Speech in the mirror? Neurobiological correlates of self-speech perception
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To cite this version:
Avril Treille, Coriandre Vilain, Sonia Kandel, Jean-Luc Schwartz, Marc Sato. Speech in the mirror? Neurobiological correlates of self-speech perception. Seventh Annual Society for the Neurobiology of Language Conference, Oct 2015, Chicago, United States. hal-02074936

HAL Id: hal-02074936
https://hal.archives-ouvertes.fr/hal-02074936
Submitted on 21 Mar 2019
Self-awareness and self-recognition during action observation may partly result from a functional matching between action and perception systems. This perception-action interaction is thought to enhance the integration between sensory inputs and our own sensory-motor knowledge.

We present a combined EEG and fMRI study that examines the impact of self-knowledge on multisensory integration mechanisms during auditory, visual and audio-visual speech perception. Our working hypothesis was that hearing and/or viewing oneself talk might facilitate the bimodal integration process and activate sensory-motor plans to a greater degree than does observing others.

The same stimuli were used for both experiments:
- **Stimuli**: /dev/ , /de/, /av/.
- **Modulations**: auditory (Av), visual (V), audio-visual (AvV) and inconsistent audio visual (Avi), self auditory signal+dialectual+visual signal.
- Half of the stimuli were related to the participant (self condition), the other half to an unknown speaker (other condition).
- A total of 1176 trials were created.

### EEG

**Integration (AV <-> A+V)**:

- **P2 amplitude : AV ↔ A+V (p < 0.02) ➞ integration**

**Self effect on integration** ➞ Visual-Self : reduced N1 latency (p < 0.02)

### fMRI

**Main Effect of Self** *(F contrast, p < .001 unc)*

- Auditory cortex
- Parahippocampal gyrus and left IP2 (pars opercularis)

**Self x Noise Interaction** *(F contrast, p < .001 unc)*

- Visual associative cortex

**Self x Modality Interaction** *(F contrast, p < .001 unc)*

### METHODS

**ETHICAL APPROVAL**

All experiments were conducted in accordance with the Declaration of Helsinki and approved by the institutional review board. Participants gave written informed consent after being fully informed about the nature of the study.

**DATA ACQUISITION**

- **EEG**: 64 scalp electrodes (international 10-20 system) recording using the Biosemi system operating at a sampling rate of 512 Hz. All recordings were digitized using the NeuroScan Scan software.
- **fMRI**: Functional imaging of speech perception (fMRI) was performed on participants in the scanner (Siemens MAGNETOM Symphony 3.0T and GE Component 3.0T). Functional data were analyzed using the SPM2 software (http://www.fil.ion.ucl.ac.uk/spm). Contrast maps were thresholded using a corrected significance threshold of p < 0.001 (uncorrected) and a voxel extent threshold of 50 voxels.

**RESULTS**

**Modality results :**

- **Auditory regions**: stronger activity for the auditory condition than the visual only condition
- **Visual regions**: stronger activity for the visual condition than for the auditory only condition
- **Greater Activity of the dorsal part of the premotor cortex for visual stimuli** (no activation for the auditory only condition)

**Self effect :**

- **Stronger activity of the cerebellum, the parahippocampal gyrus and the left inferior frontal gyrus (pars opercularis)**
- Small effect but we'll test more subjects

### DISCUSSION

**1. In line with previous studies on multimodal speech perception ➞ integration mechanisms of auditory and visual speech signals.**

**2. A visual processing advantage when the perceptual situation involves our own speech production.**

**3. Global coherent activations of the single effects during auditory, visual and audio-visual speech perception.**

**4. Hearing and/or viewing oneself talk increased activation in the left posterior inferior frontal gyrus (pars opercularis) and cerebellum.**

These regions are generally responsible for predicting sensory outcomes of action generation. Altogether, these results suggest that viewing our own utterances leads to a temporal facilitation of auditory and visual speech integration and processing afferent and efferent signals in sensory-motor areas gives rise to self-awareness during speech perception.