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# AUTOMATION OF THE TIMED WATER SWALLOW TEST USING HIGH RESOLUTION CERVICAL AUSCULTATION SIGNALS

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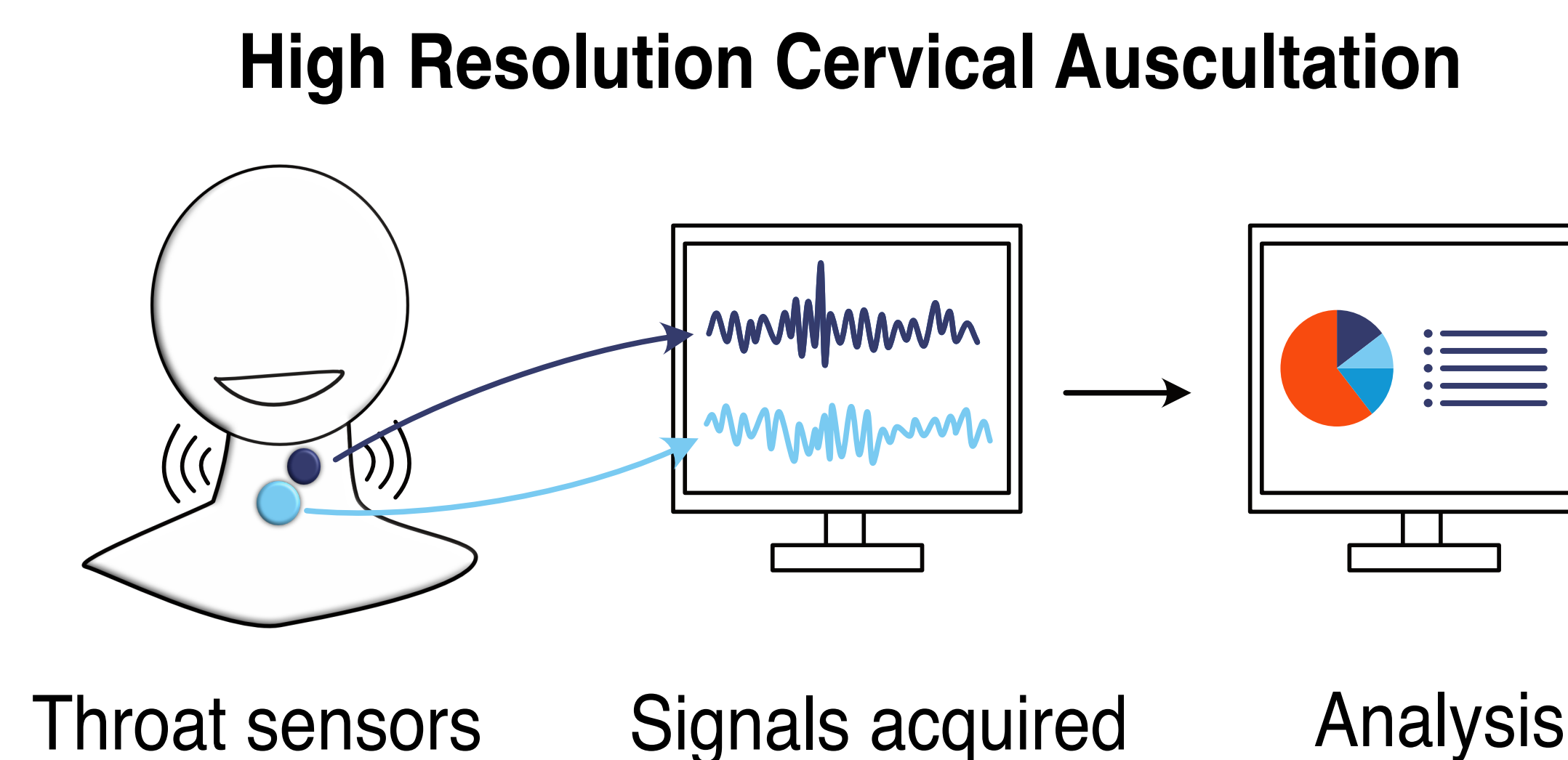
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## CONTEXT

The VideoFluoroscopy Swallowing Study (VFSS) is considered as the **reference examination** to assess dysphagia. However it cannot be done consistently due to limited accessibility, invasiveness and cost. **High Resolution Cervical Auscultation (HRCA)** is a promising alternative when VFS is not feasible<sup>[1-3]</sup>.

The **Timed Water Swallow Test**<sup>[4]</sup> (TWST) is a validated bedside assessment to evaluate dysphagia severity. This protocol consists in **timing** the patient drinking a full glass of water and **counting** the number of swallows needed to do so. The average **volume per swallow**, **time per swallow** and **swallowing capacity** are the three resulting indicators to evaluate dysphagia severity.

This preliminary study introduces a method for automating the TWST using HRCA signals.



## RESULTS AND DISCUSSION

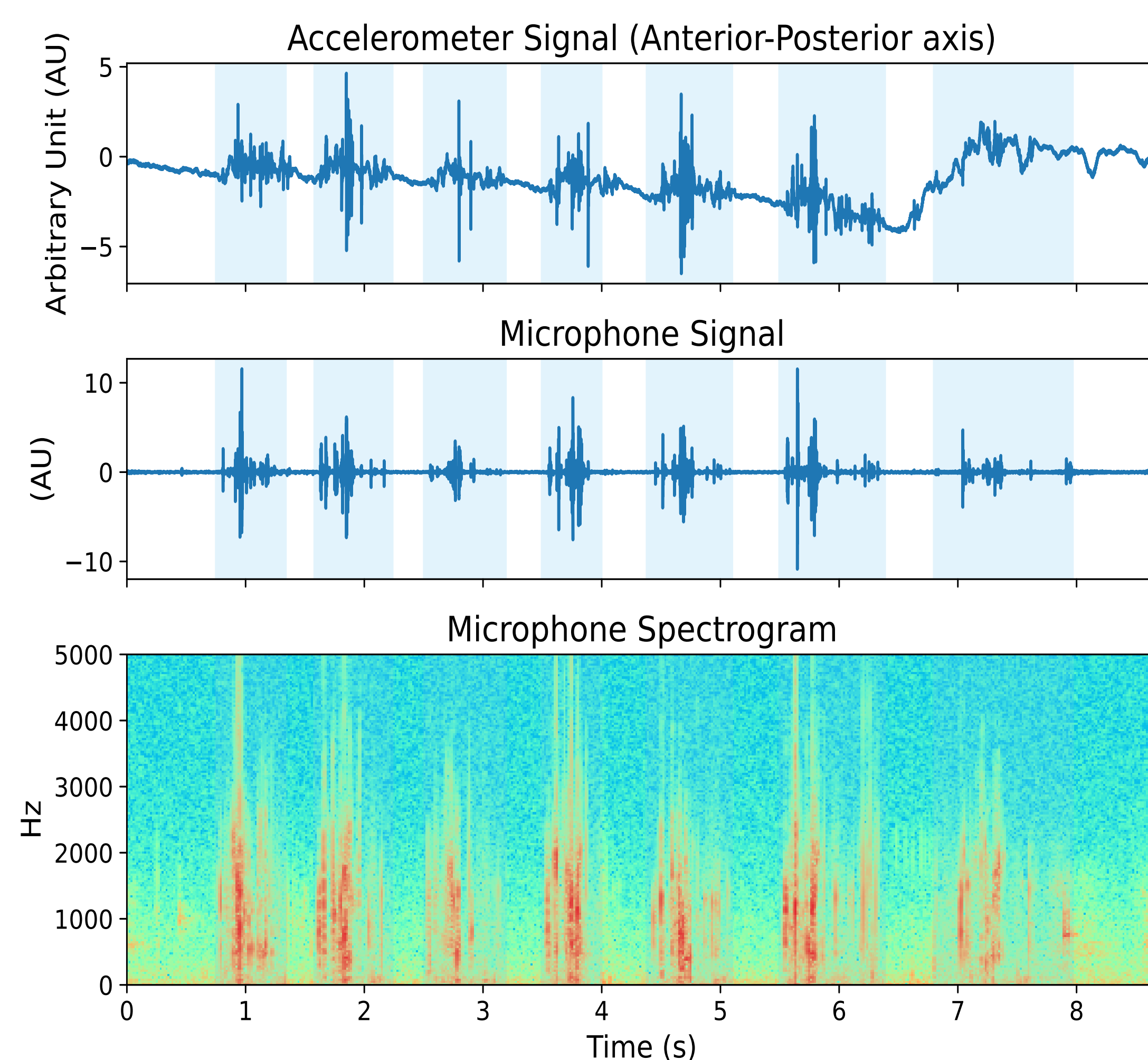
**Detection results:** 196/224 swallows detected, 28 missed and 3 false positives.

**TWST indices for each group:**

	Volume/Swallow (ml)		Time/Swallow (s)		Volume/Time (ml/s)	
	M	F	M	F	M	F
Predicted	24,4	22,3	1,1	1,3	22,7	19,1
Annotated	22,2	20,3	1,1	1,2	21,5	17,7
G1 G2 Reference Range <sup>[4]</sup>	21,4-50	13,6-30	1-1,4	1-1,7	17-41,4	8,8-24,6

The automatic predicted results **match the healthy group reference values**. Therefore this method could **help practitioners** performing TWST.

Remaining detection errors could be tackled by **adapting the algorithm** for multiple successive swallows, which slightly differ in shape and duration from isolated swallows in HRCA signals.

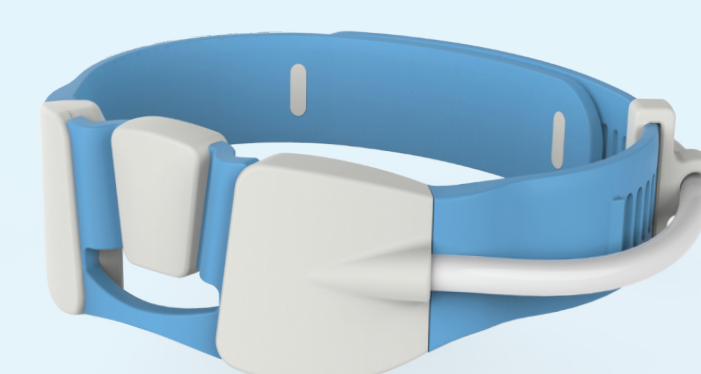


Representation of consecutive swallows signals during TWST

## DATA AND MATERIALS

### Scenario and subjects

**44 healthy** participants (25 females, 19 males) from 21 to 57 y.o. (mean 33+/-10 y.o.) were asked to **drink a 100mL glass of water** in one go.



### Device

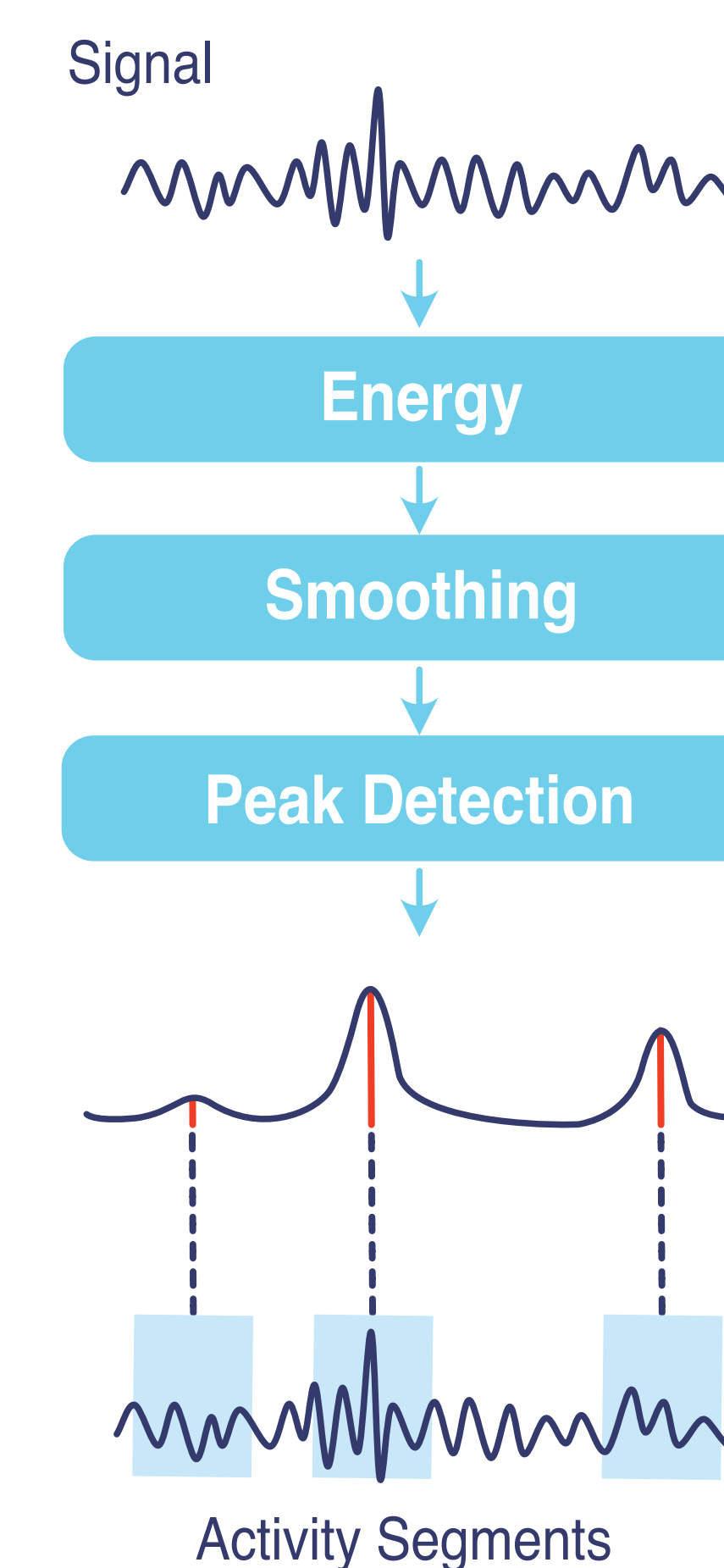
The **Swallis DSA™**, which includes a three-axis accelerometer and a microphone, was used to record vibroacoustic signals on the neck of each subject.

## METHOD

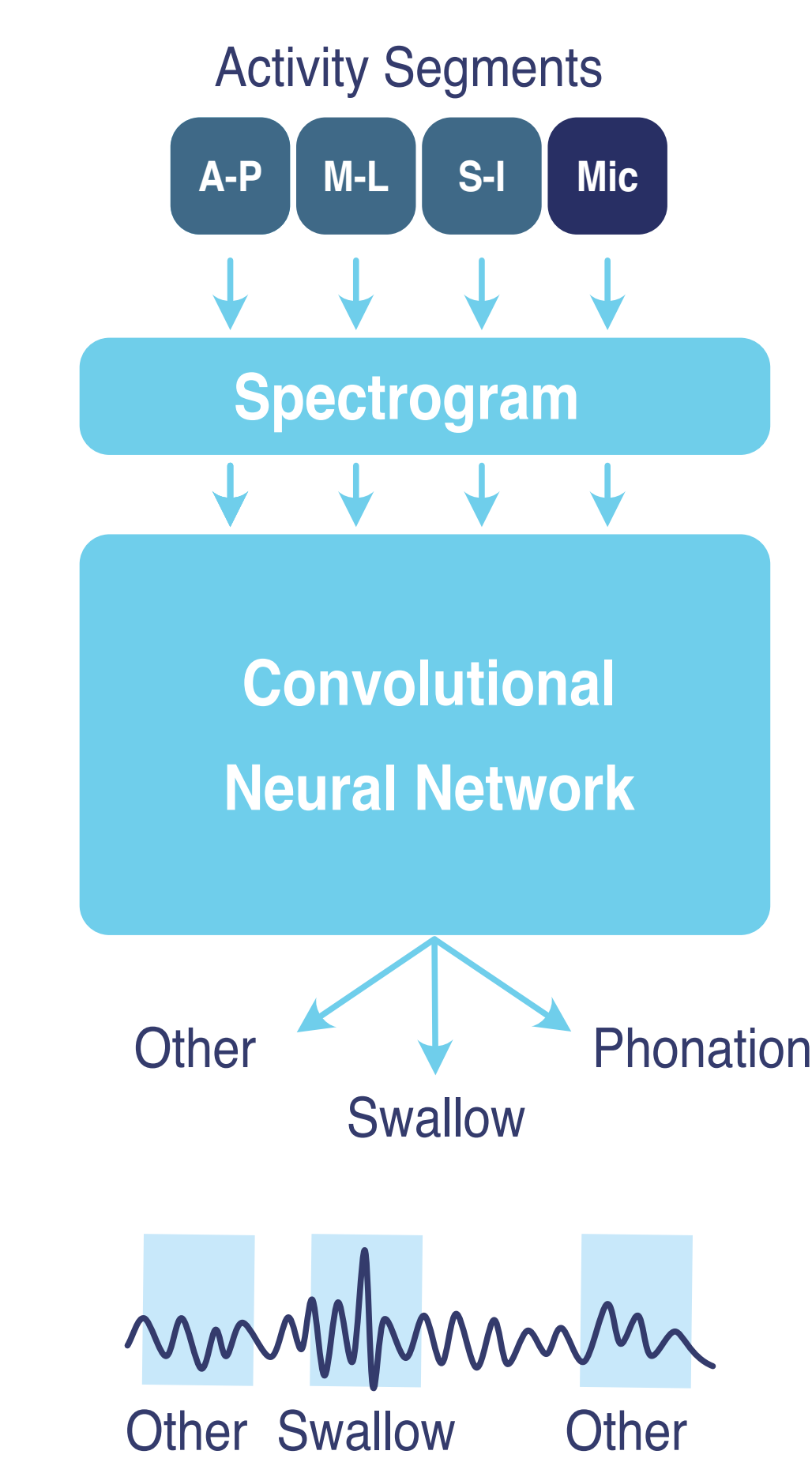
Automatic swallow detection was done by an algorithm trained on HRCA signals to detect pharyngolaryngeal activities. The TWST KPI (volume/swallow, time/swallow, volume/time) were calculated for each subject. **Average values are given by gender (F/M)** and compared with the corresponding healthy groups G1 and G2 from the literature<sup>[4]</sup> (18-54 y.o.).

## DETECTION ALGORITHM STRUCTURE

### 1. Activity detection



### 2. Swallowing identification



## REFERENCES

[1] Dudik, J.M. et al. 2015. Dysphagia Screening: Contributions of Cervical Auscultation Signals and Modern Signal-Processing Techniques. IEEE Transactions on Human-Machine Systems. 45, 4 (Aug. 2015), 465–477. DOI:<https://doi.org/10.1109/THMS.2015.2408615>.

[2] Donohue, C. et al. 2020. A Preliminary Investigation of Whether HRCA Signals Can Differentiate Between Swallows from Healthy People and Swallows from People with Neurodegenerative Diseases. Dysphagia. (Sep. 2020). DOI:<https://doi.org/10.1007/s00455-020-10177-0>.

[3] Donohue, C. et al. 2021. Establishing Reference Values for Temporal Kinematic Swallow Events Across the Lifespan in Healthy Community Dwelling Adults Using High-Resolution Cervical Auscultation. Dysphagia. (May 2021). DOI:<https://doi.org/10.1007/s00455-021-10317-0>.

[4] Hughes, T.A.T. and Wiles, C.M. 1996. Clinical measurement of swallowing in health and in neurogenic dysphagia. QJM. 89, 2 (Feb. 1996), 109–116. DOI:<https://doi.org/10.1093/qjmed/89.2.109>.