Analysis and applications of speech evoked responses:

Experiences from the NAL group (HEARLab)
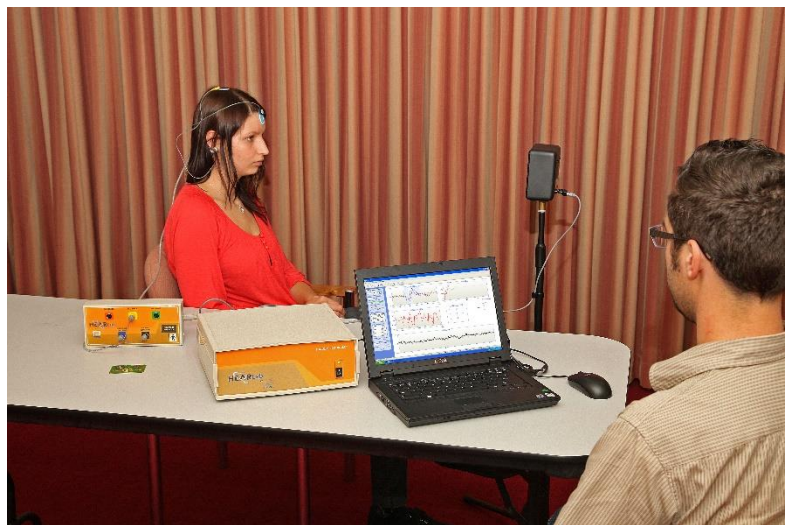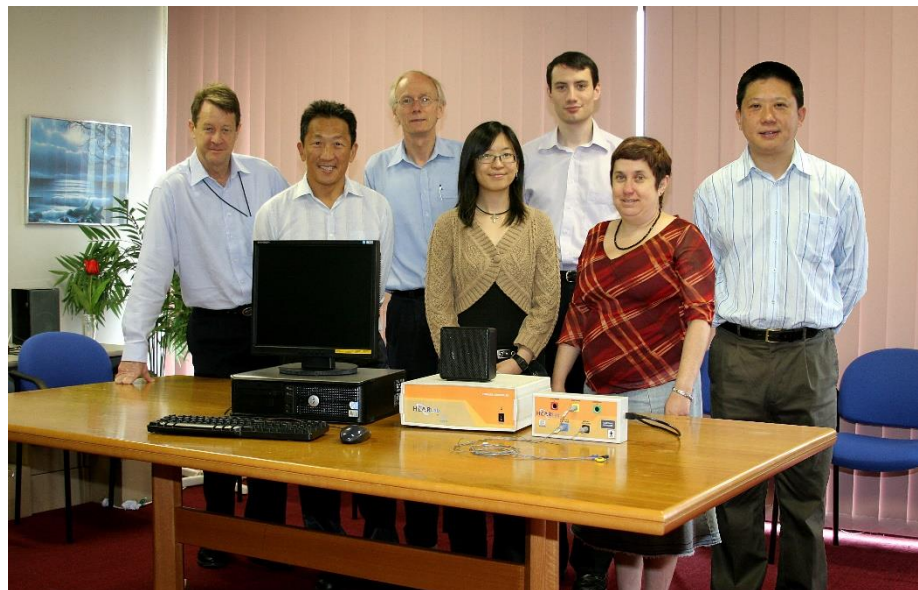
Bram Van Dun & Fabrice Bardy – National Acoustic Laboratories

Workshop IERASG 2017

creating **sound value**™

Background: HEARLab (1)

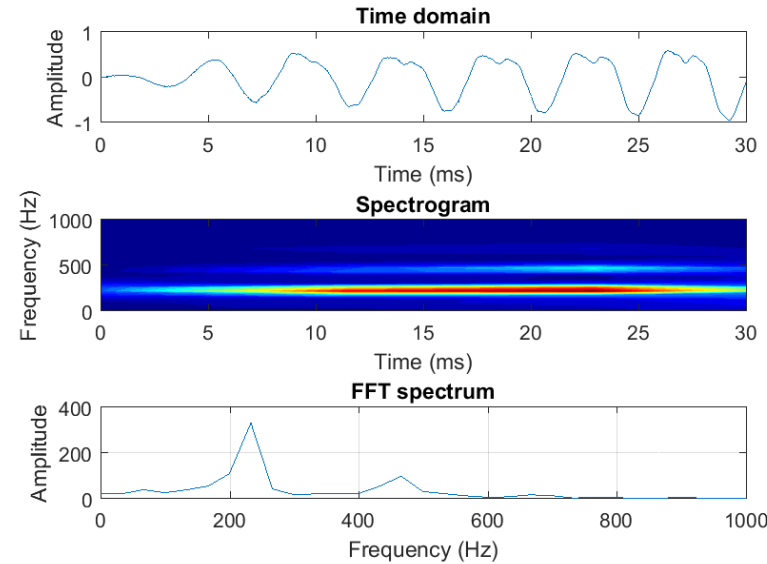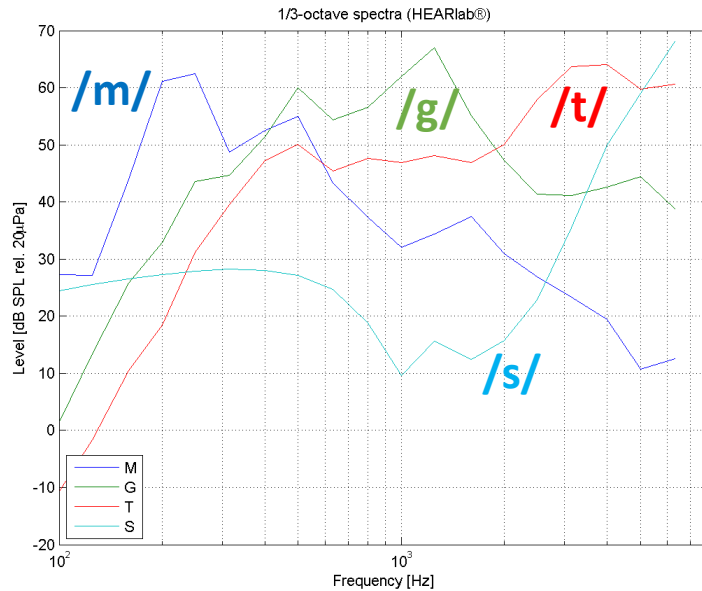# Background: HEARLab (2)
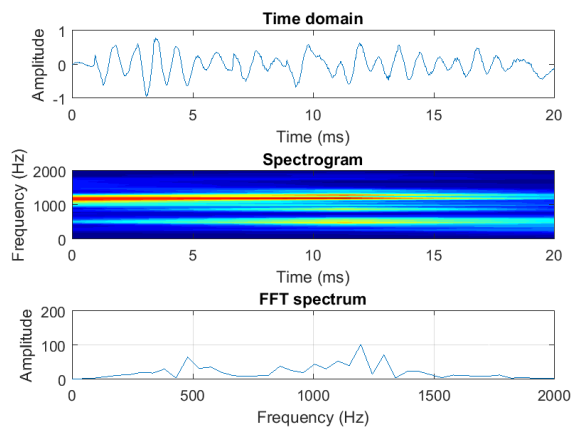
VIDEO HERE

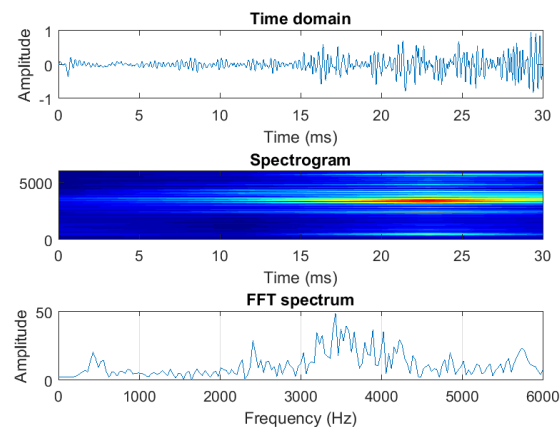# Background: HEARLab (3)

VIDEO HERE

1. Test stimuli & features
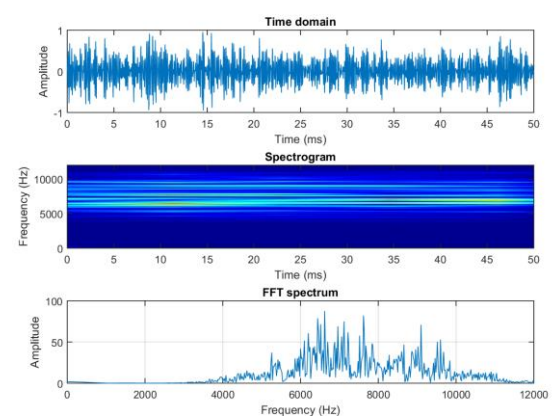
/m/

55, 65 & 75 dB SPL
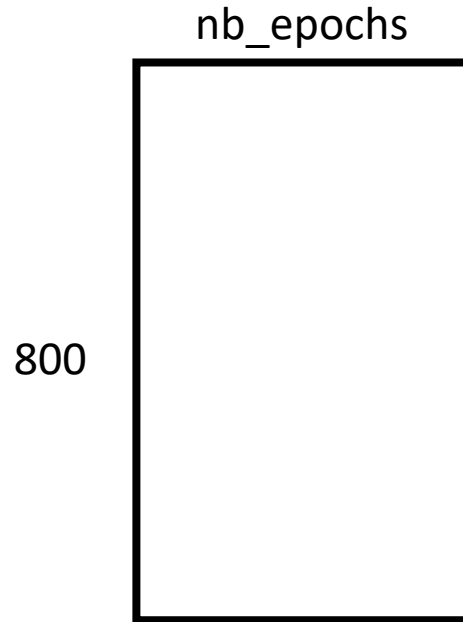
SOA 1125 ms

/g/

/t/

/s/

2. How is data pre-processed and analysed?

- Sampled at 16 kHz in 16-bit PCM format
- μV:PCM conversion
- Raw data saved after header file
  - Header included stimulus ID, Prestim, …
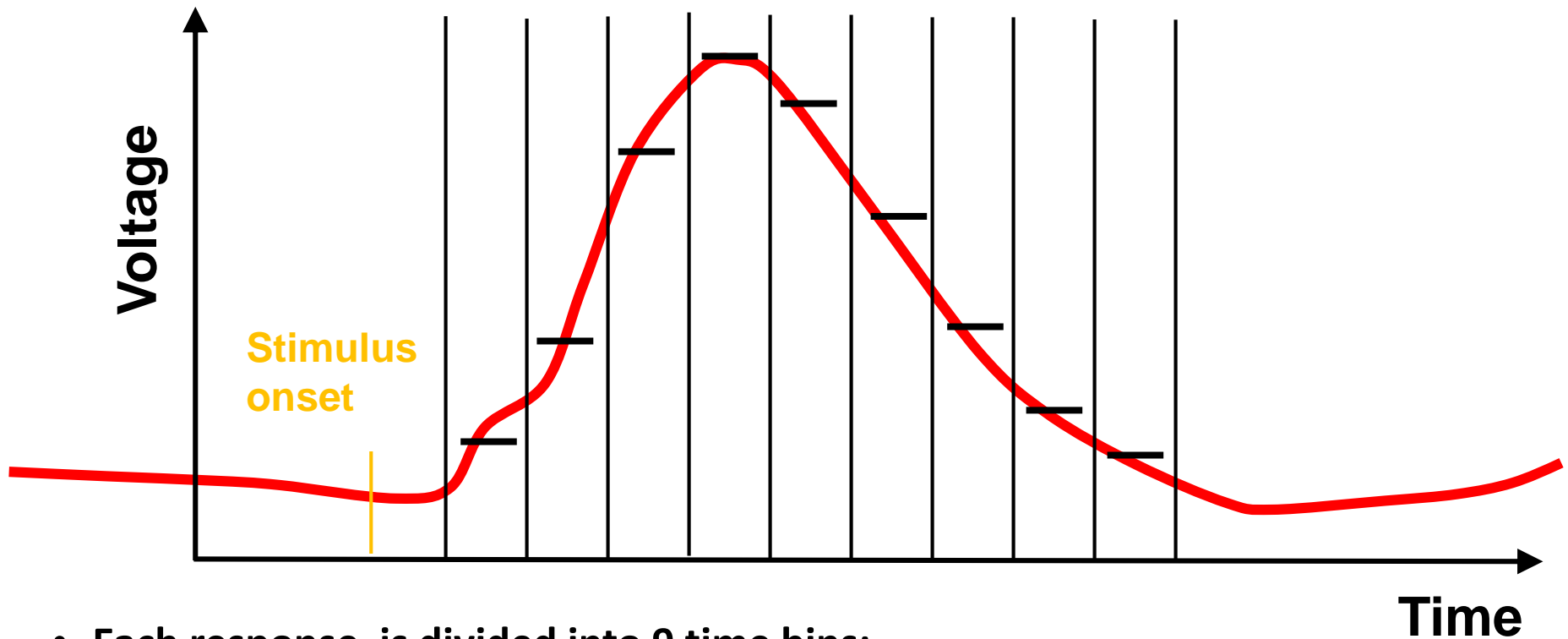- Rejection flag per epoch included

- Downsampled to 1 kHz
- Epoch: -200 to 600 ms
- Artefact rejection: sets of rules (150 μV dominant)
- BPF: 0.16 Hz – 0.33 Hz – 30 Hz

- 800 x nb_epochs matrix

nb_epochs

800

- Hotelling's T^2 for response detection

Hotelling's T^2

Voltage

Stimulus onset

Time

- **Each response is divided into 9 time bins:**
  - **Adults > 12y: start 51 ms, bins of 33 ms**
  - **2y < age < 12y: start 76 ms, bins of 41 ms**
  - **Infants < 2y: start 101 ms, bins of 50 ms**
- **The data points are averaged within each time bin to form 9 variables**
- **Multi-dimensional t-test**

3. Give an example of data and the associated response
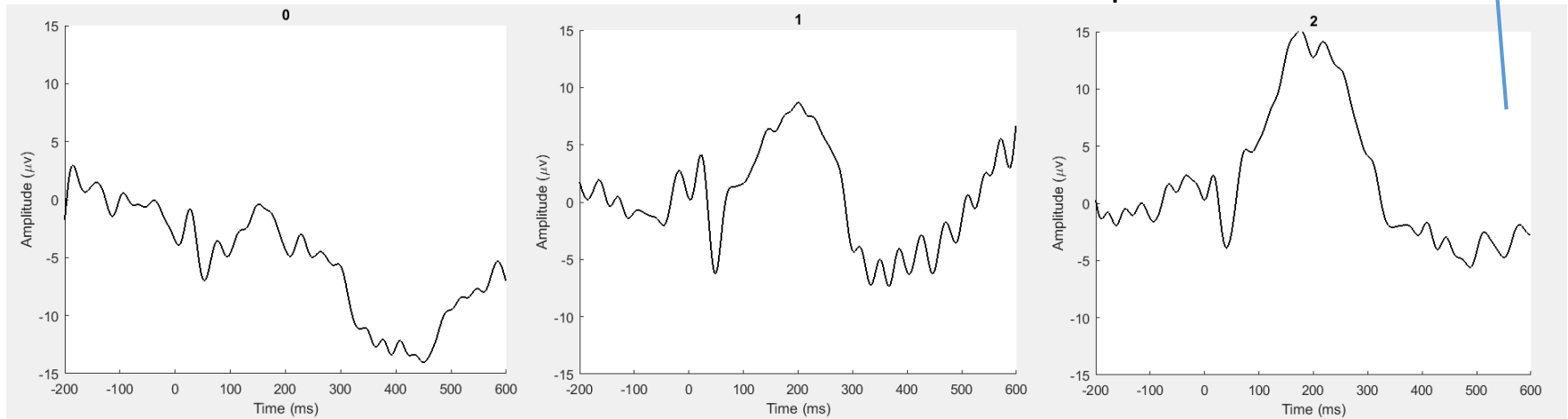
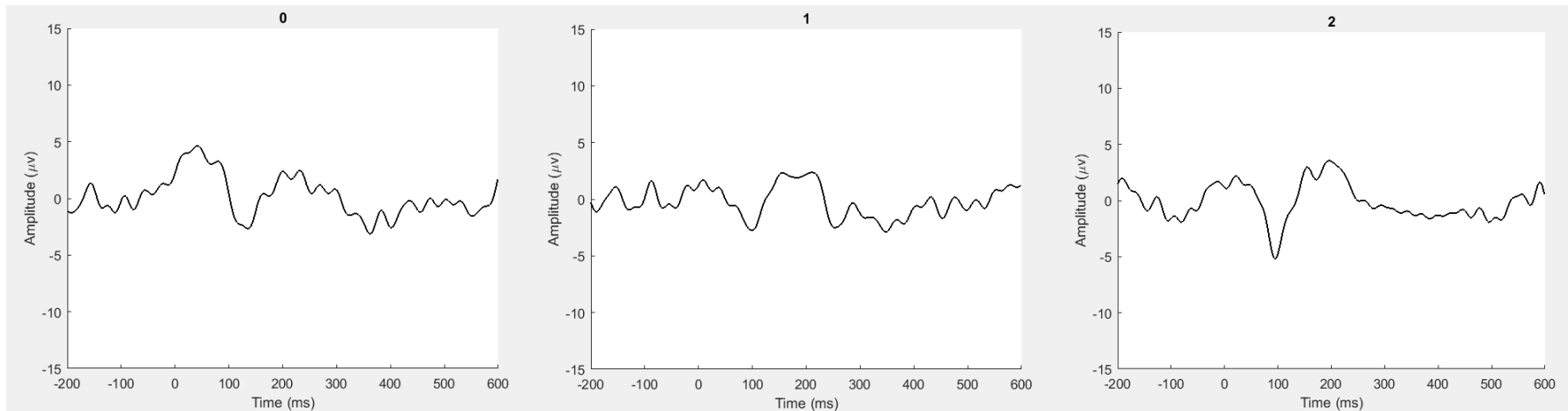sampleSize: 92 (nb of epochs)
variables: 9
T2: 75.8587
F: 7.6878
df1: 9
df2: 83
pvalue = 3.9414e-08

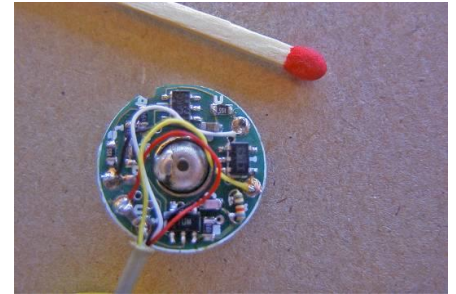- Code.zip provided
- 'A.epo'

- 'B.epo'

4. What is the typical quality of data?

- Adults:
  - 20 – 120 epochs
  - 20 seconds – 2 minutes
  - 0-10 % artefact rejection
  - Reliability: excellent

- Infants
  - 50 – 240 epochs
  - 1 – 5 minutes
  - 10-50% artefact rejection
  - Sensitivity of 75% in hearing-impaired infants & children (isolated recordings)
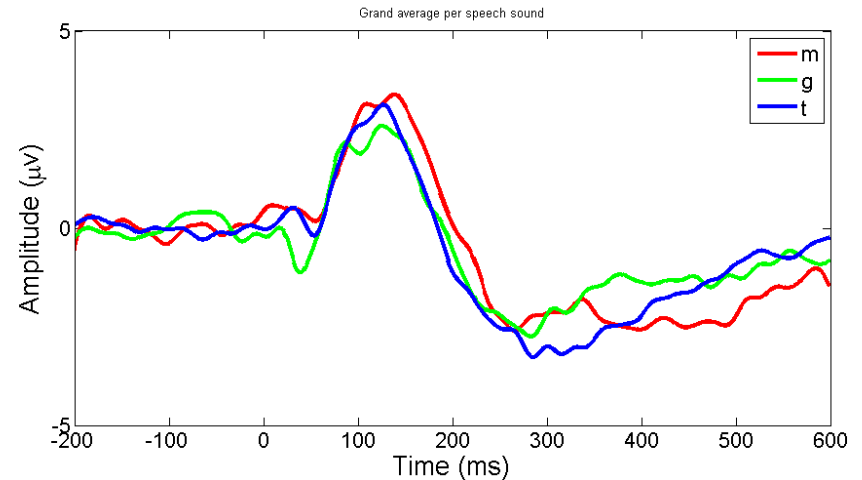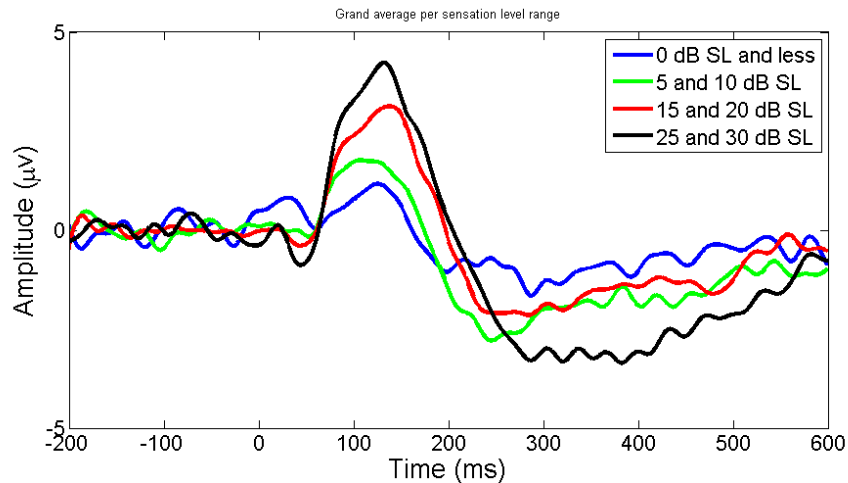
5. Tips and tricks for getting good data

- Amplify at the scalp
  - 121x
- Don't spend too much time on scrubbing
- Make sure the client is comfortable
- Track residual noise

6. Applications of the methods

- Hearing aid fitting evaluation in infants & young children

22 infants (8-30 months)

Van Dun et al (2012) *Aud Res*

Cortical testing & Australian Hearing

- Clinical protocol rolled out in 2011

- See www.nal.gov.au, or Punch et al (2016) *Semin Hear*

- Majority of hearing aid fittings is evaluated using CAEPs within 8 weeks after first fitting

- Currently 25 paediatric centres in Australian Hearing, and about 20 more external

Case 1: HA fitting over multiple visits (1)
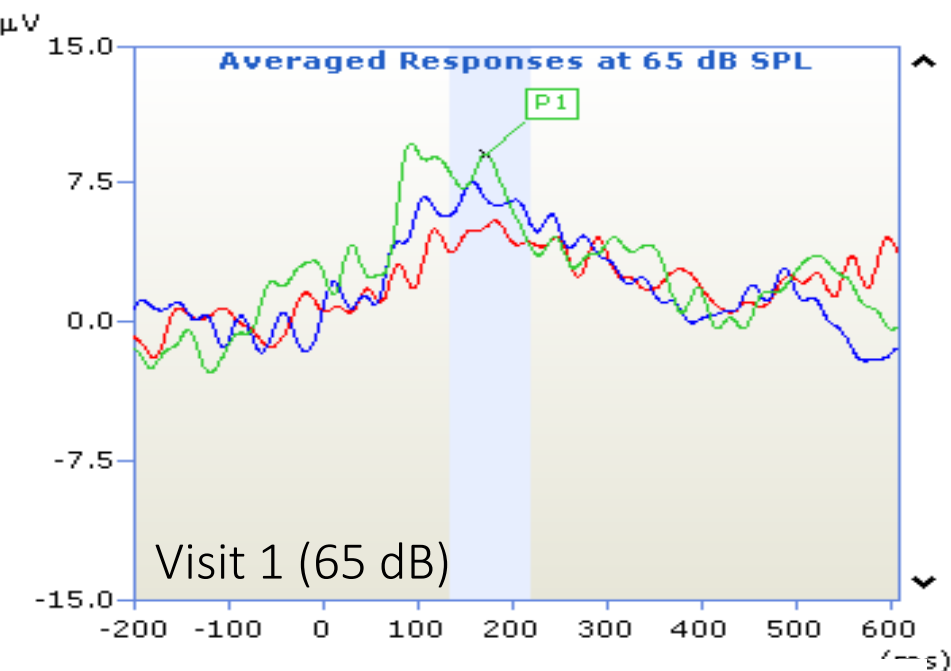
Visit 1 (65 dB)

	/m/	/g/	/t/
75 dB SPL	0.000 ✔	0.000 ✔	0.641
65 dB SPL	0.326	0.015 ✔	0.184

Estimated Audiogram (dB HL) at Visit 1

	500 Hz	1000 Hz	2000 Hz	4000 Hz
Right	45	50	55	55
Left	45	55	65	55

+1SD = 10 dB

+1.5 SD = 15 dB

Estimated Audiogram (dB HL) at Visit 2

	500 Hz	1000 Hz	2000 Hz	4000 Hz
Right	55	50	55	70
Left	55	55	65	70

Case 1: HA fitting over multiple visits (2)

Visit 1 (65 dB SPL)
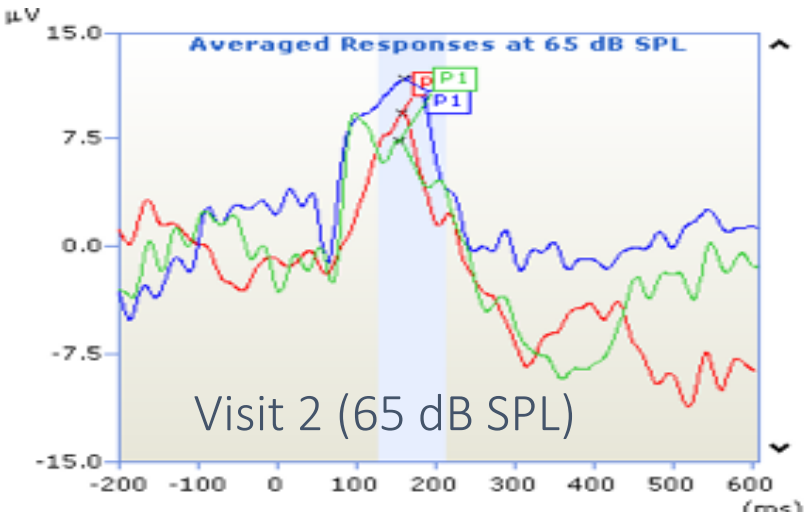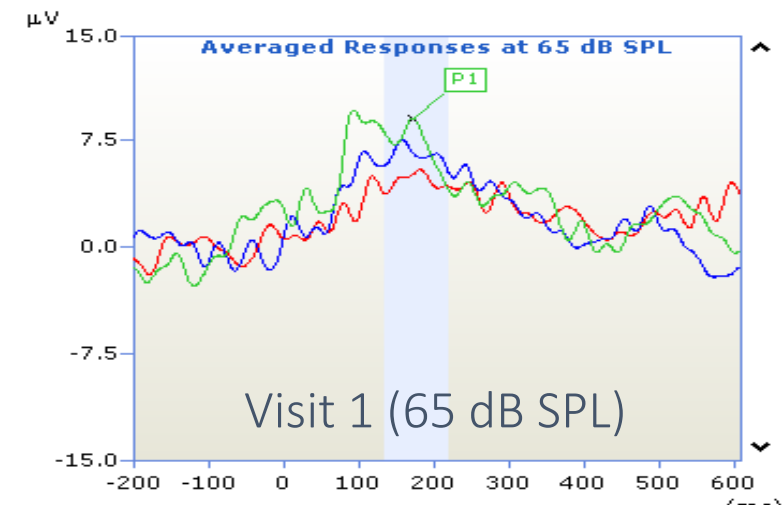
Visit 2 (65 dB SPL)

	/m/	/g/	/t/
75 dB SPL	0.000 ✓	0.000 ✓	0.641
65 dB SPL	0.326	0.015 ✓	0.184

55 dB SPL not tested as not all CAEPs present at 65 dB SPL

75 dB SPL tested as all CAEPs present at 65 dB SPL

	/m/	/g/	/t/
65 dB SPL	0.043 ✓	0.015 ✓	0.007 ✓
55 dB SPL	0.000 ✓	0.104	0.103

Case 2: Potential CI referral
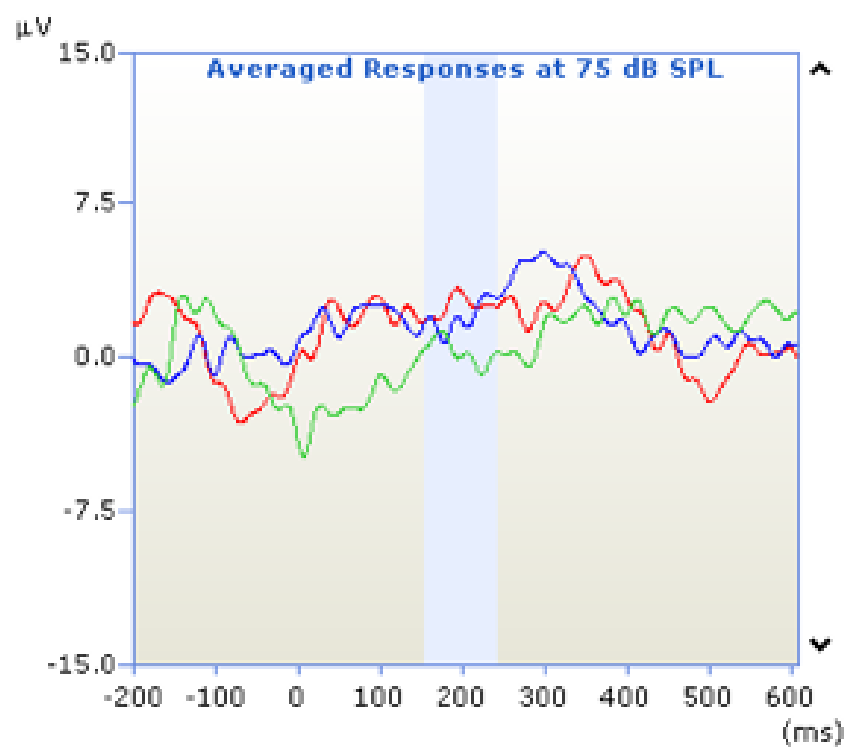
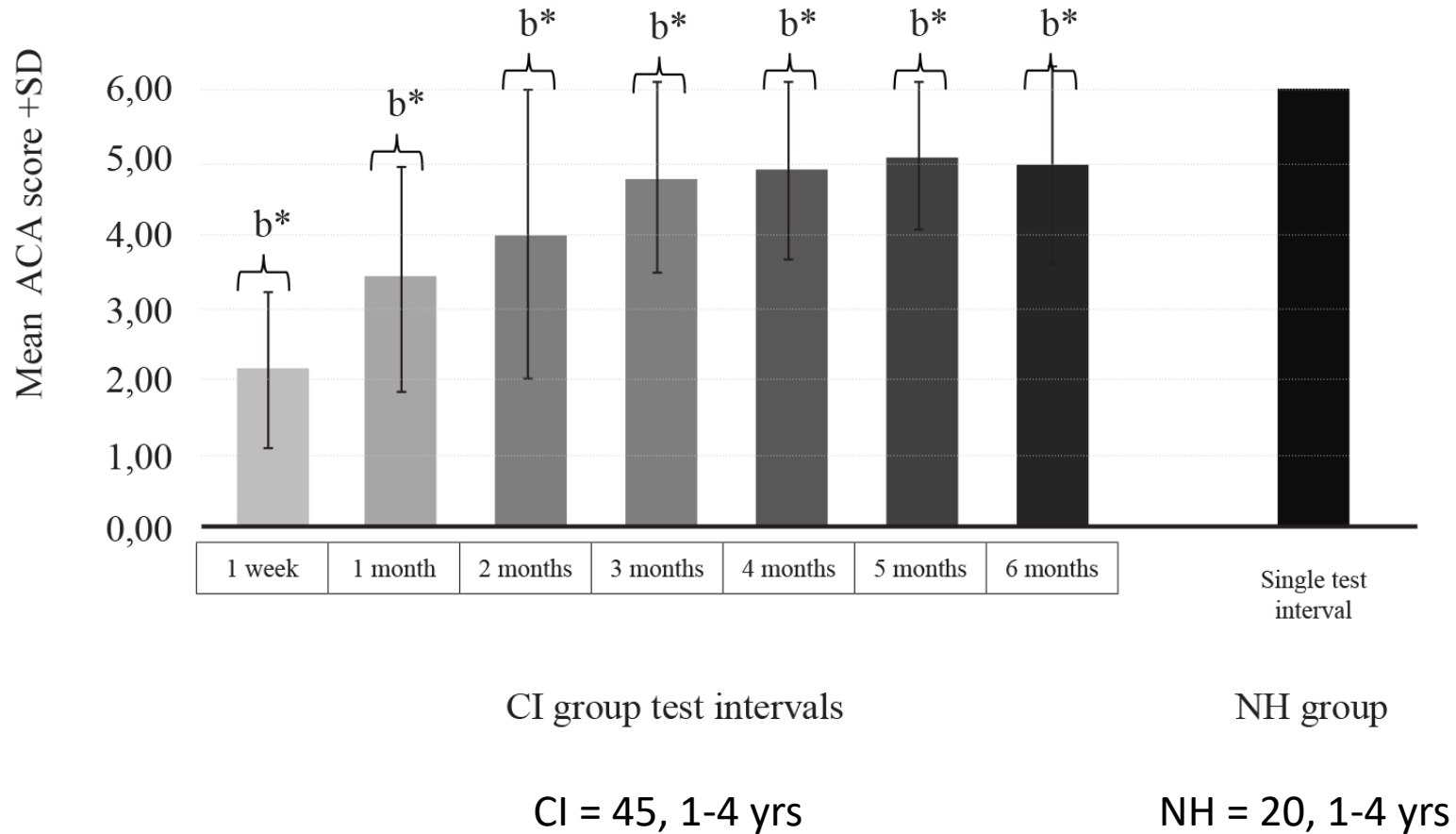Visit 3, so far hearing aid has been adjusted twice

	/m/	/g/	/t/
75 dB SPL	0.641	0.900	0.660

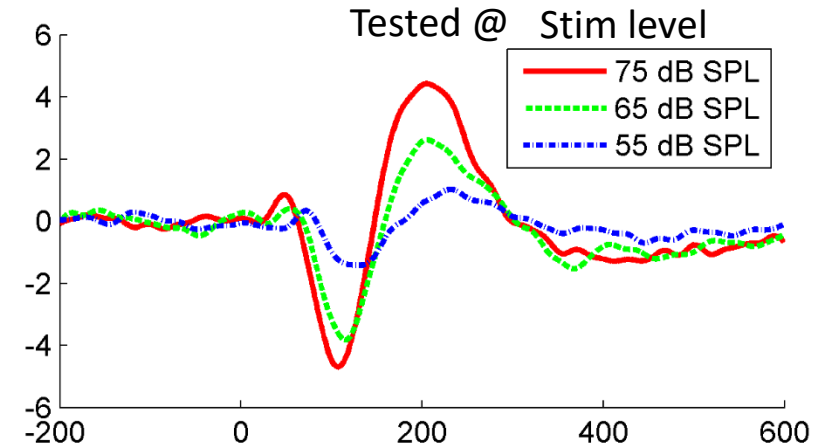| Estimated Audiogram (dB HL) at Visit 3				
	500 Hz	1000 Hz	2000 Hz	4000 Hz
Right	95	100	105	110
Left	95	95	100	105

Implant fitting evaluation in young children
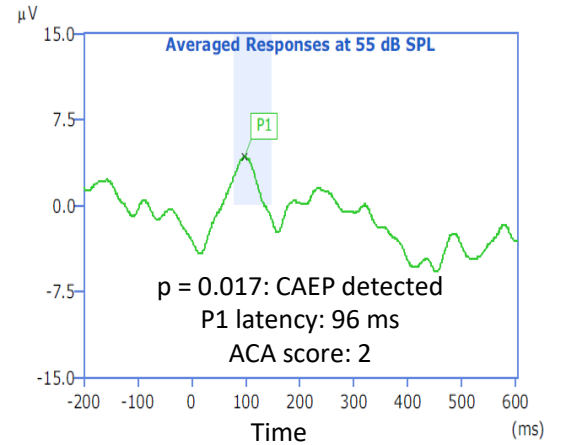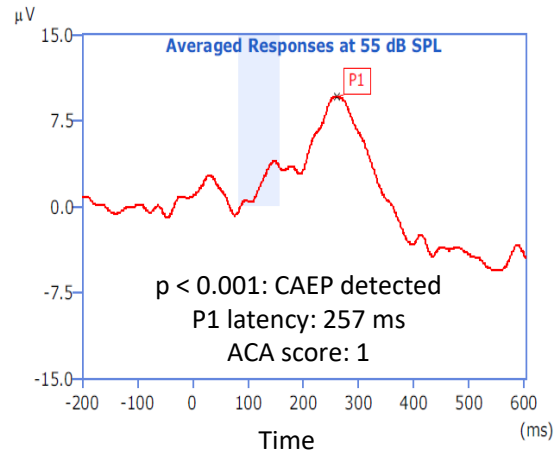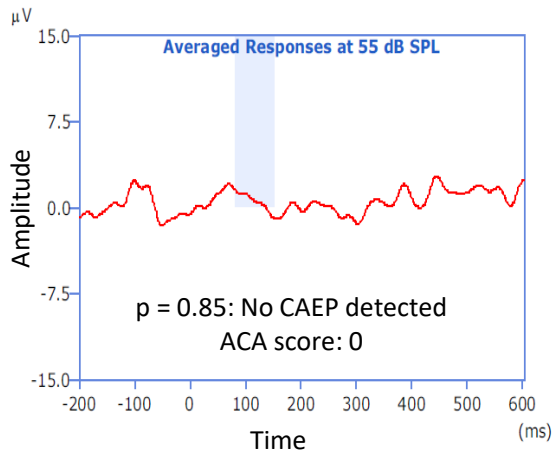
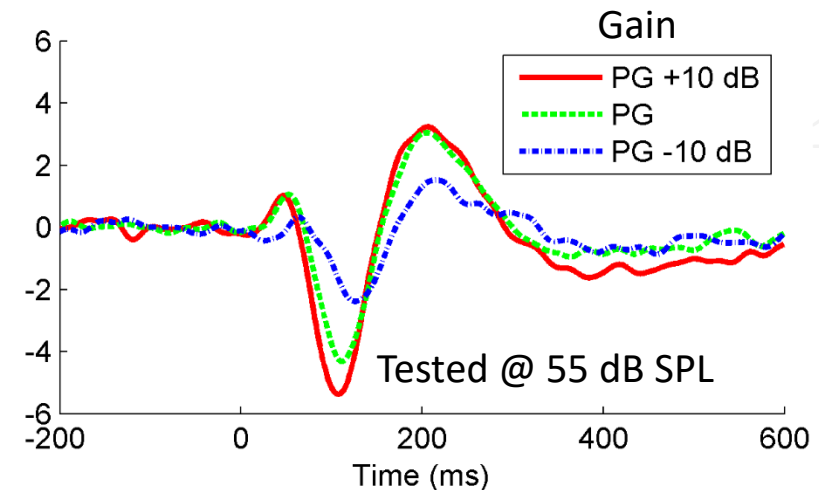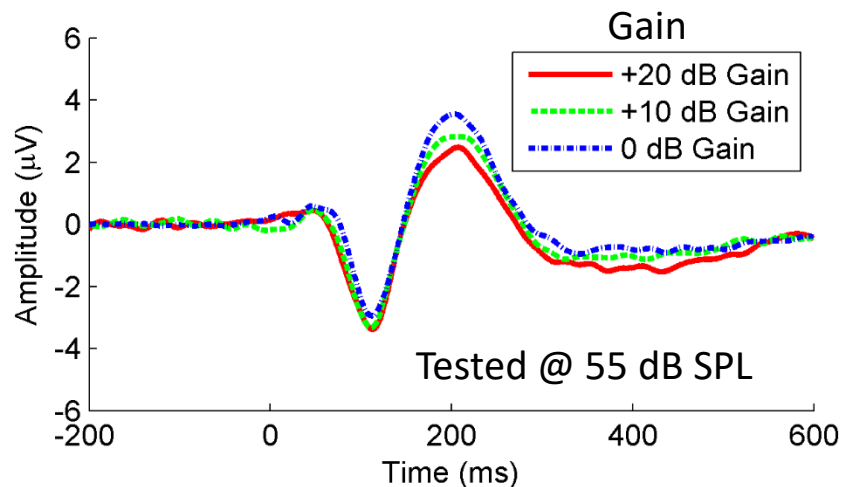Recorded clinically using the HEARLab system (one channel, 3 electrodes)

CI group test intervals

NH group

CI = 45, 1-4 yrs

NH = 20, 1-4 yrs

Kosaner et al (in prep) – MED-EL only

Effect of hearing aid gain on adult CAEPs — Van Dun et al (2016) *Semin Hear*
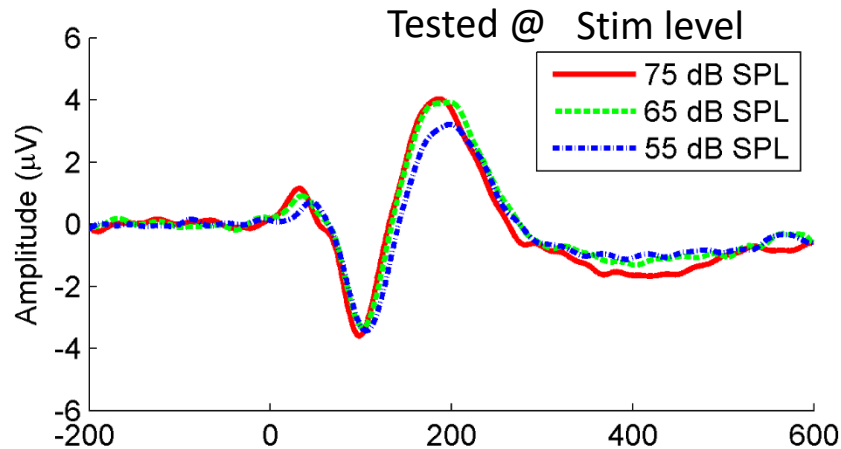
6. Applications of the methods

- Multi-tone-bursts
- Cortical Automatic Threshold Estimation (CATE)
- See talk Fabrice Bardy later

- IDEAL study
- Infant Discrimination and Early Acquisition of Language
- See my talk later

New experiment (infant discrimination): /u/ vs /i/
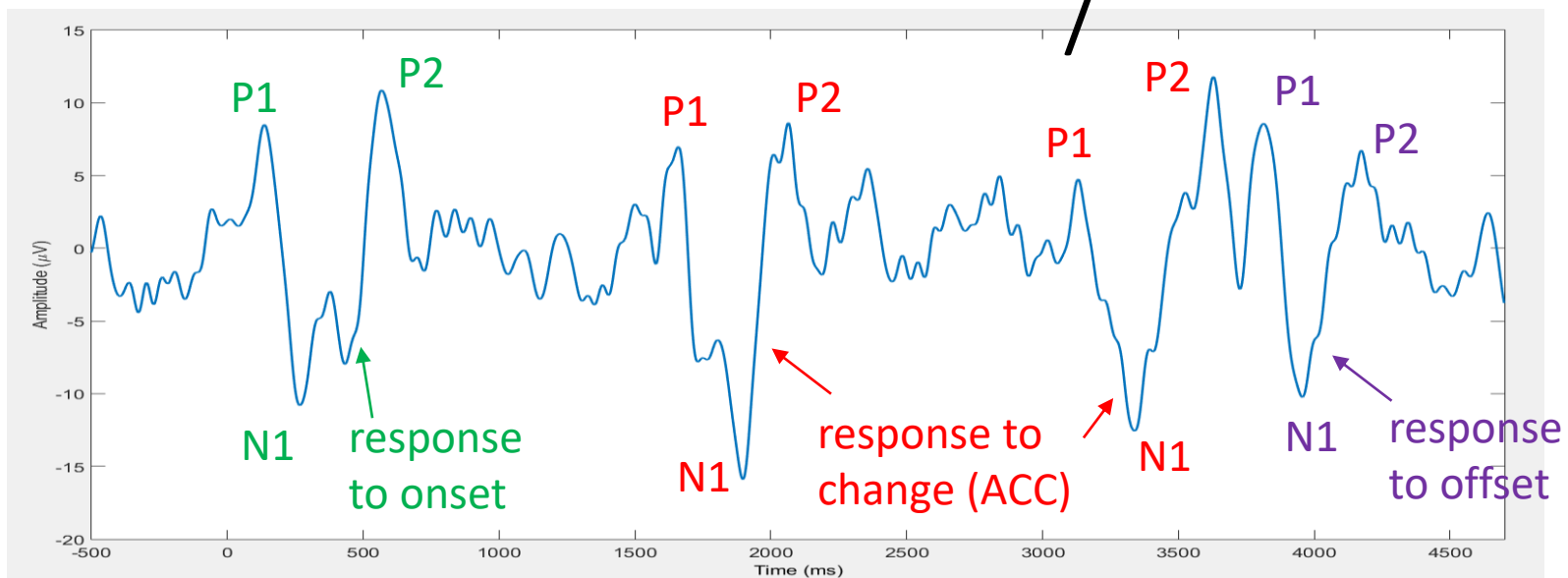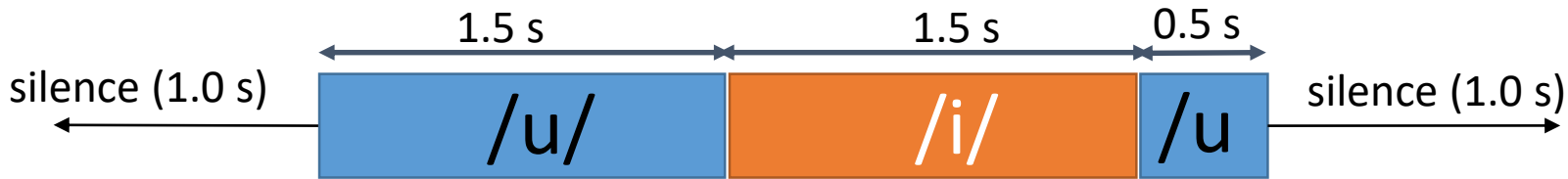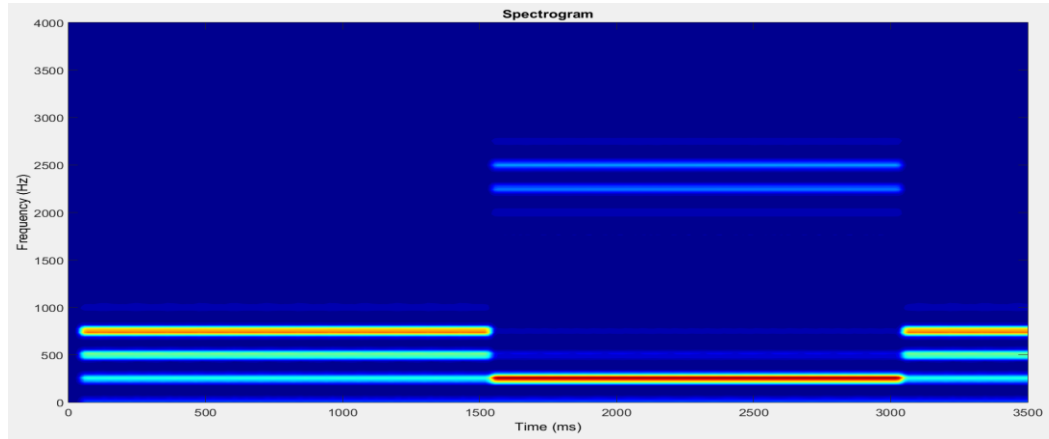
/s/ vs /z/

Voicing contrast discrimination