Does Verbal Working Memory Depend on Phonological Store or Focus of Attention to Memory?-A TMS Study

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E-Poster

Introduction:

The multi-component model of working memory (WM) is constructed by two sub-systems called "phonological loop" and "visio-spatial sketchpad", which are controlled by the "central executive". Phonological loop consists of the "phonological store" and the "rehearsal system". Functional neuroimaging studies demonstrate the activation of left inferior parietal lobule, especially supramarginal gyrus (SMG), in relation with the phonological store [1,6]. A basic assumption regarding the phonological store construct is that the phonological similarity of the items in the memory set should distort the maintenance in the WM. On the other hand, in the "Embedded Processes" hypothesis proposed as an alternative model for the verbal WM, the "focus of attention" that activates the representations in the memory replaces the phonological store [3,4].
This study aims to investigate the neuroanatomical structures responsible for the maintenance of phonological information in WM and to test the two hypotheses by using Transcranial Magnetic Stimulation (TMS).

Methods:

For activating the verbal WM, the Sternberg task was used with a memory set of four items followed by four probes presented at a rate of 1 item/s after a memory maintenance period of 6 s. The visually presented stimuli were made up of either phonologically similar or dissimilar, three-letter, meaningless, but utterable syllables. Two of the probes presented in each trial consisted of memory set items (targets). The subjects had to indicate the targets and non-targets by pressing one of the two mouse buttons.
Structural brain MRI images of the 14 right-handed healthy female subjects were uploaded to the navigation system. Before the experiment, motor TMS threshold for each individual was determined as the minimum intensity, at which single TMS pulses were able to produce motor evoked potentials (MEP) of approximately 50 μV in the tonically active first dorsal interosseus muscle. The stimulation intensity was set to 70% of the individual motor threshold.
The areas for TMS stimulation were determined by locating the supramarginal gyrus in the

center of a 3x3 matrix. TMS was carried out with a NexStim eXimia stimulator (NBS Version 3.2.1, Helsinki, Finland) using a focal 8 shaped mono-pulse coil for each of the 9 areas. For the placebo stimulation, the coil was placed vertically on the supramarginal gyrus. The simulation was applied at 250th, 300th, 350th and 400th ms after the presentation of each memory set item. For each TMS stimulation area, four blocks have been applied each consisting of eight trials.
For statistics, a repeated measures ANOVA design with factors syllable similarity, TMS location and TMS delay was applied on both accuracy rates and reaction times in SPSS 16.

Results:

Statistical analyses showed that, independent from the phonological similarity of the syllables, the stimulation of the upper and posterior point of the supramarginal gyrus significantly shortened the reaction times compared with those after placebo stimulation ($F(1/13)=8,97$; $p=0,01$ and $F(1/13)=9,45$; $p=0,009$). Additionally, the overall accuracy of the target responses was significantly higher when the memory-set items consisted of phonologically similar stimuli compared with the non-similar ones ($F(1/13)=8.07$; $p=0,014$).

Conclusions:

Our results indicate that the TMS stimulation of the superior and posterior parts of the supramarginal gyrus during encoding period significantly shortened the reaction times to the probes independent from the phonological similarity of the syllables. Additionally, in contrary to some previous reports [2,5] the phonological similarity improved the verbal working memory performance. Both findings are in support of the "focus of attention" construct of the "Embedded Processes" hypothesis rather than the phonological store for the maintenance of phonological information, and suggest that this function has a neuroanatomical component in the inferior parietal lobule.

Brain Stimulation Methods:

TMS

Abstract Information

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Please indicate below if your study was a "resting state" or "task-activation" study.

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Please indicate which method was used in your research:

TMS

For human MRI, what field strength scanner do you use?

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