

Sentence-level repetition priming as measured by brain activity is modulated by syntactic complexity and task demands



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Introduction

- Stimulus repetition results in behavioral facilitation (priming) and repetition suppression (RS) of neuronal and hemodynamic responses.
- Repetition priming and suppression suggests some kind of neural “object” representation mediates RS.
- Do specific utterances have persevering neural representations?
- Are syntactically simple and syntactically complex sentences represented in the same way?
- If comprehension of sentences is held constant, how do activation patterns in cortical networks depend on task differences?

Methods

Tasks

- ‘Active’ task: Ps (n=14) listened to spoken sentences. Button press for grammatical violation.
- ‘Passive’ task: Ps (n=11) listened to spoken sentences

Stimuli

- Simple (S1 and S2): 36 conjoined clauses; each sentence repeated once
- Complex (C1 and C2): 36 nested subject and object relative clauses; each sentence repeated once
- Grammatically incorrect: 48 Sentences with grammatical violations (‘Active’ task only).

Acquisition

- fMRI, 3T; head coil; 30 spiral gradient echo T2* functional images; TR = 2; 320 (‘Active’) or 240 (‘Passive’) whole brains collected in each of 3 runs.

Analysis

- Regression with estimates of the hemodynamic response.
- Coefficients were normalized, transformed into a standardized space, and entered into group ANOVAs.

Results

- RS obtained for simple and complex sentences in ‘traditional’ language areas of the brain, including the superior temporal gyrus and sulcus (STG/STC) and middle temporal gyrus and sulcus (MTG/MTS), in both ‘active’ and ‘passive’ tasks (**Figure 1**).

- Simple and complex sentences produced different patterns of RS within the STG/STC suggesting different neural processing across sentence types (**Figure 1**).

- ‘Active’ and ‘passive’ tasks produced very different cortical activity for both simple and complex sentences. The two tasks overlapped only for small clusters in posterior pSTG/STC and the inferior frontal gyrus (IFG) for RS associated with simple sentences and anterior aSTG/STC, the MTG, and the IFG for RS associated with complex sentences (**Figure 2**).

- The difference between the ‘active’ and ‘passive’ tasks primarily consisted of greater effects on pSTG, IFG, MFG, and precentral gyrus and the insula for the ‘active’ task even though no behavioral responses were made to the sentences (**Figure 3**).

Discussion

- Syntactically complex sentences produce more RS in more anterior STG and IFG. These regions have been previously implicated in the processing of connected discourse, syntax, and semantics.
- Although no overt response was made to sentences in either the ‘active’ or ‘passive’ task, RS for the simple and complex sentences was substantially different. Imposition of an active task (e.g. detecting non-sentences) can greatly modify sentence processing.
- Cortical network for comprehension depends on complexity of sentences and task factors thought to be independent of sentence comprehension.

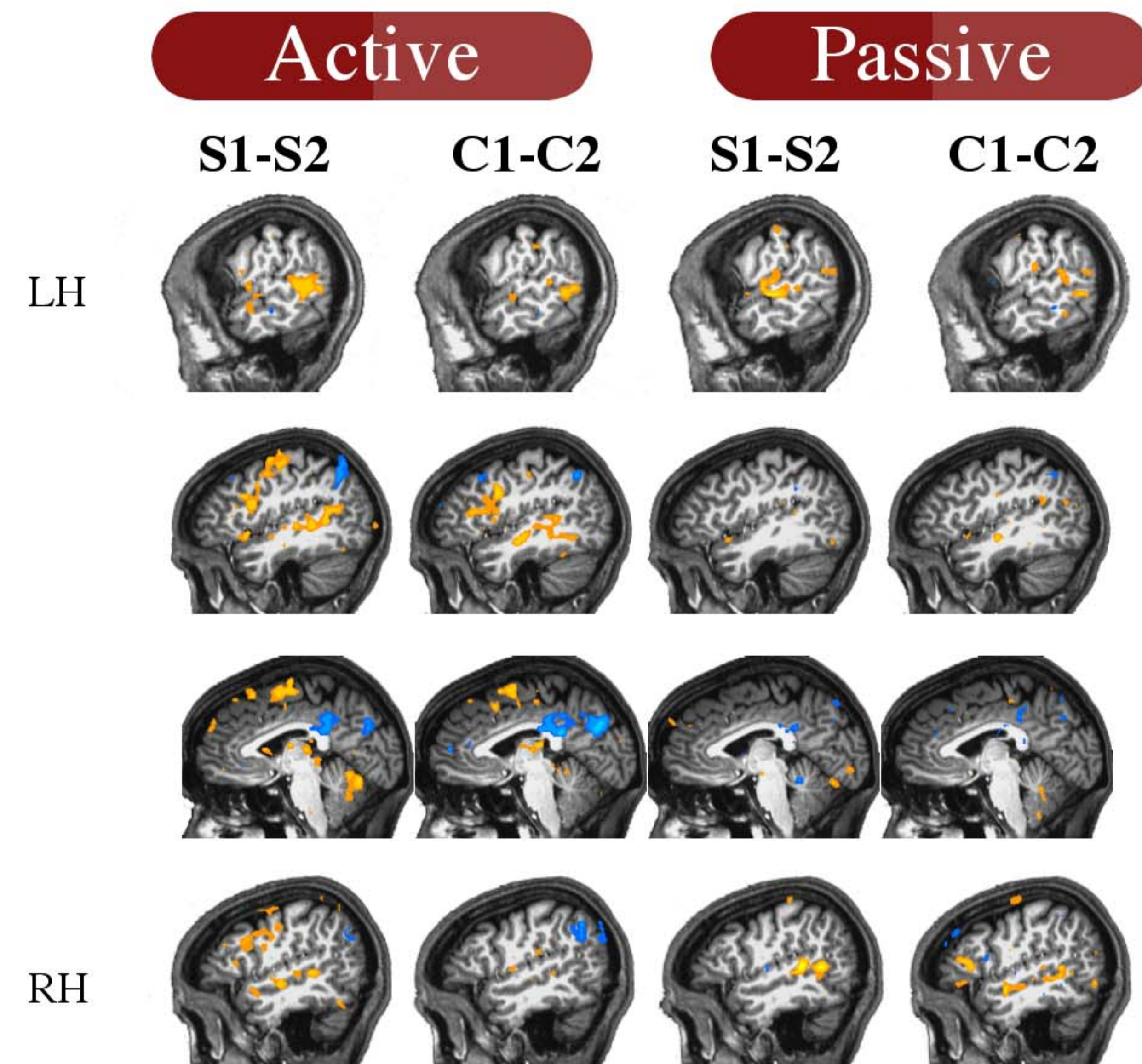


Figure 1. Activation associated with the comparison of the first and second presentations of simple (S1-S2) and complex (C1-C2) sentences for the ‘active’ ($t(13)=2.426$, $p<.02$ corrected) and ‘passive’ ($t(11)=2.426$, $p<.02$ corrected) tasks. Oranges are higher in the first and blues higher in the second presentation.

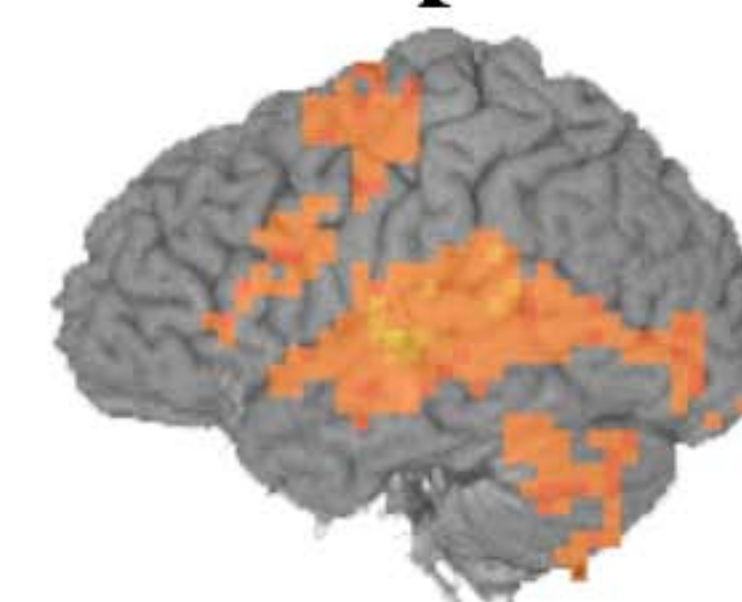
Active and Passive Overlap



Figure 2. Conjunction of activation for the comparison of the first and second presentations of simple (S1-S2) and complex (C1-C2) sentences for the ‘active’ and ‘passive’ tasks ($p<.001$ corrected).

Active

Simple 1



Passive

Simple 1

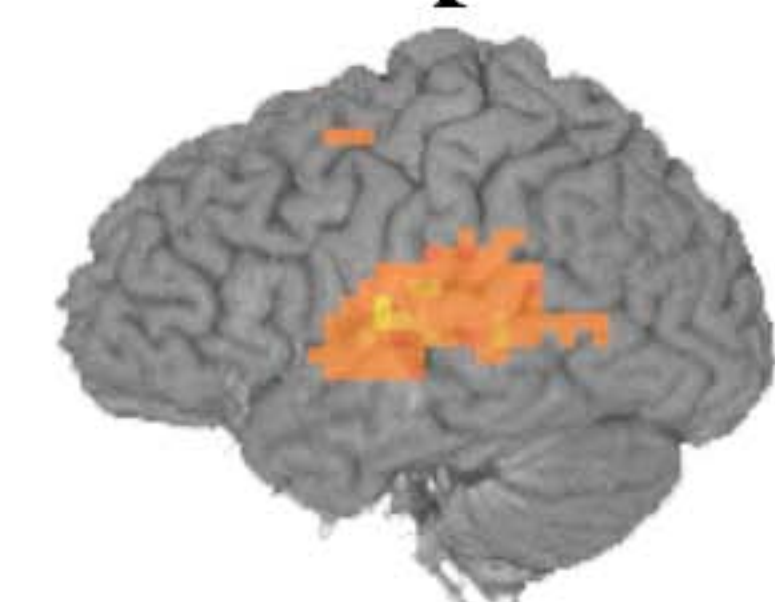


Figure 3. Activation associated with the first presentation of the simple sentences for the ‘active’ ($t(13)=5.287$, $p<.00005$) and ‘passive’ ($t(10)=5.287$, $p<.00005$) tasks.

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