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Effects of simultaneous lip-tube and auditory feedback perturbations

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BACKGROUND

-Speech production involves feedback and feedforward control mechanisms (Perkell, 2012).

-Somatosensory (SS) and auditory (AUD) aspects of speech can be perturbed to study speech production (Savariaux *et al.,* 1995, 1999; Ménard *et al.* 2016).

-Previous experiments with adult French speakers producing the vowel /u/ with a perturbation of the lips using a lip-tube showed that they were able to compensate in part by moving the tongue towards the velo-pharyngeal region, using auditory feedback (Savariaux *et al*., 1995,1999; Ménard *et al*., 2016).

- The relative importance of auditory and somatosensory feedback on compensatory strategies to a lip-tube perturbation is not clear**.**

OBJECTIVE

- This study aimed to evaluate the compensatory strategies of adult speakers of Quebec French in producing the vowel /u/ with a perturbation of the lips using a lip-tube, with and without natural or perturbed auditory feedback.

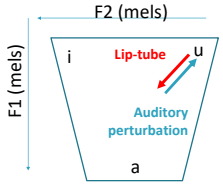
METHOD

Participants

-10 males and 10 females
-18 to 35 years old (mean age = 25.3)
-Native speakers of Quebec French
-No known pathology related to audition, language, or attention

Task

-To produce 6 blocks of 20 /u/ tokens.
-60 tokens were produced while the speaker had a plastic lip-tube between the lips that was designed to increase lip area, thus F1 and F2 values.
-20 of the 60 tokens were also produced with simultaneous real-time modified auditory feedback designed to decrease F1 and F2 (Cai *et al.,* 2008).



Experimental setup

-The participant was seated, wearing headphones and instructed not to talk after the experiment had started.

-A microphone was held by the experimenter in front of the participant.

-The participant was instructed to wait for a green signal on the screen and then produce the vowel /u/ 20 times, as clearly as possible.

- A lip-tube (2.0 cm long by 2.5 cm wide) was placed between the lips of the participant before the 3rd block of the experiment and left there until the end of the 5th block.

Data analysis

-F0, F1, and F2 values were extracted at vowel midpoints for the 120 /u/ tokens produced by each participant.

- The participants were divided into 3 groups based on their compensation strategies:
  - SS compensators: those who started to compensate in block 3 (lip-tube, perturbed auditory feedback) **(n=5)**;
  - AUD compensators: those who minimally compensate in block 3 (lip-tube) but did so in block 4 (no AUD feedback) **(n=6)**;
  - Followers: those who followed the lip-tube perturbation and did not compensate with AUD feedback **(n=9)**;

-LME models were built using R.

Block 1	Block 2	Block 3	Block 4	Block 5	Block 6
No lip-tube	No lip-tube	Lip-tube	Lip-tube	Lip-tube	No lip-tube
Natural auditory feedback	No auditory feedback	Auditory feedback perturbation	No auditory feedback	Natural auditory feedback	Natural auditory feedback

RESULTS

Figure 1: *Average perceptual score (F1+F2)/2 – F0 in Bark according to the block and position in the block (first or second half) for each group of participants (error bars are standard errors)*

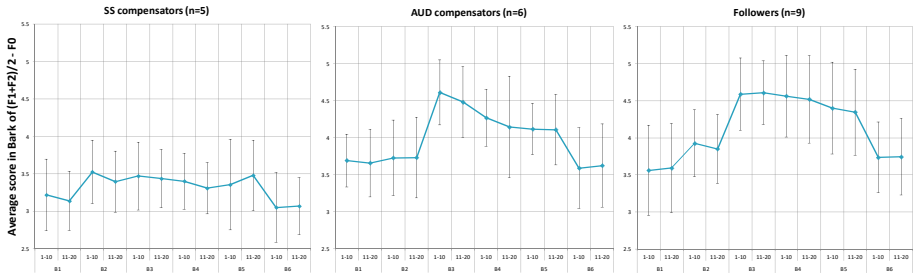
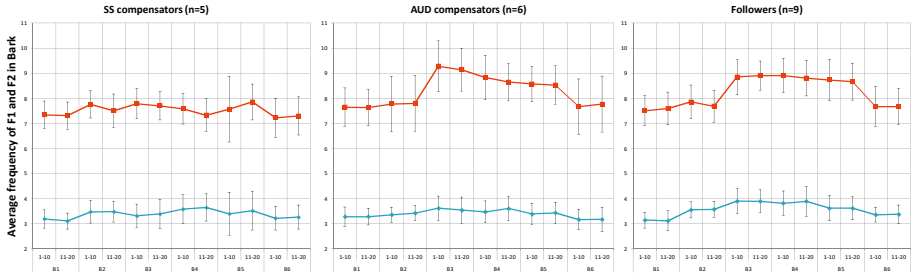


Figure 2: *Average F2 and F1 values in Bark according to the block and position in the block (first or second half) for each group of participants (error bars are standard errors)*



DISCUSSION

-There appear to be three distinct responses to SS (lip) perturbation:

1. compensation for SS perturbation when no auditory consequences are heard (SS)
2. no compensation for SS perturbation when AUD feedback is corrected (AUD)
3. no compensation

- The SS compensators' F2 values during block 3 were not higher than values from blocks 1 and 2, suggesting the immediate minimization of somatosensory feedback error (primacy of somatosensory feedback over auditory feedback).

- The AUD compensators' F2 values increased in block 3 and began gradually decreasing before access to natural auditory feedback was restored, suggesting that both auditory and somatosensory feedback were integrated in the compensation.

REFERENCES

-Cai, S., et al. (2008). A System for Online Dynamic Perturbation of Formant Trajectories and Results from Perturbations of the Mandarin. *International Seminar on Speech Production 2008*, 65–68.; -R Core Team (2012) R: A Language and Environment for Statistical Computing. Foundation for Statistical Computing, Vienna, Austria. http://www.r-project.org/ ;
-Ménard, L., Perrier, P., & Aubin, J. (2016). Compensation for a lip-tube perturbation in 4-year-olds: Articulatory, acoustic, and perceptual data analyzed in comparison with adults. *The Journal of the Acoustical Society of America*, *139*(5), 2514-2531.;
-Perkell, J. S. (2012). Movement goals and feedback and feedforward control mechanisms in speech production. *Journal of neurolinguistics*, *25*(5), 382-407.;
-Savariaux, C., Perrier, P., & Orliaguet, J. P. (1995). Compensation strategies for the perturbation of the rounded vowel [u] using a lip tube: A study of the control space in speech production. *The Journal of the Acoustical Society of America*, *98*(5), 2428-2442.;
-Savariaux, C., Perrier, P., Orliaguet, J. P., & Schwartz, J. L. (1999). Compensation strategies for the perturbation of French [u] using a lip tube. II. Perceptual analysis. *The Journal of the Acoustical Society of America*, *106*(1), 381-393.

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