Labial EMG activity during wilful inner speech and during auditory verbal hallucinations in schizophrenia

Hélène Lœvenbruck[1,2], Lucile Rapin[3], Caroline Duval[1], Marion Dohen[1], Mircea Polosan[4], Pascal Perrier[1]

[1] Département Parole & Cognition, GIPSA-lab, CNRS UMR 5216, Grenoble, France ; [2] LPNC, CNRS UMR 5105, Grenoble, France ;

[3] Université du Québec à Montréal, Department of Education and Pedagogy, Montréal, Canada,; [4] Pôle de Psychiatrie et de Neurologie- Centre Hospitalier Universitaire de Grenoble

Helene.Loevenbruck@gipsa-lab.grenoble-inp.fr, lucilerapin@gmail.com

BACKGROUND – Inner Speech = a kind of motor action (Feinberg, 1978; Frith, 1992)

➡ **Application of Motor control model** (Miall & Wolpert, 1996)

Predictive model: When motor commands are sent to the motor system, an efference copy is issued in parallel. This efference copy is used to calculate a prediction of the sensory outcome of the motor plan.

If predicted and actual sensory outcomes do match, **self-authorship** is experienced.

If predicted and actual sensory outcomes do not match, then some external influence must have been at work, resulting in delusion of control symptoms.

Extension to inner speech: a failure in the efference copy system could underlie auditory verbal hallucinations (AVH) in schizophrenia, with self-initiated covert verbal actions experienced as originating from an external cause. (Livesay et al., 1996; Inouye & Shimizu, 1970; Seal et al., 2004)

AIM – The present study examines two hypotheses: **1. Inner speech is a kind of action   2. AVHs are disrupted inner speech**

If these hypotheses are correct, then inner speech and AVHs should involve motor commands. Electromyographic (EMG) activity should be detectable in speech muscles.

METHODS

Participants: 11 hallucinating schizophrenia patients and 23 healthy controls subjects

Data: recorded on a Biopac MP150 **sEMG system**

Muscles: **orbicularis oris superior** (OOS) and **orbicularis oris inferior** (OOI) , non-dominant **brachioradialis** (BR)

Control Conditions: - *Relaxation (RELAX):* remain silent, not move, avoiding wandering thoughts (induced by a sophrology session)

   - Inner speech reading (*ISR*): mentally read sentences

   - Inner speech generation (*ISG*): mentally generate a simple definition of a word
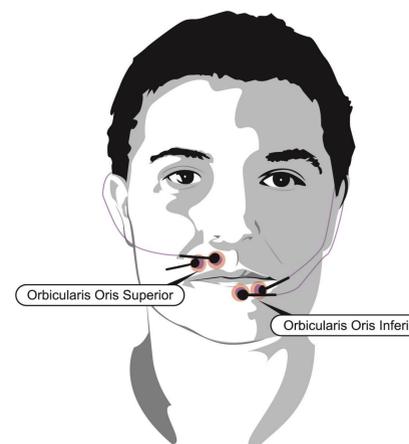
Patient Conditions*:* - *Hallucinatory period* (*AVH*): remain silent, not move and not refrain from hearing voices and press a button from the beginning until the end of a voice

   - Rest (REST): in between 2 hallucinatory periods

Analysis: - sEMG data filtered and centered

   - Average values of the peak of the pre-processed sEMG signal for each condition, each muscle, each participant

   - Repeated measures ANOVAs over controls or patients, with muscles and conditions as within-subjects factors

Orbicularis Oris Superior
Orbicularis Oris Inferior

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RESULTS

• Video monitoring: **no perceivable facial movement** during *ISR, ISG* and *AVH*

• **Patients & controls:** muscular activation for BR did not vary across conditions

➡ increase in muscular activity measured in the speech muscles is related to speech and not to general muscular tension

•**Controls:** higher OOI and OOS activations in *ISR and ISG* compared to *RELAX*

• **Patients:** higher OOI in *AVH* compared to *REST*

Mean peak muscular activation

Healthy controls

Hallucinating schizophrenia patients
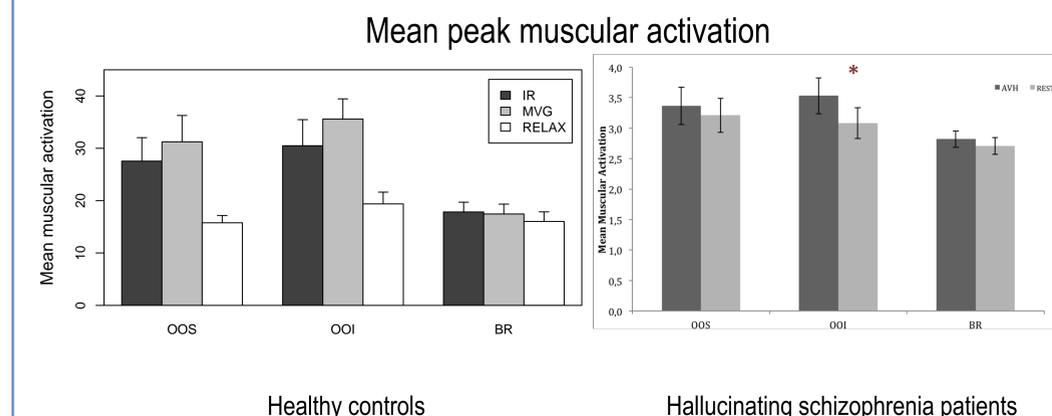
CONCLUSION

• Increase in lip EMG activity during wilful inner speech compared to relaxation in healthy participants

➡ **"inner speech is a kind of action"**

• Increase in lip EMG activity during AVHs relative to rest

➡ **motor nature of AVHs and suggests that they are associated with inner speech (Rapin et al., in press)**