

The brain mechanisms of logical inference: An fMRI study of acoustic reasoning

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1. Introduction

Logical reasoning is considered as important logical and psychological process, and it is categorized into inductive reasoning and deductive reasoning. Deductive reasoning is the way to obtain the distinct conclusion from general or widespread assumption. Previous brain imaging studies on reasoning, materials were presented visually as sentences or logical expressions. This might confound reasoning related brain activity with linguistic processing activity. In this study, we measure the brain activation of deductive reasoning with acoustically presented problems, and aimed to clarify the brain mechanisms for non-linguistic reasoning from brain activities.

2. Materials & Methods

2.1 Stimuli & Tasks

In visual reasoning session, 3 types of alphabets, (i.e., X, Y, and Z), were used to make 24 different reasoning problems. Each problem includes 3 sentences. Subjects were asked to determine a validity of the third sentence which logically derived by first 2 sentences. In an auditory reasoning session, 3 types of tone bursts were included in 24 reasoning arguments. In each argument, there were 3 types of sound pairs (i.e., 'premise 1', 'premise 2' and 'conclusion'), which consist of 2 tone bursts sequentially presented. Subjects were first presented 2 sounds pairs as premises 1 and 2s, and then 1 pair sound as a conclusion. Subjects were asked to decide whether the temporal context of the conclusion, derived from premises, were correct or not. They performed 2 visual sessions and 2 auditory sessions. Similar numbers of memory task sessions were provided as controls.

3. Results

Brain activations were observed in left parietal cortex (PPC, BA39) in both visually and auditory reasoning at conclusion. The regions are consistently reported in studies of deductive. [2]

4. Future works

Further research used multi-voxel pattern analysis (MVPA) will be needed to decode cognitive states.

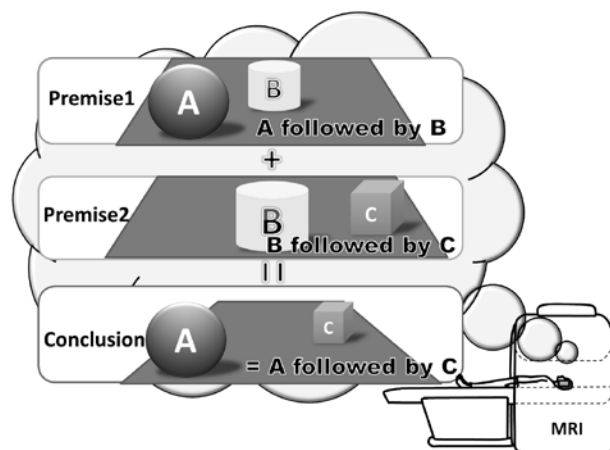


Fig.1 Hypothetical illustration of deductive reasoning based on spatiotemporal processes.

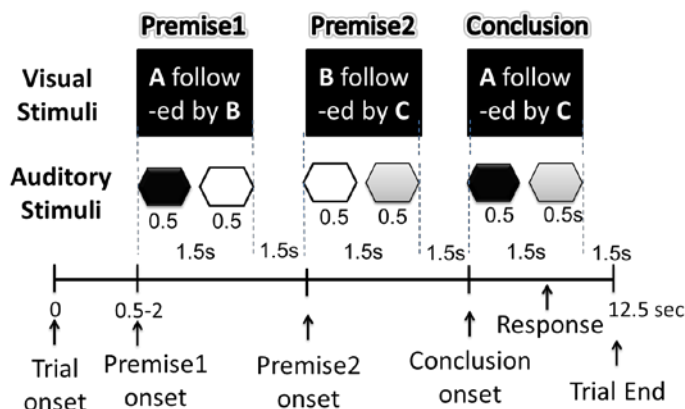


Fig.2 The sequence of the auditory reasoning session. In each session, subjects were presented two premises and one conclusion.

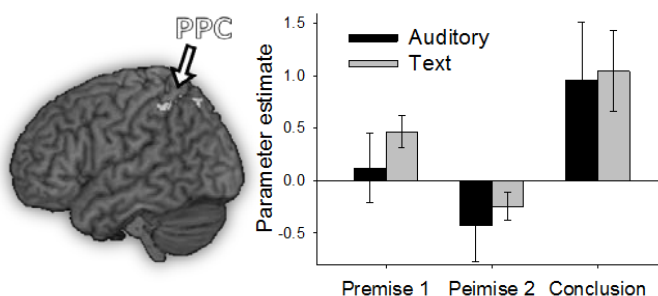


Fig.3. Brain activity during both visually and auditory reasoning while listening to conclusion in a representative subject. Right graph shows the transition of the BOLD response at PPC.

References

- [1] T.Fangmeier, *et al.*, Elsevier, Brain Res., vol.1249, pp.181-190, 2009.
- [2] J.Prado, *et al.*, MIT Press, J. Cogn. Neurosci., vol.23, Issue.11, pp.3483-3497, 2011.