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Brain stimulation and visuo-spatial improvement for neglect patients: Description of two cases

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Keywords: Spatial neglect; Stroke; Cerebral stimulation; TDCS

Neglect syndrome is frequently associated with right hemisphere stroke. The concept of interhemispheric competition is being put forward increasingly to explain this syndrome [1]. Therefore, any intervention aiming at restoring balance between the two hemispheres could be useful. Non-invasive brain stimulations (transcranial Direct Current Stimulation [tDCS] and repetitive Transcranial Magnetic Stimulation [rTMS]) have already shown their ability to modify cortical excitability [2]. Their use to restore interhemispheric balance after a stroke would therefore appear interesting. Few studies have evaluated these techniques as a potential treatment for neglect patients: most of them have used rTMS [3,4].

In a pilot study, we aimed at replicating with tDCS the results that were obtained with rTMS. Two patients had two stimulation sessions of the left parietal lobe (inhibition with cathodic stimulation, or sham stimulation). Evaluation of visuo-spatial performances (line bisection and the bell test) was performed before, during and immediately after the stimulation.

For one patient, rightward bisection bias was significantly reduced during real stimulation (0.8% bias versus 18.5% pre-test) but not sham stimulation (22.4% versus 17.3%). Visual exploration improved (+30% target found, 4.1% during sham stimulation). For the second patient, bisection bias was stable in both conditions. Visual exploration was better after real stimulation (+26% targets versus –3.2% during sham stimulation).

These first results confirm that inhibitory stimulation of the left hemisphere parietal lobe can improve visuo-spatial performances for left neglect patients. More results are necessary to statistically confirm these findings.

References

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Spatial cognition and virtual reality: Review and interest for rehabilitation

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Keywords: Unilateral spatial neglect; Prism adaptation; Virtual reality; Rehabilitation

Unilateral neglect is a disabling syndrome due to right hemisphere brain damage. Prism adaptation (PA) has been used to improve several aspects of unilateral neglect. Parameters ranging from the classical neuropsychological tests to mental imagery or to others sensory modalities have been successfully ameliorated following a brief period of adaptation to wedge prisms shifting the visual field to the right. The aim of the study was to assess whether the beneficial ‘bottom-up’ effects of PA may generalize to a virtual spatial domain. Seven right brain-damaged patients with a left chronic neglect were included. After-effect of PA was assessed by measure of straight-ahead pointing movements in darkness. Cognitive effects were assessed by neuropsychological tests and by a virtual reality task: the patient had to explore a virtual supermarket altering everyday life, and responsible for poor functional recovery and ability to benefit from treatment. Several techniques have been proposed in the last decades, but only a few have shown long-lasting effects and none have provided complete rehabilitation. Virtual reality (VR) is a possible way to overcome time, economic and physical constraints limiting clinicians’ opportunities to observe patients’ performance at complex daily tasks. Moreover, VR technology offers the potential to assist current rehabilitation techniques in addressing the impairments, disabilities, and handicaps associated with brain damage.

In the domain of spatial cognition, VR is a relatively new tool that has just begun to be adopted to assess and rehabilitate spatial cognition disorders, especially unilateral neglect. This technology enables not only to study but also affect perception, attention, and moving in an explored space as well as learning and mental representation of the learnt environment. This emerging treatment appears to be promising for rehabilitation medicine.

Here, we review the main studies using VR to explore the mechanisms of spatial cognition and mental imagery. This review also describes studies that have used VR in the assessment and rehabilitation of spatial ability impairments, especially unilateral neglect. Finally, we will try to purpose the main issues of VR and spatial cognition in clinical practice and research in physical and rehabilitation medicine.

Further reading

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Bottom-up effect of prism adaptation on hemineglect in virtual spatial domain

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Keywords: Prismatic adaptation; Virtual reality; Rehabilitation

Prism adaptation (PA) has been used to improve several aspects of unilateral neglect. Most of the patients have been assessed by prism adaptation (PA) and by a virtual reality task: the patient had to explore a virtual supermarket.
Objectives

Effect on spatial neglect [2]. Our objective was to evaluate the immediate effect of a single session of mirror therapy on manifestations of spatial neglect.

Methods

Limb. Control therapy used the same device and reproduced the visual anchor to the left space for the same duration. However, the image of the right arm was used up visuo-manual adaptation: consequences for spatial cognition. 2007;10.

Further reading


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Immediate effects of mirror therapy on spatial neglect

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Keywords: Mirror therapy; Spatial neglect; Stroke

Objectives.– A few studies have suggested an effect of mirror therapy on hemiparesis after stroke (CVA) [1]. Recent work has also suggested a long-term effect on spatial neglect [2]. Our objective was to evaluate the immediate effect of a single session of mirror therapy on manifestations of spatial neglect.

Patients and methods.– We included eight subjects (30-75 years) with spatial neglect (according to Negligence Evaluation Battery) secondary to a unilateral stroke of the right hemisphere. Mirror therapy sessions lasted for 30 minutes and used the classic mirror therapy device [1] with a cache on the right upper limb. Control therapy used the same device and reproduced the visual anchor to the left space for the same duration. However, the image of the right arm was replaced by landscape images. The effect of the two procedures was compared in a randomized cross-over protocol with a wash out period of one week. Patients were evaluated blindly, before and after each session, by a line bisection test and a cancellation test. Statistical analysis used the nonparametric Wilcoxon test with an alpha risk of p = 0.05.

Results.– Mirror therapy induced a significant improvement in line bisection test (p = 0.025) but not in cancellation test. Control therapy had no effect on performance in any test. However, no significant difference was observed between the effects of two therapies.

Discussion.– Mirror therapy is applicable to subjects with spatial neglect under certain conditions. Immediate efficiency seems to be present but only partially. This result supports the hypothesis of an effect of mirror therapy on spatial neglect [2]. The effect appears to be independent of the attentional component. The induced effect may result from right hemisphere activation in relation to the visual illusion of upper left limb movement.

References


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Study of pop-out effect in neglect patients

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Keywords: Hemineglect; Computer test; Cancellation test; Saliency; Parietal lesion

Background.– Hemineglect is a syndrome characterized by disturbances of space exploration to the left hemifield with behavior of deviation to the right. Due to the diversity of its manifestations and brain lesion responsible for symptoms, pathophysiology, diagnostic and therapeutic still remain problematic. We have implemented on a computer interface the bells cancellation test (Gauthier 1999).

Objective.– Establish the effects of striking targets (global or predominantly on the left) with color and/or movement on visual exploration according to each stimulus were presented simultaneously on the same side (left or right); they were presented on opposite sides in incongruent trials. Participants had to respond with their right hand by pressing a response-pad button corresponding to the auditory or visual target's side according to the instruction.

Results.– For the left target the patient needed more time than the control group to respond, regardless of the modality or the congruency. Nevertheless, the conflict cost was similar to the control group. For the right target, the patient presented an extensive conflict effect for auditory target and a paradoxical (reversed) conflict effect for visual target. fMRI data showed that, for the auditory target, incongruent compared to congruent trials elicited activations over a bilateral fronto-parietal network in the control group. A comparable result was obtained for the patient except for the right inferior parietal activation (BA40). Instead, we observed a right superior parietal activation (BA7). No activation was found for incongruent trials compared to congruent for the visual target whatever the group.

Discussion.– Unlike clinical visuo-motor tests, our spatial visuo-auditory conflict test revealed a left visual and auditory attentional deficit in the patient. fMRI activations suggest that he may have partially recovered from his hemineglect due to cortical plasticity after his stroke; this matched with the occurrence of a right conflict cost for auditory but not visual target.

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Hemineglect evaluation using a spatial visuo-auditory task

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Keywords: Hemineglect; Attention; Spatial visuo-auditory conflict

Objective.– Evaluate new robust clinical tests to detect visual and auditory spatial neglect in hemineglect patients who succeed in clinical visuo-motor exploratory tasks but fail in daily habits.

Material/Participants and methods.– Behavioral and fMRI data were collected during a visuo-auditory conflict task in 19 healthy adults and one hemineglect patient with right parietal lesion. An earplug system was used for auditory stimuli (1000 Hz pure tones). Adjustable coil-mounted goggles displayed the visual stimuli (filled white circles on a black background). In congruent trials, stimuli were presented simultaneously on the same side (left or right); they were presented on opposite sides in incongruent trials. Participants had to respond with their right hand by pressing a response-pad button corresponding to the auditory or visual target's side according to the instruction.

Results.– For the left target the patient needed more time than the control group to respond, regardless of the modality or the congruency. Nevertheless, the conflict cost was similar to the control group. For the right target, the patient presented an extensive conflict effect for auditory target and a paradoxical (reversed) conflict effect for visual target. fMRI data showed that, for the auditory target, incongruent compared to congruent trials elicited activations over a bilateral fronto-parietal network in the control group. A comparable result was obtained for the patient except for the right inferior parietal activation (BA40). Instead, we observed a right superior parietal activation (BA7). No activation was found for incongruent trials compared to congruent for the visual target whatever the group.

Discussion.– Unlike clinical visuo-motor tests, our spatial visuo-auditory conflict test revealed a left visual and auditory attentional deficit in the patient. fMRI activations suggest that he may have partially recovered from his hemineglect due to cortical plasticity after his stroke; this matched with the occurrence of a right conflict cost for auditory but not visual target.

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