Determining reference values for temporal kinematic swallow events in healthy community dwelling adults using HRCA

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Introduction

- Determining cutoffs for normal and disordered swallowing is vital for differential diagnosis (e.g. presbyphagia vs. dysphagia) and ensuring standardization of common measurements across research labs.

- High resolution cervical auscultation (HRCA), a sensor-based dysphagia screening method, has accurately annotated temporal kinematic swallow events in patients with dysphagia.

- **Hypotheses:** 1. Our reference values will align with a prior study; 2. HRCA will annotate temporal kinematic swallow events accurately in healthy adults.

Methods

- 70 healthy adults (62.66±14.80 years); 659 thin liquid swallows.

- Standardized VFSSs: 3mL thin liquid command swallows via spoon and self-selected cup sips.

- Comparison to a historical cohort: 38 healthy adults (M=34 years); 114 thin liquid self-selected cup sips.

- Temporal kinematic reliability: 100% intra-rater and ICCs of 0.992 for inter-rater.

- We fit a linear mixed model and calculated effect sizes to compare temporal swallow kinematic measures between groups.

- We used HRCA signals and machine learning algorithms to predict duration of UES opening (DUESO) and laryngeal vestibule closure (LVC).

Some measurements *closely matched* a historical cohort and HRCA *independently* and *accurately* detected **UES opening**, **UES closure, LVC,** and **LV re-opening**.

HRCA has diagnostic potential to noninvasively determine **normal** vs. **disordered** swallowing*.*
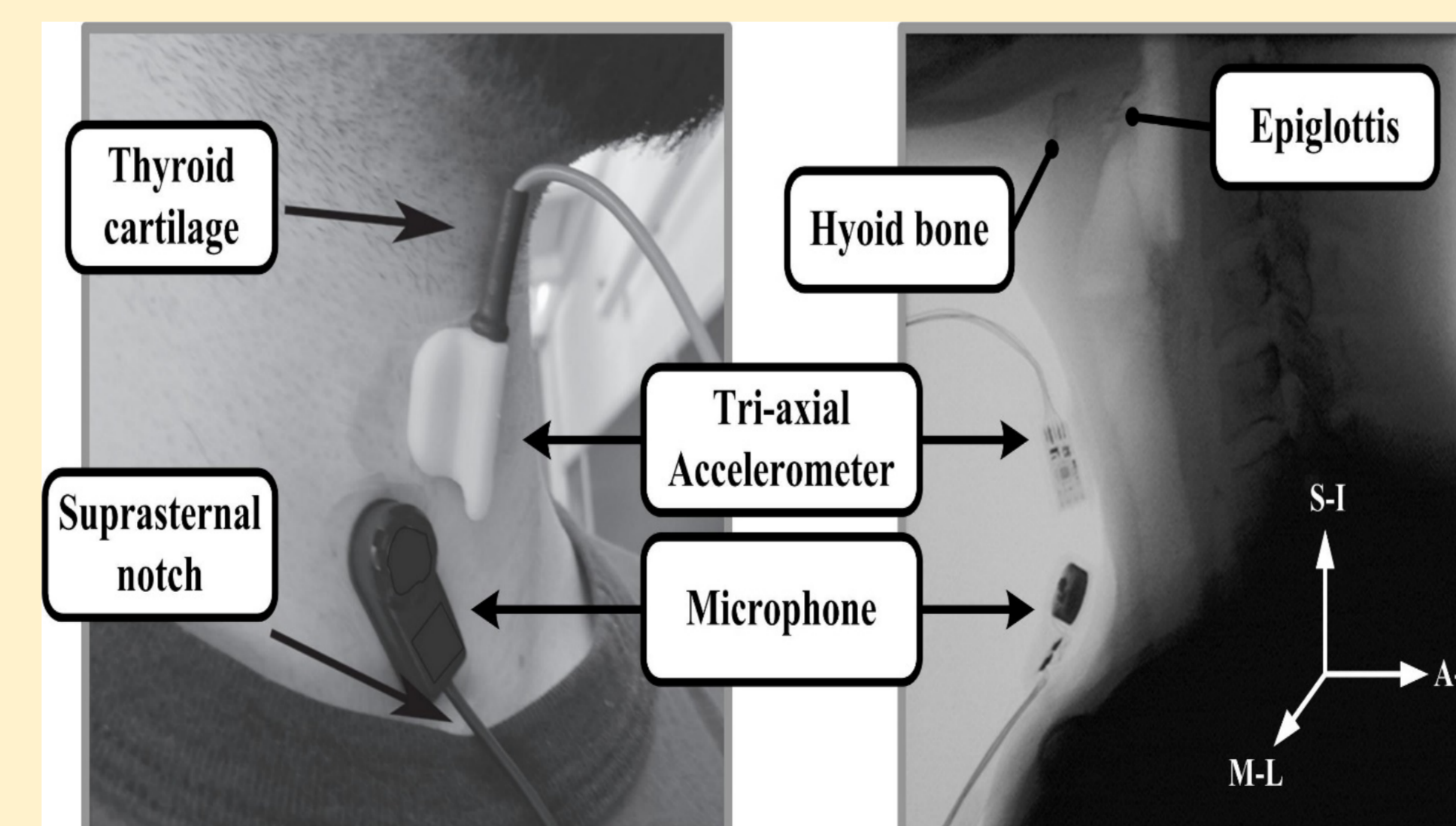

Figure 1: Placement of HRCA sensors during data collection.

Results

Table 1: Comparison of temporal swallow kinematic measures in milliseconds from our lab and from the historical cohort (Steele et al., 2019) using a variant of Cohen's d after averaging multiple swallows from the same person.

	Study Data (ms)		Steele et al. 2019 data (ms)		
Temporal measure	Mean	SD	Mean	SD	Cohen's d
Swallow reaction time	76	66	109	177	0.495
Hyoid onset to UES opening	215	342	116	48	0.290
Duration of UES opening	711	360	458	63	0.702
LVC reaction time	384	86	179	100	2.40
LVC Duration	404	313	436	108	0.103

- Swallow reaction time and LVC duration did not differ (p >0.05) between groups of healthy swallows.
- Differences were found for hyoid onset to UES opening, DUESO, and LVC reaction time (p<0.05).
- The convolutional recurrent neural network (CRNN) for UES opening and closure performed with 88.53% accuracy, 88.37% sensitivity, and 89.44% specificity.
- The CRNN for LVC and LV re-opening performed with 81.14% accuracy, 76.83% sensitivity, and 85.45% specificity.

Figures 2 and 3: Accuracy of CRNN for detecting UES opening and closure compared to human ratings within a 3-frame tolerance (0.1 second).
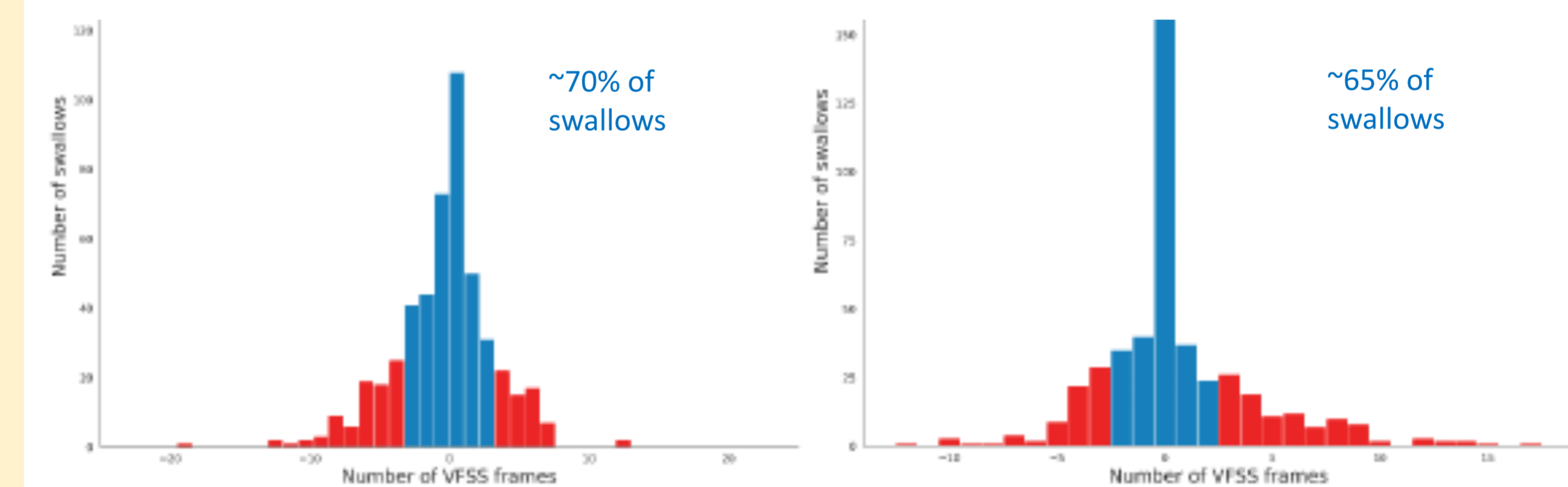
Figures 4 and 5: Accuracy of CRNN for detecting LVC and LV re-opening compared to human ratings within a 3-frame tolerance (0.1 second).
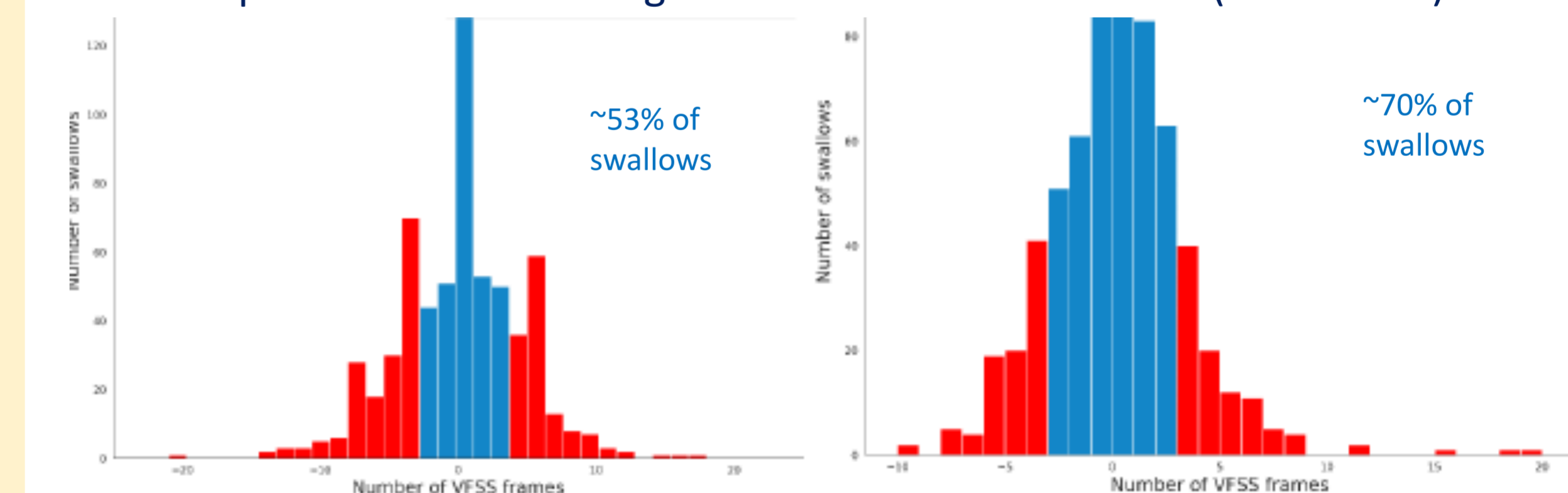

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Acknowledgements

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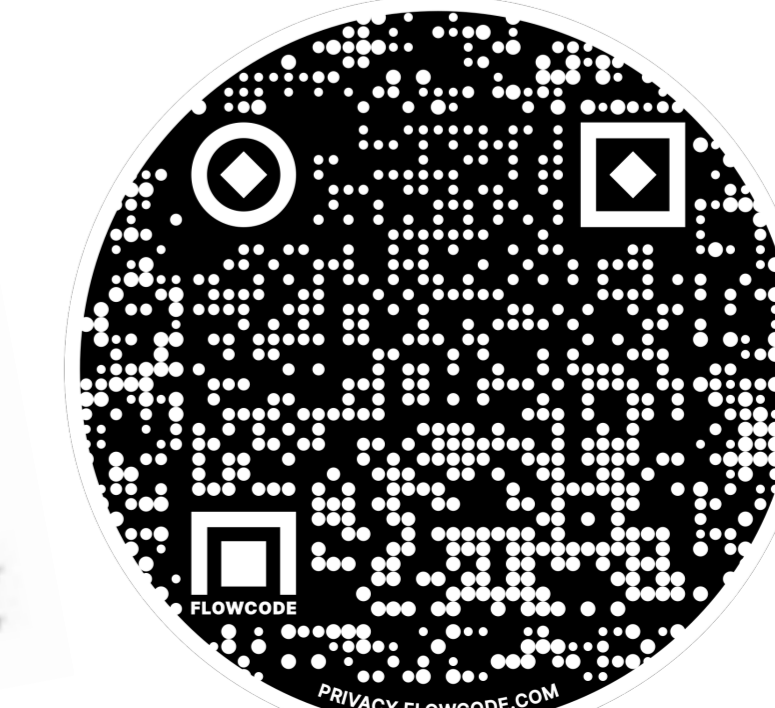
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