Analysis of dysarthria by means of articulatory modelling: a preliminary study

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Background

Dysarthria is a motor speech disorder affecting the motor control system of the vocal tract, leading to impaired movements of the vocal tract. Articulatory research on this disorder often relies on electromagnetic articulography (EMA). For this purpose, most studies focus on the analysis of the kinematics[1–3]. In speech production research, articulatory modelling is however used to quantify and characterise the articulatory degrees of freedom of the vocal tract, providing complementary insights. This study intends to take advantage of this technique to provide for the first time an individualised analysis of the articulatory degrees of freedom of dysarthric patients.

Material and method

The TORGO database[4], comprising 8 dysarthric patients and 7 control subjects, was considered. The articulatory data consist of vocal tract point coordinates recorded through EMA. For each participant, an articulatory model of the tongue was derived from the midsagittal coordinates of the tongue coils, leading to four components: Jaw Height (JH), related to the height of the jaw, Tongue Body (TB), related to the frontward-backward movement of the tongue, Tongue Dorsum (TD), related to its flattening-arching movement, and Tongue Tip (TT), related to the movement of its tip. The articulatory models between patients and subjects were qualitatively and quantitatively compared.

Results

Preliminary analyses were carried out on two female (F1, F2) and one male (M1) patients, and on two female control (FC1, FC2) subjects. The data variance explanations are provided in Table 1. An illustration of the simulation of the TB component for F1 is provided on Figure 1.

The two subjects present similar components as those already reported in the literature. The patients on the contrary tend to show more limited articulatory degrees of freedom, with JH component being less important, at the expense of the TB component.

Table 1: Percentage of data variance explanation per component and per subject

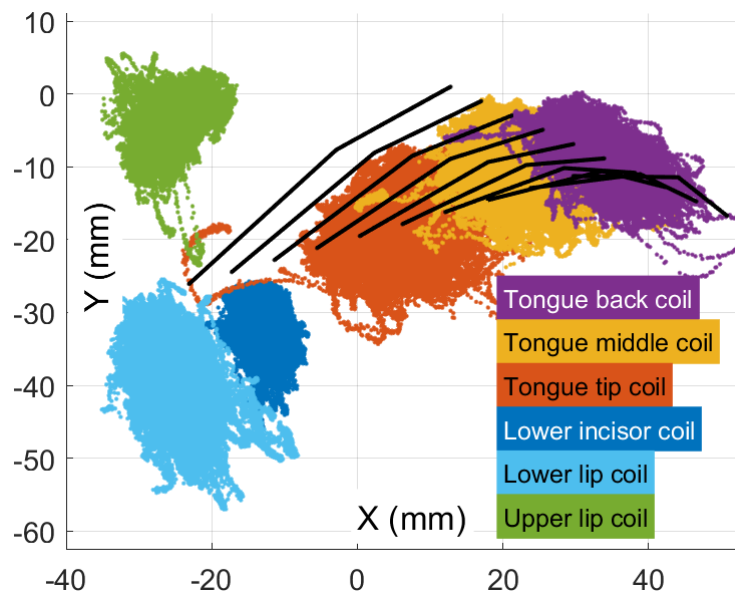|	F1	F2	M1	FC1	FC2
JH	6%	6%	10%	34%	34%
TB	65%	48%	46%	41%	40%
TD	18%	29%	28%	19%	20%
TT	6%	11%	9%	4%	4%

Figure 1: Simulation of the TB component variations (black lines) superposed on the coil positions for a single session of patient F1.

Discussion

The analyses show that the patients have a more limited balance between the articulatory degrees of freedom. The variability of the tongue due to the opening-closing of the mouth is very limited and a larger part of the tongue variability is carried by the frontward-backward movement of the tongue, dominating by far all other articulatory components. The figure characterises exactly the variations of the tongue shape associated to this dominant degree of freedom for one speaker.

Conclusion

This study shows that original insights on the articulatory degrees of freedom of dysarthric patients could be obtained. It provides an individual assessment of the articulatory strategy of the patient. Further qualitative and quantitative analyses are currently being carried out on the 15 speakers of the TORGO database, especially to characterise more precisely the articulatory movements related to the model's components.

References

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