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Network localization of hallucination in acquired brain injury

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Introduction

Perception is the Result of a complex cerebral process where the information concerning the external world and the internal world is integrated. Hallucination is a profound distortion in a person's perception in the absence of external stimulus. Although hallucinations have been extensively studied in various neuropsychiatric diseases, only little is known about the underlying pathophysiological mechanisms. Here we analyze brain lesions causing hallucination to identify regions causally involved in symptom generation.

Method

We identified 77 cases of lesion-induced hallucination from the literature and mapped each lesion volume onto a reference brain. Using a recently validated technique termed lesion network mapping, we tested whether these lesions belonged to the same functional network. To accomplish this, the network of brain regions functionally connected to each lesion was identified using a connectome dataset from healthy participants. Network maps were overlapped to identify any region functionally connected to our set of lesions (Figure 1). Specificity was evaluated using a case-control design; control cohorts included a group of similar lesions randomized to different brain locations and a second group of lesions causing other neuropsychological disorders. We also investigated differences in lesion network map according to the modality such as auditory and visual hallucination.

Result

Lesions showed heterogeneity in anatomical location (Figure 2). However, at least 80% of these lesions showed network overlap in the cerebellar vermis (Figure 3A) and this connectivity pattern was highly specific for hallucination compared to four other lesion-induced neurological syndromes ($P < 0.0001$). In addition, there was no significant lesion location in subgroup analysis of visual (N=31) and auditory hallucination (N=17) but striking contrast in connectivity with thalamus was shown according to modality of hallucination (Figure 3B).

Conclusion

Strokes causing hallucination, while anatomically heterogeneous, localize to a common functional network. In addition, it could lead a different manifestations based on that lesion's unique pattern of functional connectivity. These Results advances our understanding of the brain regions involved in neuropsychological disorders.

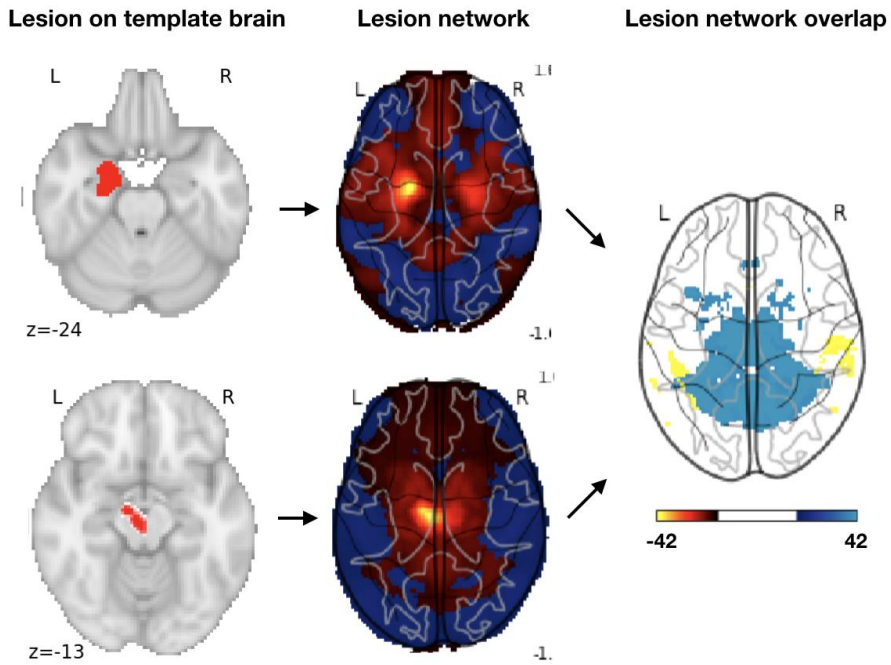

Figure 1. Lesion network mapping Methods

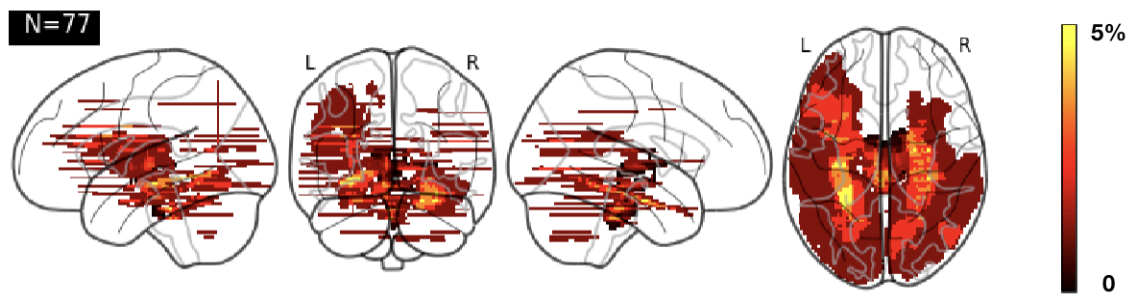

Figure 2. Result of Lesion overlap. Peak overlap was only 4/77 (5.2%)

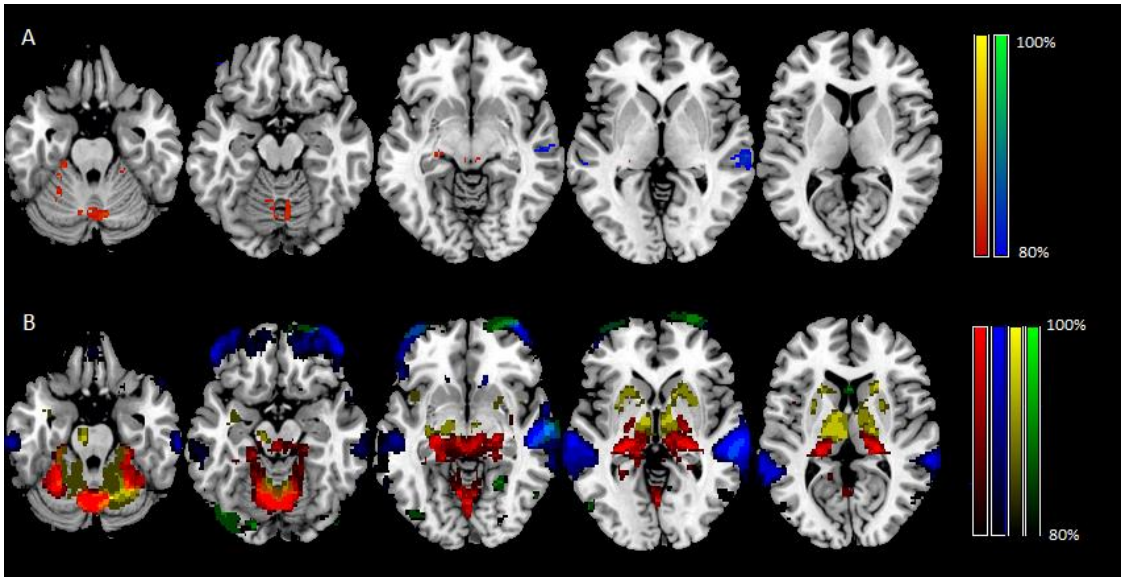

figure 3. A) The connectivity profile of lesions causing hallucination and B) Distinct patterns of lesion network overlap according to modality of hallucination. Functional connectivity of lesions causing visual hallucination was shown as Red-blue color and auditory hallucination as yellow-green color.