

# Hypoactivation of the Linguistic Processing Network Contributes to Hallucinations

Besso, Larivière, Roes, Yip, Sanford, Percival, Damascelli, Lim, Enz, Moscovitz, Menon, Ćurčić-Blake, Aleman & Woodward

Department of Psychiatry, UBC

## Introduction

- Auditory verbal hallucinations (AVHs) involve perceptions, often voices, without external stimuli and are one of the most common symptoms of schizophrenia<sup>1</sup>.
- The metrical stress (MS) task invokes auditory imagery by eliciting phonological processing<sup>2</sup>. Due to the relation between auditory imagery and AVHs<sup>1,3</sup> this task can be used in neuroimaging studies of AVHs.
- In recent years, a universal linguistic processing network (LPN) has begun to emerge, consisting of a left-lateralized frontotemporal network with key regions such as the left inferior frontal gyrus<sup>4,5</sup>, also known as Broca's area. It has been suggested that linguistic processing, and therefore the LPN, is dysfunctional in patients with schizophrenia and contributes to hallucinations<sup>1,3</sup>.
- The present study conducted constrained principal component analysis for fMRI (fMRI-CPCA) on fMRI data previously collected by Ćurčić-Blake et al. (2013).

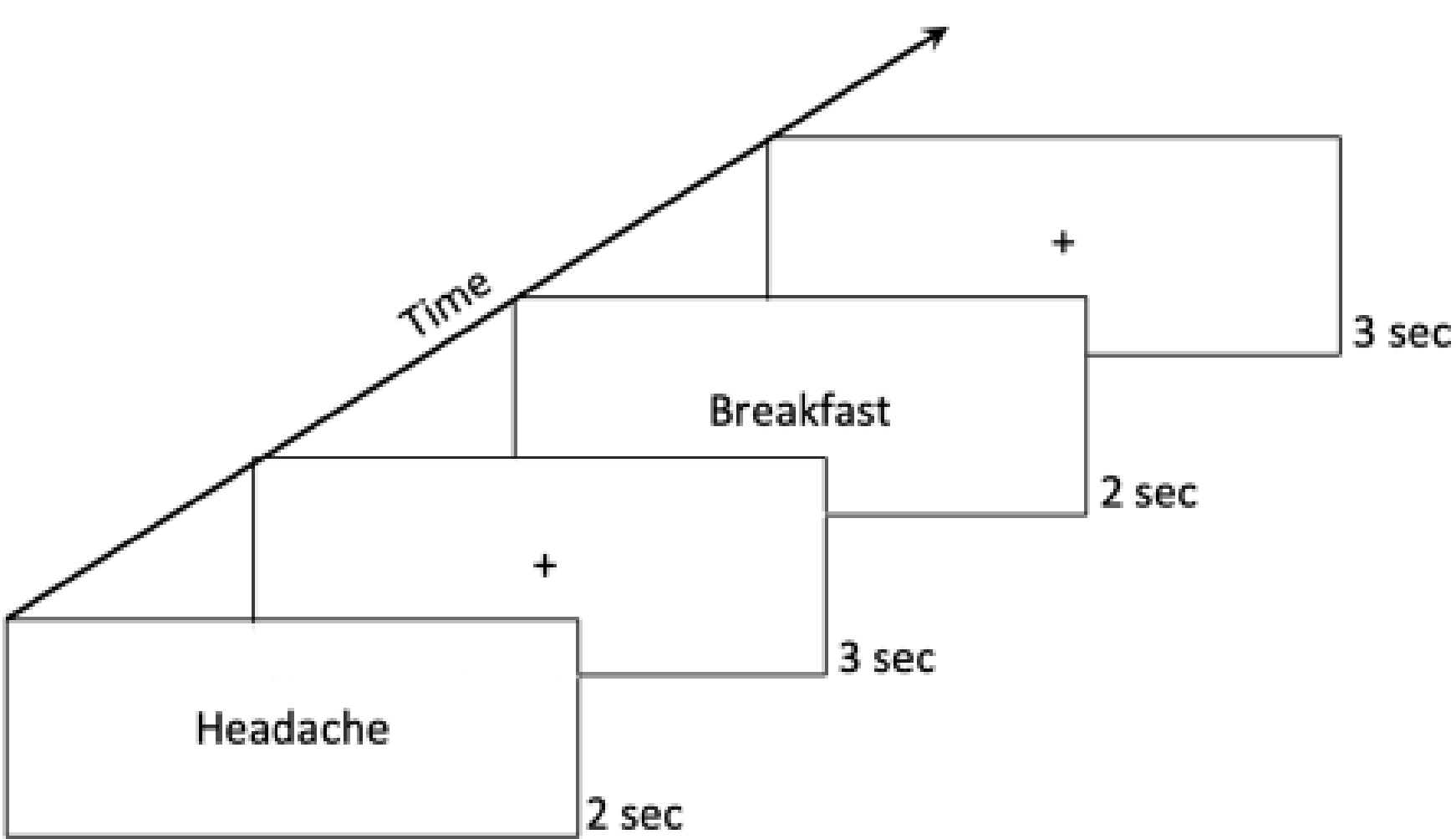
## Objective

This study aimed to assess the functional brain networks involved in AVHs by using fMRI to observe auditory imagery in hallucinating and non-hallucinating patients with schizophrenia, and healthy controls.

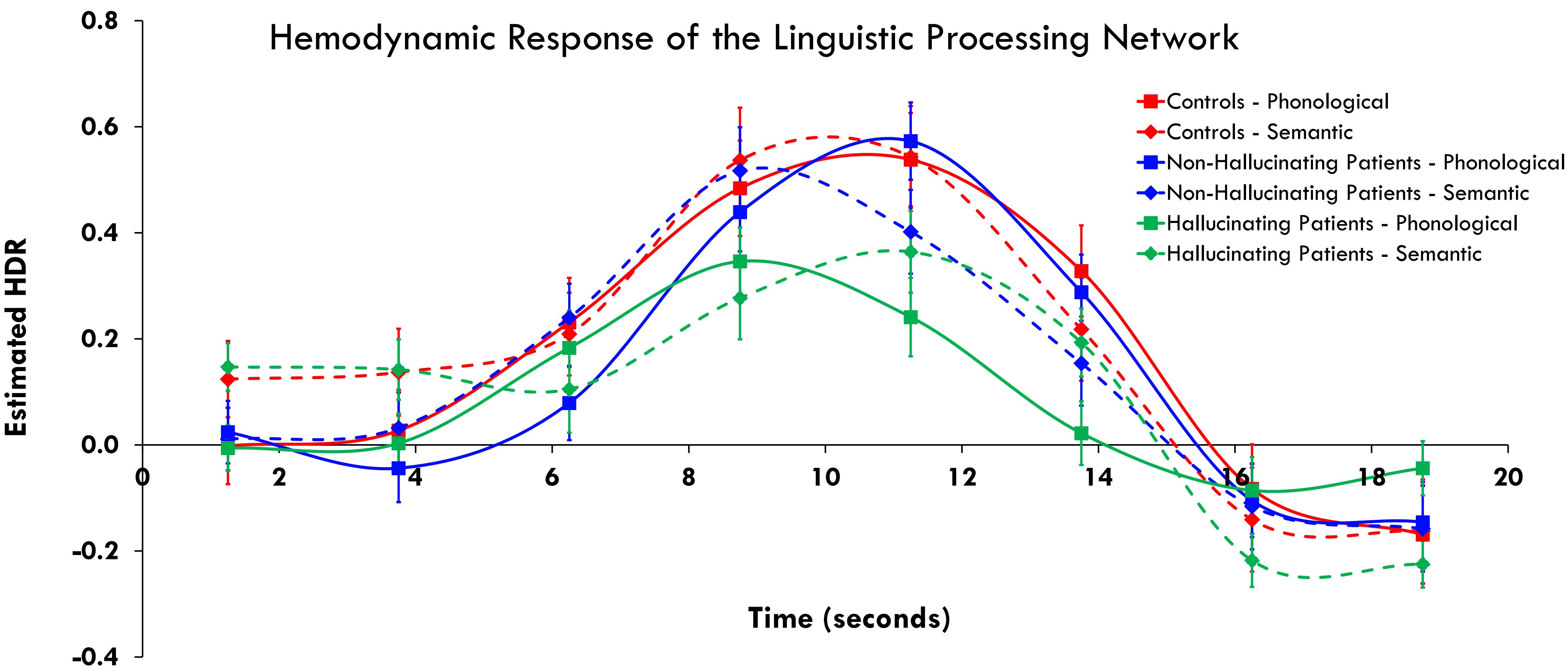
## Methods

- Patients with schizophrenia (hallucinating n = 30, non-hallucinating n = 17) and healthy participants (n = 31) were shown 48 bisyllabic words.
- Participants were asked about the metrical stress placement ('phonological'/auditory imagery condition) and semantic connotation ('semantic'/control condition).
- The data were analysed using fMRI-CPCA, which allows the identification of numerous simultaneously active functional networks.

Figure 1. Task diagram. ▶



## More Results



- The LPN showed an earlier and shallower response for hallucinating patients in the auditory imagery condition when compared to non-hallucinating patients and controls combined.
- Hallucinating patients also failed to sufficiently decrease network activation during the return to baseline.
- Controls showed the highest overall LPN activation of the three groups, followed by non-hallucinating patients and then hallucinating patients.

## Discussion

- The present results suggest that hypoactivation of the LPN may contribute to AVHs, along with the well-documented hyperactivation of superior temporal gyrus-based auditory perception network<sup>6</sup>.
- This conclusion is in line with previous theories, particularly the 'Misattribution Model'<sup>7</sup>, which states that hallucinations are internal thoughts that have been misattributed to an external source.
- The hypoactive internal cognitive process (LPN) and hyperactive external cognitive process (auditory perception network) may create a network imbalance, resulting in an increased emphasis on external representations.
- Importantly, the superior temporal gyrus did not form a part of our LPN, confirming previous results linking it with an auditory perception network<sup>6</sup>.

## Summary

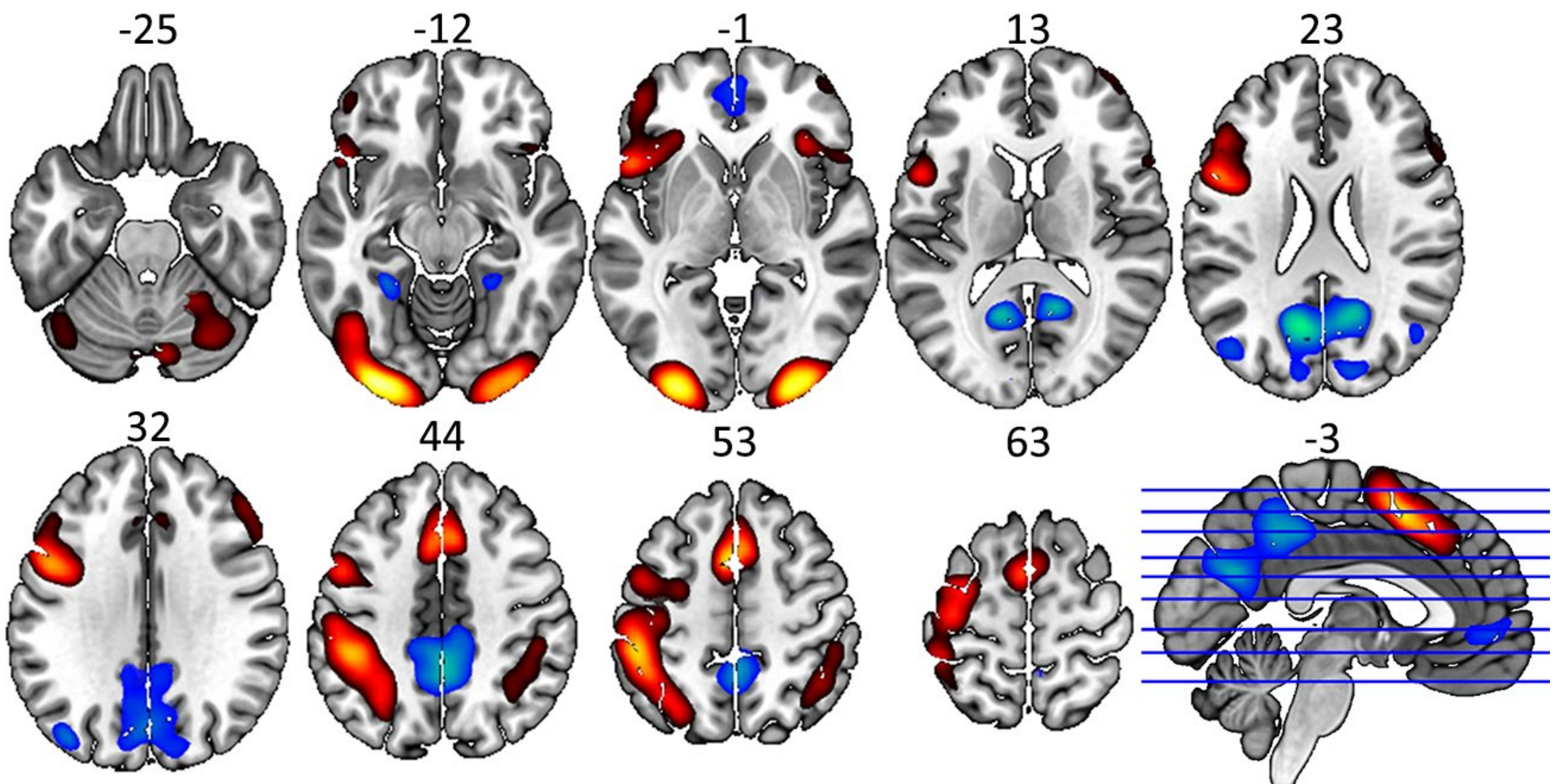
- Hypoactivation of the LPN appears to contribute to the symptom of AVHs, in combination with hyperactivation of an auditory perception network. This may finally provide a convincing biological underpinning for hallucinations.

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## Results

Figure 2. ▶  
Dominant 10% of component loadings for Component 2 (Language; red/yellow = positive loadings; blue/green = negative loadings). Axial slices are located at the MNI Z-axis coordinates listed above brain slices.



- Three functional networks were extracted: an attention-based network, a LPN and a response network.
- The language network was a left-lateralized frontotemporal network, consisting of regions thought to be involved in language including the left inferior frontal and left middle frontal gyrus<sup>8</sup>.