ASHA 2021

# RISING UNITED

NOVEMBER 18–20 | WASHINGTON, D.C.

# Examining Emotional Responses to speech in noise using Facial Expressions.

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ASHA 2021 RISING UNITED NOVEMBER 18–20 WASHINGTON, D.C.

# Learner outcomes

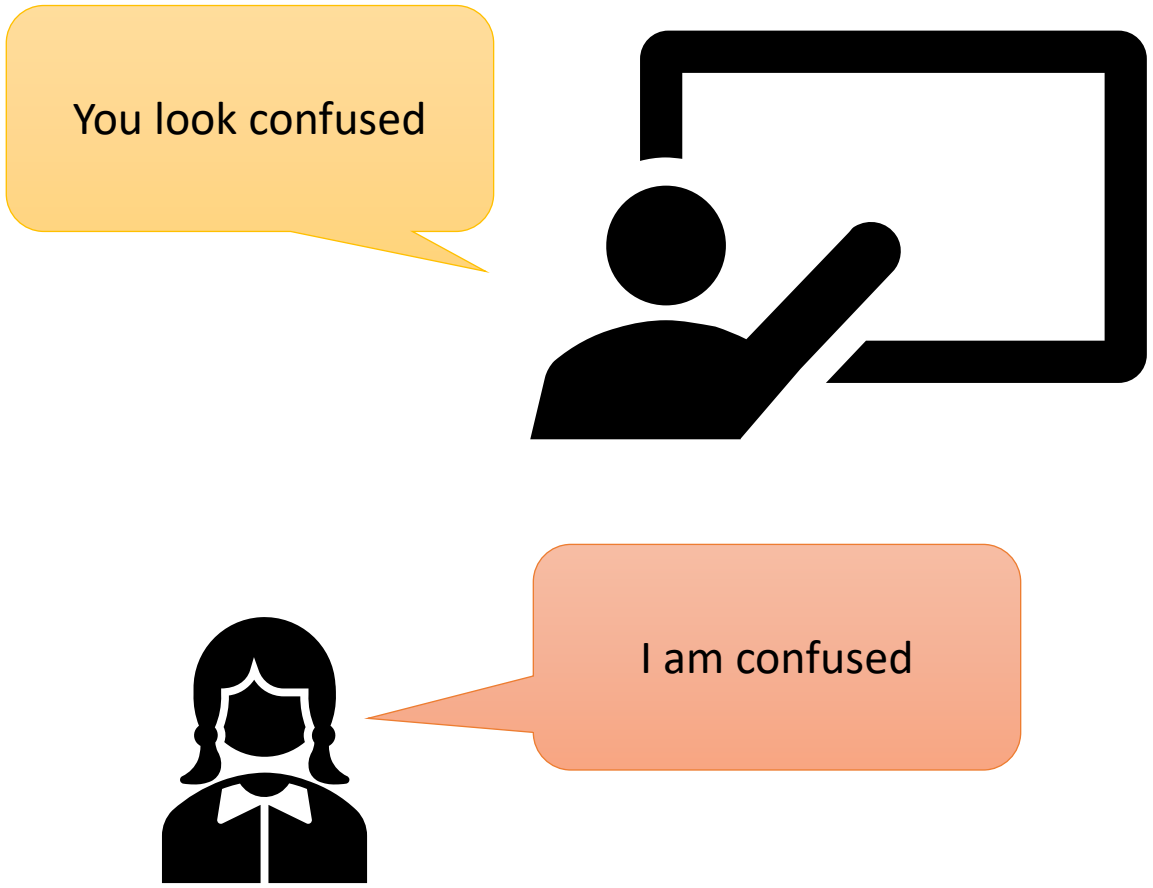
- Listeners will be able to:
  - Differentiate between emotion recognition and emotional response
  - Express how facial expressions were used to measure emotional responses
  - Describe how facial expressions changed with changes in listening difficulty.

# Emotions connect us to humanity…

…affect attention, memory, behavior and overall quality of life

Lench & Carpenter, 2018; Chirico & Yaden, 2018; Storbeck & Wylie, 2018, Frijda,2003; Kensinger,2009; Schweizer, 2019

# Emotional processing




- **Emotion recognition**: how an individual identifies emotions displayed by their communication partner(s).
- **Emotional response**: the response of an individual to emotional stimuli

# Emotions and hearing loss

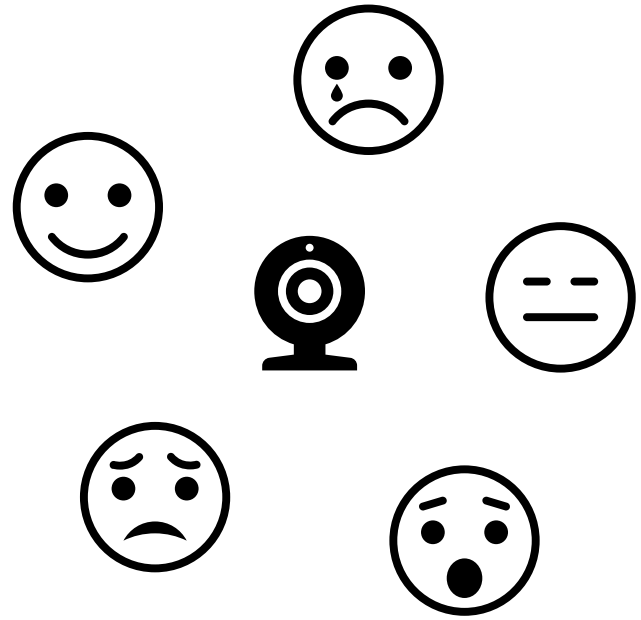
- Neuronal re-organization in the emotion networks of individuals with mild-moderate HL (Husain, Carpenter-Thompson, Schmidt, 2014).
- Individuals with hearing loss: reduced range of emotional responses (subjective ratings) to non-speech sounds (Picou, 2016) and to television clips (Picou, 2019).
- Emotional responses have been found to be related to social disconnectedness (Picou & Buono, 2018).

- Experiencing a full range of pleasant and unpleasant emotional stimuli: important for normal emotional processing.
- If individuals with hearing loss do not derive pleasure (experience positive emotions) or if they experience heightened negative or unpleasant stimuli, then they may avoid such social situations.

- Past studies- non-speech stimuli/ subjective rating scales for assessing emotional responses.

# Using facial expressions with an automatic facial expression detection algorithm

- Objective measure/ mostly unbiased response
- Can help identify the emotion, in addition to the intensity of response
- Can track the time course of emotional response during the task.



# Emotions in difficult listening situations

Complex situations: problem-solving

Cognitive disequilibrium

Breakdowns in system

Encounter gaps in knowledge

(D'Mello, Picard & Graesser, 2007; Craig, D'Mello, Witherspoon & Graesser, 2008; Lehman, D'Mello & Person, 2008; Di Leo, Muis, Singh & Psaradellis, 2019; Taub et al., 2019).

**Confusion**

**Frustration**

Anxiety

Boredom

Complex process: Peripheral and higher-level processing

Segregation of information

Maintaining attention

Decoding the message

Committing it to memory

# Research Question

- Do facial expressions reflect the change in listening difficulty experienced by listeners in speech-in-noise situations?

- Hypothesis: With an increase in signal to noise ratio, the likelihood of facial expressions of negative emotions, e.g. confusion, frustration, would increase.

# Method

## Participants:

- Twenty young normal hearing participants with no self-reported emotional disorder were recruited.

## Stimuli

- IEEE sentences in speech shaped noise
- 20 sentences each in Quiet and in Signal to noise ratios (SNR) of -3, -5, -7, -9, and -11 dB.

## Procedure

- Repeat each sentence while their facial movements are recorded.

# Working of the facial expression detection algorithm

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# Working of the facial expression detection algorithm

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# Working of the facial expression detection algorithm

Face Detection

Feature Detection

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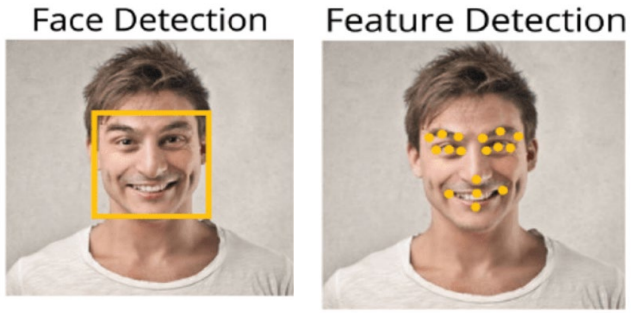
# Working of the facial expression detection algorithm

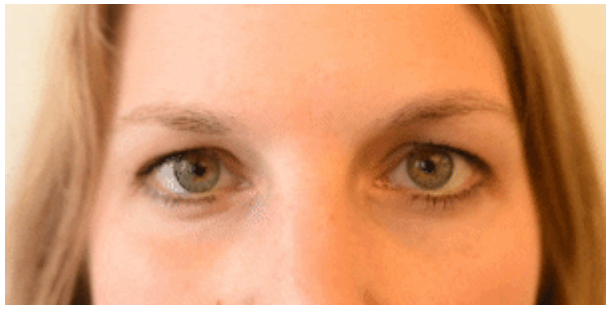



Facial Action Coding System (FACS)
Developed by Ekman & Friesen (1978).

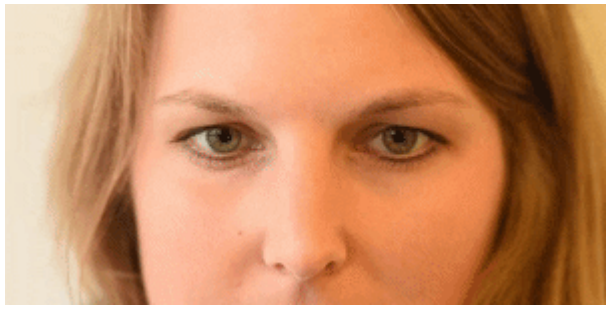
**Action Units:** Actions of muscles/ muscle groups

**AU4: BROW LOWERER**

**AU6: CHEEK RAISER**



**AU5: UPPER LID RAISER**



**AU12: LIP CORNER PULLER**

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# Action units → Emotions

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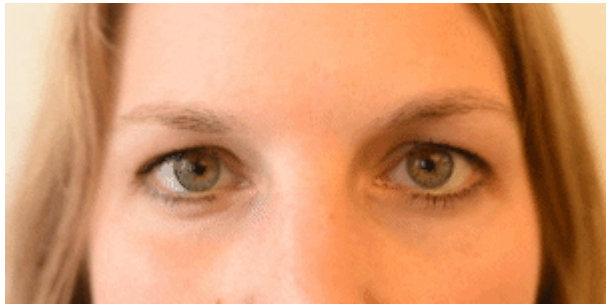
## JOY

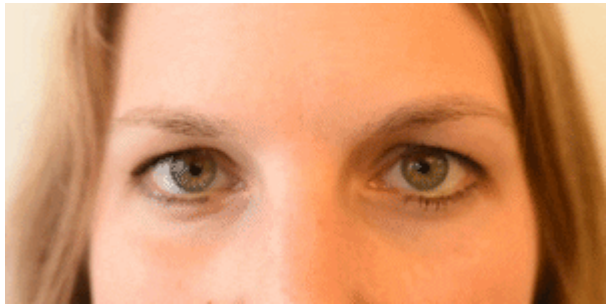
### AU6: CHEEK RAISER



### AU12: LIP CORNER PULLER

## CONFUSION

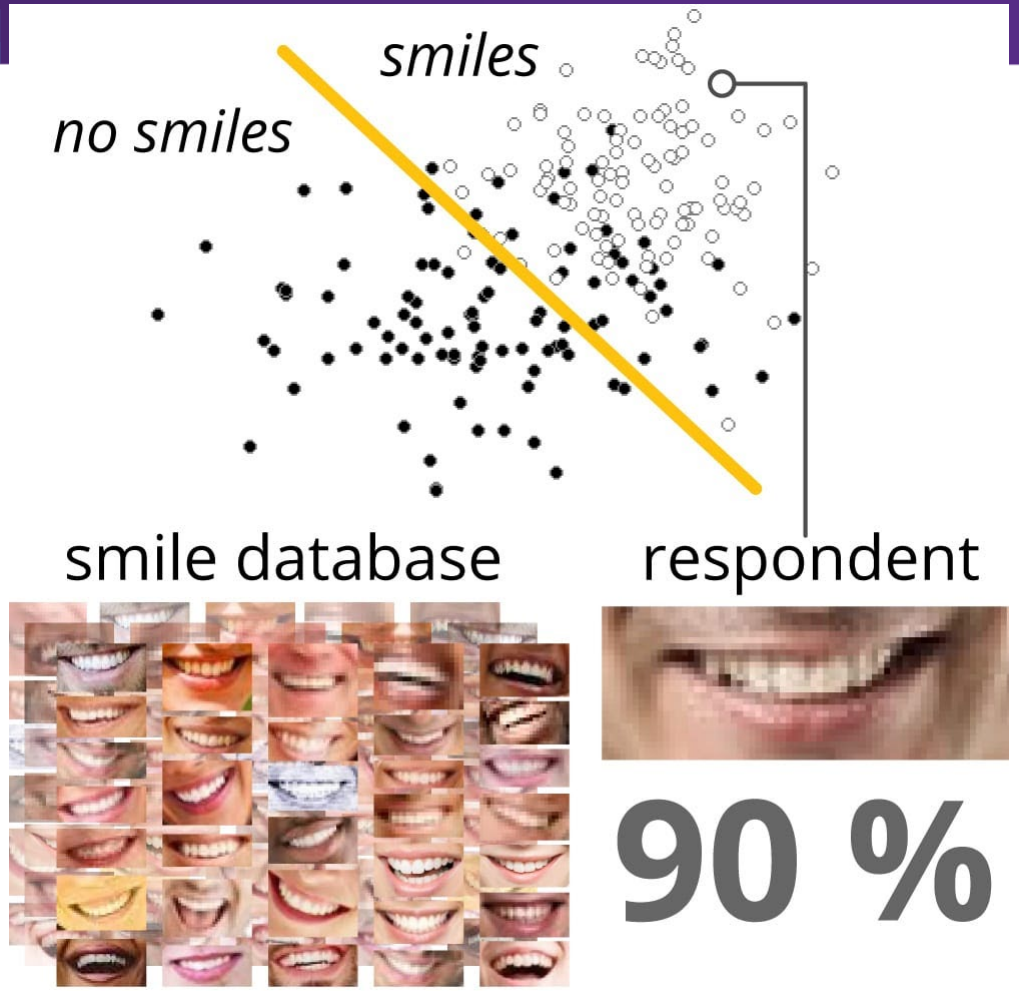
### AU4: BROW LOWERER



### AU7: LID TIGHTENER

### AU12: LIP CORNER PULLER

# Measurement of facial expressions




The **evidence value** for an expression channel represents the **odds, in logarithmic** (base 10) scale, of a target expression being present.

For instance:

An evidence value of **1** for joy means that it is **10 times more likely** that the facial expression seen will be classified as joy by an expert human coder.
An evidence value of **2: 100 times more likely**
An evidence value of **0: equally likely**

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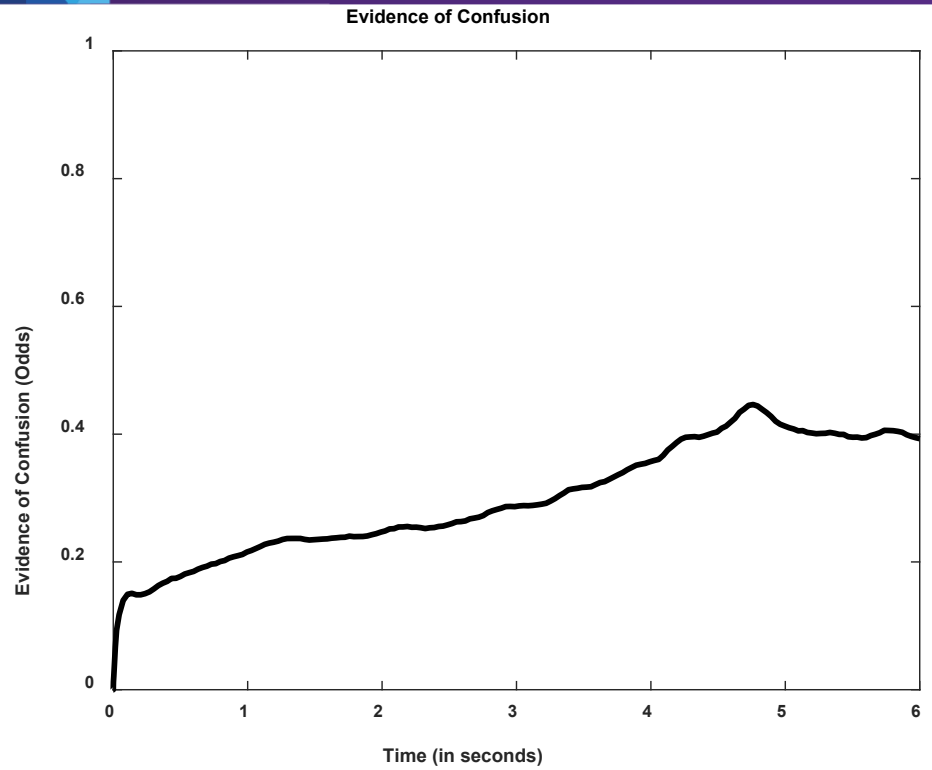
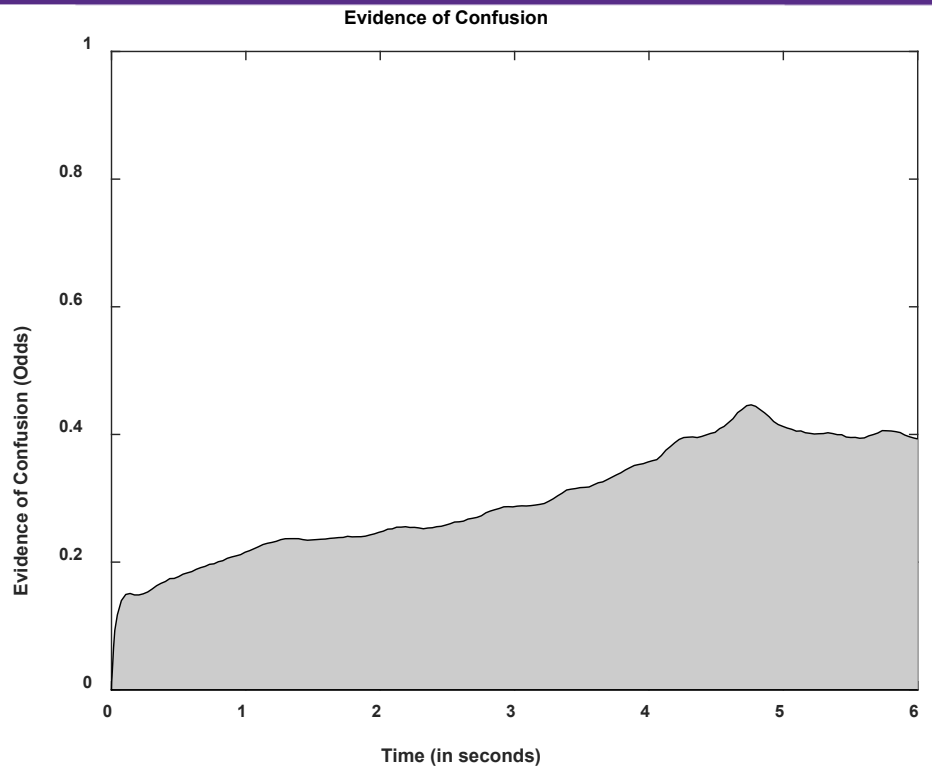
# Time course of emotion: Confusion




The **evidence value** for an expression channel represents the **odds, in logarithmic** (base 10) scale, of a target expression being present.

For instance: An evidence value of **1** for confusion means that it is **10 times more likely** that the facial expression seen will be classified as confusion by an expert human coder.

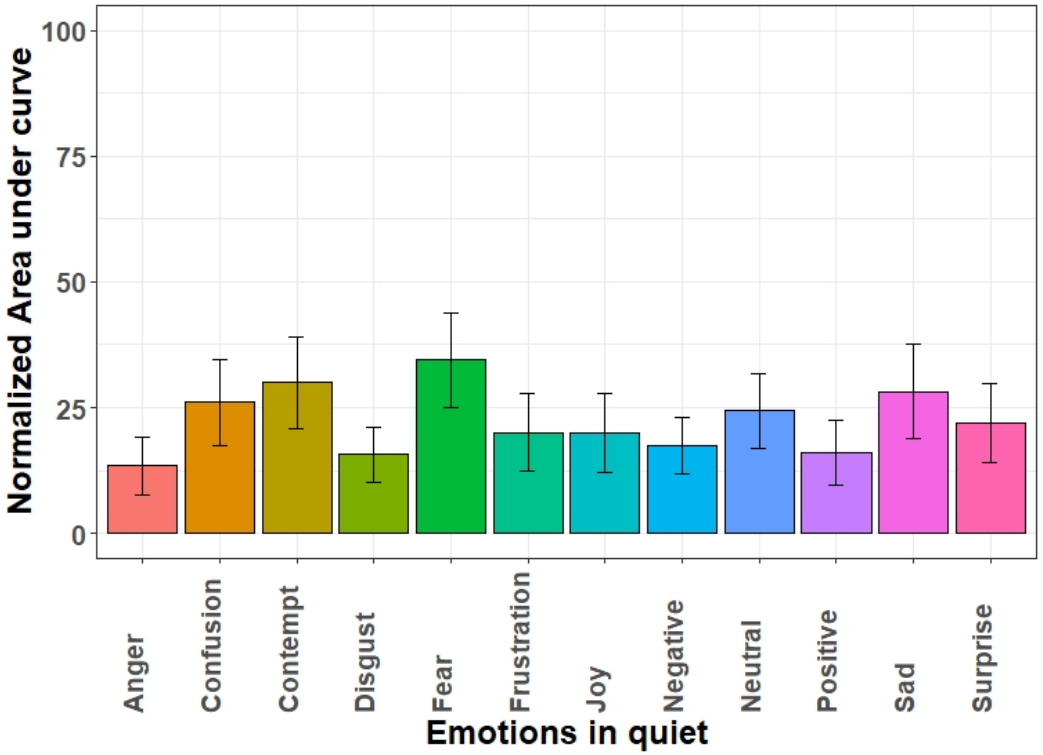
An evidence value of **2: 100 times more likely**

An evidence value of **0: equally likely**

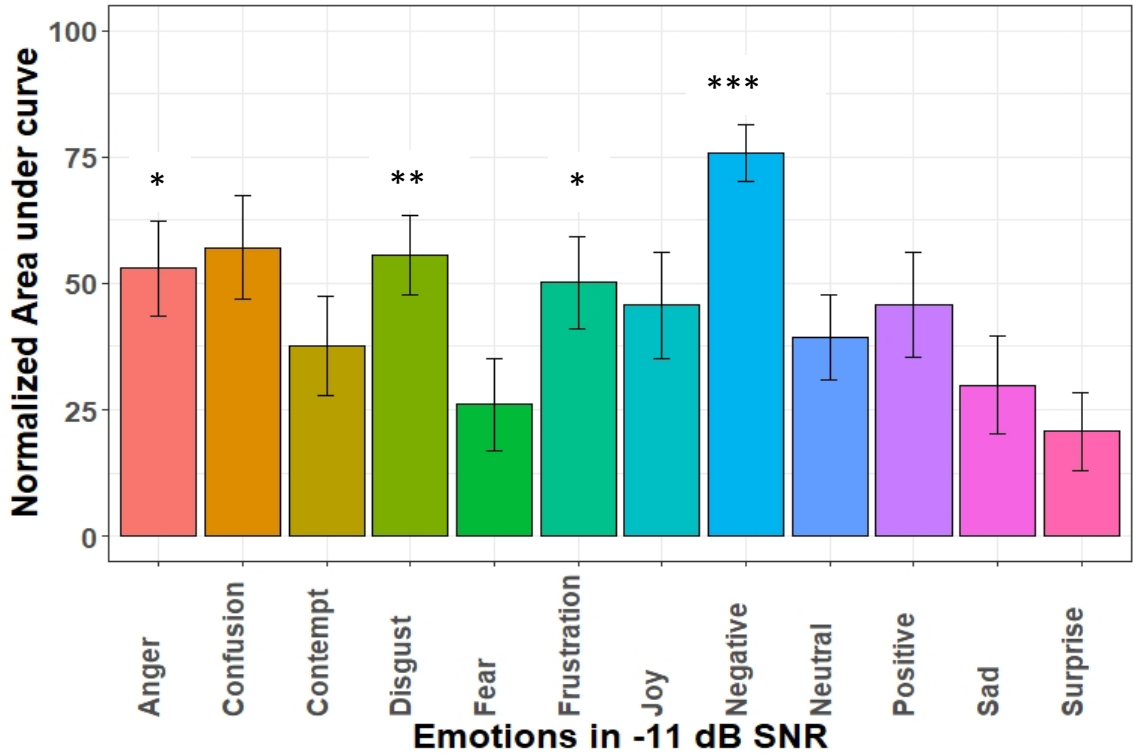
# Analysis

- Linear mixed effects models to determine the difference between different SNR conditions.
- SNR: Independent variable/ fixed effect
- Subjects: random effect
- Baseline-corrected and normalized evidence of facial expressions: dependent variable

# Results




*Area under the curve for all emotions for quiet condition.*




*Area under the curve for all emotions for -11 dB SNR condition.*

***Significance key: *: p< 0.05 **: p<0.01 ***: p< 0.001***

# Conclusion

- Our **aim** was to determine if facial expressions of emotions change with changes in listening difficulty.
- Findings:
  - Emotions of anger, disgust, frustration and negative emotions show a significant increase from easiest to the most difficult condition.
  - Emotion of confusion did not show a significant change contrary to expectations.
- **Conclusion:** Facial expressions can be used to measure emotional responses in speech-in-noise situations.
- **Future research:** Explore the effect of hearing loss on emotional responses using facial expressions.
- **Applications:** Automatic recognition of facial expressions has applications for tele-rehabilitation and in the assessment of emotional responses in the real-world using a mobile phone camera.

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