USING GLOSSOGRAM TO INVESTIGATE TONGUE MOVEMENT IN ULTRASOUND EVALUATION OF SWALLOWING

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Swallow Vision

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INTRODUCTION & OBJECTIVES

- Movement of the tongue is essential for different stages of swallowing
- However, tongue movement is not well-documented due to challenges in imaging and analysis
- Tracking of tongue surface was developed for speech (Wrench & Balch-Tomes, 2022) and applied to swallowing (Ma & Wrench, 2022)
- This study aims to:
  - examine the potential use of glossogram in evaluating the coordination and the movement of the different portions of the tongue
  - explore the tongue contour at different stages of swallowing

METHODS

Ultrasound Evaluation of Swallowing (USES) was used to collect swallowing data.
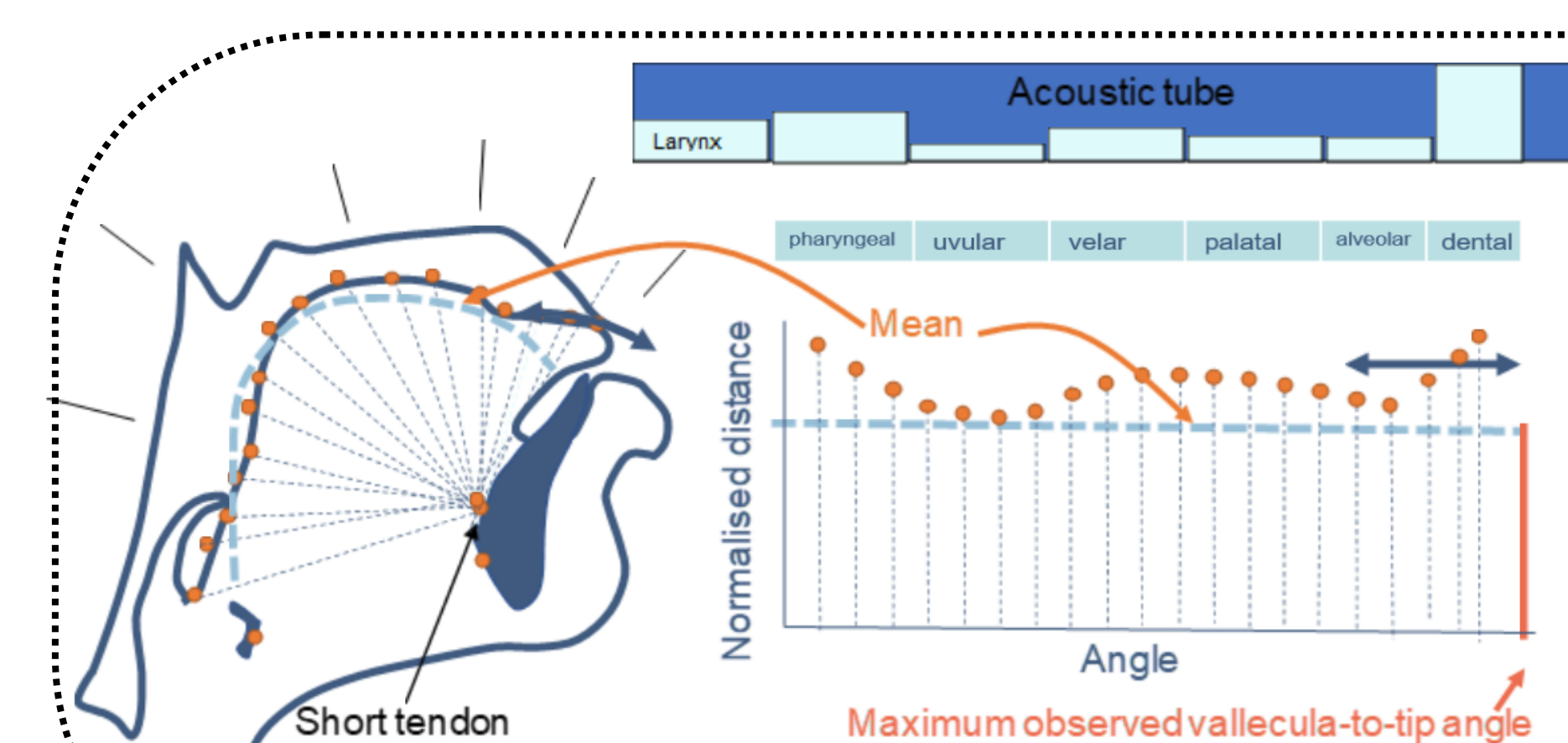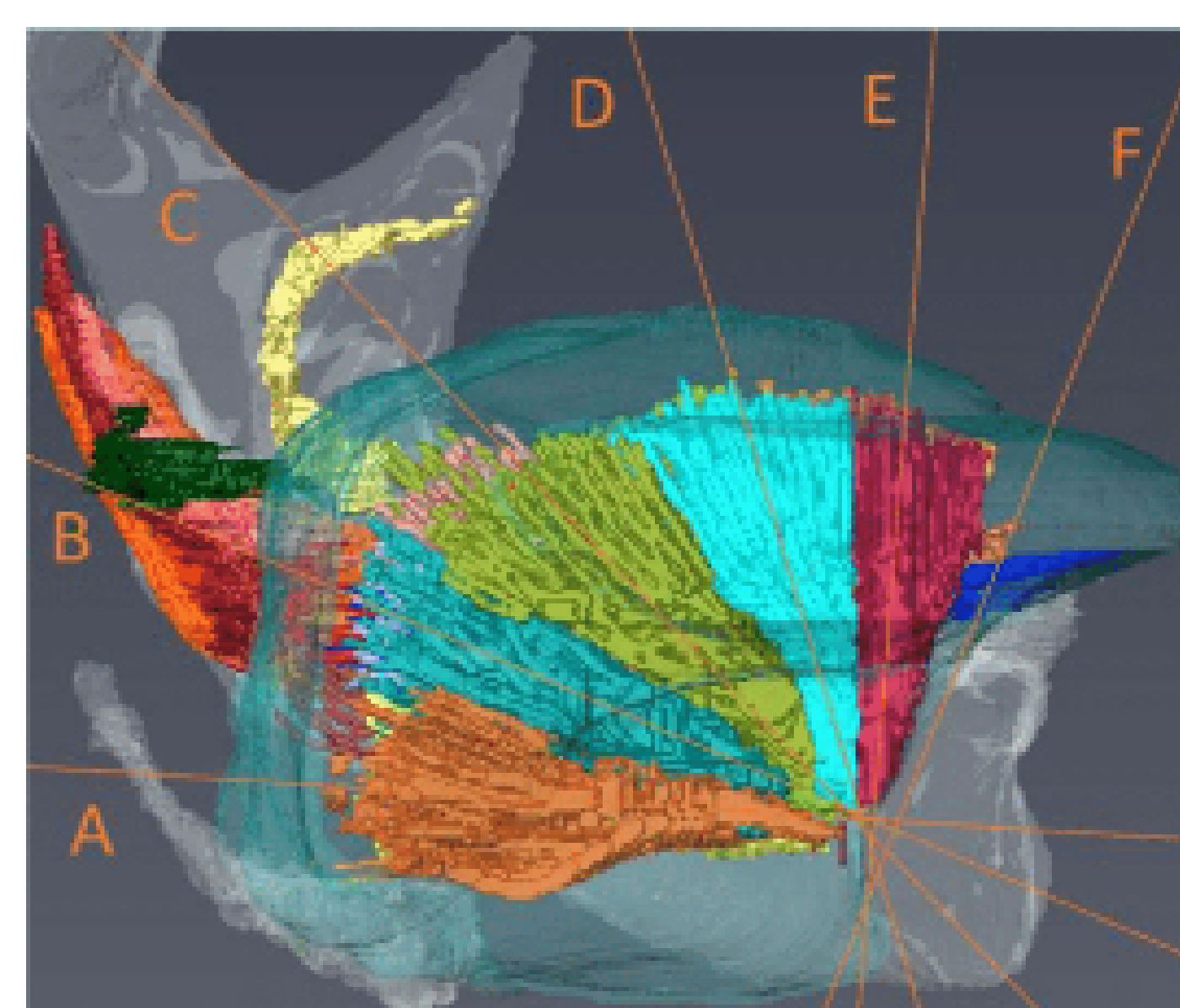- Pocket-sized Micro ultrasound system connected to a Windows laptop
- 2-5MHz 60mm radius convex probe
- UltraFit headset to maintain a stable midsagittal probe position
- Customised acoustic gel pad
- Side-mounted camera monitoring the bolus approaching the mouth

Participants:
- 8 participants with normal swallows
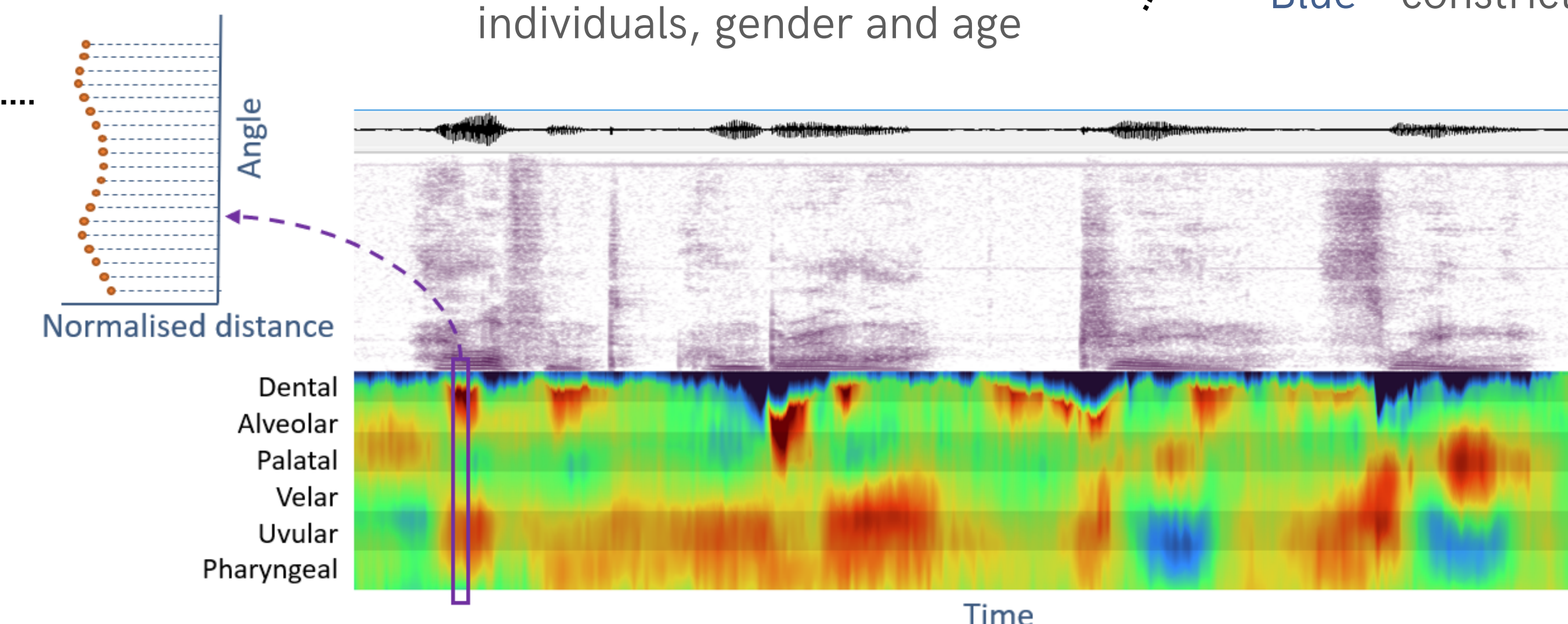 - 100ml continuous swallow x1
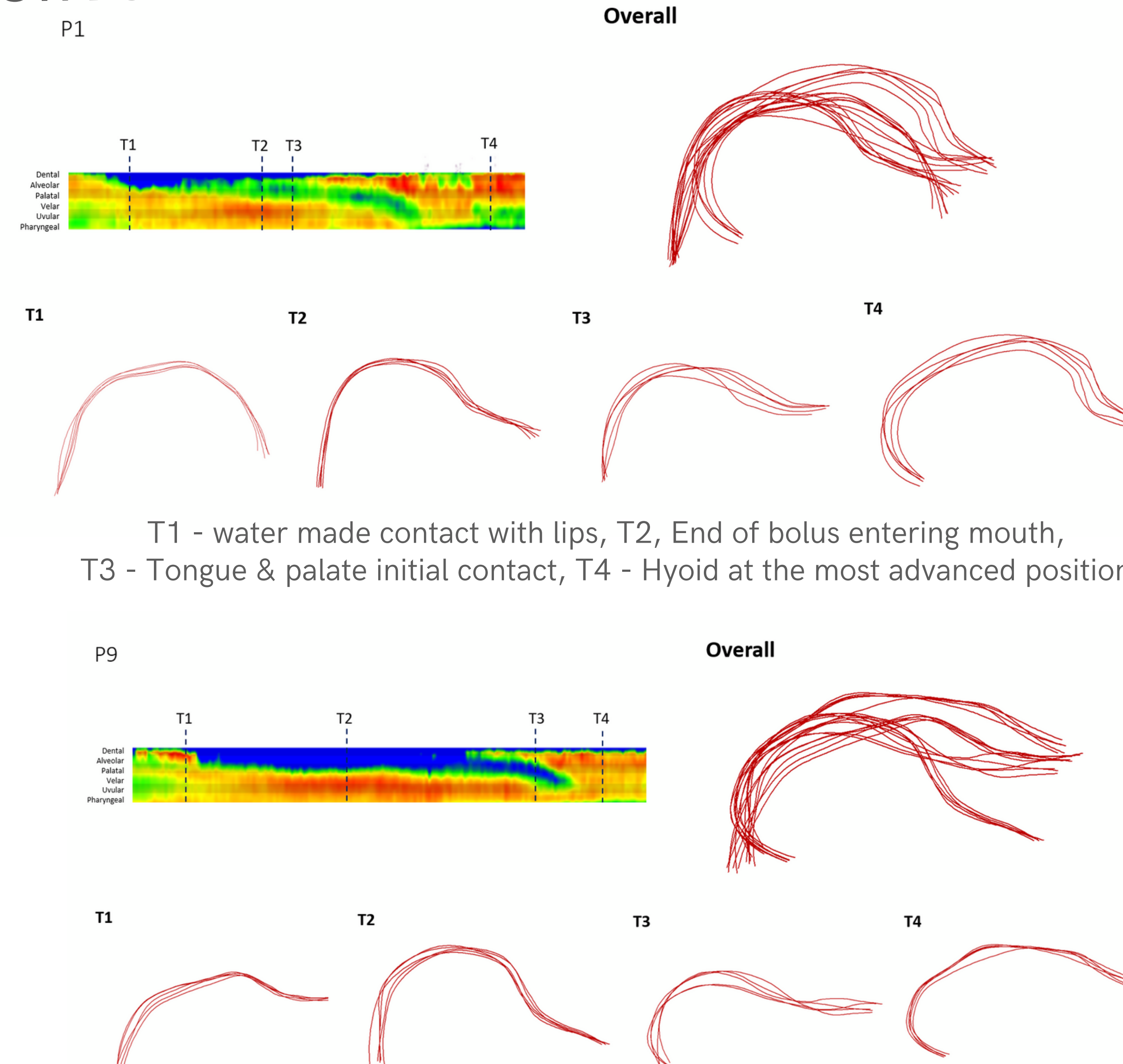 - 10ml single swallows x 5

GLOSSOGRAM

- Genioglossus- contains five pairs of neuromuscular compartments (A to E), which work in localised antagonistic teams with tranversus and verticalis compartments to control tract constrictions
- Tongue blade/tip (F) is mainly occupied by transverse and vertical muscle compartments and controlled by longitudinal muscles.

- Glossometer - A display of the normalised distance vs normalised angle of 100 evenly-spaced points along the tongue contour with reference to the short tendon
- Normalisation allows comparison across individuals, gender and age

- Glossogram - a time-series of glossmeters with normalised distance represented by a colourscale:
  Red - tongue raised
  Green - relaxed
  Blue - constricted

Why is this important?
- A unique and immediate visualisation of tongue movement
  - Deviation in pattern, e.g. repetitive A-P movement in Parkinson's
  - Coordination between tongue and hyoid movement
- Quantification of tongue movement by measuring changes in length in different portions of genioglossus, e.g., tongue root constriction in T4
- Additional information on the oral stage to inform clinical decision-making
- Measuring changes in tongue function over time for monitoring or therapy outcome measures

SINGLE SWALLOWS

T1 - water made contact with lips, T2, End of bolus entering mouth, T3 - Tongue & palate initial contact, T4 - Hyoid at the most advanced position
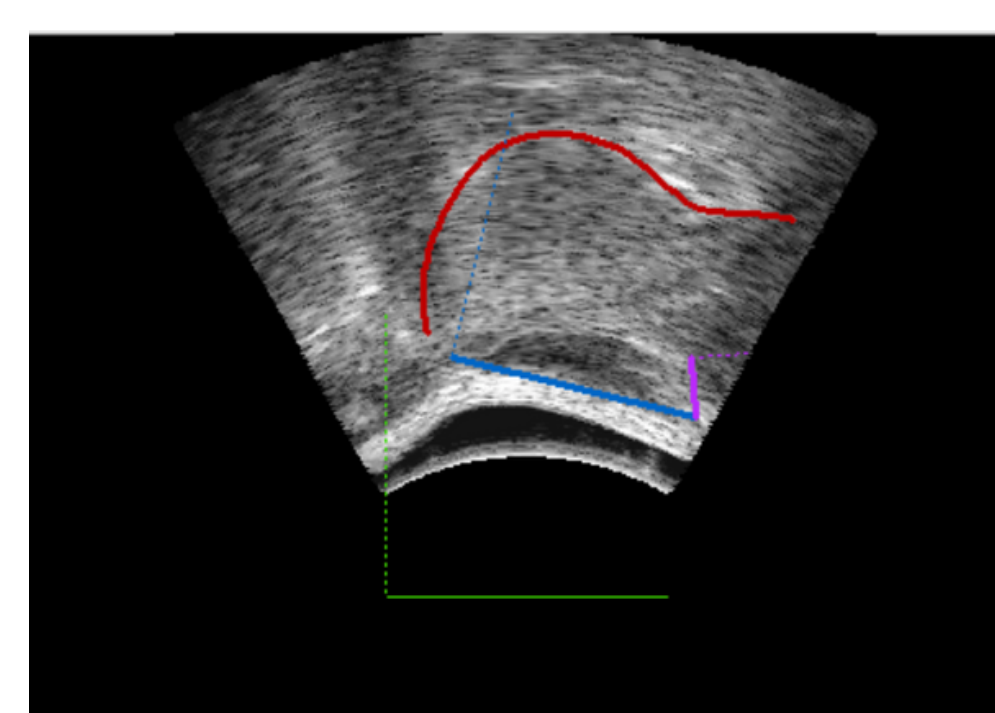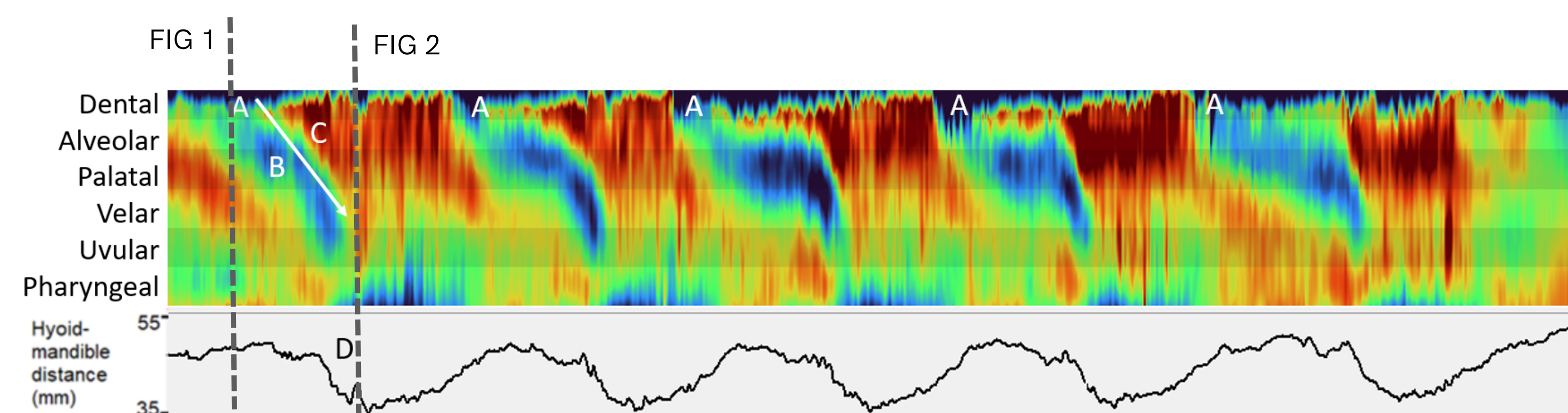
CONTINUOUS DRINKING

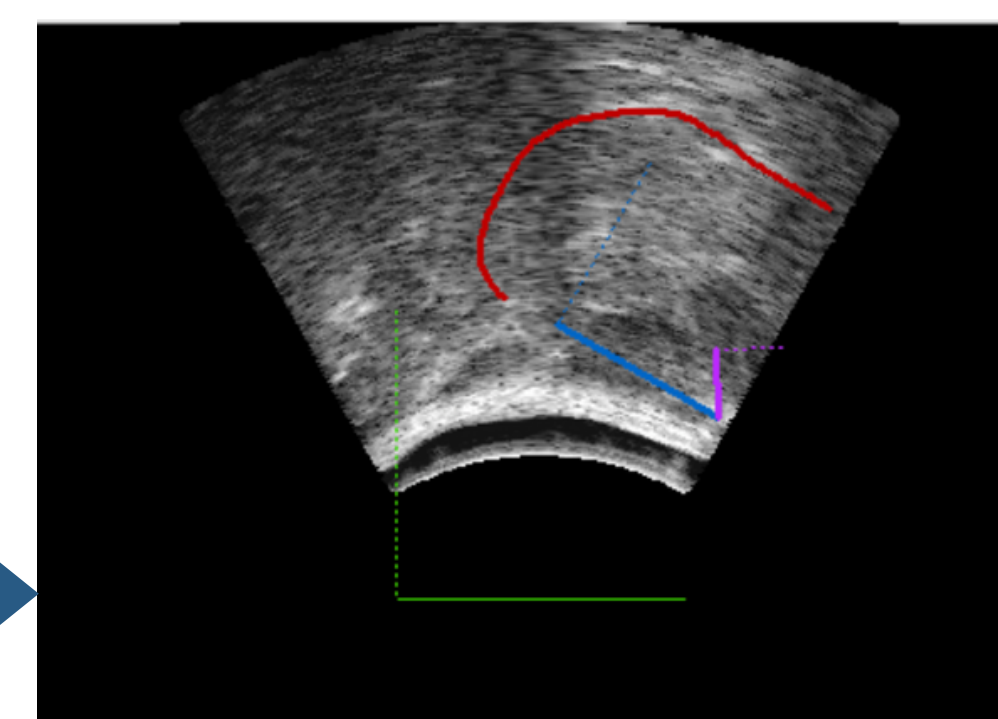Fig 1. Tongue contour when water made contact with lips before first swallow

Fig 2. Tongue contour when bolus passes into pharynx and hyoid at its most advanced position

Coloured glossogram showing a sequence of swallows of 100ml water from a cup.
Trajectories can be described as:
A – Tongue tip lowers to accept bolus
B – Tongue sectors constrict in sequence to carry the bolus posteriorly.
C – Sectors of the tongue extend to squeeze the bolus posteriorly.
D – Hyoid advances as bolus reaches pharyngeal stage, as shown in the plot of hyoid-mandible distance in mm.

RELATED LITERATURE

Wrench, A., & Balch-Tomes, J. (2022a). Beyond the Edge: Markerless Pose Estimation of Speech Articulators from Ultrasound and Camera Images Using DeepLabCut. Sensors, 22(3), 1133.
Wrench, A., & Balch-Tomes, J. (2022b). The glossogram: A cross speaker measure of tongue shape. [Paper presentation]. Ultrafest, Manchester, UK.