Orofacial Somatosensory Effects for the Word Segmentation Judgement

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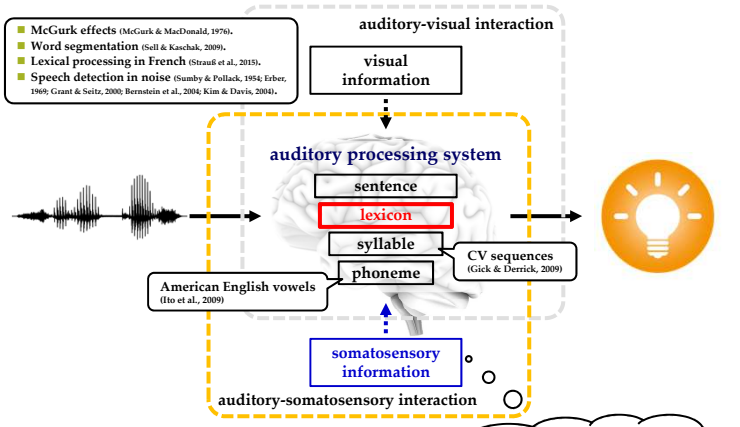
Summary

- Somatosensory inputs associated with facial skin deformation systematically biased the perceptual judgements depending on the stimulation onset timing, but not depending on the amplitude differences.
- Orofacial somatosensory system could be involved in the process of lexical perception concerning word segmentation.

Introduction

Speech perception is an interactive process with multiple modalities and some perceptuo(multisensory)-motor connections (Schwartz et al., 2012).

- McGurk effects (McGurk & MacDonald, 1976).
- Word segmentation (Sell & Kaschak, 2009).
- Lexical processing in French (Strauß et al., 2015).
- Speech detection in noise (Sumby & Pollack, 1954; Erber, 1969; Grant & Seitz, 2000; Bernstein et al., 2004; Kim & Davis, 2004).



How does somatosensory input affect the processing of speech ?

Do somatosensory inputs associated with facial skin deformation modify the lexical perception ? Exp. 1

Do amplitude differences of somatosensory inputs provide different effects in lexical perception ? Exp. 2

Methods

- Participants : 31 native French speakers.
  - 20 for Exp. 1 and 11 for Exp. 2.
- Identification test.
  - Task : to identify which word you heard ?

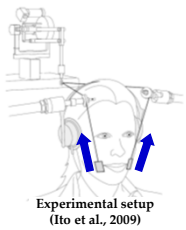
"l'attache" vs. "la tache" ?

Pronunciation : /lataʃ/
Meaning : "the string" vs. "the stain"

  - The judgement probability for "la _____" (e.g. "la tache") responses.
  - Stats : Linear Mixed-Effects Model analysis.
- Corpus : 17 French phrases lead elision.
  - Phrase examples.
    - "l'apesanteur" - "la pesanteur" (/lapœzɑ̃tœʀ/).
    - "l'attache" - "la tache" (/lataʃ/).
    - "l'affiche" - "la fiche" (/lafiʃ/).
  - 3 speaking accent styles.
    - S_a0 : neutral & natural speech.
    - S_a1 : accented on the 1st vowel, /lataʃ/.
    - S_a2 : accented on the 2nd vowel, /lataʃ/.
- Experiment conditions for each experiment.

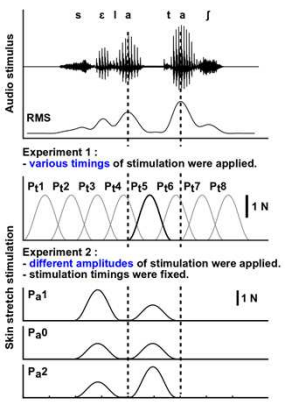
Experiment 1	Experiment 2
S_a0	S_a0, S_a1, S_a2
P_t1-P_t8 & no stimulation condition (P_t0)	P_a0, P_a1, P_a2

- Somatosensory stimulation.
  - Upward direction.
  - A half-wave 6 Hz sinusoidal pattern.



Experimental setup (Ito et al., 2009)

- Temporal relationships.

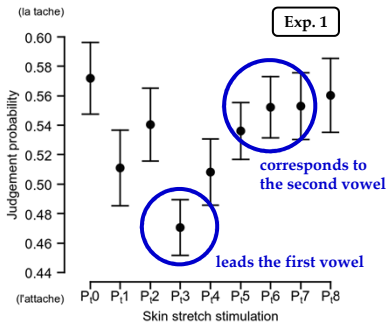


Results

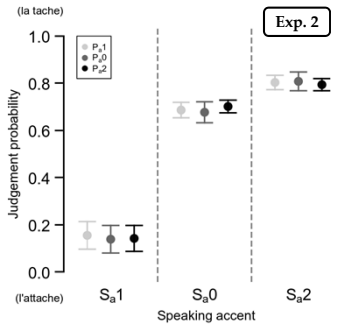
Stimulation onset timing

somatosensory inputs → lexical perception

Amplitude differences



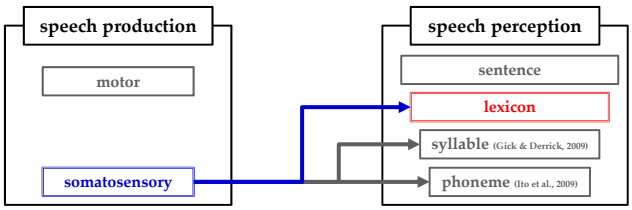
- Significant effect of stimulation timing (χ^2 (8) = 39.04, $p < 0.01$).
  - $P_t3 << P_t2$, P_t5, P_t6, P_t7 and P_t8 ($p < 0.03$).
  - $P_t0 >> P_t3$ and P_t4 ($p < 0.04$).



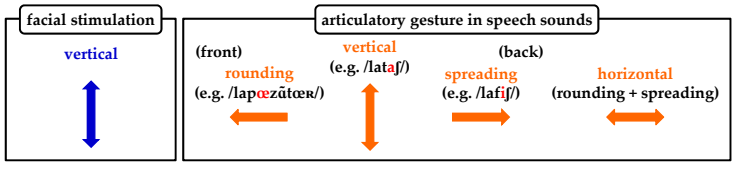
- No effect of stimulation amplitude, alone (χ^2 (2) = 0.06, $p > 0.97$) or in interaction with accent (χ^2 (4) = 0.39, $p > 0.98$).
- Significant effect of speaking accent (χ^2 (2) = 179.97, $p < 0.01$).
  - $S_a1 << S_a0$, $S_a1 << S_a2$, $S_a0 << S_a2$ ($p < 0.01$).

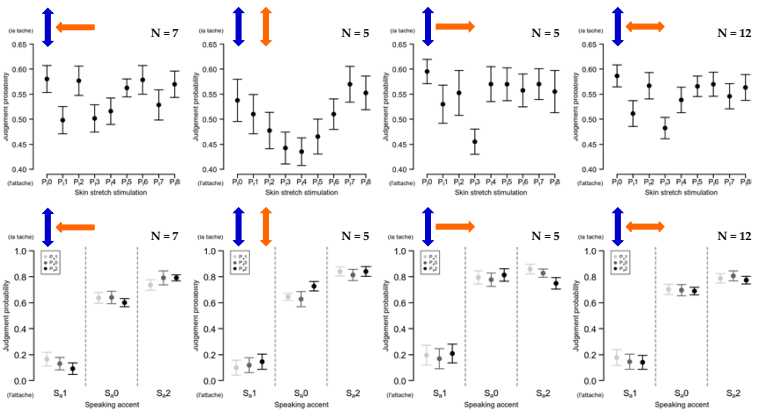
Discussion

- Extend the validity of somatosensory effects in speech processing.



- A directional relationship between facial stimulation & articulatory gesture.
  - The phrases were divided into 4 groups based on the 2nd vowel in the phrase.





Somatosensory effects in lexical perception seem compatible with vertical articulatory gesture (Vatikiotis-Bateson et al., 1999).

Acknowledgments

- This research was supported by the European Research Council under the European Community's Seventh Framework Programme (FP7/2007-2013 Grant Agreement no. 339152, "Speech Unit(e)s").
- We also thank Nathan Mary and Dorian Deliquet for data collection and Silvain Gerber for statistical analysis.