Project

Response preparation and encoding in word production

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Abstract

Le traitement cognitif du langage demande une grande quantité d'anticipation. Cela est vrai dans le volet perceptif de décodage aussi bien que dans le volet actif de production. Un lecteur ne se contente pas d'interpréter les stimuli visuels fixés par son regard, il interprète le stimuli en cours et anticipe les stimuli à venir sur la base de ses connaissances à long terme (connaissances grammaticales, sémantique, etc.). De même un locuteur ne prépare pas ses mots un par un, mais encode des séquences (syntagmes, phrases) avant et possiblement en même temps qu'il en articule.

Dans ce projet nous explorons les capacités d'anticipation des lecteurs à l'aide de la technique de magnéto-encéphalographie. Cette technique permet le recueil d'activités magnétiques évoquées par des stimuli linguistiques. Ces activités reflètent les sources corticales de l'activité cérébrale avec une très haute résolution temporelle. De cette façon cette recherche pourra révéler comment, en une fraction de seconde, un contexte conduit ou pas à anticiper les mots à venir.

Publications

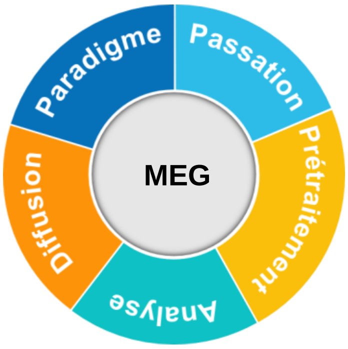
Strijkers, K., Chanoine, v., Munding, D., Dubarry, A.-S., Trébuchon, A., Badier, J.M. & Alario F.-X. The neural dynamics of syntactical predictions (submitted).

Posters

Strijkers, K., Chanoine, v., Munding, D., Dubarry, A.-S., Trébuchon, A., Badier, J.M. & Alario F.-X. The neural dynamics of syntactical predictions. *SNL Annual Meeting*, 8-10 November 2017, Baltimore, USA.

Grammatical anticipation? Neural dynamics of noun and verb processing. Alario F.-X.(1), Badier J.-M.(2,3), Chanoine V.(3), Dubarry A.-S(1,2). Munding D.(1), Strijkers K.(4), Trébuchon–Da Fonseca A.(2), Workshop BLRI 2015

Fiche-résumé contribution CREx



Noun/Verb

Préparation de la réponse et encodage de la production de mots

Investigateurs : FX Alario(LPC), K Strijkers (LPC) JM Badier (INS)

Durée : 16 mois **(**de mars 2014 à juillet 2015)

Contribution : aide à la passation et à la conception expérimentale, traitements et analyses des données MEG et IRM anatomique

Objectif : *Tester les modèles courants de la production de mots* ancrés dans la psycholinguistique, le contrôle moteur et les neurosciences.

Paradigme – Au cours de l'examen MEG, des noms ou de verbes sont présentés sur un écran et précédés soit par un pronom (possessif pour le nom et personnel pour le verbe) soit par un symbole (####). La tâche du sujet consiste en une à détecter des pseudo-mots insérés en faible proportion (10%) dans ces séries de mots.

Passation – Le CREx a contribué à la passation de 35 sujets. Les données MEG et IRM anatomiques ont été acquises dans ce projet.

Prétraitement – Le prétraitement des données a été réalisé principalement à l'aide du logiciel Brainstorm (cf. Annexe pour plus de détails)

Analyse – (cf. Annexe pour plus de détails)

Diffusion – (cf. section Publications)

Vendredi 24 Juillet 2015

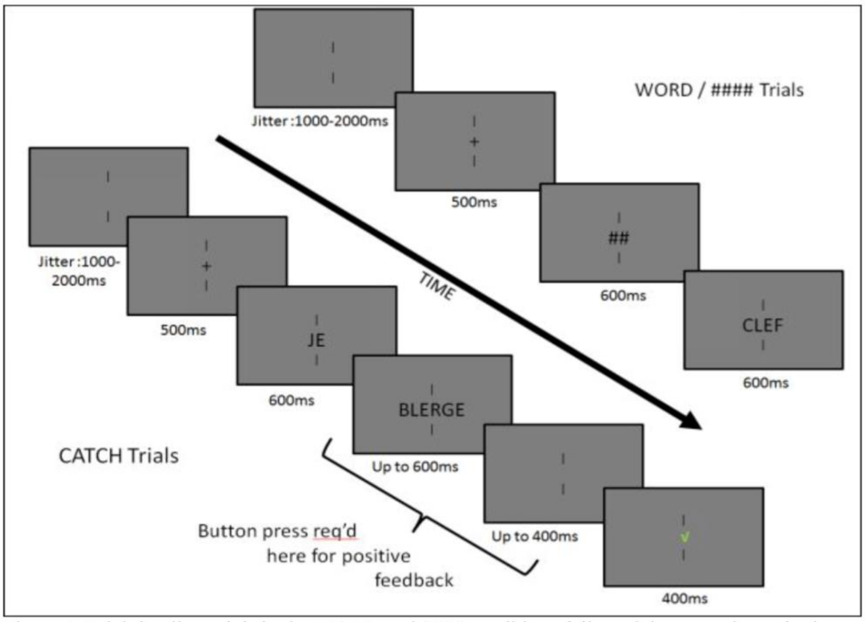
Annex

Short description of Experimental Protocol

Participants are presented with (a) possessive/personal pronouns (600 ms) or (b) meaningless symbols (####), followed by nouns/verbs (600 ms)

600ms	**600ms**
Prime	*Target*
tu	PRENDS
ta	CHAISE
##	PRENDS
##	CHAISE

MEG Task: Lexical decision on the TARGETS (noun-verb presentations). About 10% of the trials (catch trials) were pseudowords and required a button-press.



DATA RECORDING AND PROCESSING

MEG recordings

Continuous MEG of cerebral activity was recorded using a whole head, 248-channel biomagnetometer system (Magnetometers. 4D Neuroimaging, San Diego, CA, USA). Recordings were obtained from subjects in supine position in order to limit the movement during the recording. Electro-(EOG) and electrocardiogram (ECG) were recorded simultaneously to facilitate the ulterior rejection of eye movements and cardiac artifacts.

In order to determine the location of the head with respect to the MEG array, five coils were fixed on the subject's head. The position of these coils as well as the surface of the head were digitized with a

3-D digitizer (Polhemus Fastrack, Polhemus Corporation, Colchester, VT, USA), and head position was measured at the beginning and at the end of each run. The head shape obtained from the digitization of the head was used to check and eventually compensate for differences in head position between runs or to match to the participant's MRI. All participants were scanned with MRI to get a high resolution T1 volume with a 1mm voxel dimension. Brain activity was recorded at a sampling rate of 678.17 Hz with a DC-400Hz bandwidth. A recording session consisted of approximately one 14 minutes run.

MEG an MRI preprocessing

The cortical surface was reconstructed using FreeSurfer software (http://freesurfer.net) for each individual from high-resolution 3D T1-weighted **MRI structural image** (3T Brucker, Timone Hospital, Marseille). Functional and structural data were exported in Brainstorm software (http://neuroimage.usc.edu/brainstorm//) in order to achieve preprocessing, cortical sources and anatomical regions of interest (ROI) analyses.

In Brainstorm system (CTF), the cortex surface was defined with 15000 vertices and the MRI was realigned on six fiducials (nasion, left and right pre-auricular point, anterior and posterior commissure, and Interhemispheric point. The alignment of head points and MRI were also controlled visually.

MEG data was first filtered by a band-pass filter in the range of 0.3-300 Hz (Butteworth IIR filter, 2-order filter and zero-phase forward and reverse filter) using Anywave software (http://meg.univ-amu.fr/wiki/AnyWave). The rejection of system artifacts on MEG signal were performed visually on the basis of the combination of the power spectrum density (Welch) and the 3D sensor topography. The cardiac and ocular artifacts were detected and removed using the Signal-Space Projection Process.

Before epoching, the signal was filtered by a low-pass filter of 40 Hz and corrected with a baseline defined between -200 ms and 0 milliseconds. Event-Related Fields (ERFs) were time-locked to stimulus prime onset and epoch was comprised between -200 and 1200 ms. For artifact rejection on trials, a cut-off of 3000 fT was used to remove marginal trials and a manual inspection to improve the quality of trial sets. Only successful and good trials were retained for the sensor averaging.

The sensor averaging was computed for each participant and represented the mean time courses per channel over epochs of the same experimental condition (Predicted nouns, Predicted verbs, Unpredicted nouns and Unpredicted verbs).

The cortical sources of the neuromagnetic activity were calculated using Minimum-Norm Current Estimates (wMNE) with constraints on source orientations. The forward modeling method was overlapping spheres one, the number of dipoles used for source estimation was about 15,000. For each dipole the time course was normalized relative to the baseline (-200 to 0 ms) to compute an absolute z-score.

Anatomical ROI analysis

Brainstorm distribution includes predefined segmentations of the default anatomy (MNIColin27, Collins et al, 1998) into regions of interest based on the anatomical atlases of Tzourio-Mazoyer et al. (2002). These anatomical regions of interest are called 'scout' in Brainstorm software.
The Desikan and Killiany atlas consisted of 68 cortical scouts and 4 sub-cortical scouts (left and right hippocampus and amygdale) were selected in our study. For each subject and for each experimental condition (Predicted nouns, Predicted Verbs, Unpredicted nouns and Unpredicted Verbs), all 68 scout time series were extracted on the basis of an averaging of the absolute values of all the scout source signal. Scout time series were imported in Matlab for statistical analyses and reporting. Traditionally, event-related magnetic fields (ERFs) are typically analyzed via ANOVAs on mean activity in a priori windows. Here, we conducted voluntary a mass univariate analyses to have no a priori knowledge of effect locations and latencies. The approach consists of thousand of non-parametrical statistical tests (permutation tests via EEGLAB toolbox Delorme & Makeig, 2004) on each time point and corrections for multiple comparisons (False Discovery Rate; Bejamini & Yekutieli, 2001).

MAIN RESULT ON SOURCE ANALYSIS PER ROI

MEG task. Participants are asked to make a lexical since they are presented with (a) possessive/personal pronouns (600 ms) or (b) meaningless symbols (####), followed by nouns/verbs (600 ms)

Independent variable. MEG signal on sources per ROI an per timepoint (25ms of duration)

Dependent variables

- 2 levels for the nominal factor: word or veb
- 2 type of pronouns :   possessif or personal

Statistical Analysis. Mass univariate analyses (with no a priori knowledge of effect location and latency): 2000 non-parametrical **permutation tests** (EEGLAB toolbox, Delorme & Makeig, 2004) were computed on absolute sources values per ROI and per time point. Corrections for multiple comparisons (False Discovery Rate; Bejamini & Yekutieli, 2001) were also computed on pValues.

Only significant differences in frontal regions for the interaction between noun and pronoun classes are presented on the Figure 1. For more details, see Strikers et al. (in preparation).

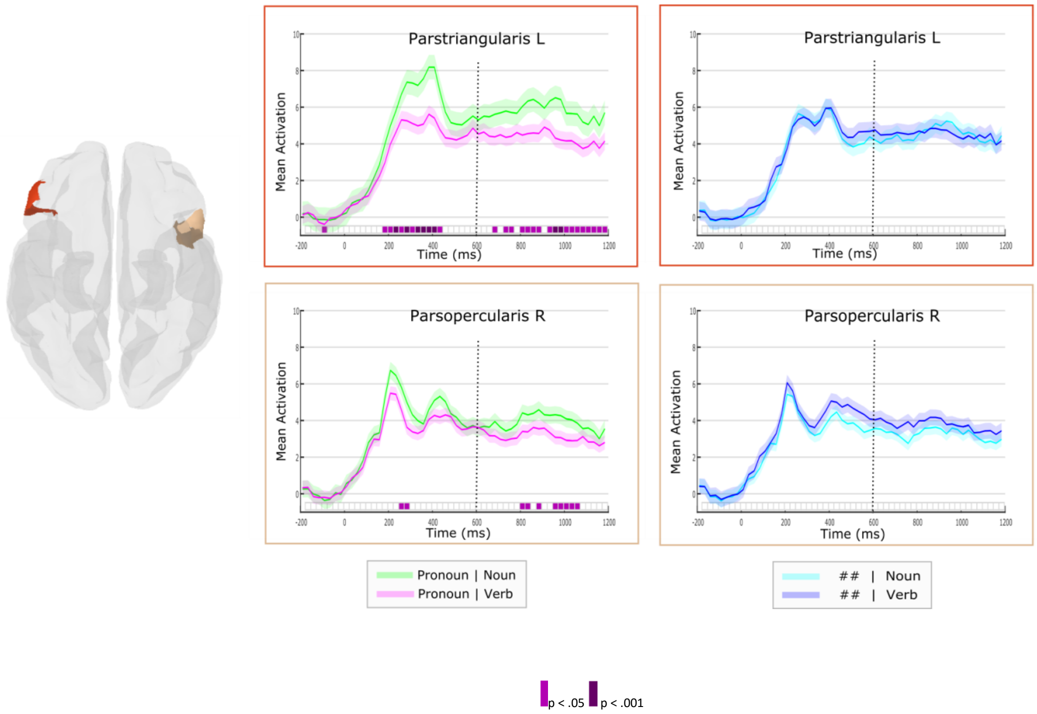


Figure 1. In the interaction between noun and pronoun classes, two regions of Interest in Frontal Gyrus were revealed in permutation tests: the Infero-Frontal Gyrus pars Triangularis on left hemisphere (Parstriangularis L) and the Infero-Frontal Gyrus pars Opercularis on right side (Parsopercularis R).

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N. Tzourio-Mazoyer, N., Landeau, B., Papathanassiou D. et al. (2002). “Automated anatomical labeling of activations in SPM using a macroscopic anatomical parcellation of the MNI MRI singlesubject brain,” *NeuroImage*, vol. 15, no. 1, pp. 273–289.

Delorme, A., & Makeig, S. (2004). EEGLAB: An open source toolbox for analysis of single-trial EEG dynamics including independent component analysis. Journal of NeuroscienceMethods, 134, 9–21. doi: 10.1016/j.jneumeth.2003.10.009.