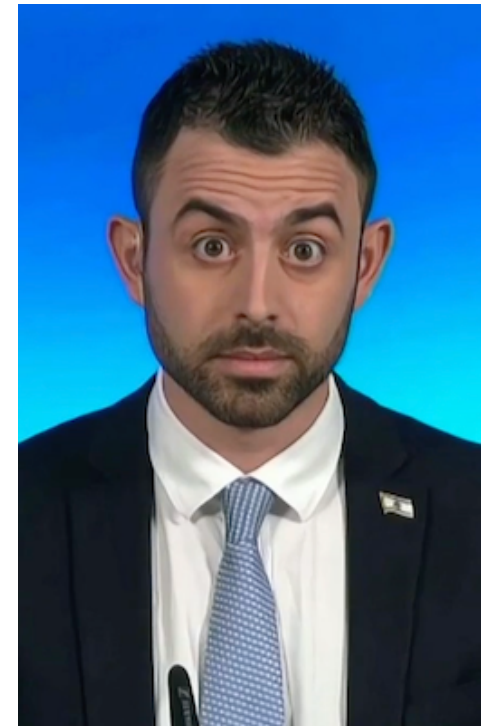
Emotions in speech (auditory):

- expressed in lexical semantics, through word and sentence meaning
- expressed by non-lexical cues, like prosody (intonation, stress, and rhythm)
- research shows that prosody can be favored over lexical meaning in the interpretation of sentences (Ben-David et al 2016)

For deaf signers (visual):

- auditory prosody is not available
- the same visual displays, e.g., an eyebrow raise, can serve either linguistic or emotional functions – signaling yes/no questions (linguistic) or surprise (emotional)
- many non-auditory emotional cues are available to both deaf and hearing people: gestures, facial expressions, head and body movements

These factors present a challenge for analyzing the perception and the production of emotion expression in the deaf population, and for comparison with hearing people



Roadmap

Research questions:

- **Study 1: Perception.** What is the interplay between lexical & non-lexical channels in the perception of emotions in Israeli Sign Language?
- **Study 2: Production.** Are emotions produced the same way or differently by deaf and by hearing people, signers and non-signers?

This project is the first to compare the perception and production of emotion of signers, deaf and hearing, and of non-signing hearing people.

T-RES – tool for examining the interplay of lexical and non-lexical channels in **speech perception** (Ben-David et al 2016)

e.g, Target: **happy**

On my birthday, everyone wished me happy birthday!

- 1) **Happy lexical content** + **Happy intonation** = Congruent condition — Match between the two channels

On my birthday, everyone wished me happy birthday! (and it was annoying)!

- 2) **Happy lexical content** + **Angry intonation** = Semantic condition — the lexical content matches the target, but the emotional intonation does not

On my birthday, no one wished me happy birthday!

- 3) **Angry lexical content** + **Happy intonation** = Prosodic condition — the emotional intonation matches the target, but the lexical content does not

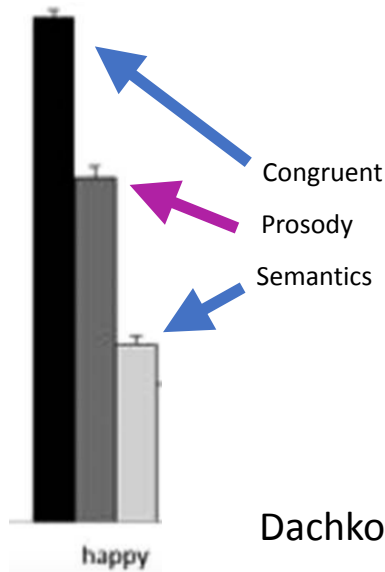
T-RES – Test for Rating of Emotions in Speech (Ben-David et al. 2016)

Interplay of lexical and non-lexical channels

Angry lexical content + **Happy intonation** = **Prosodic condition** — the emotional intonation matches the target (happy), but the lexical content does not

On my birthday, no one wished me happy birthday!

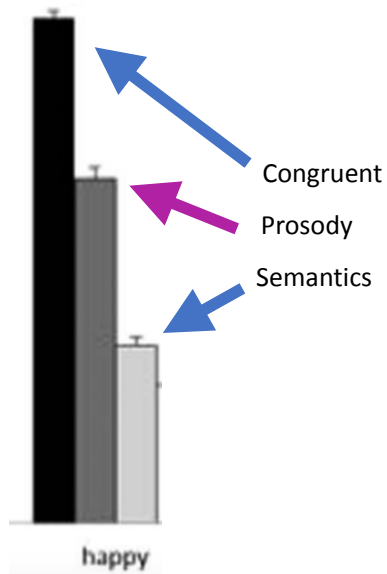
Often interpreted as “I was **happy** that no one wished me happy birthday”



In spoken language, prosody has more impact than lexical meaning in the interpretation of emotional content.

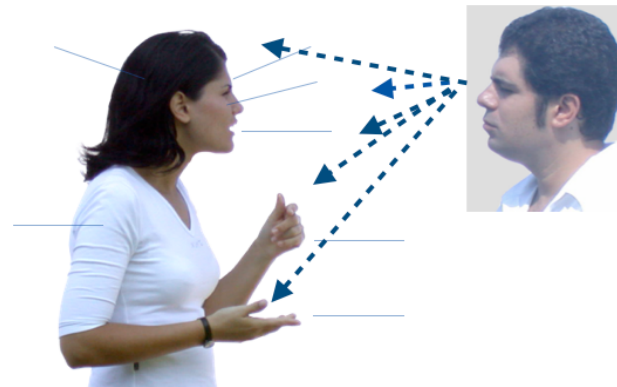
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For speech:



For sign?

What about language in the visual modality?



Methodology: T-RES adaptation > T-RES^{SL}

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Study 1: Perception of emotions in sign language – interplay of channels

In sign languages emotion can be conveyed in two ways:

- **Lexical Semantics** – word/sentence meaning on hands
- **Non-lexical (prosodic cues)** – facial intonation and head movements, signing rhythm and stress



lexical semantics

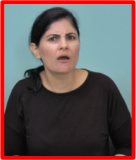
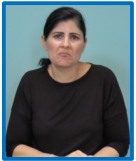



non-lexical ⁹

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T-RES adaptation > T-RESL

- A native deaf signer produced 32 sentences with 3 lexical emotional states:
angry, sad, and happy
- Each sentence was signed with 3 different emotional prosodies, 1 congruent and 2 incongruent:
, angry, sad, and happy
- participants: deaf and hearing signers

LEXICAL EMOTION	Angry <i>My sister is making a mess</i>	Sad <i>My mom is very depressed</i>	Happy <i>I won the lottery</i>
Angry 	Congruent		
Sad 		Congruent	
Happy 			Congruent

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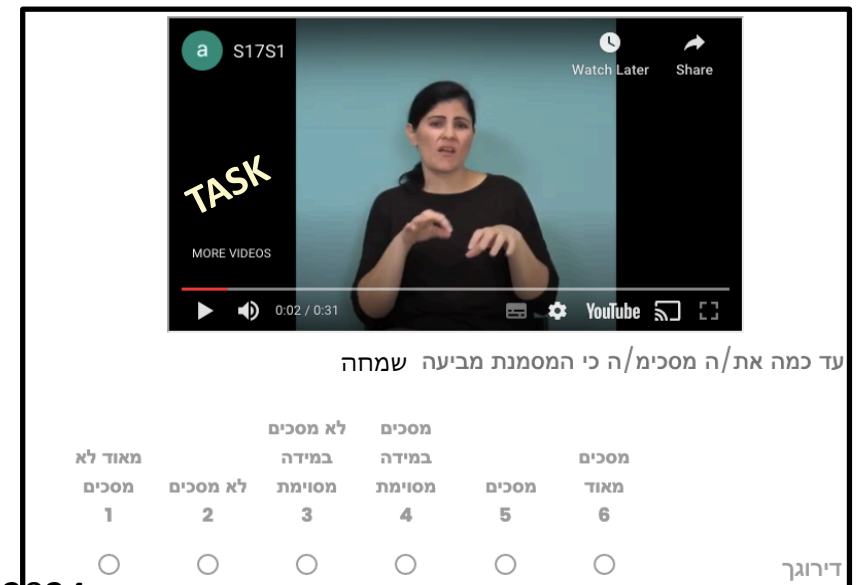
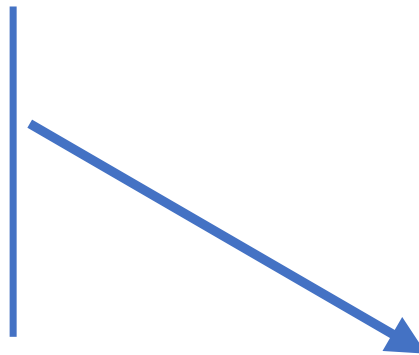
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Methodology: T-RES adaptation > T-RES^{SL}

- 42 deaf and 31 hearing ISL **signers** rated the sentences
 - for each target emotion separately
 - on a **6-point scale** for each target emotion (in written Hebrew)

*E.g. (target, happiness) To what extent do you agree that the signer expresses **happiness**?*

1. *Do not agree at all*
2. *Do not agree*
3. *Do not agree to some extent*
4. *Agree to some extent*
5. *Agree*
6. *Agree very much*



דירוגך

1. Congruent example with **happy** as the target

Congruent condition:

happy prosody + happy semantic

Yesterday my team won the competition



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2. Incongruent example — **happy** target emotion in lexical content only

Incongruent semantic condition:

happy semantic + **angry prosody**

On my birthday everyone wished me happy birthday.



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3. Incongruent example — **happy** target emotion in prosody only

Incongruent prosodic condition:
happy prosody + **sad semantic**

For a month, I've been crying every day



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T-RES adaptation > T-RES^{SL}

The sentences present three trial types of stimuli;

Here, **happiness** is the target

HAPPINESS as
target emotion

1) Congruent:
happiness in
both channels



*Our team **won**
the contest*

2) Incongruent: prosodic
happiness only

?



?

*I've been **crying**
every day*

3) Incongruent: semantic
happiness only



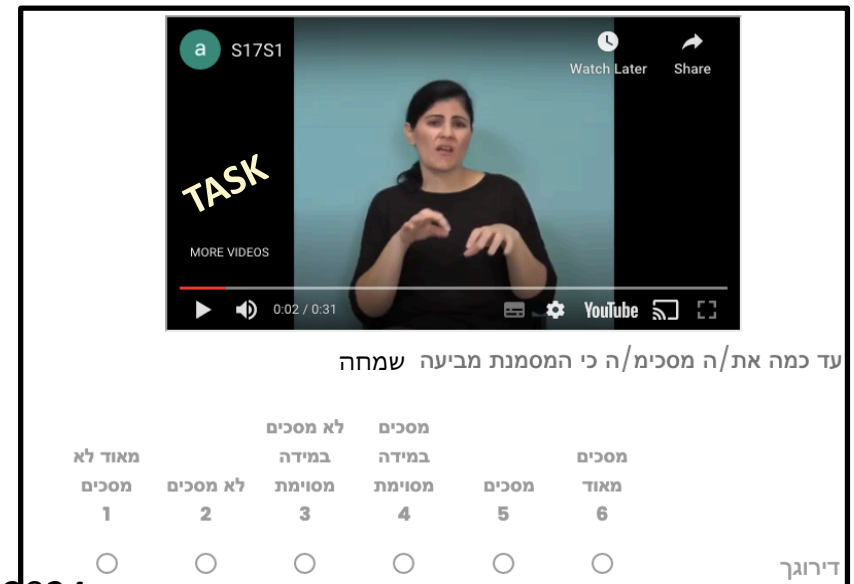
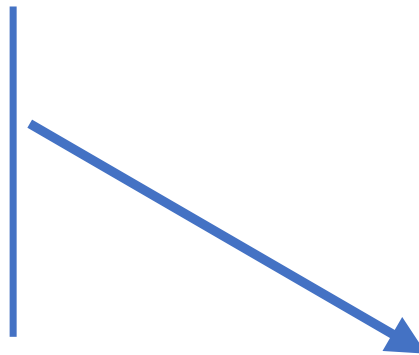
*On my **birthday**
everyone wished
me happy birthday*

Methodology: T-RES adaptation > T-RES^{SL}

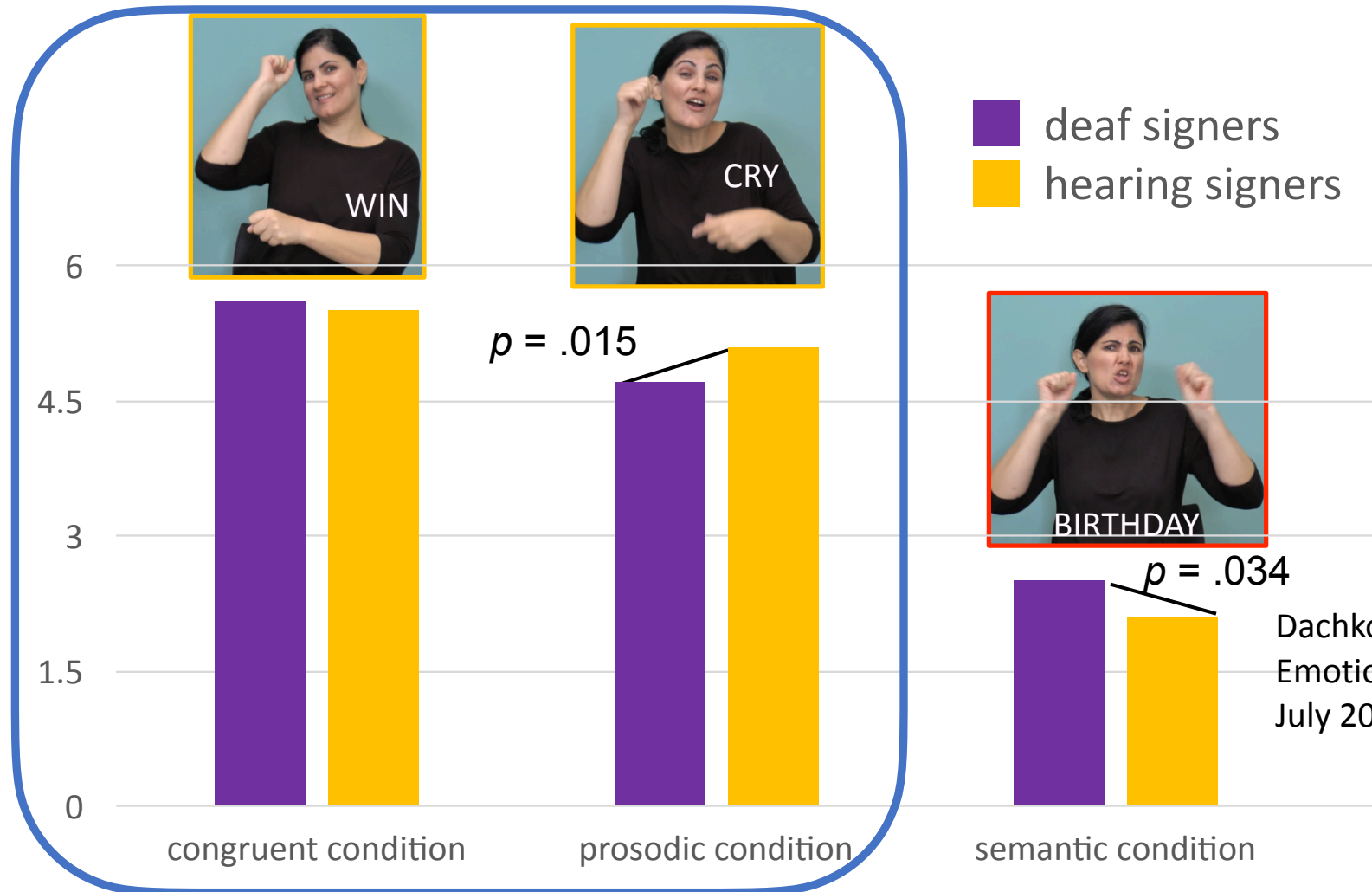
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Study 1: Results: For deaf and for hearing signers, prosody is favored over lexical meaning



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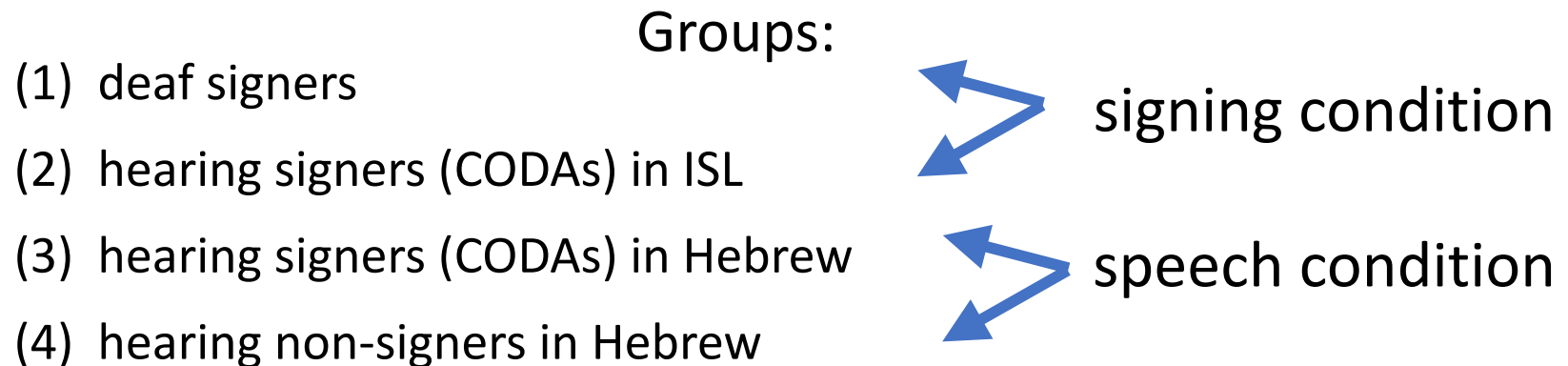
Study 1: Discussion and Conclusion

- High prosodic (non-lexical-semantic) dominance for both signing groups, similar to that shown in spoken languages
- But higher prosodic dominance for hearing signers than for deaf signers

Is this because they **express**
emotions differently?

Study 2: Production of emotions

Study 2: In collaboration with our colleagues from the Computer Science Department, the different groups' emotions were computationally coded within each condition (using machine learning & cluster analysis).



Study 2: Production. Methods

Sentences with the most robust emotional ratings from the perception study served as written Hebrew stimuli (with congruent prosody)

ANGRY

You are the manager. The employee has been absent from work for two days without updating you. You are talking to the employee:

**I am not satisfied with your behavior.
What nerve!**

SAD

You are telling your friend about your recent loss:

My partner died and it broke my heart.

You just became a parent, and it's the best day in your life. You say to your close friend:

My first son was born today!

HAPPY

Study 2: Methods cont'd

- 45 participants used **written** emotive stimuli to express emotions
- They produced emotive sentences either in ISL or in Hebrew speech
- CODAs produced spoken sentences on one occasion to a hearing RA, and signed sentences on another occasion to a deaf RA

	Deaf signers	Hearing CODAs	Hearing non-signers
ISL signing	15	13 in both conditions	-
Hebrew speech	-		17

Study 2: Methods cont'd

Our collaborators used the **OpenFace** program to computationally track:

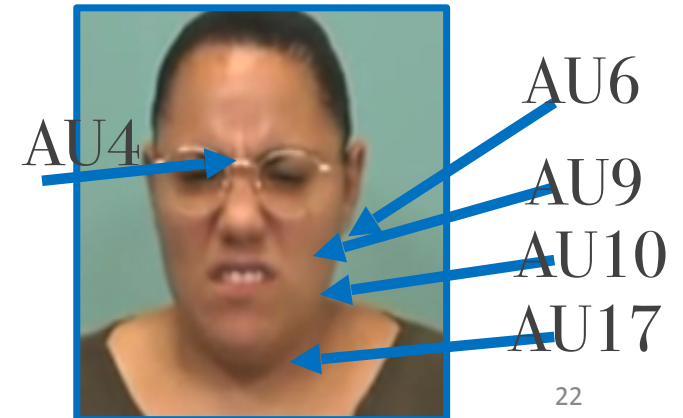
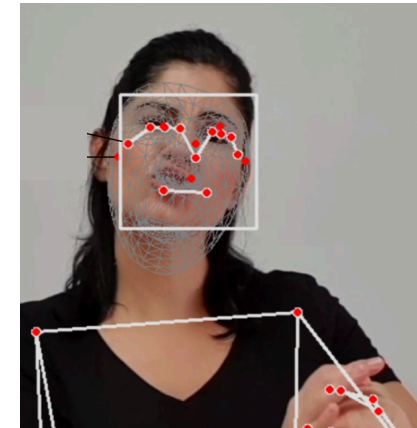
11 Facial Action Units (AUs)

(Ekman & Friesen 1978)

AU01 - inner brow raise
AU02 - outer brow raise
AU04 - brow lowering
AU05 – eyes wide
AU06 - cheek raise
AU07 - lid tightening
AU09 - nose wrinkler
AU10 - upper lip raiser
AU12 – outer lip raise
AU15 - lip corner depressor
AU17 - chin raiser

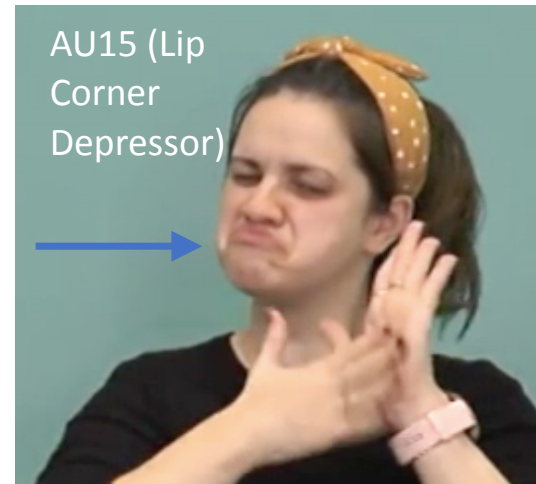
Features

e0_length
e1_length
e2_length
e0_amount
e1_amount
e2_amount
e0_intensity
e1_intensity
e2_intensity
Mean St. dev.



Study 2: Results for **Signing** condition (Deaf signers vs. CODA signers)

- 77.6% accuracy in machine classification of hearing vs. deaf signers
- AU15 (Lip corner depressor)
 - top ranking distinguishing feature for deaf signers vs. hearing (CODAs)
 - i.e, significantly more frequent in deaf signers than in CODA signers



Deaf and CODA examples

Happiness: *My teacher complimented me on the wonderful work that I submitted.*

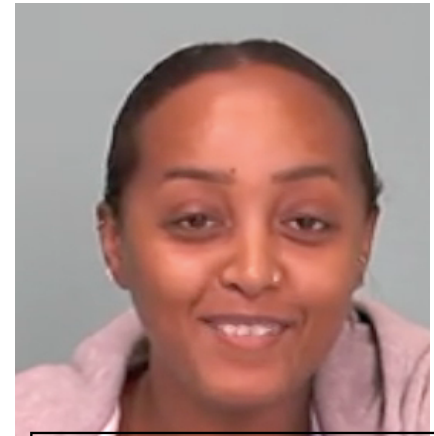
Study 2: Results for **Speech** condition (CODA speech vs. non-signer speech)

- 82.5% accuracy in machine classification of hearing signers (CODAs) vs. hearing non-signers
- AU 05 (Eyes Wide)
 - top ranking feature distinguishing CODA speakers from non-signing speakers
 - this feature was used more in hearing CODAs when speaking than in hearing non-signers

AU 05
(Eyes
Wide)



**CODA
speech example**



**Non-signer
speech example**




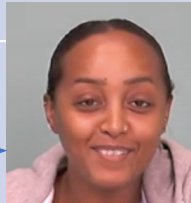
Happiness: *My teacher complimented me on the wonderful work that I submitted.*

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Study 2: Results

- Deaf and hearing people **do** express emotions **differently**:
 - Deaf** signers use lip corner depressor (AU15) more than hearing signers
 - Hearing** signers while speaking use the intensifying facial expression Wide Eyes (AU5) more than hearing **non**-signers

EXAMPLES	Deaf signers	Hearing CODAs	Hearing non-signers
ISL signing			-
Hebrew speech	-		

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General Summary

The results suggest some differences in deaf and hearing people, for both the production and the perception of emotions:

- Perception:
 - Comparing hearing signers with deaf signers, we find prosody prominence (over word meaning) in both groups, but more so in the hearing signer group.
 - In the original speech T-RES studies, prosodic prominence was found for hearing non-signers. Our findings suggest that **all** humans are strongly influenced by prosody in interpreting language (auditory or visual).



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 - In the original speech T-RES studies, prosodic prominence was found for hearing non-signers. Our findings suggest that **all** humans are strongly influenced by prosody in interpreting language (auditory or visual).
- Production:
 - Comparing CODA signing with deaf signing, we find that deaf signers use more lip depressor expressions than CODAs. (> Does lip corner depressor interfere with enunciation experience?)
 - Comparing CODA speech with the speech of non-signing hearing people, we discern different intensification patterns (> wide eyes for CODA speech)

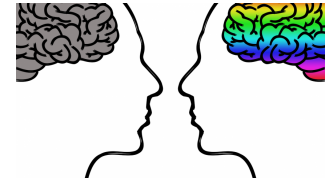


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Just cracking the surface


Implications:

1. Theoretical question raised: Given prosodic prominence for both types of natural language, Did contrastive emotional intonation precede linguistic structuring in language evolution?



Just cracking the surface

Implications:

1. Theoretical question raised: Given prosodic prominence for both types of natural language, Did contrastive emotional intonation precede linguistic structuring in language evolution? 
2. Research conclusion: Intuition isn't enough. We have to test and analyze our intuition with much finer tools, larger samples, naturalistic data, and in other sign languages.

Thank you!!

הקרן הלאומית למדע
المؤسسة الإسرائيلية للعلوم
National Science Foundation



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