

Advancing Speech Breathing Analysis: Benefits of Using EMA

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Autrans

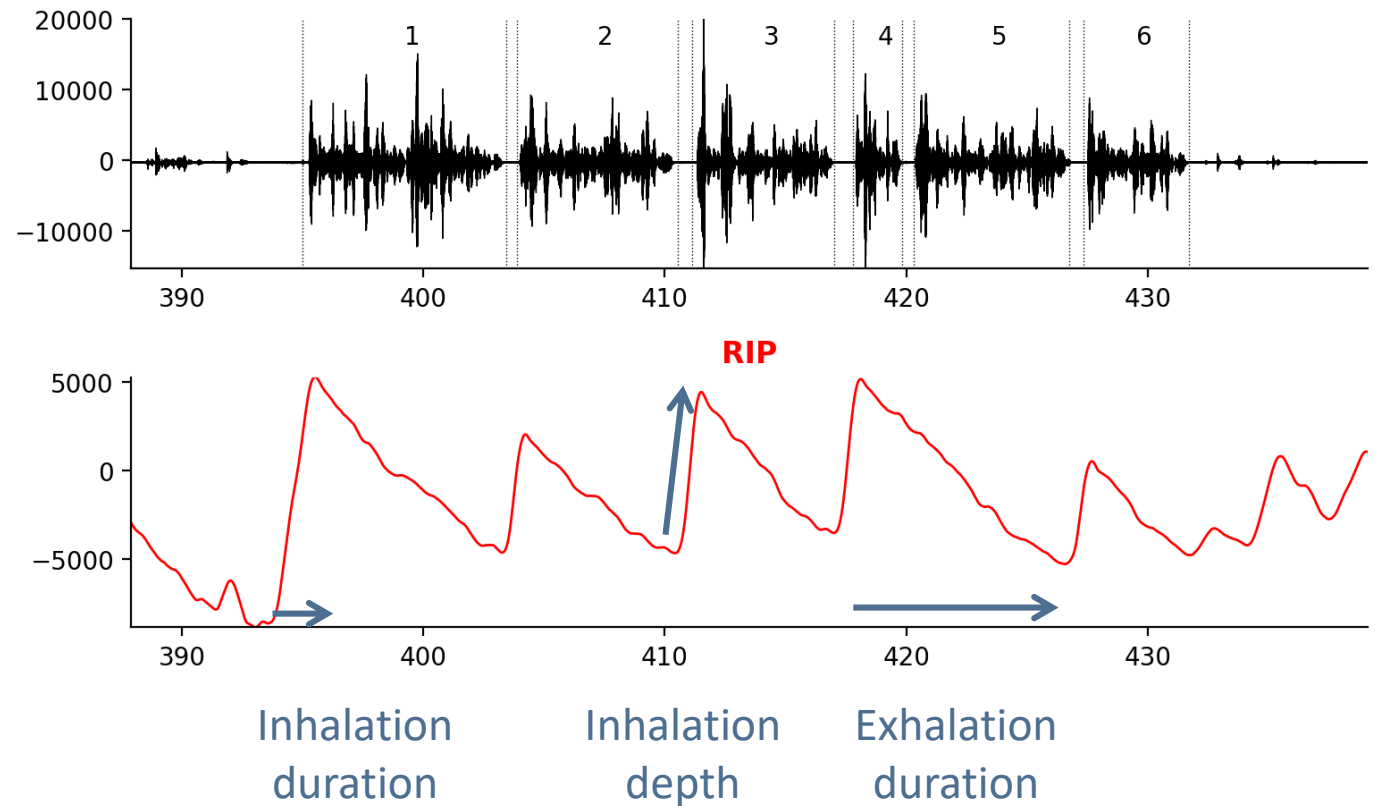


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Speech Breathing Research

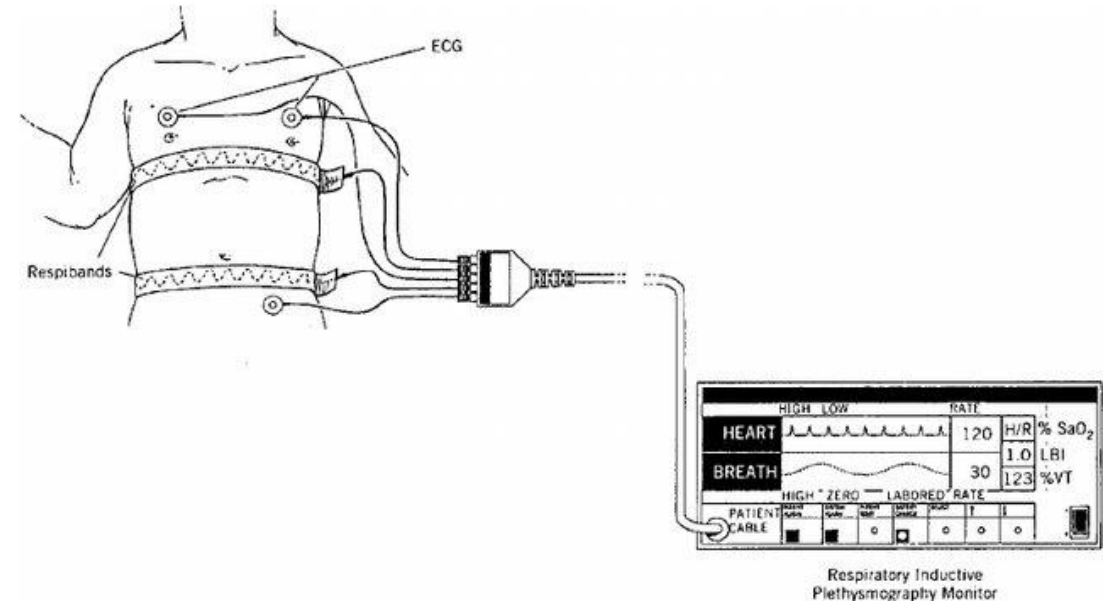
- Breathing adaptation
 - Sentence complexity
 - Cognitive demand
 - Sentence length
 - Speaking rate
 - Speech loudness
- Interaction with other speech systems
 - Phonatory system
 - Articulatory system



Speech Breathing Research

Inductance Plethysmography (RIP)

- Commonly used technique
- Two flexible belts that track changes in ribcage and abdominal motion
- During inhalation and exhalation



(Bar-Yishay et al. 2003:152, Physiol. Meas.)

Aging- and Disease-related Research



- Essential to investigate speech breathing
 - Reduced breath support
 - Reduced respiratory muscles strength
 - Less lung volume
 - Less respiratory control
 - Cognitive decline, e.g. less complex sentences

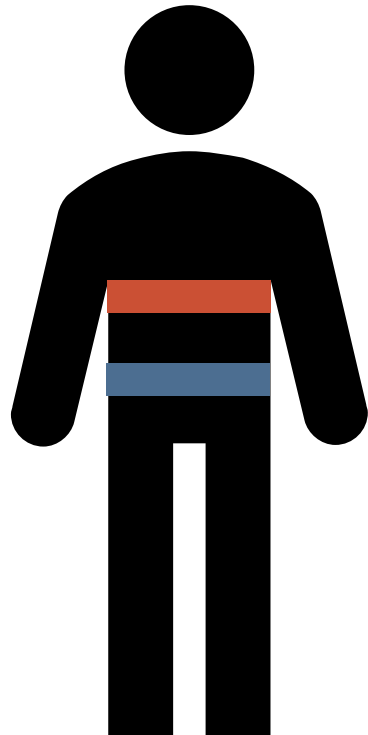


Larger studies planned on breathing and aging/disease for which simplified data collection is preferred (using only one method).

Objective

Respiratory Inductive Plethysmography

(RIP, Inductotrace®)

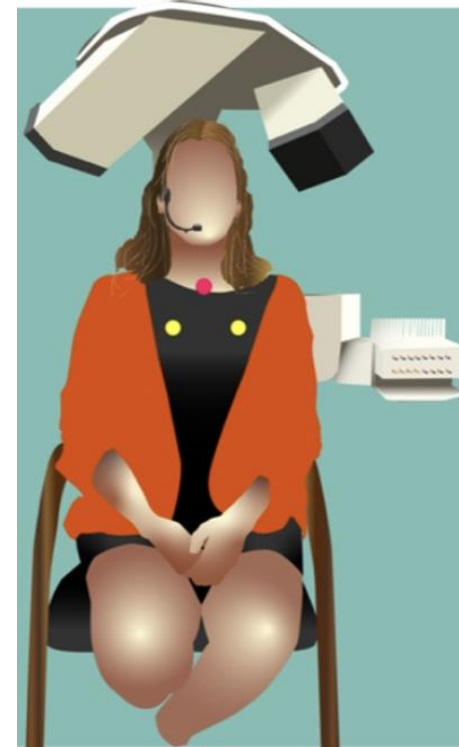


Ribcage Signal

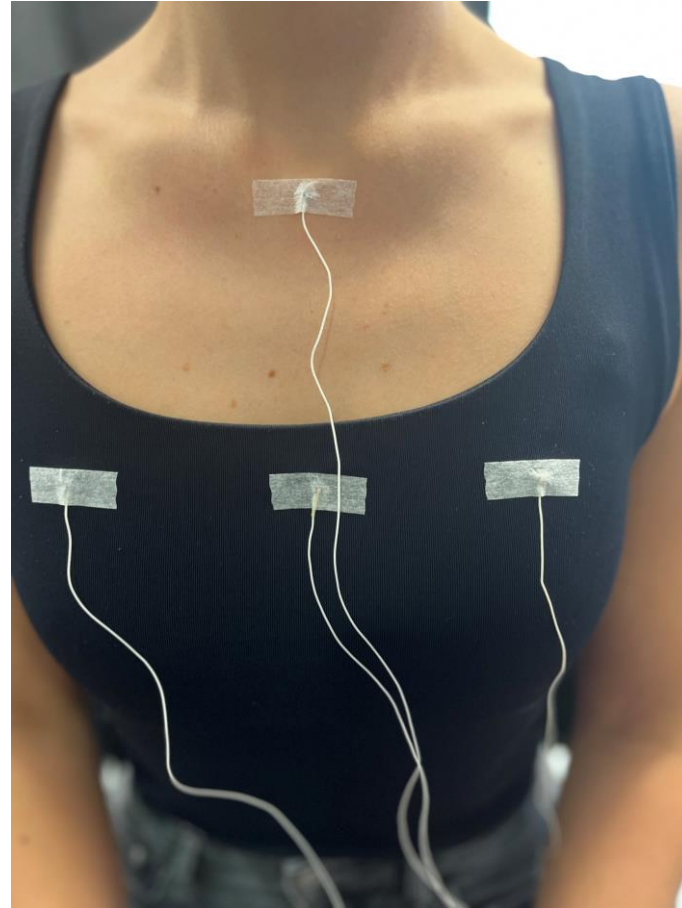
Abdominal Signal

Electromagnetic Articulography

(EMA, Carstens AG 501)



Methods



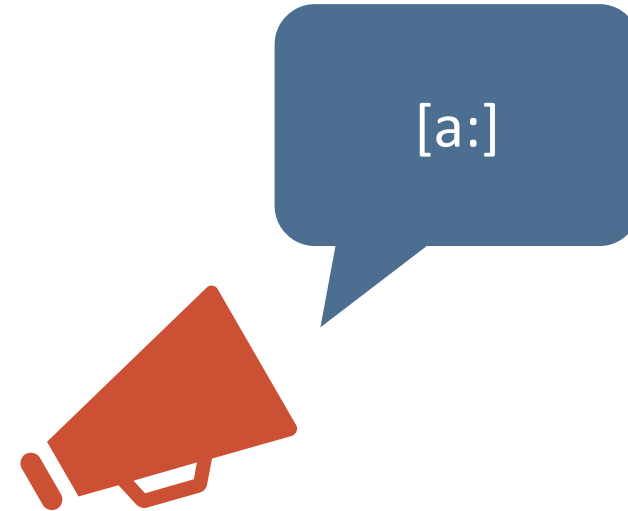
Sample

- 18 participants
- 9 females, 9 males
- Native speakers of German
- Aged between 23 – 54 years (\bar{M} 33)
- Different body sizes
 - Band sizes: 7 x S, 5 x M, 6 x R

Material



Habitual speech



Loud speech (80 dB)

Data Processing

1

Align RIP and
EMA signals

2

Calculate
EMA sensor
distances

3

Landmark
detection

4

Parameter
calculation

5

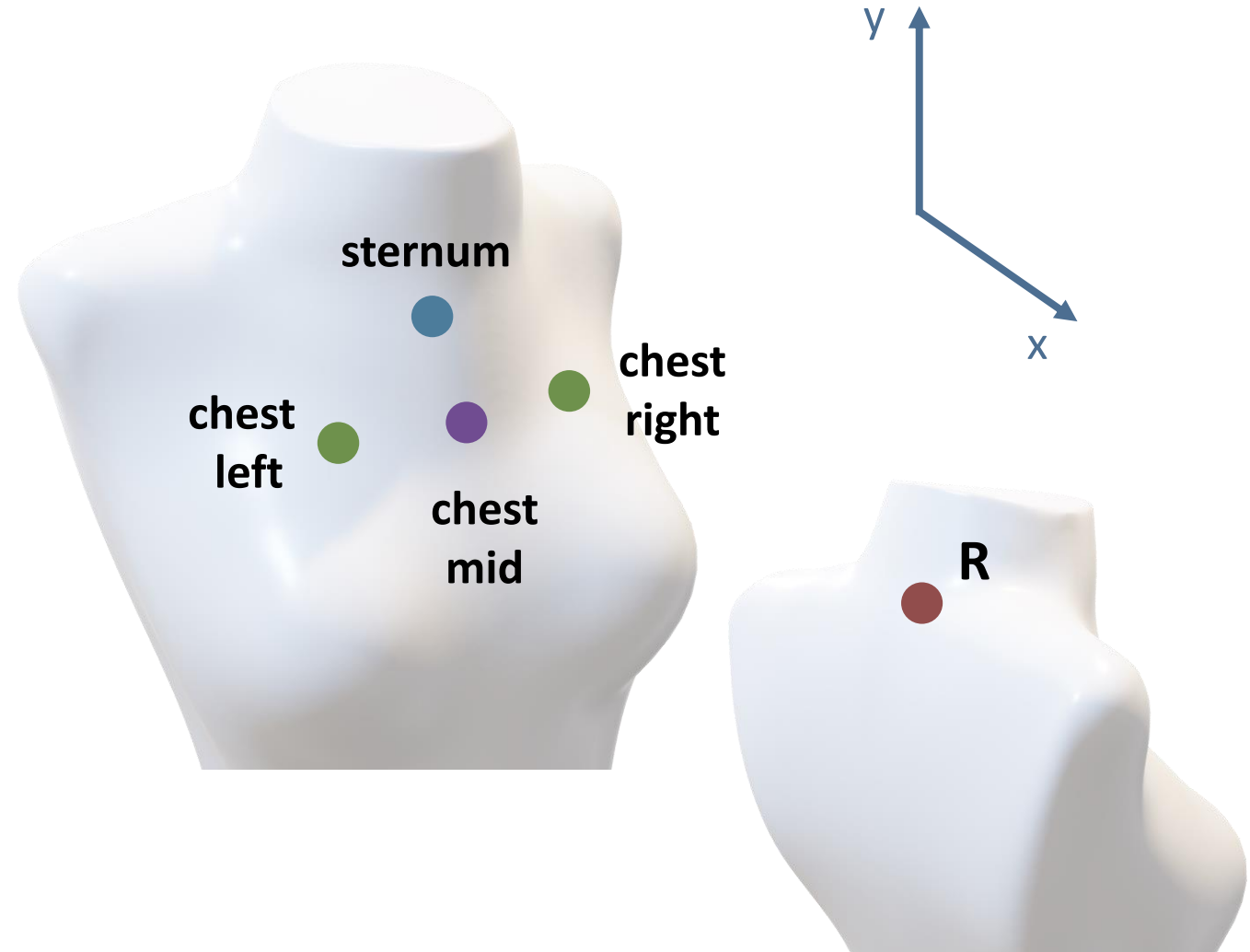
Trajectory
comparison

EMA Sensors: Distance Measures

D1: Chest's **middle sensor** to the **reference sensor**

D2: Calculated **midpoint** between **left sensor** and **right sensor** on the chest to the **reference sensor**

D3: **Sternum** to the **reference sensor**



Landmarks

Onset

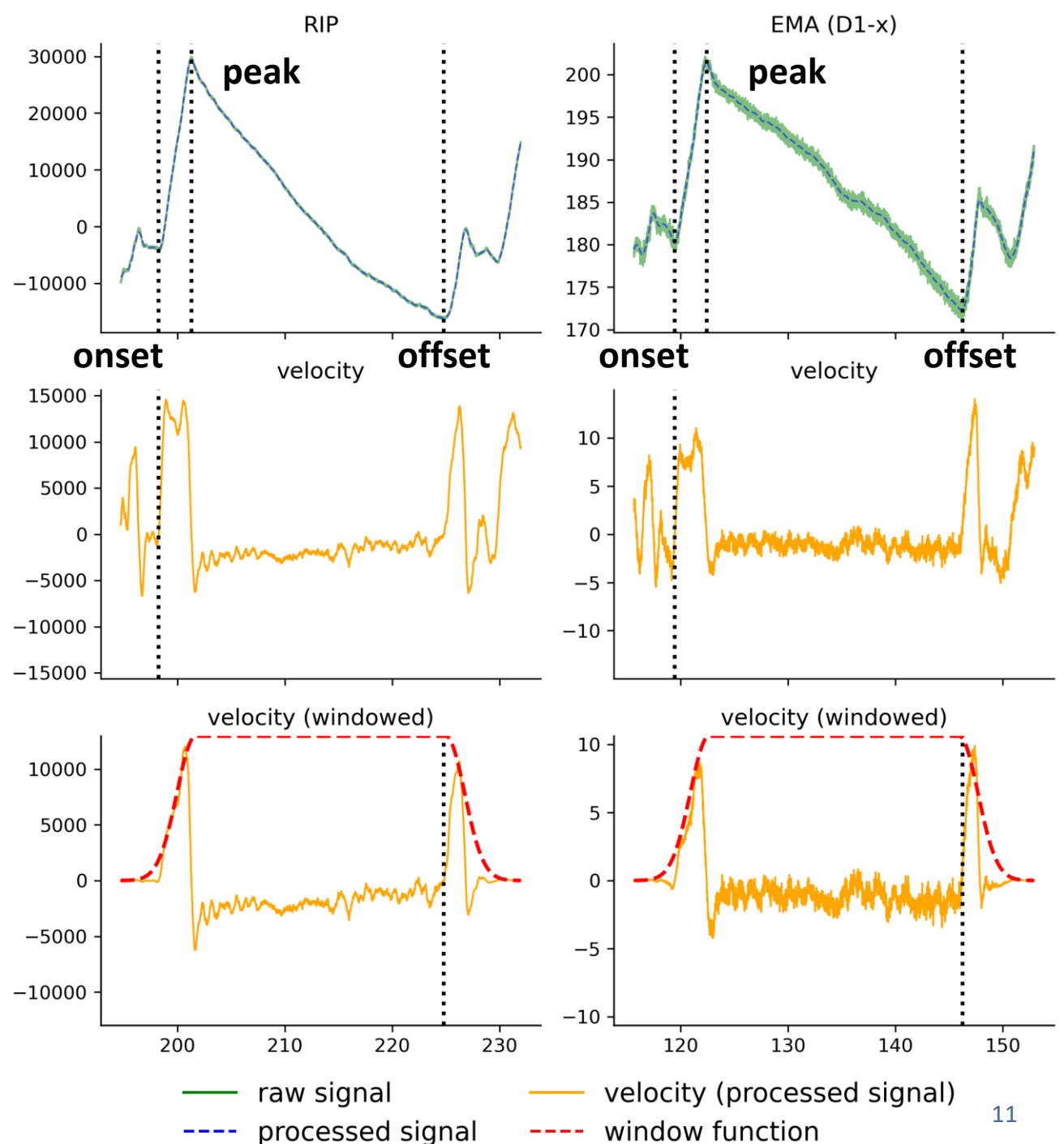
- Zero crossing in velocity left of the first velocity peak

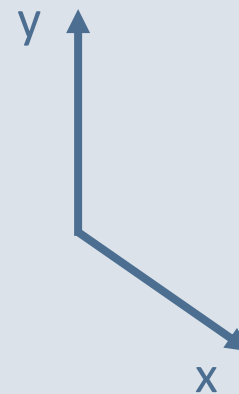
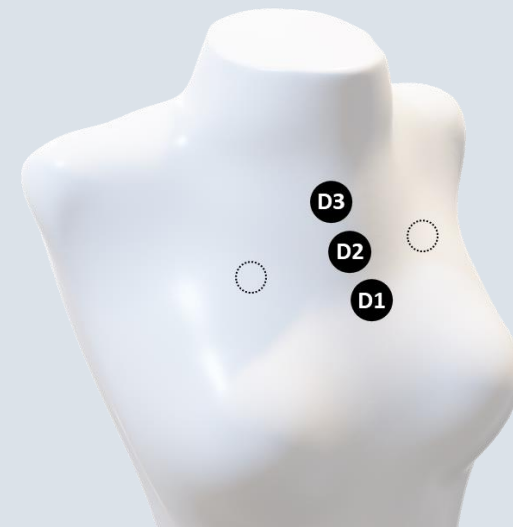
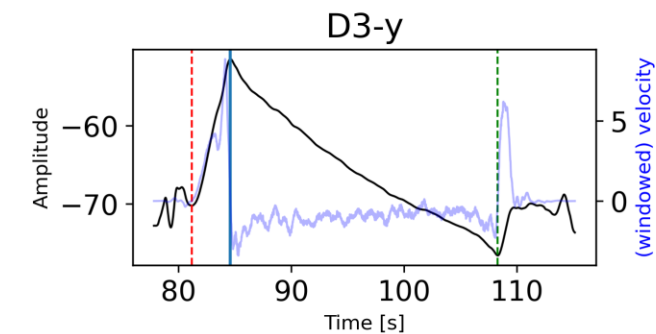
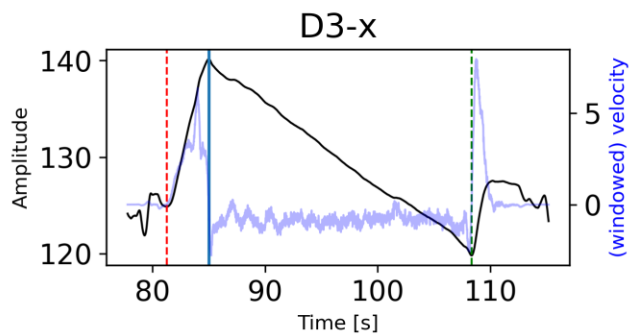
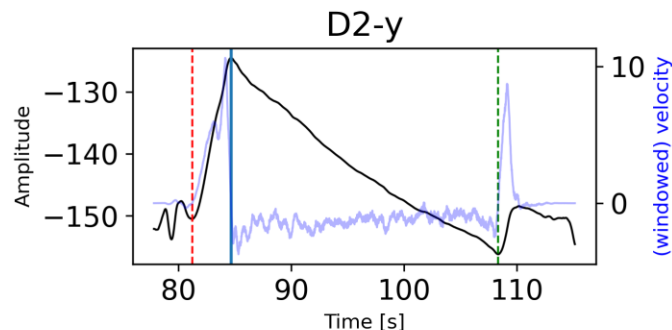
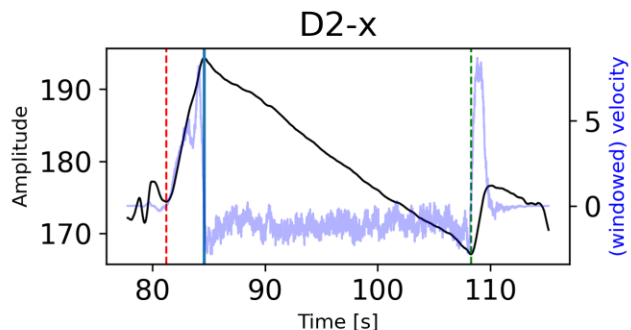
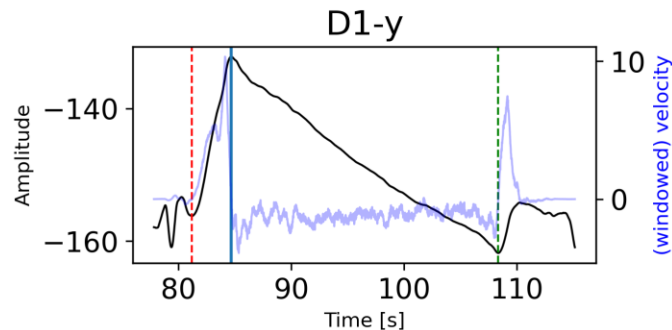
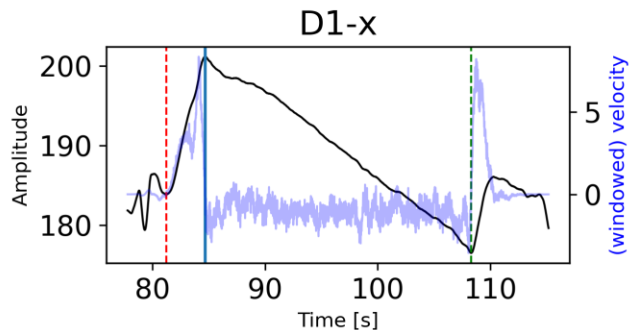
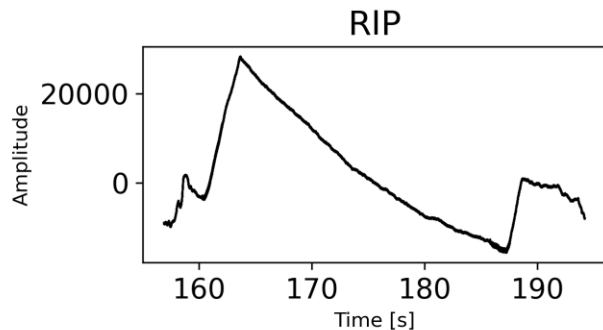
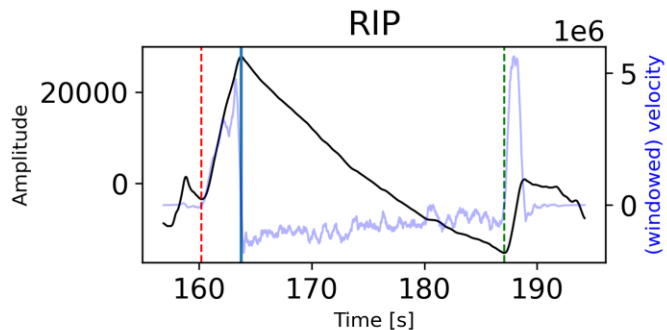
Peak

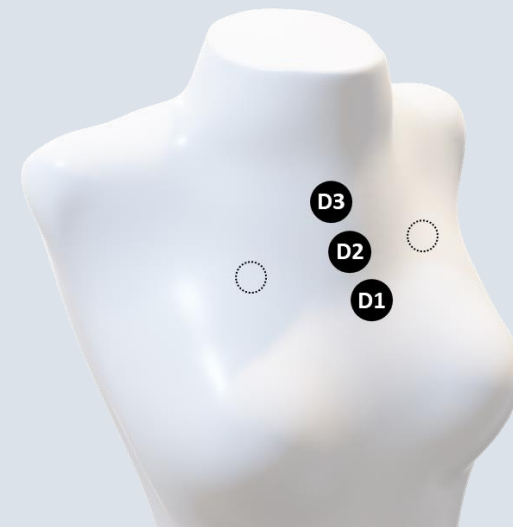
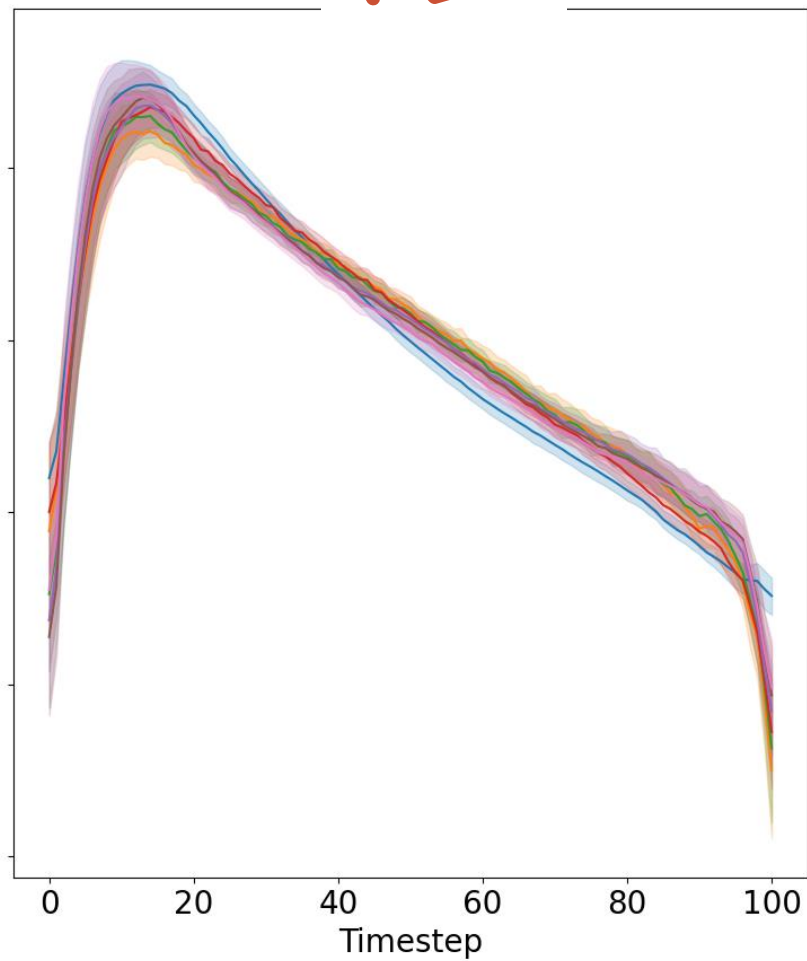
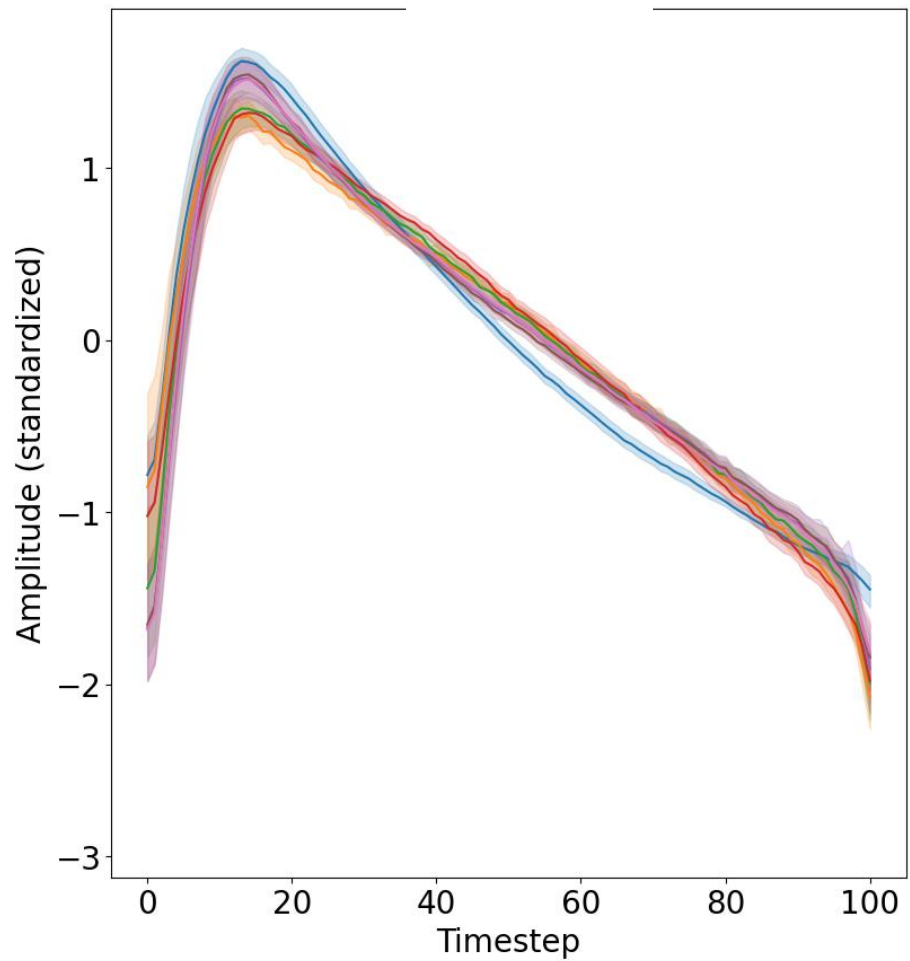
- Maximum in the signal

Offset

- Velocity multiplied by a window function consisting of two half Gaussians and a stable region during the acoustic segment
- Zero crossing left of the velocity peak in second half of window

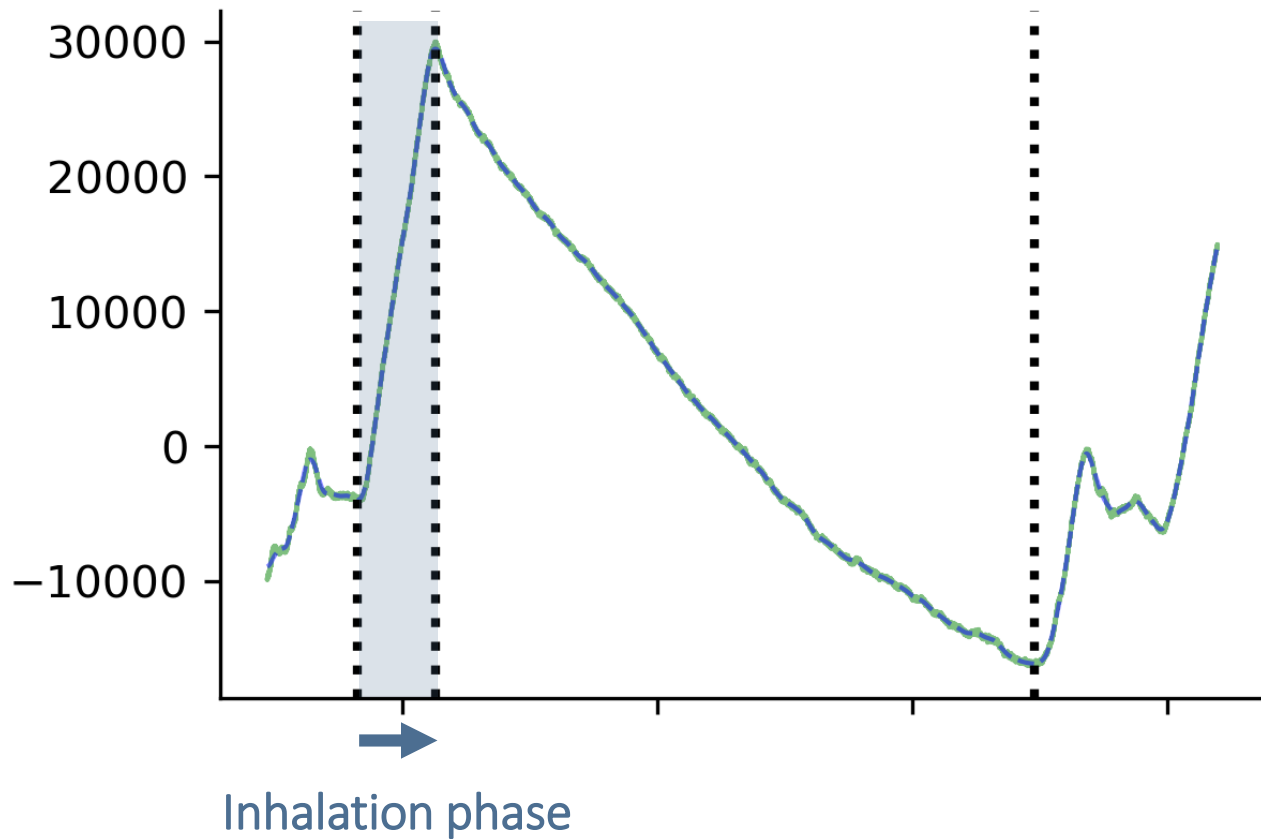




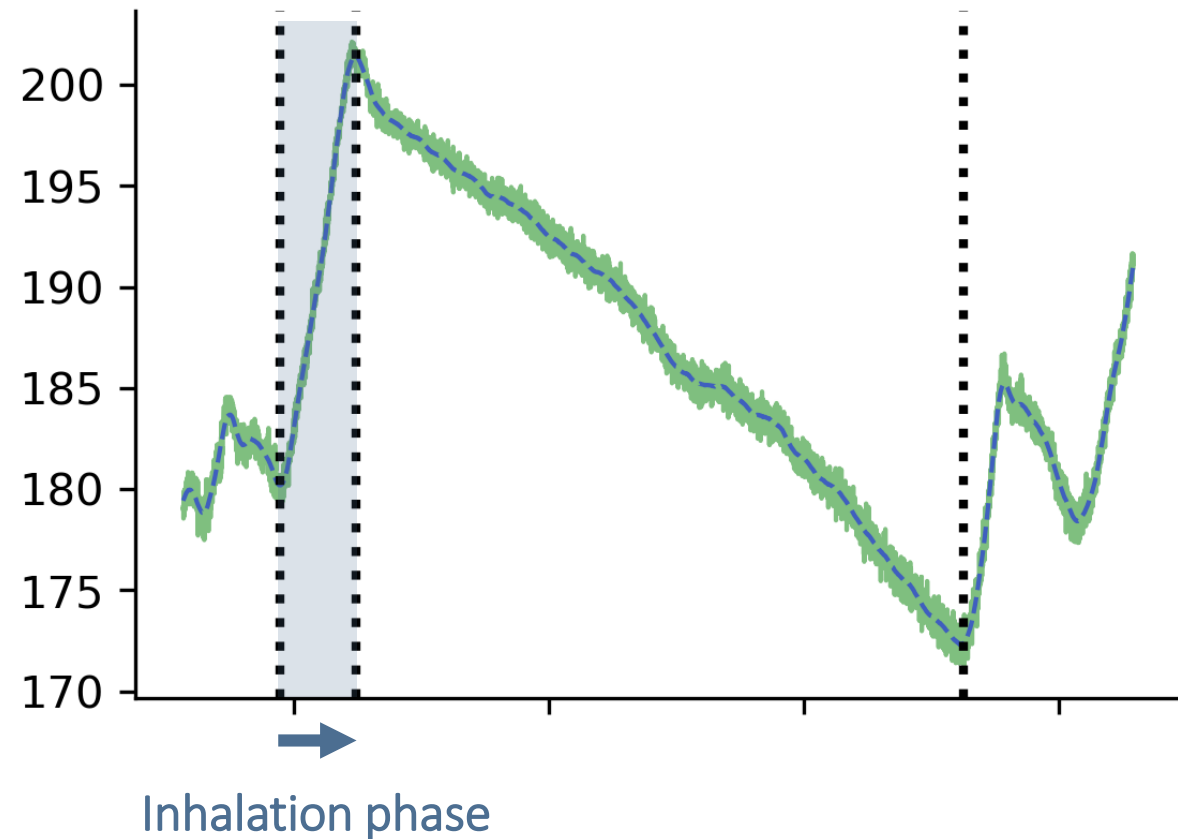


Parameters

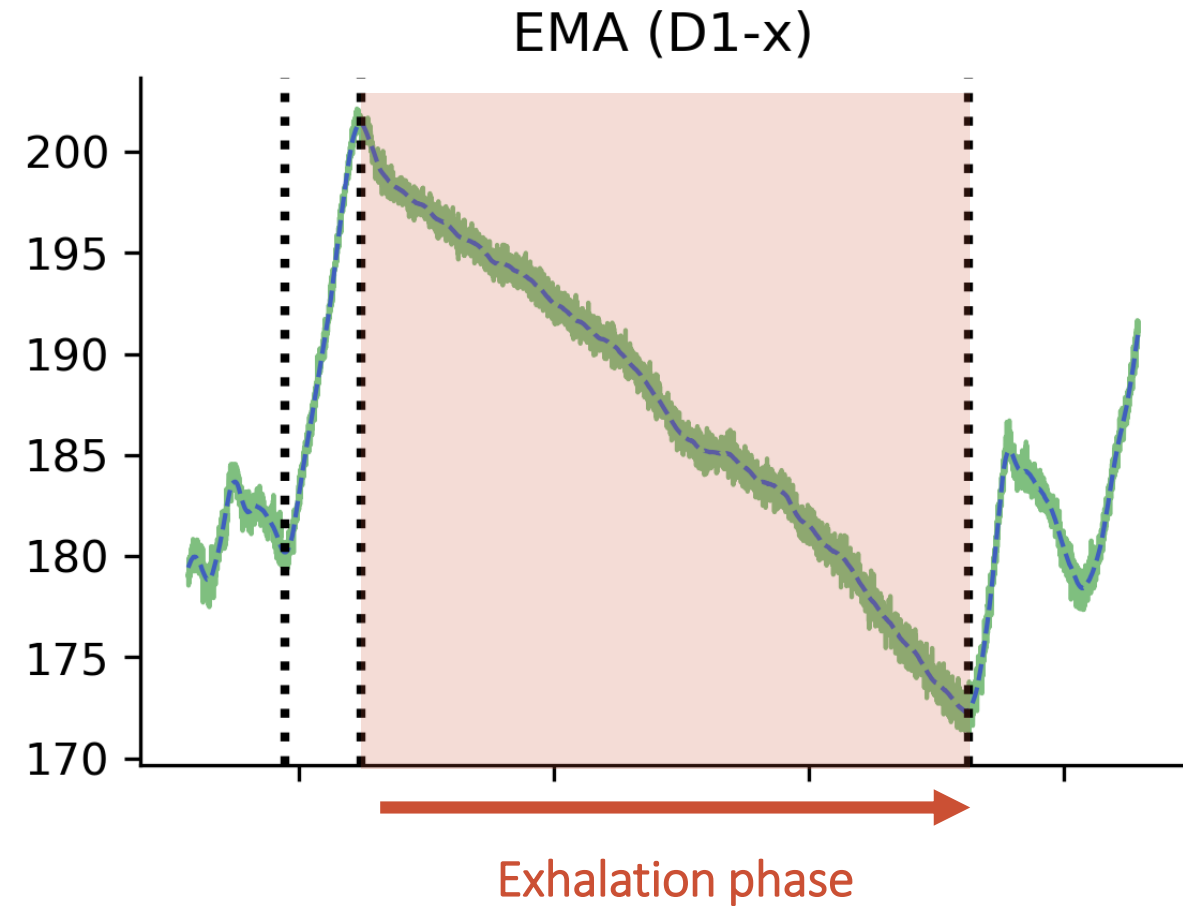
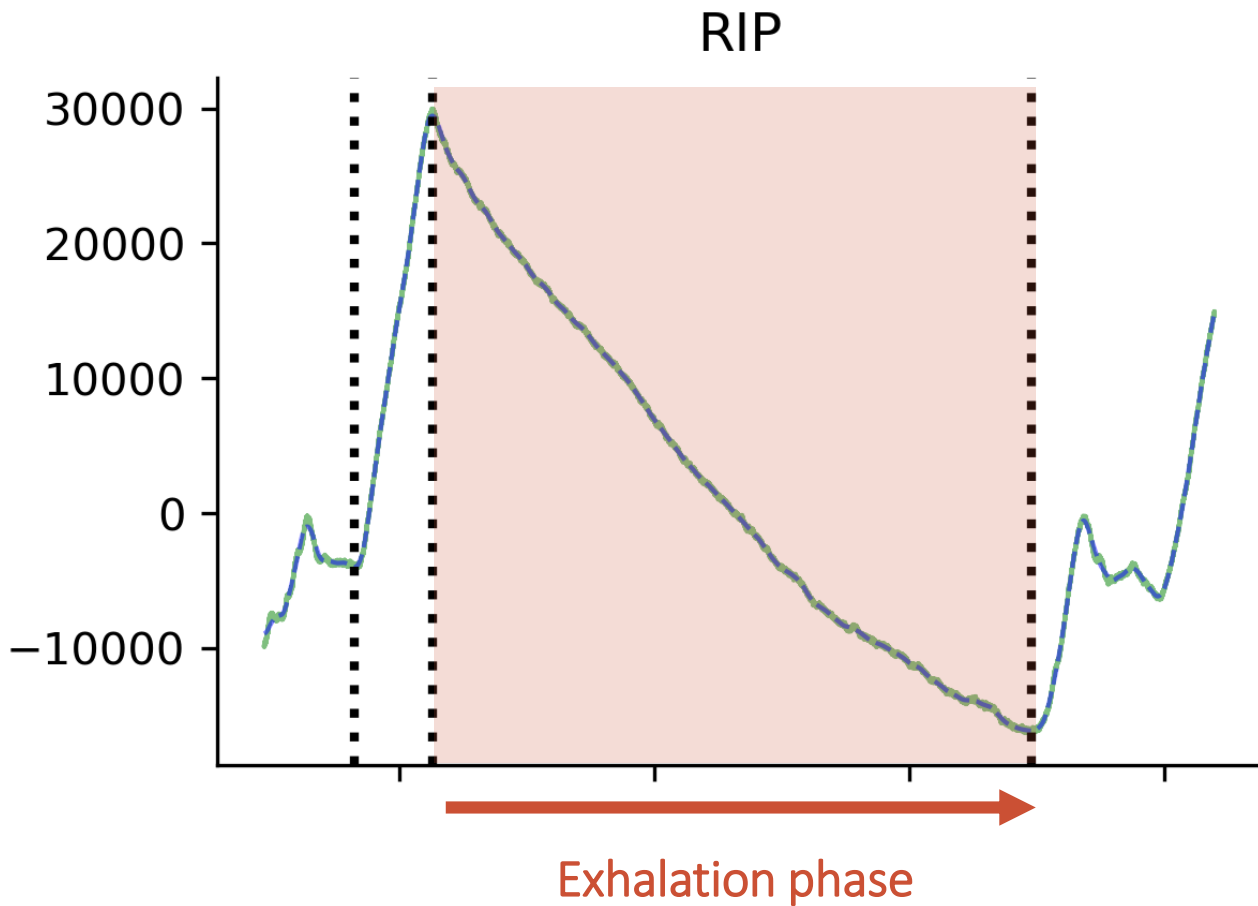
RIP



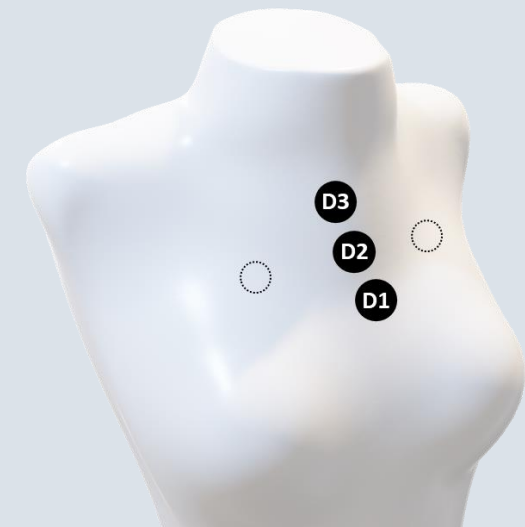
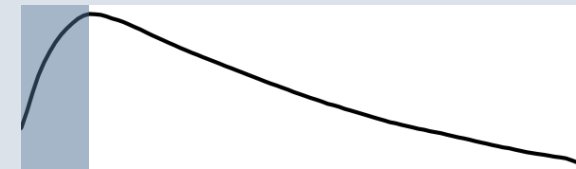
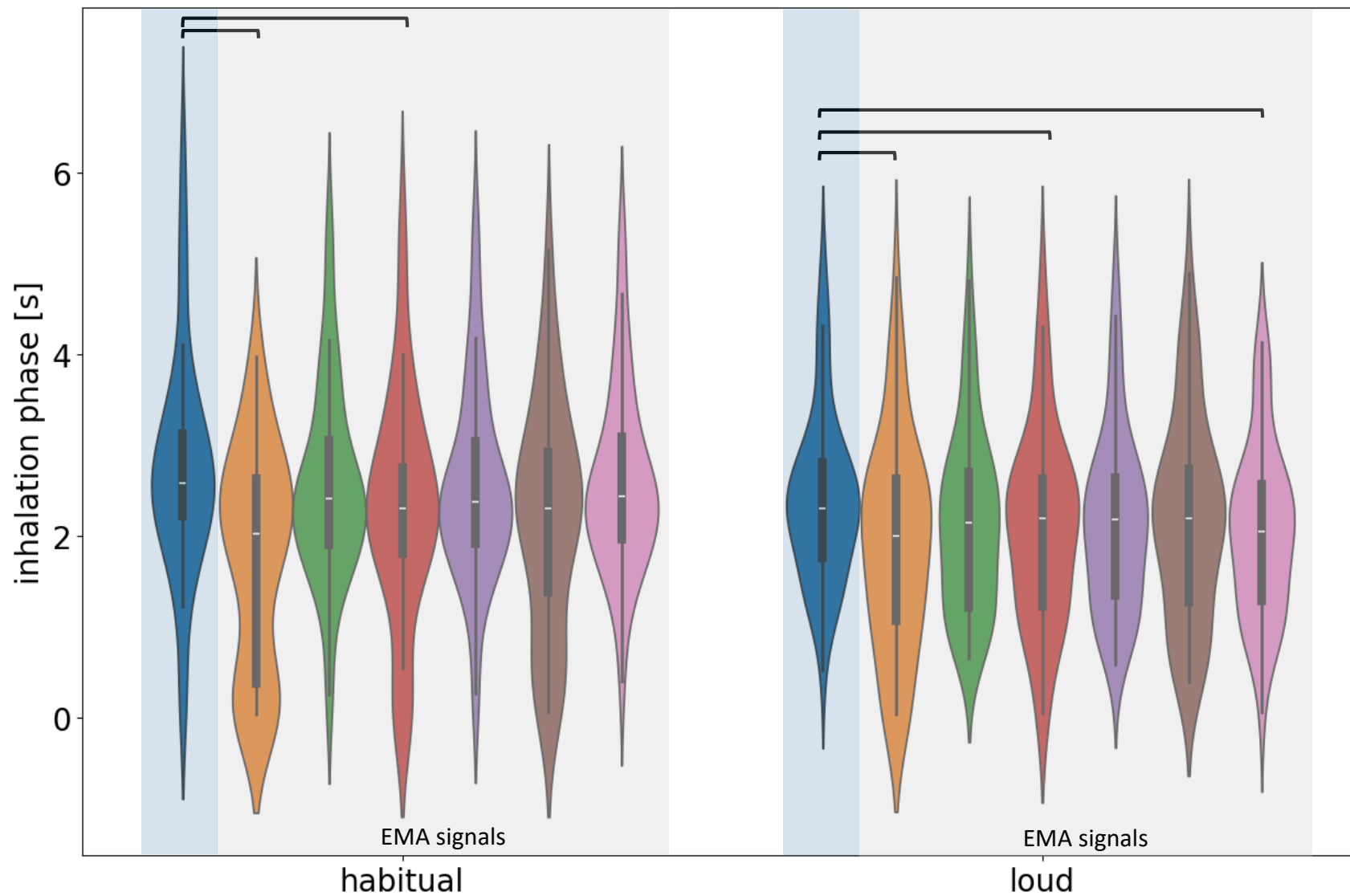
EMA (D1-x)



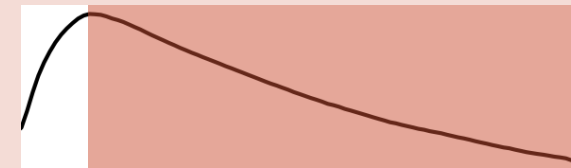
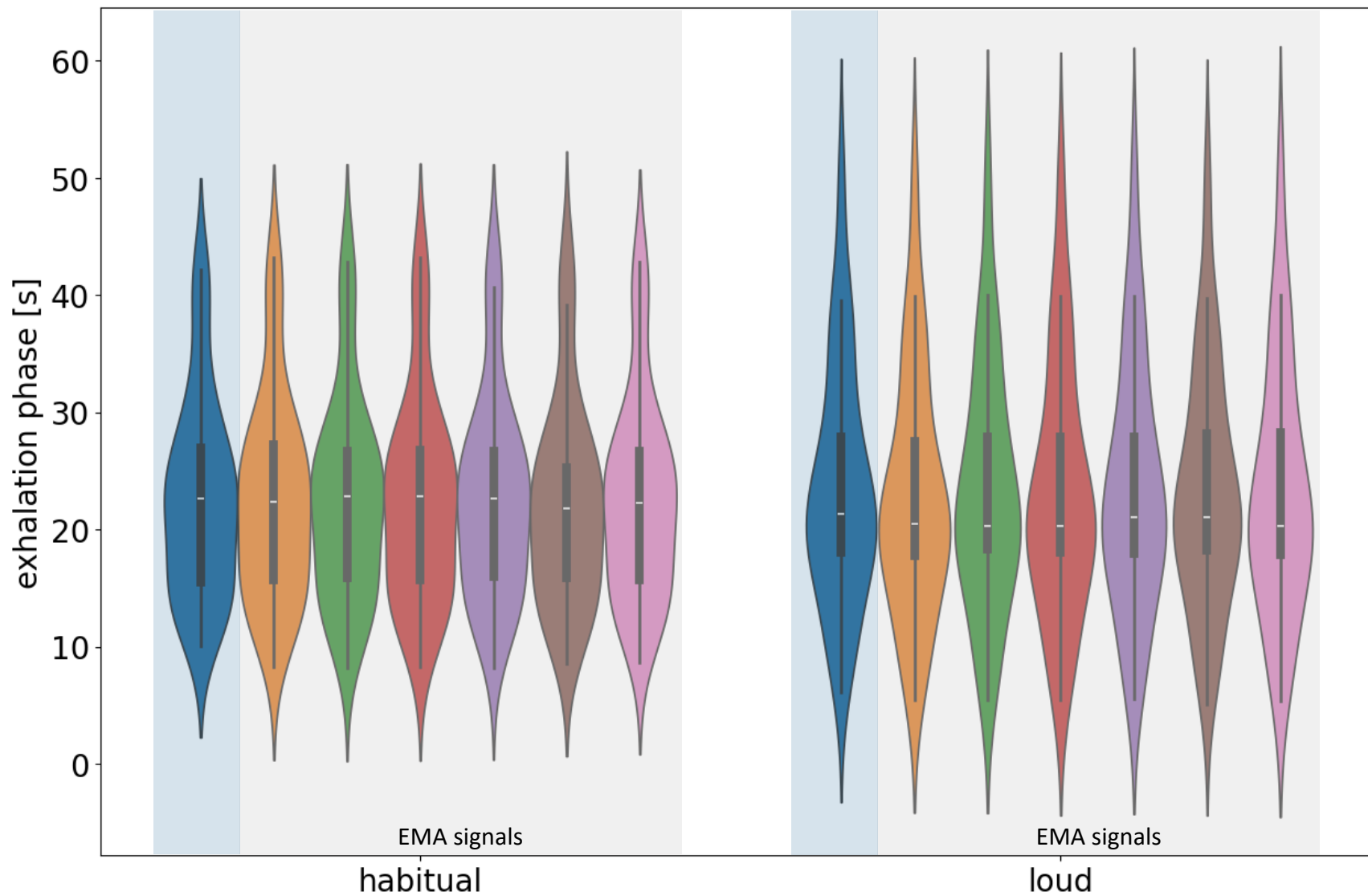
Parameters



Results: Inhalation Phase

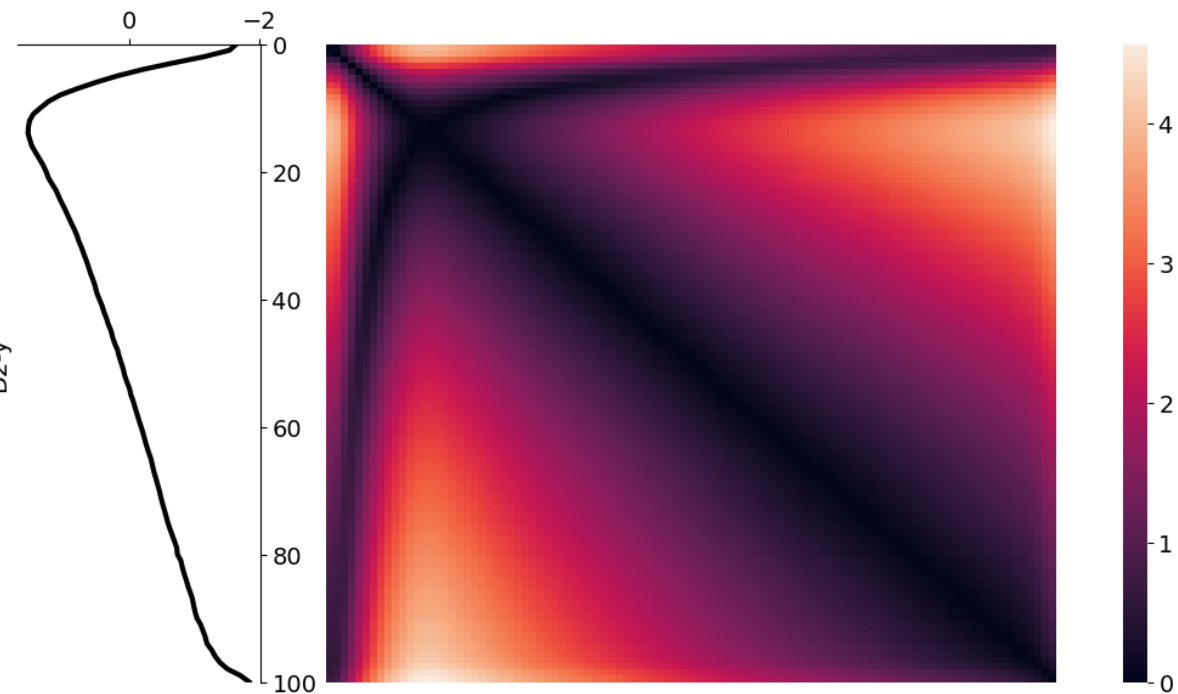
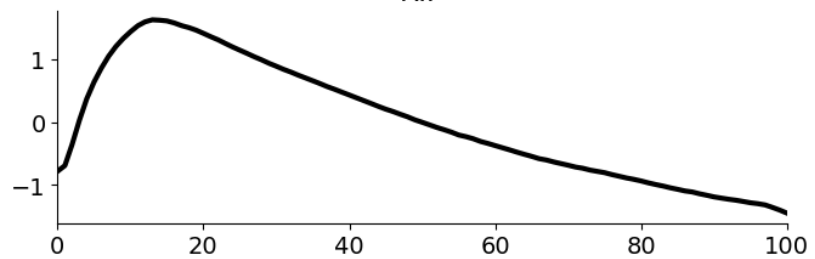


Results: Exhalation Phase

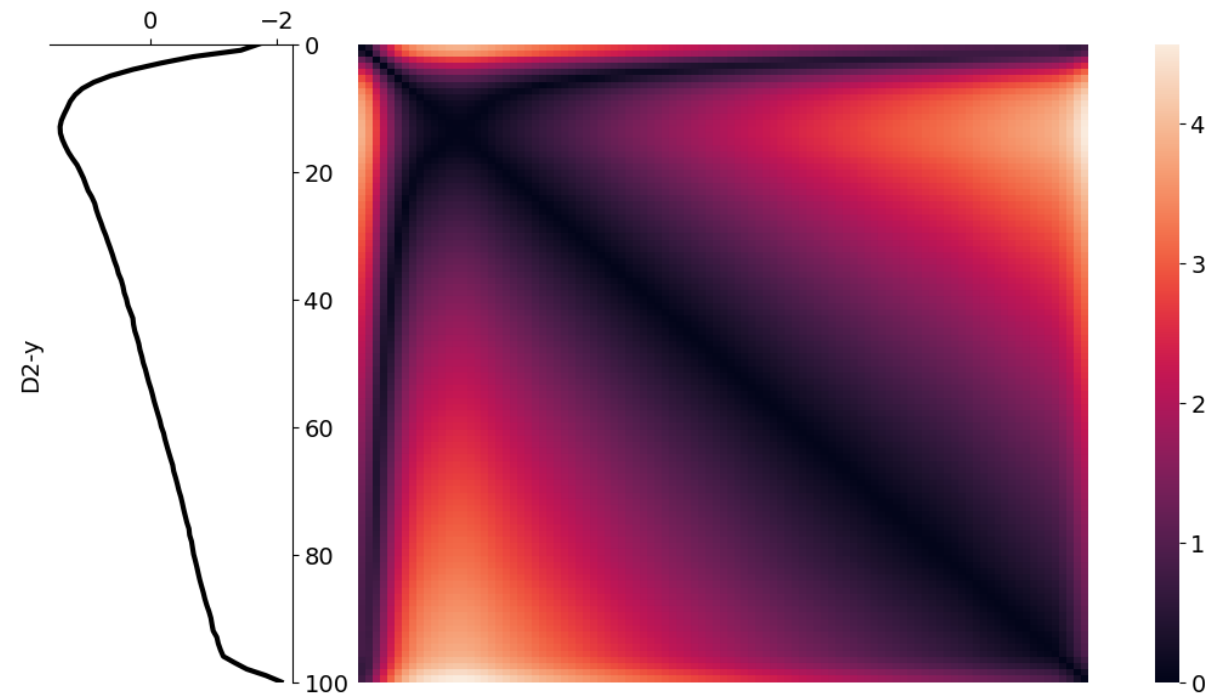
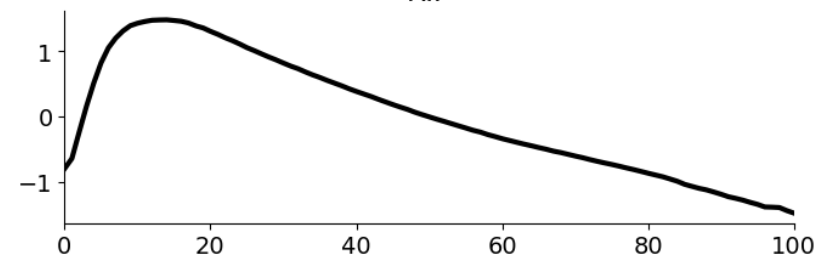


Distance Plots

RIP



RIP



Limitations

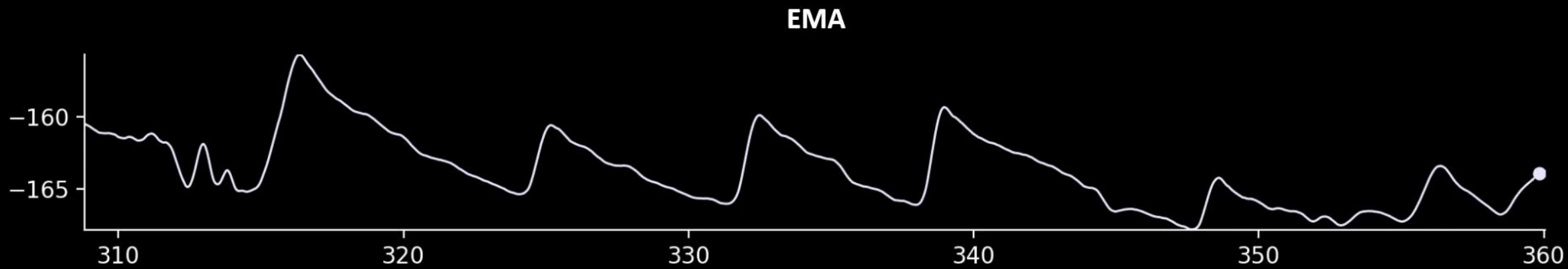
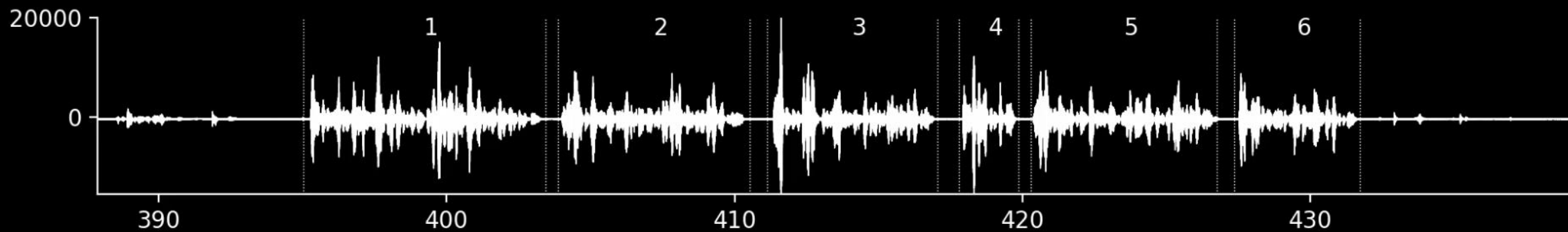
- Only thorax movements
- EMA device is expensive
- More fine-grained analysis needed to recommend “best” sensor placement

Limitations

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Future Application/ Outlook

- EMA can track temporal speech breathing patterns
- Combinable with articulatory recordings
- 3D movement analysis possible
- Easy to use (if lab has an EMA system)





Thank you &
take a breath!



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