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Attention to one side increases early response at the visual and auditory gates of the mind

The human mind reacts slower and differently than earlier neurological studies had shown.x

You are in trouble and your attention is directed to where your boss is. Even though you may not be looking at your boss directly any uttering, look or sign of disapproval is picked up immediately bringing with it that sinking feeling fast. In fact, researchers at RIKEN's Brain Science Institute say that the enhancement of processing to where your attention is directed starts with the first sensory (auditory and visual) impulses arriving at the cortex, in the primary auditory, A1, and visual, V1, cortices, the main gates through which the auditory and visual analysis begins.

Brain scientists accepted that attention to sound modifies the immediate cortical response in A1 at 25 ms. But they had previously thought that in a case of attending to a visual image it takes some 150 ms for the first attention-related change to appear in V1. It was thought that the effect of attention appeared first in "higher visual" areas, outside V1, around 80 ms. This attentional effect was then "fed-back" to V1. Although this difference between the auditory and visual processing was theoretically messy, the data presented so far appeared to support it. In a study published this week in the journal *Neuron*, Vahe Poghosyan researcher in the BSI's Laboratory for Human Brain Dynamics and the head of the laboratory Andreas A. Ioannides, show that the change in the V1 response when attending to a visual image is much faster, it begins with the immediate cortical response in V1 at 55 ms. By comparison, the blink of an eye takes 200 to 300 ms, about the same time as it takes to become aware of a change in the external environment.

In the lab research, pictures (faces or checkerboards) and sounds (high and low tones) were presented either to the left or right side to five subjects who were asked to raise their right index finger when a target stimulus (image or sound) appeared. The subjects were pre-warned to respond to one category and side for the test of how fast their

"attention response" was (as with a runner who has to ignore everything that is irrelevant and react immediately to the starting pistol).

For every subject the responses to the images were both uniformly fast and accurate, with the mean hit rate and reaction time at 97% accuracy and 451 ms, respectively. Responses to auditory stimuli, in the form of high and low tones, were somewhat faster than the visual reaction time, with a success rate of 94% and a reaction time of 437 ms. As the tests were run, magnetoencephalography (MEG) was recorded, and from these measurements "images" of the activity inside the subjects' brains showed precisely when and where the visual and auditory responses were registering. Attention-related increase in the brain activity was observable at the earliest stages of visual and auditory processing. The results showed that this attentional increase in the brain response occurred in some subjects as early as 25 ms for auditory and 50 ms for visual stimuli.

If true, this finding clarifies a perplexing theoretical puzzle, by placing the earliest effect of attention where it counts most, at A1 and V1, the entrance into the mind's auditory and visual machinery respectively. The authors suggested that the earlier studies may have missed the subtle early modulations due to differences in data analysis, and went on to demonstrate how this may have happened. The new evidence has direct consequences for theoretical models explaining the mechanisms of how paying attention works, for example its role in improving performance. The findings could also help our understanding of how some failures of attention may lead to problematic behavior, for example in attention deficit syndromes in children and schizophrenia.

Original work:

Poghosyan, V., Ioannides, A. Attention Modulates Earliest Responses in the Primary Auditory and Visual Cortices. *Neuron* 2008

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