Articulating Finnish Vowels: Results from MRI and sound data

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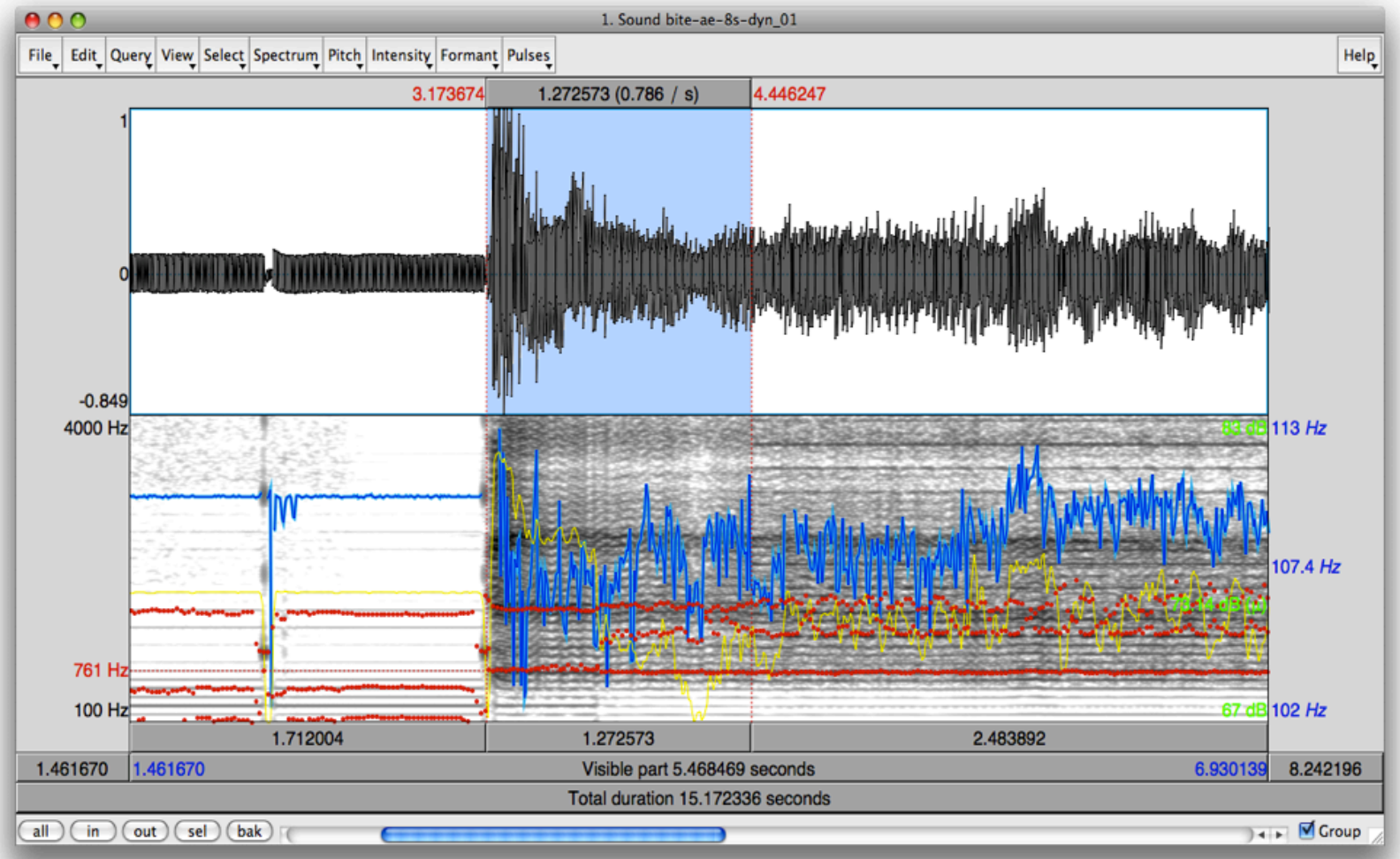
Introduction

- We are building a mathematical and numerical model of vowel production.
- For this we need geometrical (i.e. anatomical) data on vowel production.
- We also need simultaneously recorded audio data for validation of the model.
- We are currently assessing the reliability of the pilot data set.
- At the same time we are developing a systematic assesment kit for new data sets.

Data acquisition: The setup

Data acquisition: The protocol

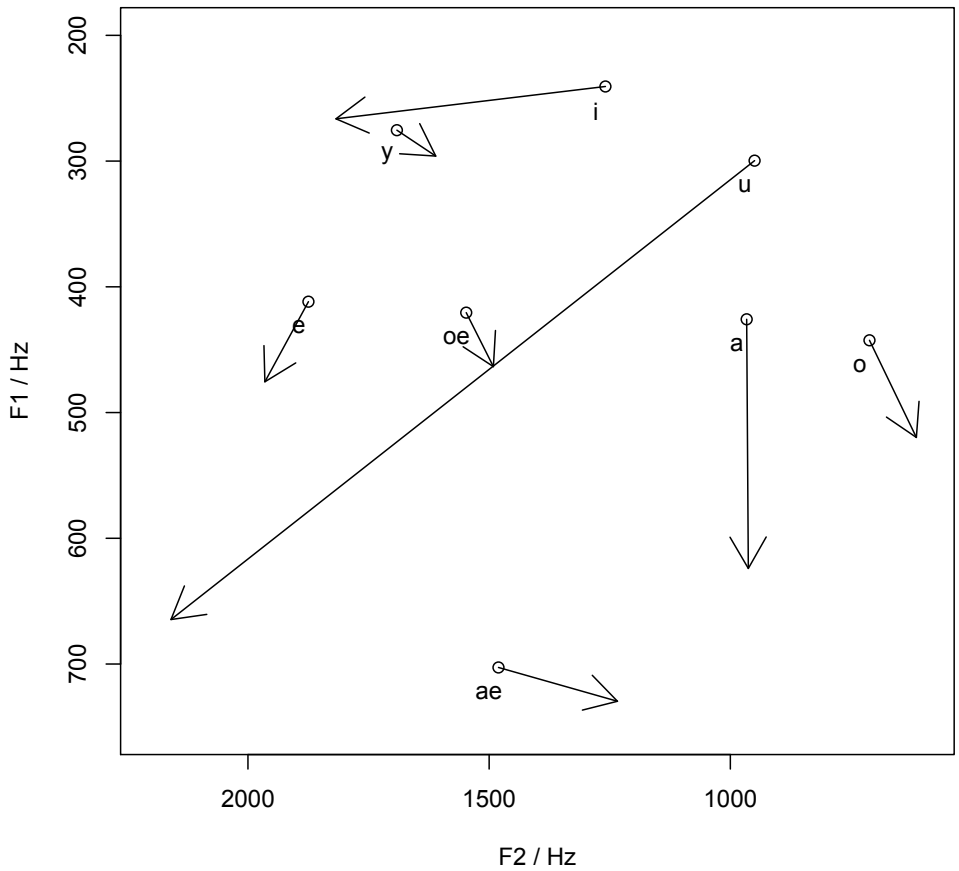


Cue (3 s); 110 Hz sine

Dynamic MRI sequence (7.8 s)

Sustained [æ] (10 s)

Acoustic analysis of audio data



- The data consists of the 8 Finnish vowels.
- For each we have a clean sample from the beginning and end of the production.
- From a purely F1-F2 point of view, the most reliable samples are /e/, /y/ and /ø/.
- The acoustic analysis presents challenges.

Perceptual analysis of audio data: Setting

- 200 ms samples were listened by three students of phonetics.
- They categorised the samples as vowels in a forced choice setting.
- They also rated the samples in prototypicality (epätyypillinen vs. tyypillinen) and nasality (epänasaalinen vs. nasaalinen).
- Prototypicality and nasality were rated on a visual analog scale.

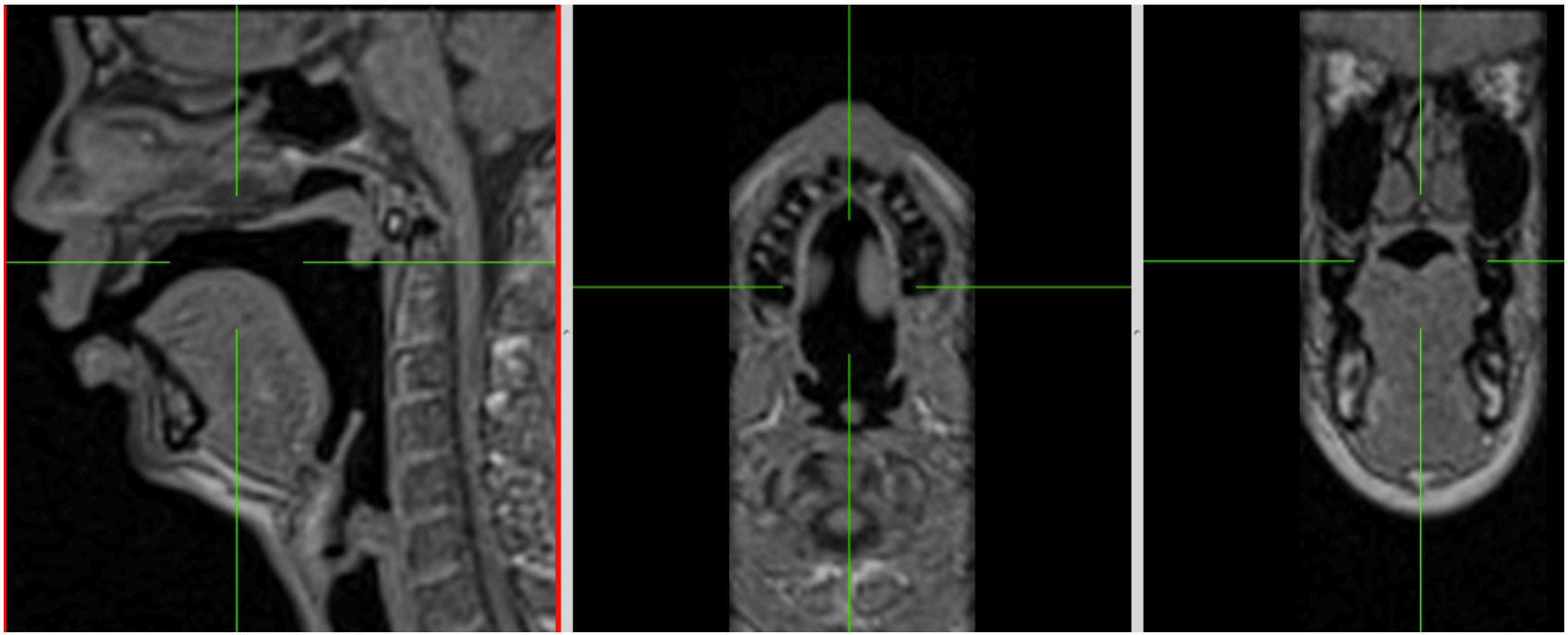
Perceptual analysis of audio data: Preliminary results

- /ɑ/, /e/, /y/ and /ø/ were correctly categorised in all cases.
- The rest had one error each either in beginning or end.
- /e/ got the highest prototypicality score for both begin and end samples.
- The current /e/ sample seems to be the most reliable of this set.
- For the others the results are nonconclusive.

MRI data

MRI is a tomographic technique: The data is acquired in slices (on the right) rather than as a projectional average (on the left).

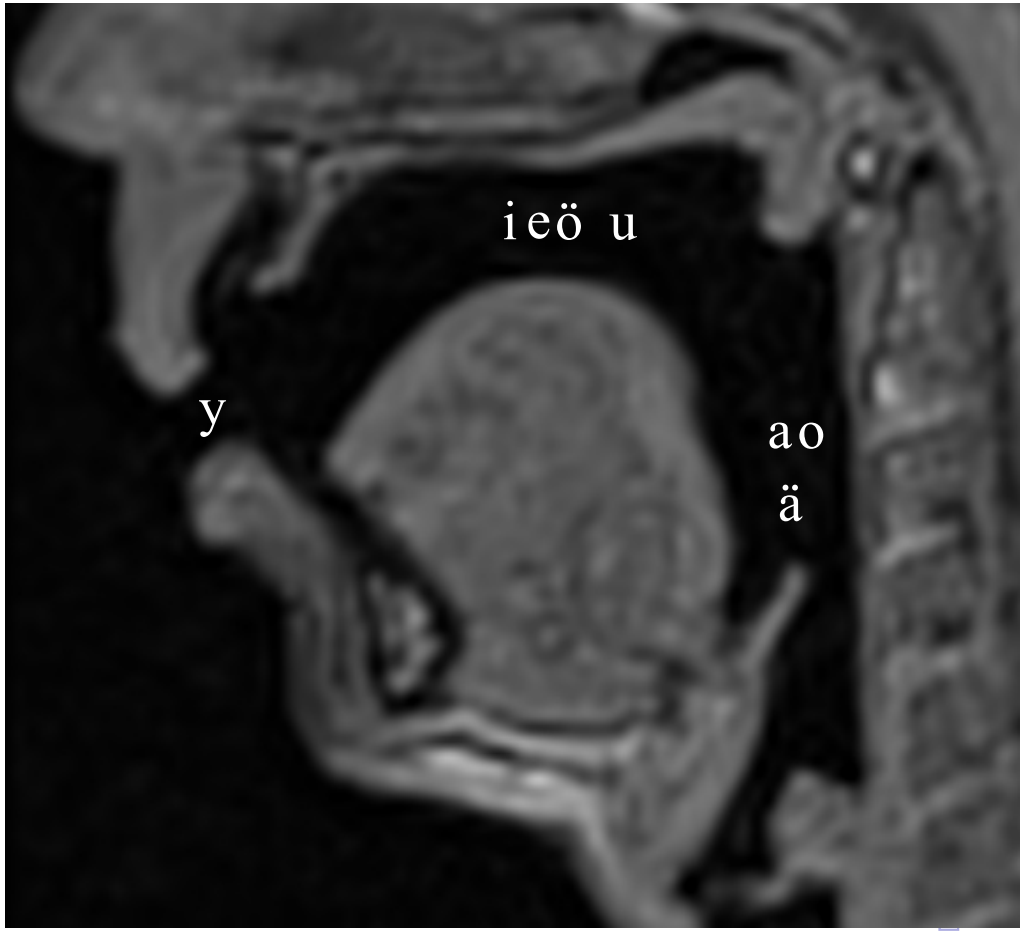
MRI data: Asymmetry



Asymmetry is evident in most samples. For example, in the tongue position of the /y/ sample.

MRI data analysis: Measurements

Phoneme	/ɑ/	/e/	/i/	/o/	/u/	/y/	/æ/	/ø/
Jaw opening (cm)	7.4	7.3	6.8	8.2	8.2	7.0	8.6	8.2
Smallest area (cm^2)	1.3	1.6	0.3	0.5	0.9	0.3	2.5	3.9

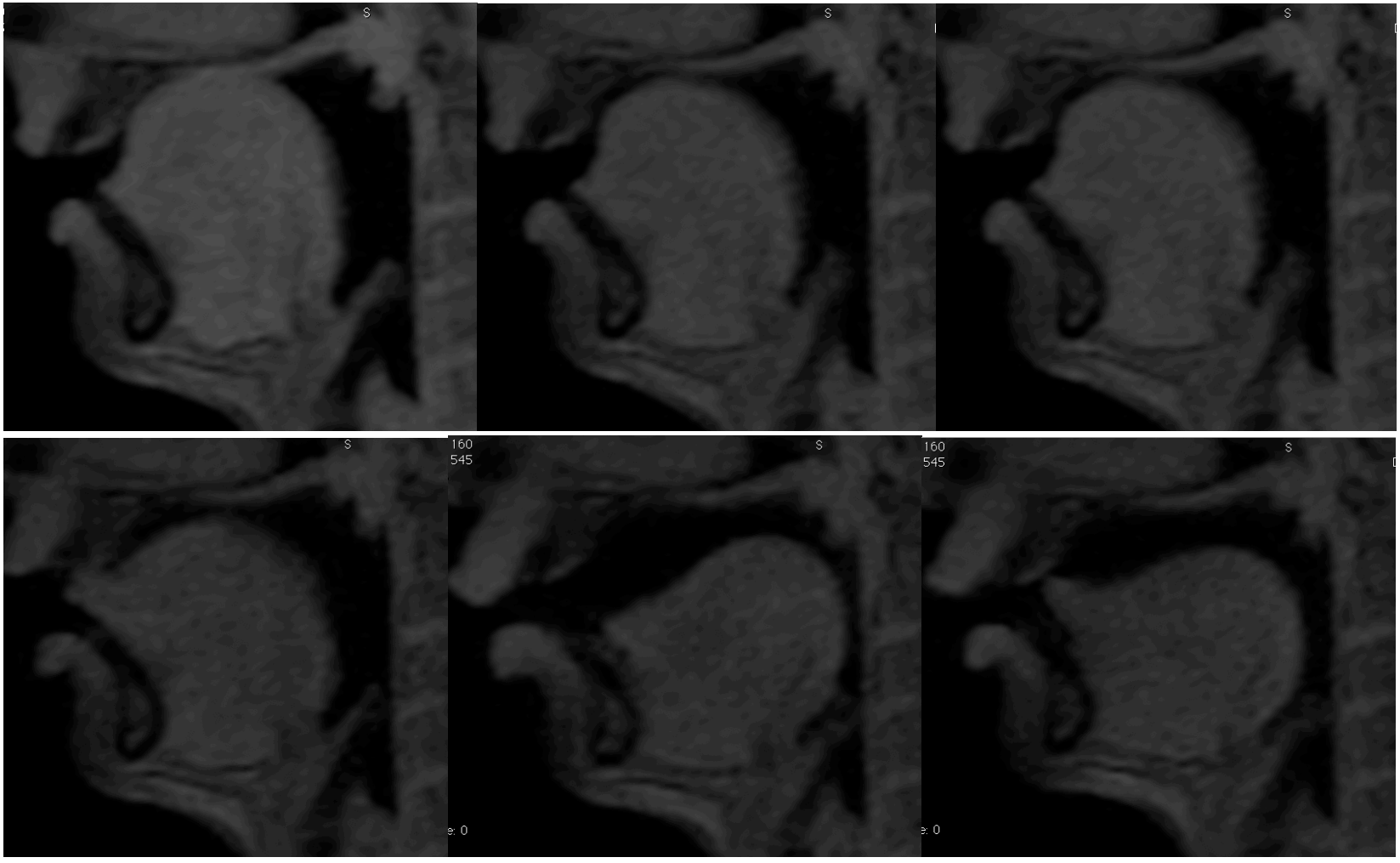


MRI data: Three dimensions

Play videos.

Conclusions

- It is difficult to produce representative vowels in these conditions.
- The tongue is grooved regardless of the vowel.
- There is contact between the sides of the tongue and either the palate or the pharyngeal wall regardless of the vowel.
- There is asymmetry in the articulations.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