Neural basis of irony in patients with Multiple Sclerosis : an exploratory fMRI study

Quentin Duché, Florian Chapelain, Elise Bannier, Jean-Christophe Ferré, Philippe Allain, Philippe Gallien, Virginie Dardier, Christian Barillot

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M. Quentin DUCHE[1], M. Florian CHAPELAIN[2,3], Mme Elise BANNIER[1,4],M. Jean-Christophe FERRE[1,4], Philippe ALLAIN[4,5], M. Philippe GALLIEN[2], Mme Virginie DARDIER[6], M. Christian BARILLOT[1]

1-Univ Rennes, Inria, CNRS, Inserm, IRISA, EMPENN ERL U1228, F-35000, Rennes, France
2- Pôle MPR Saint-Helier, Rennes
3- Bretagne Loire University-Rennes 2, Laboratory of Psychology: Cognition, Behaviour, Communication (LP3C, EA 1285).
4-Radiology Department, University Hospital of Rennes, France
5-Neuropsychology Unit, Neurology Department, University Hospital of Angers, Angers, France
6-Laboratory of Psychology of the Pays de la Loire, PRES Lunam, University of Angers, Angers, France

Text constraints :Title 100 characters, Text 4000 characters

Introduction

Irony is a form of non-literal language that is characterized by the opposition between the literal meaning of a statement and the message that the speaker wishes to convey. Its role is essential in social interactions since it makes it possible to convey a judgment (positive or negative) in an indirect way about a situation or a person. It is also a complex form of language that requires the involvement of various cognitive processes such as the formation of representations of mental state which is called theory of mind. Knowledge about the neural bases of non-literal language has largely developed in recent years from injury studies or more recently through data from functional imaging studies. This research has highlighted the participation of a vast bilateral fronto-temporal network that covers in part the brain areas recruited during tasks of theory of the mind. (Rapp et al., 2012 ; Reyes-Aguilar, 2018). Multiple sclerosis (MS) is a neurodegenerative disease that, in addition to cognitive dysfunction, results in variable impairment of theory of mind and non-literal language skills. However, to our knowledge, only one very recent study investigated the neural bases involved in the comprehension of complex language (Carotenuto et al., 2018). This work aims at exploring neural basis underpinning the comprehension of irony in MS patients compared to a group of healthy subjects.

Methods

After approval from the Institutional Review Board, 21 healthy controls (14 women, mean age 43.9) and 20 MS patients (14 women, mean age 45.7), all right-handed and matched in years of education were included in the study. Participants were presented with 90 stories for each of which they had to evaluate a statement (ironic or not). The statement could either be sincere, ironic or unrelated (30 items for each type) in regard of the previously displayed context (Fig1). The participants were scanned using a 3T MRI scanner (Magnetom Verio, VB17) equipped with a 32-channel phased-array coil. A structural scan was obtained with an MPRAGE sequence (TR = 1900 ms, TE = 2.26 ms, TI = 900 ms, flip angle = 9°, voxel size = 1x1x1mm3) and functional data was obtained with a single-shot spin-echo EPI sequence with the following parameters: TR=2000ms, TE=30ms, 36 axial slices, voxel size = 3x3x3mm3, slice thickness of 3 mm. The data were processed using SPM12. For individual analysis, the BOLD signal was modelled using a 4 regressors general linear model (3 statement types and context), where each regressor was constructed as the convolution of the onsets modelled with a boxcar function of duration equal to the reaction time with the canonical hemodynamic response function and six movement parameters as regressors of no interest. Trials that were incorrectly identified were excluded from the analysis. The contrast of interest was irony-specific activations (irony *vs* sincere). The contrast maps were computed individually and brought into a second level analysis to infer group activation results. Reported statistical maps show activations exceeding a voxel-level FWE-corrected threshold of $p<0.05$.

Results

There were no statistically significant differences in the percentage of correct answers in either of the trial types between both groups. A slightly, but significant, longer reaction time was measured for MS patients compared to healthy controls (+300 ms) consistent across statement types. A higher activity in three left hemispheric clusters was observed: middle occipital, lingual and fusiform gyri in MS patients when they were exposed to ironic statements compared to sincere statements while no significant cluster was found in healthy controls. However, the between-group analysis did not reveal any significant differences. These results are summarized in Fig2.

Conclusions

These results suggest that multiple sclerosis patients require higher left hemisphere resources than healthy controls to understand irony.

Figure 1. Example of a single (ironic) trial that participants underwent when performing the event-related task. The task consisted of 90 randomly selected trials, 30 for each statement type (ironic, sincere, unrelated) across three runs of 10 minutes and 20 seconds. A single trial lasted 18s and consisted of the following sequence : 1) reading a neutral context (5s), 2) viewing a fixation cross (2s) 3) reading a statement (5s) 4) providing an answer (ironic or not ironic) in up to 5s and 5) viewing a fixation cross for up to 6s.

References

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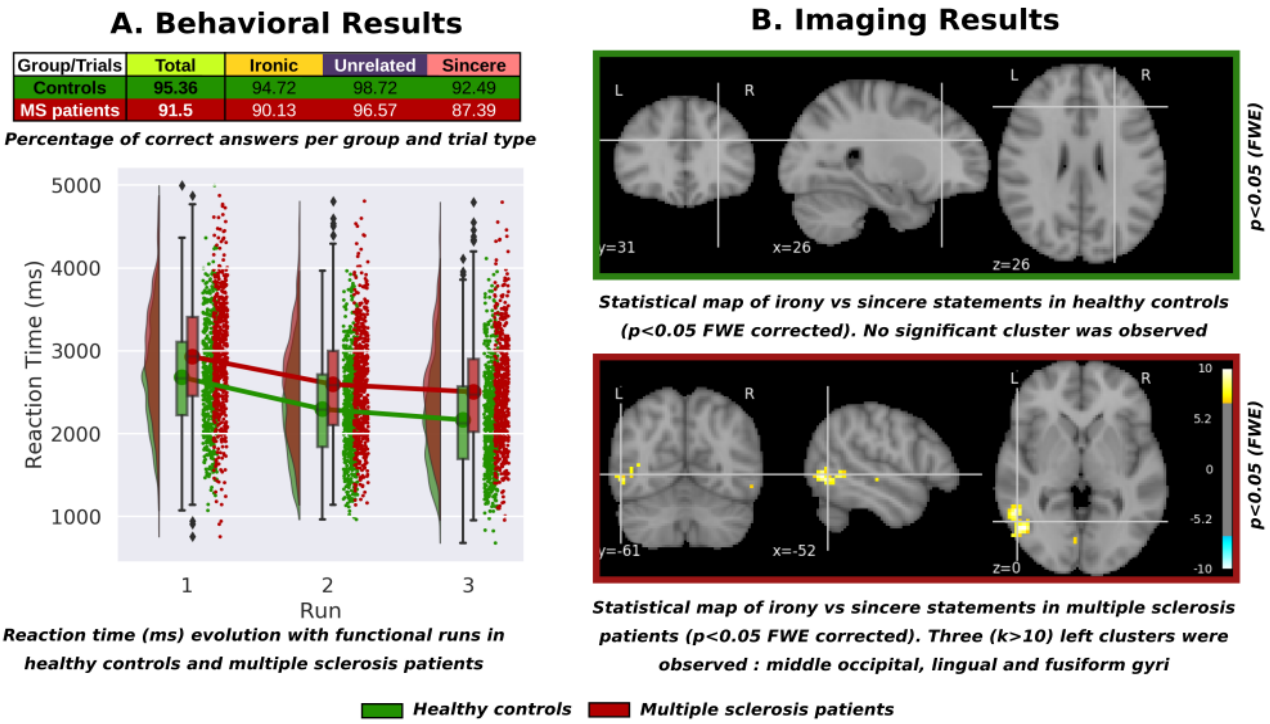

Figure 2. A Behavioral results demonstrate comparable results in the percentage of correct answers. The reaction times analysis demonstrate a slighly longer reaction time for the MS group (+300 ms on average). **B**. In the MS group, three significant clusters were found in three left clusters: middle occipital gyrus (-48,-67,1, k=57), lingual gyrus (-18,-70,-10, k=25) and fusiform gyrus (-33,-70,-16, k=14)