Introduction

Hierarchical relations between words impact sentence comprehension and are often formalized through tree-like structures (Fig. 1A). Their structural complexity has been consistently shown to correlate with activity in core brain areas of the language network (Ben-Shachar et al. 2004; Pallier et al. 2011; Shetreet and Friedman 2014; Nelson et al. 2017). Along with such structural complexity, different computational parsing strategies can be used to investigate the neural correlates of syntactic structure-building. Modelling how sentence structure can be parsed can reveal different sub-components of sentence processing and syntactic complexity.

Questions

If we computationally decompose sentence structure processing into constituent-structure building and sentence-level predictive processes, can we observe distinct neural correlates for these two aspects of syntactic structure-building?

Bottom-up and Top-down Parser Action Count

By comparing the fMRI activation patterns to bottom-up (BU) and top-down (TD) parsing strategies (Fig. 1B&C), we aim to unravel different components of the complex cognitive process of sentence-structure building:

- BU can instantiate constituent-structure building. It builds and collects sub-parses towards the end of the phrase/sentence, while the rules of a grammar are applied at each incoming word (see Fig. 2A left).
- TD better approximates expectation-driven structural processing, as rules are applied predictively, in advance of each word, thus assigning higher scores at the beginning of sentences (see Fig. 2B left).

Data Collection

Participants (n=51) were college-aged, right-handed, native English speakers. They listened to a spoken recitation of *The Little Prince* for 1 hour and 38 minutes across nine separate sections; 15,388 words in total. Comprehension was confirmed through multiple-choice questions at the end of each section.

Analysis

Regression analyses reveal that the activation patterns for BU and TD are largely bilateral and involve different brain areas. For BU the peak activation is observed in the right TP. While ATL involvement is bilateral, one of the main clusters is extending from STG to MTG is right-lateralized. Increased activation of LIFG and RIFG stretching over Pars Orbitalis and Triangularis, to the anterior Insula (/Putamen) was also observed (Fig. 2A). For TD, two bilateral clusters were observed along STG extending from its posterior portion to MTG, reaching TP in the right hemispherc (Fig. 2B).

Results

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Conclusion

Predictive syntactic processes modeled by TD strategy evoke an activation pattern that is spatially-dissociable from compositional structure-building modeled by BU strategy. Thus, replicating findings about prediction during story listening *(surprisal* Willems et al. 2015).

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Selected References