Published in : NeuroImage (1998), vol. 7, n°4, pp. S883
DOI: -
Status : Postprint (Author's version)

Processing of Contextual Information during an Implicit Probabilistic Sequence Learning Task: Left Ventrolateral Prefrontal Cortex Involvement

Philippe Peigneux[1], Pierre Maquet[1'], Martial Van der Linden[2], Thierry Meulemans[2], Christian Degueldre[1], Guy Delfiore[1], André Luxen[1], Axel Cleeremans[3], Georges Franck[1]

[1]*Cyclotron Research Center, Université de Liège, Belgium*
[2]*Department of Neuropsychology, Université de Liège, Belgium*
[3]*Cognitive Science Research Seminar, Université Libre de Bruxelles, Belgium*

Introduction

This study explores the cerebral structures involved in implicit learning by means of a serial reaction time (SRT) task in which the sequence of stimuli was based on a probabilistic finite-state grammar, and in which random material was interspersed with structured material[(1)]. Regional cerebral blood flow (rCBF) was recorded in a positron emission tomography (PET) experiment while participants performed the aforementioned SRT task without any prior practice.

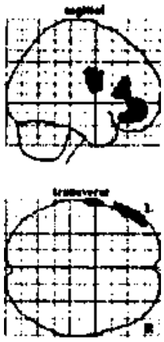
Task

Ten normal right-handed subjects performed a six-choice reaction time (RT) task and were instructed to press with the right hand as fast and as accurately as possible on the key corresponding to the location of a stimulus appearing on a screen. Unknown to them, the sequential structure of the material was manipulated by generating successive stimuli based on a finite-state grammar. To assess learning, there was a 15% chance on each trial of replacing the grammatical (G) stimulus with a non-grammatical (NG), random stimulus. This procedure generates material such that the predictability of each stimulus depends probabilistically on the context set by previous elements of the sequence, and predictable G stimuli should thus elicit faster responses than NG stimuli only if the context in which stimuli may occur has been encoded by participants. This contextual sensitivity implicitly emerged through practice as a gradually increasing difference between the RTs elicited by G and NG stimuli occurring in contexts defined by either one (i.e., variable LI) or two (i.e., variable L2) previous stimuli.

Brain mapping

Twelve PET scans were obtained with a Siemens CTI 951 R 16/31 scanner in 3D mode. The rCBF was measured using $H_2{}^{15}O$ infusions during practice of the SRT task. After data spatial transformations (realignment, coregistration to individual Tl-weighted MRI scans, and 16mm smoothing) and using SPM96[(2)], the specific rCBF response to the interaction between LI (or L2) and the increasing time was estimated using a design matrix which included the latter variables, block effect and global activity as confounding covariates. Results are significant at cluster level $p < 0.05$.

Published in : NeuroImage (1998), vol. 7, n°4, pp. S883
DOI: -
Status : Postprint (Author's version)



CONCLUSION

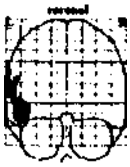


Figure: SPM{Z} thresholded at voxel and cluster level corrected p<0.05

RESULTS

Statistical analysis of the RTs for G and NG stimuli revealed a significant effect of the interaction between grammaticality and global RT in LI context, in accordance with previous studies'", suggesting that with restricted practice participants are able to learn about the constraints set only by the preceding trial. Significant correlated rCBF responses were observed (see figure) in left ventrolateral frontal (BA 10/47; -52 50 -6; Z = 4.74, $p^{corr} < .016$) and left precentral gyrus (BA 4; -66 -2 22; Z = 4.70, $p^{corr} < .019$).

Ventrolateral prefrontal cortex has been found mainly activated in naming and reading tasks, but to our knowledge it is the first time that a relationship is highlighted between the metabolic activity of this cortical area and the processing of contextual information in a sequential learning paradigm. Further studies should precise the role of this cerebral region in the processing of more sophisticated contextual information.

REFERENCES

1. *Jimenez L. et al. J. Exp. Psychol.:Learn. Mem. Cog. 1996; 22: 948-969.*
2. *Friston K.J. et al. Neuroimage 1997; 6: 218-229.*

This research was supported by a grant of the Belgian National Fund for Scientific Research P. Peigneux is supported by the Interuniversity Poles of Attraction, Program P4/22, Belgian State. Prime Minister's Office, Federal Office for Scientific, Technical and Cultural Affairs