Physiology of Audio-Visual Entrainment

By

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In order for entrainment to occur, a constant, repetitive stimuli of sufficient strength to "excite" the thalamus must be present. The thalamus then passes the stimuli onto the sensory-motor strip, the cortex in general and associated processing areas such as the visual and auditory cortexes. The illustration to the right shows the visual pathway with the retina of both eyes becoming excited and sending pulses down the optic nerve, through the optic chiasm, and into the lateral geniculate of both thalami. From here, the visual signals are passed onto the visual and cerebral cortexes for further processing. There is very little delay from the onset of the flash to the response in the optic nerve, a delay of approximately 100 msec occurs by the time the visual evoked potential (VEP) is elicited in the visual cortex. This delay may be why entrainment occurs best at the natural alpha frequency -- as 100 msec equates to 10 Hz, a frequency that produces sensorial relaxation as seen in the meditative state.

Visual Pathways

The way in which visual information travels from our eyes to our brain is different from the way sensory and motor information travels to the brain. Unlike the body, where the nerves on the left side are connected to the right hemisphere of the brain the right side are connected to the left side of the brain, our eyes are wired so that the left visual field of our total vision (both eyes) goes to the right side of the brain and vice versa.

The visual neural pathways in humans start with rods and cones, located at the back of the eye and end at the visual cortex, located at the back of the brain. The visual signals travel from the rods and cones via two to four synapses (nerve cell connections in the brain) in the ganglion cells, located behind the retina of the eye. These nerve impulses from the ganglion cells leave the eye via the optic nerve. By this time, a certain amount of visual analysis has taken place in the brain, delaying the signal for a few milliseconds. The nerve impulses from each eye travel down the optic nerve (a bundle of approximately one million nerve fibers) on their way to the brain.

The optic nerve from each eye splits into the optic chiasm. The optic chiasm is the nerve network that routes the visual image from the right visual fields of both eyes (left half of each retina) to a nest of neurons called the left lateral geniculate and on to the visual cortex. The reverse holds true for the left visual field (right half of each retina). Therefore, the flash of light seen in the left visual fields of both eyes is represented on the right side of the retina of both eyes. The impulse caused by the flash then travels to the right geniculate and right visual cortex. This means that visual input seen in both fields of each eye goes to both the left and right side of the brain.

The geniculate cells are attaché physically and by synapses to the thalamus, the brain's main sensory coordinating area or "gateway." Photic stimulation evokes potentials into the thalamus. Because the thalamus relays sensory information into the neo-cortex, the visual impulses are therefore distributed into the neo-cortex. This often produces more brainwave entrainment at the frontal and central areas of the brain than in the visual cortex. The visual signals continue from the geniculate to the visual cortex, where they meet millions of synapses. From the visual cortex the visual messages are sent to several further destinations, neighboring cortical areas, as well as, several targets deep within the brain.

Photic Driving

Every flash of light enters the eye imprints itself on the rods and cones. This in turn evokes a response in the optic nerve. When this electrical firing from the optic nerve stimulates the primary visual cortex, a response known as the visual evoked response is produced. When the visual stimulus approaches 4 Hz, the start of the response from the next stimuli performs a vector addition on the tail of the previous evoked response. At this point, the many individual visual evoked responses become the cortical frequency following response. In other words, the response of the brain is to match the frequency of the flashing light. This frequency following response is now referred to as brain wave entrainment or audio visual entrainment (AVE).

(information provided by Dave Siever, C.E.T. "The Rediscovery of Audio-Visual Entrainment Technology", 2000).