DO HEMISPHERES SPECIALIZE IN PROCESSING DIFFERENT ASPECTS OF VISUAL STIMULUS?

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ABSTRACT

To test whether the two hemispheres process orientation (a dorsal system task) and shape (a ventral system task) with different paces, we flashed a visual stimulus into each visual field and in one set of trials we asked the subjects to decide its orientation and in another block of trials, its shape. We used three shapes (a rectangle, a triangle and an ellipse) in four orientations (vertical, horizontal and two obloquies). The subjects responded with either left or right hand.

We found that besides an overall better performance of right hand, there was only a superiority of right visual field over the left in orientation task and no significant difference between visual fields in shape task.

We think that our unexpected results seem reasonable if we break the tasks to finer blocks: the categorical spatial relations being processed better in the left brain than coordinative spatial relations though both are dorsal system tasks.

INTRODUCTION

Lateralization in brain has been a tantalizing subject for neuroscientists. In visual system there are many attempts to explore such asymmetry but not always successful and sometimes conflicting results have been found (Springer,S.P & Deutsch G. ,1981).Marzi et al (1991) in a meta-analysis and also later Iacoboni and Zaidel (1995) using Poffenberger's simple reaction time paradigm showed asymmetrical RT's when facing a simple flash of light as visual stimulus with an overall better performance of the right hand and left visual field (right brain). Can the superiority of the right hemisphere be described by the task it was doing? A flash of light doesn't have any particular shape and only its place is important and current data show that finding out the place, size, and the orientation of the stimulus are processed by the dorsal system, mainly located in the posterior parietal regions of the brain and its shape is processed in the ventral system, mainly in inferior temporal region. According to C. Gross, M. Mishkin (1977) and Anderson R A, Essick G K and Siegel R.M (1985) and fully explained and modelled by Randal O'Reilly et al(1990) there are anatomic and functional differences between the two systems. According to above mentioned findings can we speculate that dorsal system is more competent in one hemisphere and ventral system in another? So we picked out one dorsal system task (orientation) and one ventral system task (shape recognition) and tested them with both hemispheres. The same pictures were shown in both tasks (elongated triangles, rectangles and ellipses) but in each task the subjects had to respond to the corresponding attribute: either orientation of the stimulus or its shape. We expected to find out a better performance of right hemisphere in orientation task and that of left hemisphere in shape task.

METHODS

Subjects:

The subjects were 15 male high school students of NODET between 15 to 18 years old. (Usually top students are selected by NODET for exceptional scientific training- it maybe a bias, although we do not know if IQ has any effect on RT or laterality).14 were right handed and one left handed. The student with the best results was to receive a present. Each subject passed the test for about one hour in a day.

Methods:

To show the stimuli and record the results, one of us (Farshad Moradi) developed a software on IBM-compatible 486-based computer and SVGA monitor of 55 Hertz scanning mode. The stimuli were elongated triangles, rectangles and ellipses in four orientations, namely vertical, horizontal and two obliques. Each block of trials contained 40 trials and each subject performed 14 trials, seven with each hand. The subjects sat 50 to 57 cm from the monitor and their appropriate hand on the keyboard with two fingers on the due buttons. In each trial at first a shrinking block appeared for 1 second to attract attention and serve as the fixation point, immediately after which the image flashed for 42 ms followed by a mask for 500 ms. The pictures could be fitted into an imaginary block 4' lateral to vertical meridian and 4' above and below the horizontal meridian. Before each block a written message was shown that told the students their duty in that block, for example that they had to press with their index finger if any rectangle (or any particular orientation) was shown and with their middle finger if anything else appeared. The shapes appeared in random orders and random orientations and in random visual fields in each block. The lack of instruments prevented us to monitor the eye movements in the test; the subjects were requested to fix only in the middle of the screen.

RESULTS

The subjects results were analyzed and those who had less than 85% correct answers were omitted from the study and there remained 6900 trials. Among these RTs only those between 160 ms and 800 ms were selected (+-2SD). The different orientations had not any significant difference ($p>.1$) so we released this constraint and analyzed all different orientations together. The same hold true for different shapes.
The right hand performed significantly better than left ($p<.01$). In the shape task there was no difference between the visual fields ($Z=1.288$ $p>0.05$).But contrary to our expectation there was significant difference between hemispheres in orientation task with the RVF better than LVF ($p<.001$) regardless of the performing hand.

DISCUSSION

As mentioned above speaking of one system's better performance in one hemisphere is rather a big generalization. Though location and orientation both are dorsal system tasks, there was a better ability of the right hemisphere to find the location (Marzi et al) and a better performance of the left hemisphere in finding orientation. This argues for a "more fine grained" approach to at least dorsal system, as S.Kosslyn and O.Koenig put forward in their book: WET MIND. They argue that the Categorical spatial relation subsystem is more competent in the left and Coordinative spatial relation subsystem in the right. If we consider location a matter of coordination and orientation a matter of category the conflict seems to be solved.
We did not find any difference between visual fields in shape task. Maybe the degree of difficulty of our shapes was not enough to evoke a tiny difference between hemispheres if some persists.

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