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ARTICULATORY ORAL SPACE MEASURES USING THE MODIFIED A-SPACE

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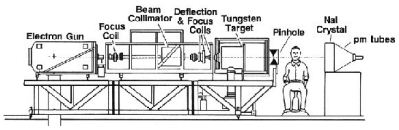
Introduction

- The **Modified A-Space** method is described.
- It allows the detailed characterization of the **articulatory oral space** (**AOS**) in terms of
  - mid-sagittal-plane area,
  - antero-posterior distance,
  - occlusal plane area,
  - posterior pharynx wall tilt,
  - mandible arch width, and
  - oral cavity volume.

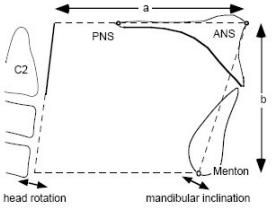
Introduction

- The **X-ray Microbeam Speech Production Database** (**XRMB-SPD**), developed at Wisconsin University, USA (Westbury 1994), includes a vast amount of coordinate data describing articulatory movements.

From Myers (1995)



- Honda et al. (1994) examined the geometry of the vocal track of speakers from the XRMB-SPD, using a quadrilateral (**A-Space**) limited by
  - the palate plane,
  - the anterior nasal spine-menton line,
  - the outline of the posterior pharyngeal wall, and
  - a line parallel to the palatal plane, passing through the menton and extending to the pharyngeal wall.



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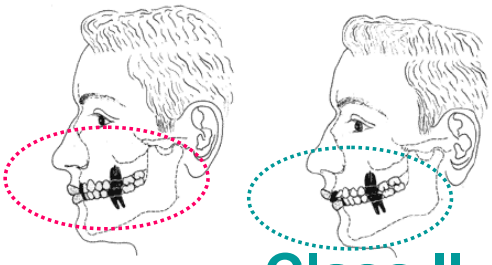
Introduction

- The **Modified A-Space** method was used to select 4 speakers in a study that relates **occlusal classes** with vowel (Araújo, Jesus and Costa 2007), fricative and stop (Araújo, Jesus and Costa 2008) production adaptations.

- It allows the detailed characterization of the XRMB-SPD speakers not just in terms of mid-sagittal-plane area.

- The oral cavity volume has proven to be a far more reliable measure and has revealed more speaker dependent characteristics than the measure previously proposed by Honda et al. (1994).

Introduction



From Nojima and Gonçalves (2001)

- **Class I malocclusion**
  - Normal molar relationship
  - Other anterior teeth have problems like spacing, crowding, over or under eruption.

From Ashouri and Wadden (2006)

- **Class II malocclusion**
  - Upper molars are placed not in the mesiobuccal groove but anteriorly to it.

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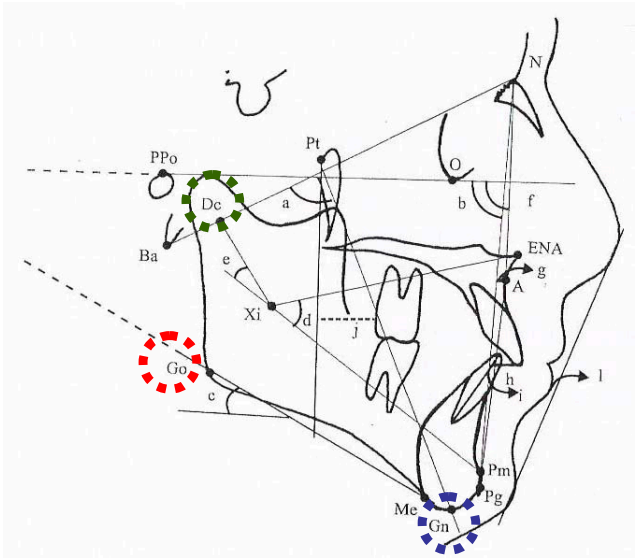
Method

Cephalometric x-ray

Ricketts' cephalometric analysis



From Bianchini (2002)

Method

- **XRMB-SPD** provides
  - occlusion classification,
  - dental measures,
  - anthropomorphic measures,
  - reference pellets coordinates,
  - biteplate records and
  - palatal outlines,

  for each of the 57 speakers.
- This was used to measure the **AOS** in the absence of cephalometric analysis, based on the **Modified A-Space**.

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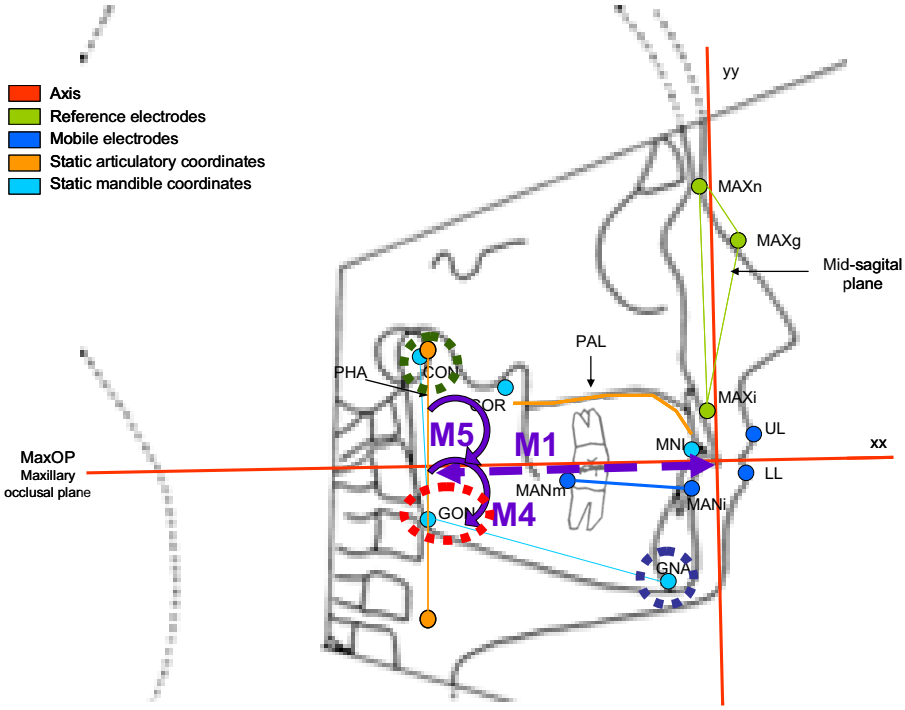
Method



Method

- There is no cephalometric data in XRMB-SPD
  - Missing coordinates at the basis of the cranium and the maxilla.
- There is, however, data on 4 key points at mandible:
  - **Condyle** (CON) ⇔ Cephalometric data point **Dc**;
  - Coronoid process (COR) ⇔ ×;
  - **Gonion** (**GON**) ⇔ Cephalometric data point **Go**;
  - **Gnathion** (GNA) ⇔ Cephalometric data point **Gn**;
- Still, these are unreliable reference point because they were determined using conventional x-ray techniques.

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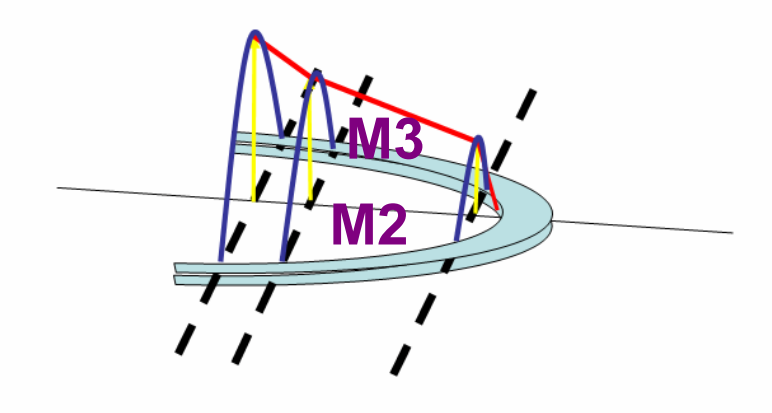
Method

- **M1** – **antero-posterior distance**, calculated from the upper incisors to the posterior pharynx wall.
- **M2** – **mid-sagittal plane area**, from the mandible to the palate midline.
  - Areas of trapeziums (**A1**, **A2** and **A3**).
- **M3** – **occlusal plane area**, from the distal-buccal cusp tip of the second molar to the lips.
  - Areas of trapeziums (**A5** and **A6**) and a triangle (**A4**).

Method

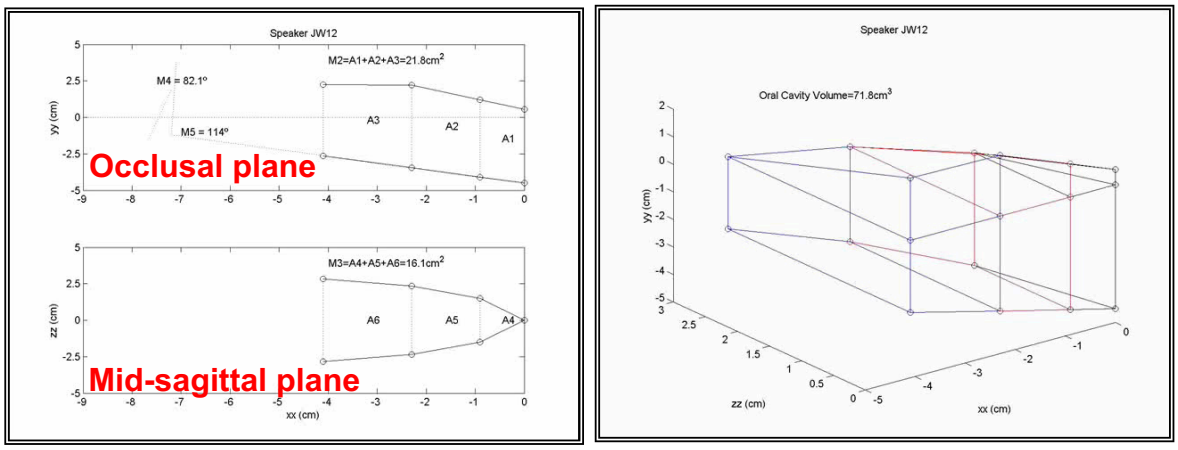
- Maxillary arch and mid-sagittal palate height of the anterior oral cavity (from the distal-buccal cusp tip of the second molar to the lips).



Method

- **M4** – **posterior pharynx wall tilt**, i.e, the angle between the pharynx and the occlusal planes.
- **M5** – **mandible arch angle**, calculated with several mandible points.
- **M6** – **anterior oral cavity volume**.
  - Volumes of convex hulls (using Matlab convhulln.m) of cubes and tetrahedrons.

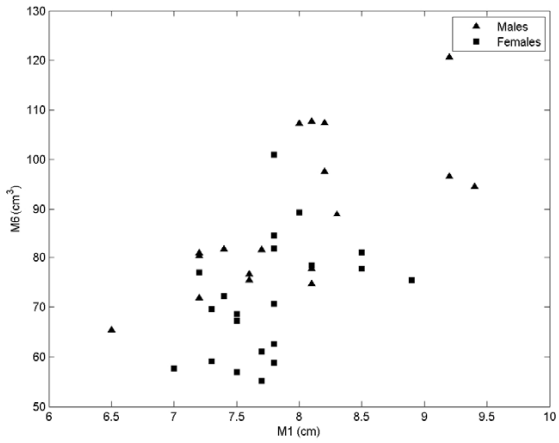
Method

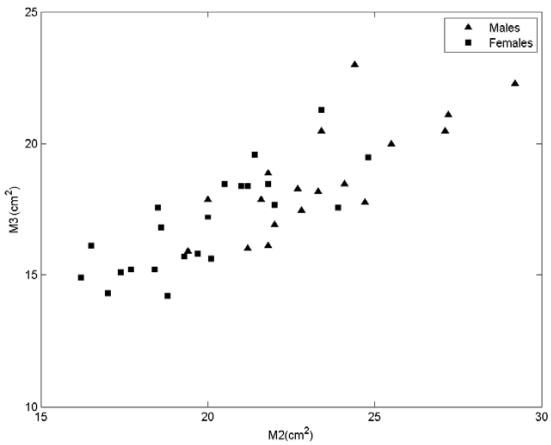


Results

- Results showed a larger average oral cavity volume (**M6**) and greater antero-posterior distance (**M1**) AOS in male subjects than in females.
- **Class II malocclusion** subjects present a slight AOS reduction, due to the anterior and tipped position of the posterior pharynx wall.
- The detailed characterization of the XRMB-SPD speakers revealed great variability.

Results





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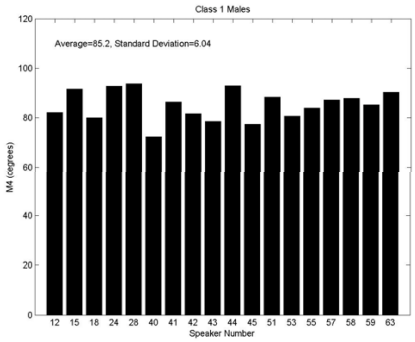
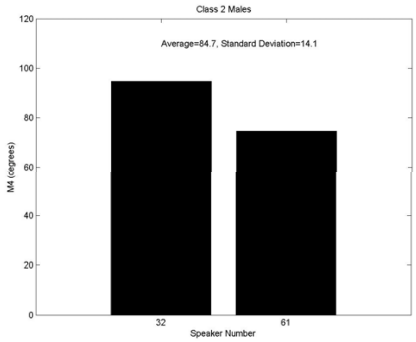
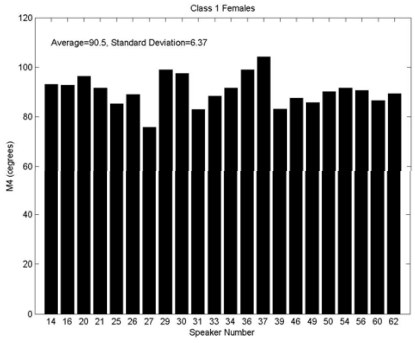
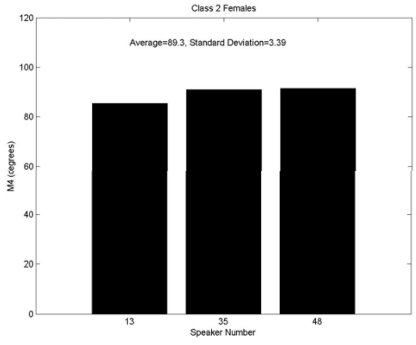
Results









Conclusions

- The Modified A-Space provided additional information, allowing the characterization of cranio-facial features and the selection of a uniform set of speakers in studies involving XRMB-SPD.
- This method combines anatomical data and biomedical signals producing a reference dataset for research into speech production.
- We believe that this method may provide additional information to regular cephalometric analysis.

Acknowledgements

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