

# Designing a Language Task for Clinical Routine - An Application of Incremental Analysis of t-statistics for Task Design

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## Introduction

For clinical brain mapping, it is usually aimed to search and assign the known activation rather than analyzing complicated cognitive process. Although functional magnetic resonance imaging (fMRI) is a powerful tool to visualize the brain function, the reliability depends on the statistical power of a multi subject study. Furthermore, there is a potential risk to underestimate the activation, especially in a single subject study of language areas, since the activation pattern is variable among the subjects. A combined task analysis (CTA) [1], which appends multiple sessions of language tasks, was proposed to enhance the detection of brain activation. In this study, we propose a modification of CTA to include all task conditions in one session of 10 minutes using a real-time fMRI technique [2,3]. The effect of task block ordering to combine multiple tasks in one session on the activation level was investigated to improve the detectability.

## Material and Methods

Ten subjects (5 males) who gave written informed consent participated in this study. Three kinds of language task conditions were prepared, L-condition: listening comprehension of newspaper articles (40 words / min), N-condition: covert naming of the objects visually presented on a LCD, W-condition: covert word generation starting with the visually presented characters. The subjects maintained fixation during the rest blocks. These three conditions were arranged into three sequences for performance; 1) I-task: independent 3 sessions for the three conditions (NNN/WWW/LLL), 2) S-task: sequential performance of the three conditions in one session (NNNWWWLLL), and 3) A-task: alternative performance of the three conditions in one session (NWLNLNLNL).

Functional data were obtained using a T2\* weighted gradient recalled echo EPI sequence (TR = 3000 ms, TE = 30 ms, 30 axial slices, 4 mm thick, FOV = 22 cm) on a 3T MRI scanner (GE Signa VH/i3.0T). The image data were realigned and the t-statistics ( $p < 0.001$ ) for each time point were estimated using an incremental analysis algorithm [3, 4]. The time course of the t-value was extracted for the ROIs (5x5x3 pixels), which was determined by reference activation maps obtained by SPM2 (UCL, London).

## Results

Figure 1A shows the rendered activation map obtained by the three different methods of combined task analysis from the 10 subjects ( $p < 0.005$ , uncorrected). The representative activation of interest was Wernicke's area (BA22, yellow arrow), the premotor area (PMA, BA6, red arrow) and Broca's area (BA44, green arrow). Figure 1B shows the average of the dynamic change of the t-value obtained by the incremental analysis in Broca's area and that in Wernicke's area by S-task and A-task. Among the 3 methods of CTA, the cluster size was largest and the t-value was highest in the I-task, and they were least in the S-task. The main regions of interest, such as Broca's area and Wernicke's area, were significantly detected in the I-task (t-value: Broca's Area 7.7, Wernicke's Area 5.7) and A-task (B 4.78, W 5.64), but their t-value was lower in the S-task (B 2.28, W 4.42). The t-value in both areas constantly increased in the A-task and it was higher than that by the S-task, although both included the same number of task blocks for each condition.

## Discussion

The cluster size of the activation was largest by the combination of the three independent sessions than the other two CTA designs. A HRF is emphasized by the post stimulus undershoot in a session repeating only one condition (I-task) than in a session switching multiple conditions (S or A-task) [4]. The maximal t-value of the language areas by A-task was almost to that detected by I-task, since the HRF in such area is emphasized by the post-stimulus undershoot after the condition which strongly induce the % change of the BOLD signal in the area even if the next condition does not induce enough (data not shown). This feature resulted as the constant increase of the t-value in both language areas throughout the session in A-task.

In conclusion, it was suggest that a combined task design employing alternative task performance in one session (9 task blocks in 10 minutes) may be a routine method for clinical applications.

## References

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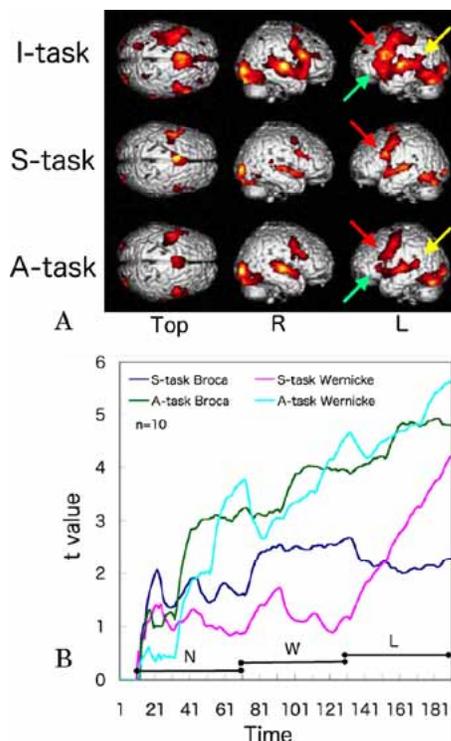


Fig. 1