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

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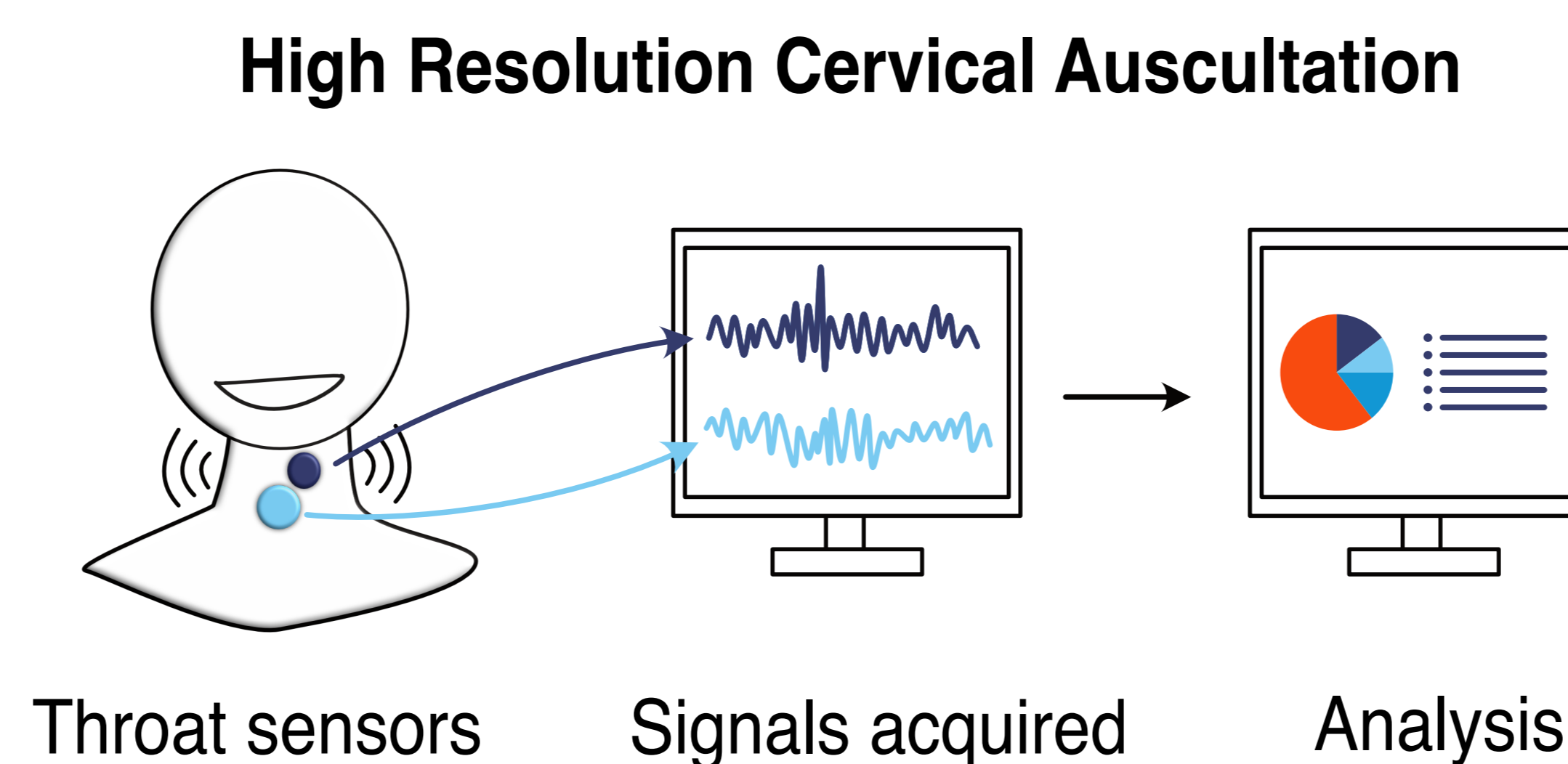
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CONTEXT

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^[1-3].

The **Timed Water Swallow Test**^[4] (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

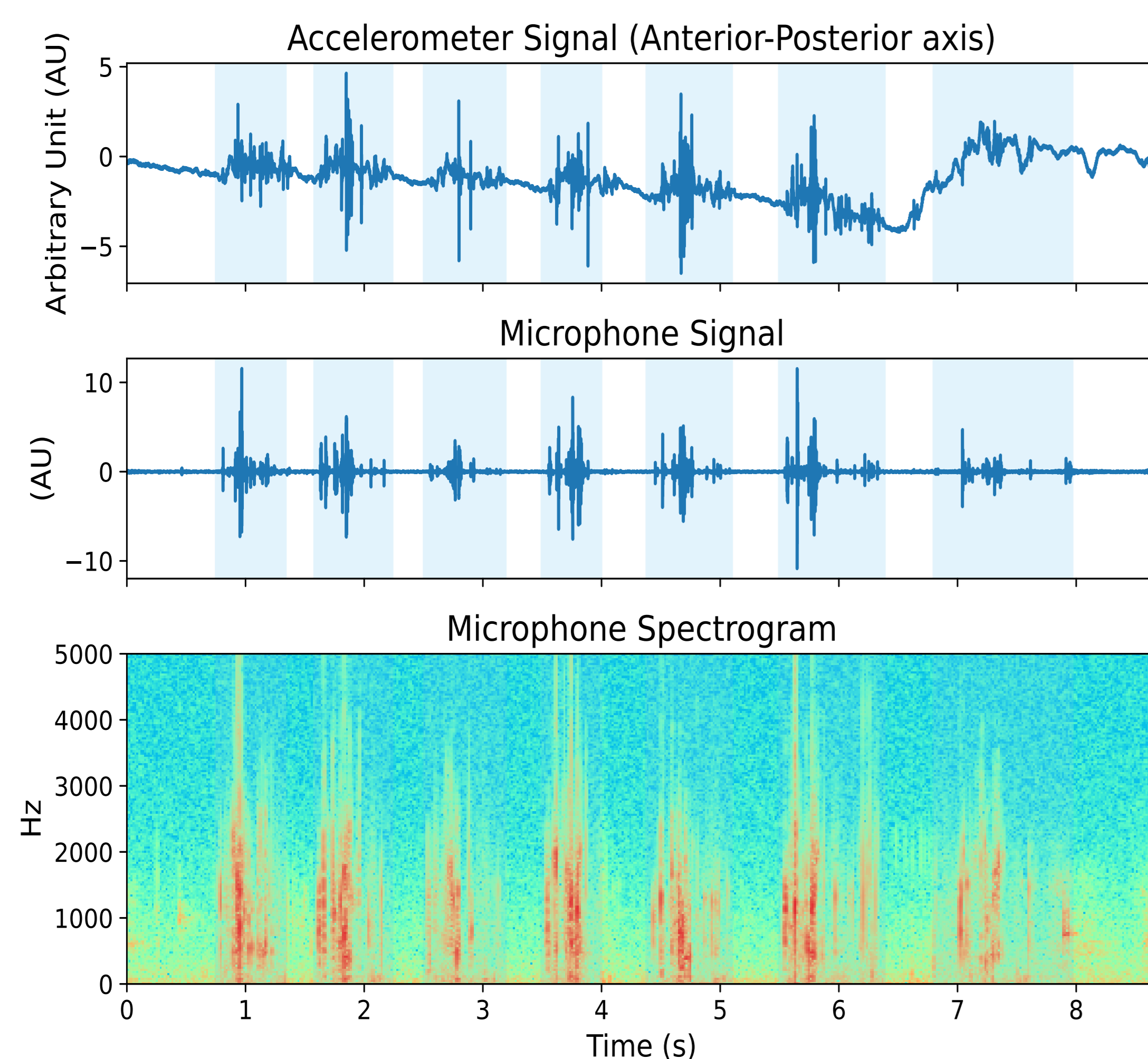
Detection results: 196/224 swallows detected, 28 missed and 3 false positives.

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 ^[4]	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.

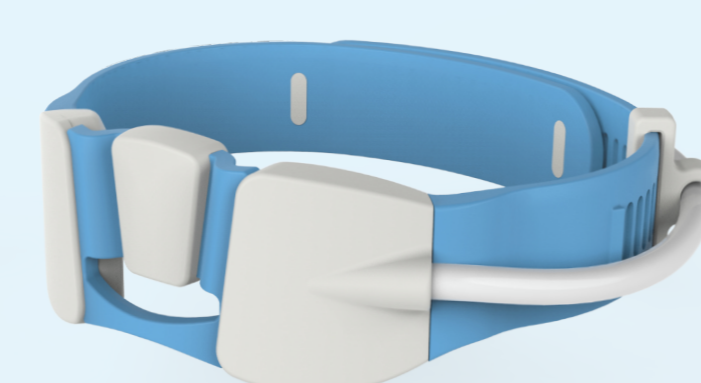


Representation of consecutive swallows signals during TWST

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

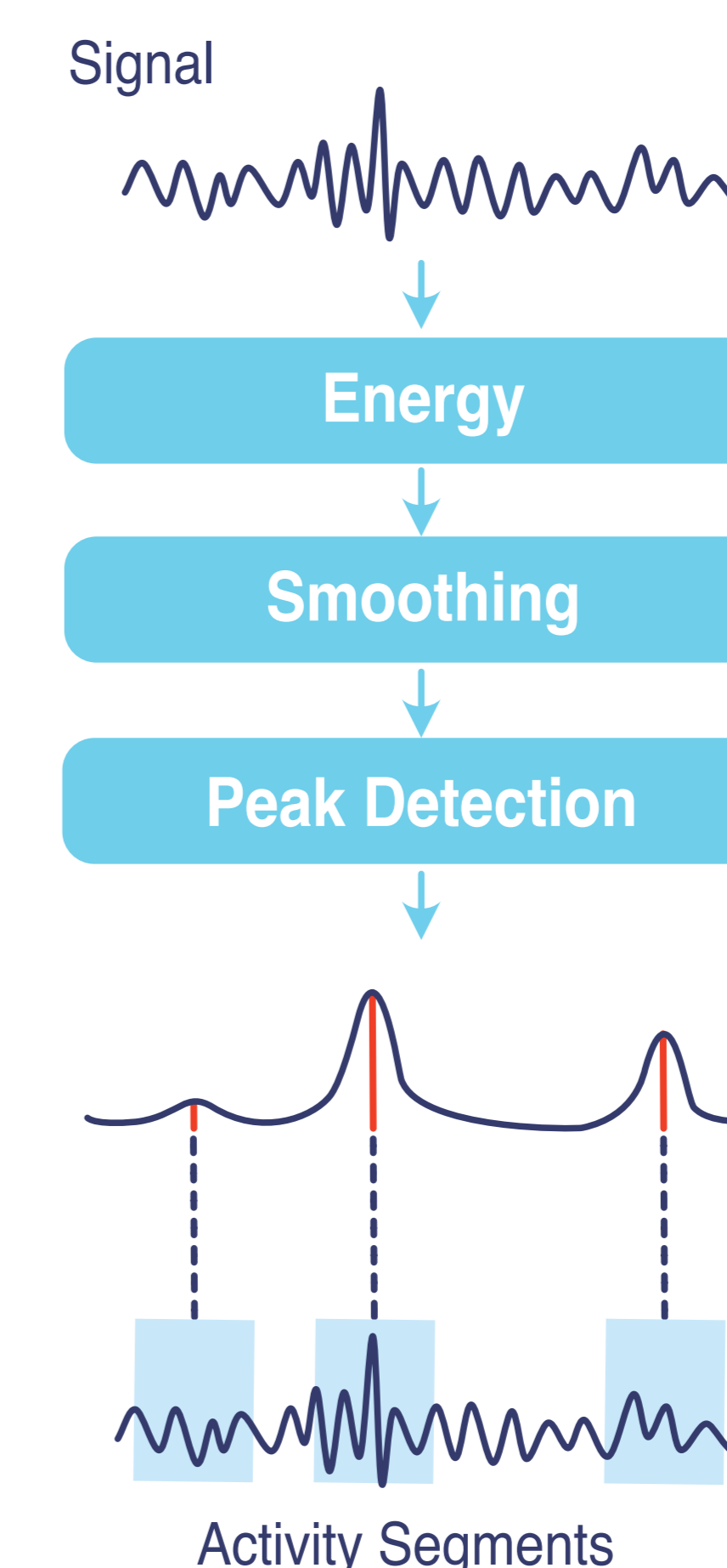
The **Swallis DSA™**, which includes a three-axis accelerometer and a microphone, was used to record vibroacoustic signals on the neck of each subject.

METHOD

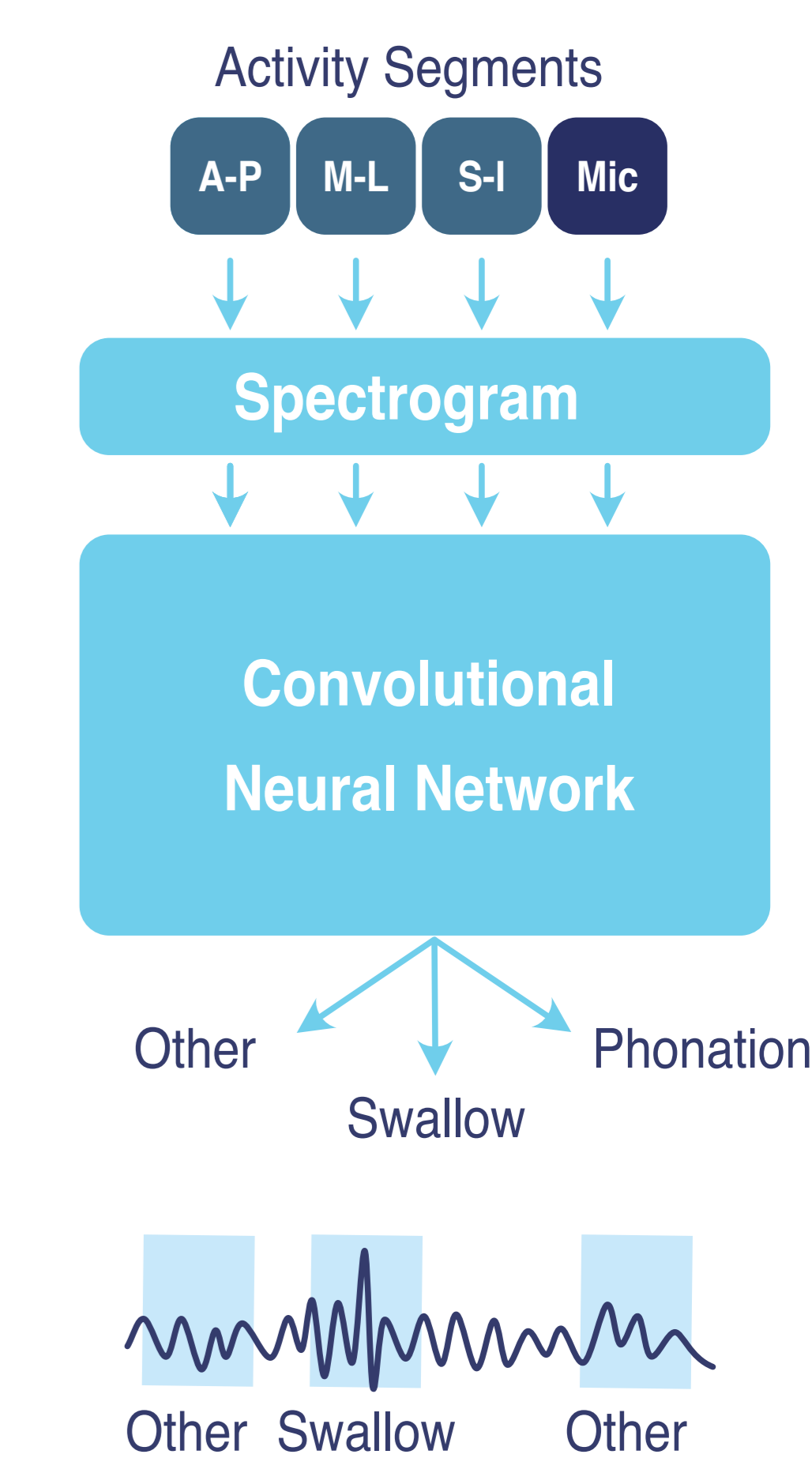
Automatic swallow detection was done by an algorithm trained on HRCA signals to detect pharyngolaryngeal activities. The TWST KPI (volume/swallow, time/swallow, volume/time) were calculated for each subject. **Average values are given by gender (F/M)** and compared with the corresponding healthy groups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