Project

The role of consciousness and top-down processes on the contribution of the auditory cortex during reading

Chotiga Pattamadilok[(1)], Johannes Ziegler[(2)], Pascal Belin[(3)]

(1) LPL, (2) LPC, (3) INT

Abstract

De nombreuses études comportementales ont montré que la reconnaissance des mots écrits est influencée par les représentations phonologiques qui leurs sont associées. Au niveau cérébral, cela se traduit par la présence de l'activité dans les régions « phonologiques » durant la lecture. Notre étude cherche à caractériser les conditions d'apparition de cette activation « cross-modale », à savoir si cette activation a lieu de manière systématique dès que les mots écrits sont perçus et ce indépendamment de la tâche effectuée par les participants.

Publications

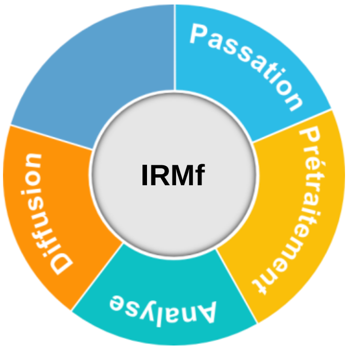
Pattamadilok, C., Chanoine, V., Pallier, C., Anton, J-L, Nazarian, B., Belin, P., Ziegler, J.C (2017). Automaticity of phonological and semantic processing during visual word recognition. Neuroimage. Vol 149. Pages 244–255

Poster

Pattamadilok C., Chanoine V., Anton J-L, Nazarian B., Pallier C., Belin P., Ziegler J. (2015). The influence of bottom-up and top-down information on the activation of orthographic, phonological and semantic representations during reading. Society for Neurobiology of Language, 15-17 octobre 2015, Chicago, USA.

Pattamadilok C., Chanoine V., Anton J-L, Nazarian B., Pallier C., Belin P., Ziegler J. (2015). The role of bottom-up and top-down processes in the activation of orthographic, phonological and semantic representations during reading. Workshop BLRI 2015 (France)

Fiche-résumé contribution CREx



Intermod

The role of consciousness and top-down processes on the contribution of the auditory cortex during reading

Investigateurs : Chotiga Pattamadilok (LPL), Johannes Ziegler (LPC), Pascal Belin (INT).

Durée : 17 mois (depuis novembre 2014-avril 2016)

Contribution : Aide à la passation. Elaboration des routines de pré-et post- traitements des données. 3 analyses (du cerveau entier ou par régions d'intérêt) ont été conduites.

Objectif : *Etudier la contribution du système auditif pendant la lecture.*

Paradigme – Les participants doivent effectuer 3 tâches pendant l'examen IRMf : une détection de symboles ('&&&&'), une détection de phonèmes ('/o/') et une tâche sémantique ('animal'). Les variables manipulées sont : la demande cognitive liés au facteur *top-down* (tâche visuelle, phonologique et sémantique) et la visibilité de l'entrée visuelle liés au facteur *bottom-up* (L0 niveau subliminal –L1 – L2 – L3 niveau conscient).

Passation – Passation effectuée sur 25 volontaires.

Prétraitement – Elaboration des routines de prétraitements des données sur SPM8

Analyse – 3 analyses principales ont été réalisées

- Analyse du cerveau entier (modèle linéaire généralisé (GLM ou *General Linear Model* ; voir Figure 1)
- Analyse par régions d'intérêt (ROI) probabilistes à l'aide de la boîte à outils spm_ss
- Mixed model Analysis in ROI analysis (voir Figure 2)

Diffusion – (voir section Publications)

- 1 article publié dans Neuroimage et 2 posters

- 1 publication dans Neuroimage

Annexe

Short description of Experimental Protocol

Experimental protocol during functional MRI scanning. Each session started with a short instruction indicating the task to perform (symbol, rime or animal). The participants were required to push the response button as they detected a Go trial (symbol '&&&&' for visual detection; 'words ended with the sound /o/' for phonological detection and 'animal' for semantic detection).

Independent variable: BOLD (blood-oxygen-level dependent) signal on each voxel (contraction of *volumetric pixel, in our case, one voxel had a volume of* $3mm^3$)

Dependent variables

- 3 levels for cognitive demand (top-down factor): Visual, Phonological and Semantic tasks.
- 4 levels of input visibility (bottom-up factor): L0 (lowest), L1, L2, L3 (highest). The interval between word and masks was manipulated to obtain the 4 levels of visibility

Data acquisition and preprocessing

Data acquisition was performed on a 3-T MEDSPEC 30/80 AVANCE imager (Bruker, Eittlingen, Germany) at the fMRI centre of Marseille, France. A fieldmap acquisition (3D FLASH sequence inter-echo time 4.552 ms) was collected in order to estimate and correct the B0 inhomogeneity. Functional images were acquired using a T2*-weighted gradient-echo planar sequence with 36 interleaved 3 mm-thick/1 mm-gap slices (repetition time = 2.4s, echo time = 30 ms, field of view = 192 mm, 64×64 matrix of 3×3×3 mm voxels). During the main tasks, a total of 1080 functional scans were acquired during six sessions of 180 scans each. During the localizers, 140 functional scans were acquired. Whole brain anatomical MRI data was acquired during the behavioural forced-choice task using high-resolution structural T1-weighted image (MPRAGE sequence, resolution 1×1×1 mm) in the sagittal plane.

The fMRI data were pre-processed and analyzed using SPM8 software (Welcome Institute of Cognitive Neurology, London, UK). The four five volumes of each run were discarded to ensure that the longitudinal relaxation time equilibration was achieved. The anatomical scan was spatially normalized to the avg152 T1-weighted brain template defined by the Montreal Neurological Institute using the default parameters (nonlinear transformation). Functional volumes were corrected for slice timing differences, realigned, spatially normalized (using the combination of deformation field, coregistred structural and sliced functional images) and smoothed with an isotropic Gaussian kernel (FWHM=6mm). The fieldmap images were used during the realign and unwarp procedure for distortion and motion correction.

Statistical Analysis: Whole Brain Analysis using GLM

For each subject, a general linear model was generated. It included, for each of the two sessions per task, 18 regressors modelling the 12 combinations of task and level of visibility of the Nogo trials (i.e., visual/L0; visual/L1; visual/L2; visual/L3; phonological/L0; phonological/L1; phonological/L2; phonological/L3; semantic/L0; semantic/L1; semantic/L2; semantic/L3), the three mask (one per task) condition (one per task) and the three types of Go trials for motor responses (one per task).
For the group analysis, individual contrast maps representing coefficients to the 12 regressors (three tasks by four levels of visibility) of the Nogo trials and the three regressors of mask trials were smoothed with a Gaussian filter (FWHM of 8 mm). In a group analysis of variance (random effects analysis), they were entered with one regressor per subject using Statistical Parametric Mapping sotware (SPM8, http://www.fil.ion.ucl.ac.uk/spm/software/spm8/).
The influence of bottom-up information was examined by searching for the areas where activation increased linearly with the visibility of the stimulus. A linear contrast with the weights -3, -1, 1, 3 for the L0, L1, L2 and L3 level of visibility, respectively, was used to estimate the slope of the BOLD response (see Figure 1b).

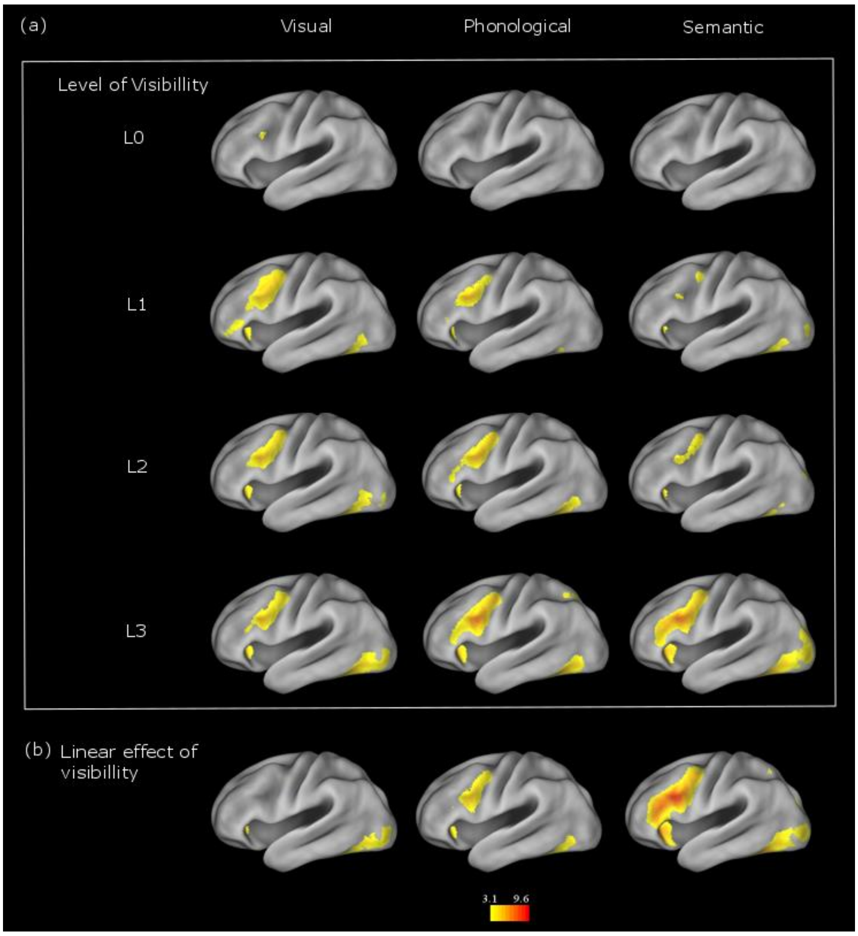


Figure 1. (a)Whole Brain Analysis and comparison between activation and baseline condition as a function of task demand and level of Visibility. A statistical significance threshold of *p*<.001 (uncorrected for multiple comparisons) and a spatial extent threshold of at least 5 contiguous voxels was used in the random effects analysis. [L=Level of Visibility : L0 (lowest), L1, L2, L3 (highest); (b) Linear effect of visibility using an weighting of -3 -1 1 3 for L0 L1, L2, L3 respectively.

Example of mixed models in region of interest analysis

Overall, the activity of most brain areas that are sensitive to stimulus visibility also seems to be modulated by task demand. Seven ROIs were revealed by the analyses of the interactions between the linear effect of visibility and task. On the Figure 2, the BOLD signal was extracted from these 7 ROIs defined as intersections of spheres of 10mm radius with the clusters obtained in a conjunction analysis of the three tasks (a combination of Visual, Phonological and Semantic tasks). Mixed effect models were performed on the mean of BOLD amplitude extracted from each ROI, with task and stimulus visibility as fixed factors and subjects as random factor.

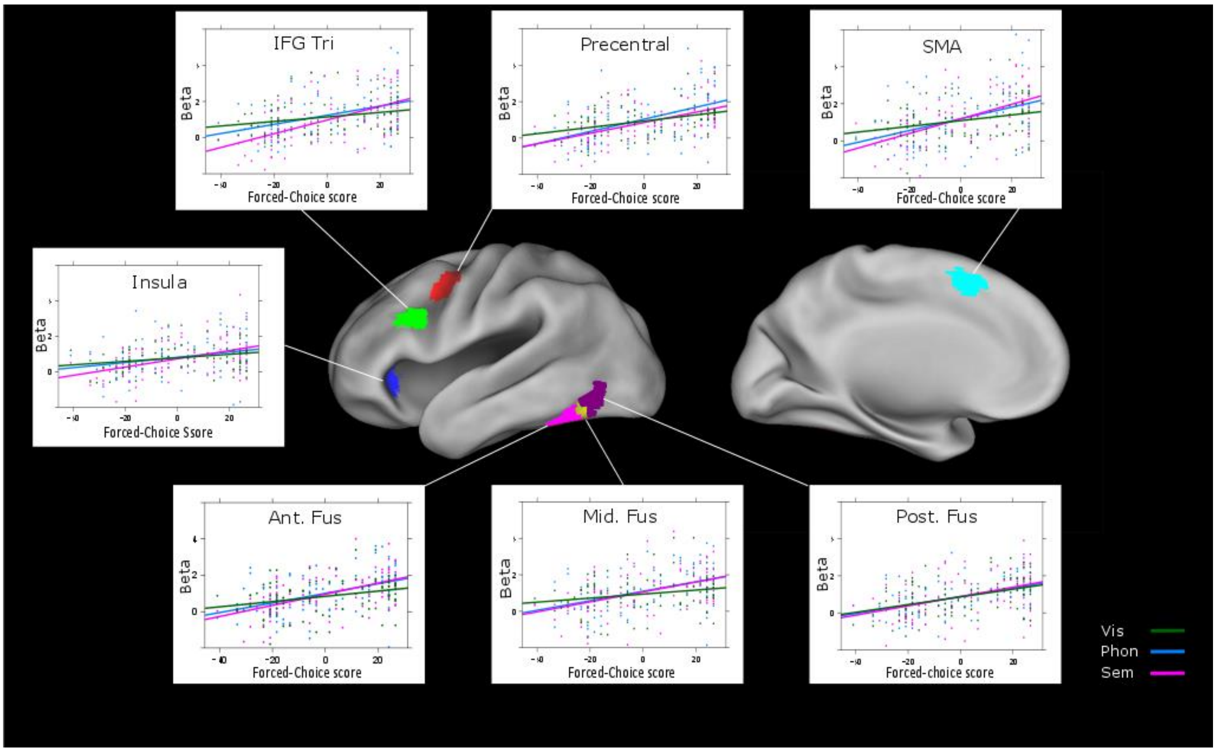


Figure 2. Region of Interest Analysis to study the interaction between task demand [Vis for Visual, Phon for Phonological and Sem pour Semantic tasks] and level of Visibility (correct Score as a function of L0, L1, L2 et L3 Visibility) on Beta values (mean of BOLD amplitude per ROI). 7 ROIs in left hemisphere were studied: Infero-Frontal Gyrus pars Triangularis (IFG Tri), Precentral cortex, Supplementary Motor Area (SMA), Insula, Anterior Fusiform gyrus (Ant. Fus), Middle Fusiform gyrus (Mid. Fus), Posterior Fusiform gyrus (Post. Fus).