**REVIEW ARTICLE**

# BEYOND RETINA TO VISUAL CORTEX; A REVIEW

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**Abstract**

Retina and visual cortex system is important regarding the light energy to the retina,information processing,the perception and cognition and visual contrast,color,movement and depth.V1(primary visual cortex)is the hallmark of early cortical computation in visual system.Understanding how V1 encodes images is crucial.The notion of encoding images was first directed to the primary visual cortex via discovery the edge and line detector neurons by Hubel and Weisel in the late 1950s.From computing sciences to behavioral diseases,memory disorders all are engaged in this system.

## INTRODUCTION

Vision means to gather information from the external world.Wiring in visual system starts with photoreceptors which change light energy to electrical stimulus with neural signals via retinal ganglion cells.Twenty different subtypes are directed to lateral geniculate nucleus then to visual cortex,but a portion of them go to superior colliculus,suprachismatic nucleus for head movement and circadian rhythm .Visual information reaches the cerebral cortex through a major thalamocortical pathway that connects the lateral geniculate nucleus of the thalamus with the primary visual area of the cortex;thalamocortical signaling is the primary excitatory with a trend for activation through control of the inhibitory mechanisms. [1,2,3]This is the start of information handling by the retina and brain, and with parallel processing is a major mechanism in the visual system.The visual system in human is the source of the information for colors, location, size, shape, texture of objects with motion and direction.[4.5,6]

## ANATOMICAL AND PHYSIOLOGICAL ASPECT OF VISUAL SYSTEM

In human the retina formation starts in the embryo at around forty days, in five months the cells are complete.The development continues with physical growth of the neurons and proliferation of synapses,many major structures in cortex and subcortex are complete by the end of the second trimester. Signaling in the retina starts when the photons of light cause photoisomerism of the retina, resulting in the activation of the opsin protein which in turn leads to activation of trimeric G protein ,G1.The released G1alfa causes the activation of phosphodiesterase which catalyses the rapid breakdown CGMP(Cyclic Gauanosine Monophosphate).the subsequent drop in CGMP in the cytoplasm leads to closure of the cationic specific channels in the plasma membrane and formation of electrochemical potentials propagating synaptic region of the cell from here electrical signals pass to the brain where the picture is made ,the signaling system of the eye has to be reversed to allow the perception of the more light.the control of light perception in the rods and cones of the eye is a complex of many signaling components,allowing a coordinated response across a wide range of light intensities.[7,8,9,10]

**Diverse Tasks of Visual System**

**COLOR AND VISUAL SYSTEM**

Rod and cone photoreceptors respond to illumination in dim and bright light respectively.The visual pigments are densely packed on rod and cone membrane,transduction occurs in a series of steps involving a G protein and cyclic GMP,in the darkness photoreceptors are depolarized and release glutamate continuously. One study showed that women prefer colors in red spectrum but men do not show such preferences,color causes human to react quickly and efficiently in their environment,for example, a red traffic light is a signal to stop and a green traffic signal is a sign to go,the colored information was more informative.[11,12,13,14]

**VISUAL PROCESSING**

Visual processing of the brain is the ability to interpret visual information from our environment. Low level visual processing is handling of different types of contrast among images projected onto the retina,high level processing means cognitive process and integration of information. Object recognition,location are examples that depend on top down and button up process.Visual signals as studied in monkeys, is a three separate processing area,the first is processing information about shape, the second is about color,and the third is movement,location,spatial organization.In primates, area V1 plays a critical role in visual information processing, because most visual information ultimately reaching the rest of the visual cortex is first directed through V1. This anatomically complicated pathway explains why “striate” cortex is so markedly laminated (striated); in cortex, ascending and descending inputs and outputs are anatomically segregated in different layers. In fact, primate striate cortex has been subdivided into 11 identifiable laminar divisions (1, 2, 3, 4A, 4B, 4Ca, 4Cb, 5A, 5B, 6A, and 6B) rather than the customary six layers described in most cortical areas.

Organization of information in the brain is a very important factor like finding a person in a crowd, is more efficient with a fast data-based storage system .The other computing system is sensory coding ,which defines how different sets of neurons respond to the same stimulus.The binding problem is a reminder that every part of nervous system is connected to all of the parts of brain and different aspects of the same object are represented in different groups of neurons in different parts of the visual pathways with synchronized firing fashion.Areas along occiptoparietal and occiptotemporal pathways are organized such that low level inputs are transformed into more abstract representations through successive stages of the processing.After V1 and V2 activation from area to area the responses are complex,V4 for color and occiptotemporal for shape.Visual pathways extending from V5 or mediotemporal through parietal cortex are largely responsible for coding motion.Visual cortex is also involved in the perception of tactile orientations.[15,16,17,18]

## PROSTHTETIC VISUAL SYSTEM,A FUTURE PLAN FOR BLIDNESS

Retinal prostheses developed for retinal degenerations such as retinitis pigmentosa and macular degeneration.Three types of retinal implants is in trials,epiretinal,subretinal,suprachoroidal.

With the artificial device a miniature camera mounted in eyeglasses and captures images and wirelessly sends the information to a microprocessor and changes data to an electronic signals and transmits it to a receiver on the eye.The receiver sends the signals through a tiny thin cable to the microelectrode to emit pulses.The artificial retina device thus bypasses defective photoreceptor cells and transmits electrical signals directly to the viable retinal cells,the pulses travel to the optic nerve and ultimately to the brain which receives pattern of light dark spots corresponding to the electrodes ,but System render retina or optic tract not viable is the next two stages of visual processing and future devices targeting lateral geniculate nucleus and primary visual cortex is another option.Cortical optogenetics based prosthtetic ,are an emerging approach for vision restoration in future. [19,20,21,22,23,24]

## LEARNING AND MEMORY AND BEHAVIORAL DISORDERS AND VISUAL SYSTEM

Visual stimulus with perception forms in visual cortical areas and this is a substrate for the formation of visual memory in a distinct part of the brain called the medial temporal lobe.Entire visual cortical pathways and connecting medial temporal lobe are important for both perception and visual memory, areas specialized for visual object recognition in the ventral stream have a more inferior location in the temporal cortex, whereas areas specialized for the visual-spatial location of object in the dorsal stream have a more superior location in the parietal cortex,intercommunication along their entire

 

rostral course.[25,26,27,28] Visual memory in environment entails work with pictures, symbols, numbers, letters, and especially words. Children who have not developed their visual memory skills cannot readily reproduce a sequence of visual stimuli. They frequently experience difficulty in remembering the overall visual appearance of words or the letter sequence of words for reading
and spelling.[29] In diseases like schizophrenia, Visual processing deficit is a pathophysiological mechanism. It can be related to a genetic mechanism's findings of hypergyrification which is suggestive of a disrupted corticogenesis of these visual key regions andmight constitute an anatomical basis for the visual processing.[30,31,32,33]

### Work of Hubel and Wiesel

They are Noble Laureate prize winners,and opened the research about the visual system and showed how neurons in the brain can be organized to produce visual perception and behavior after work on visual processing.in cat cortex increasing information about columnar organizations of cortex ,wavelength response and finding ocular d ominance and neuronal organization in monkey ,it was also significant that orientation processing was organized into columns of neurons within the cortex.

## DISCUSSION

Medical sciences explains a diverse spectrum of life,and vision is the window of the brain in communication with world,All information available about the external world is present in sensory receptors but sensory signals are perceived as meaningful real world objects only after the elaboration of these signals within the cerebral cortex,many types of sciences engaged in visual system,from light energy to sciences of computation and memory ,learning and behavior all were important involving brain areas such as occipital lobe ,temporal lobe and parietal lobe.The human brain has more than twenty cortical areas that support our visual perception,changes in any part of cortical areas can affect visual perception and abnormal visual experience in peoples especially children. Visual system can open a new in dept thinking to increase the information to resolve more rapid to human diseases such as retina to diseases of cortex such as Alzheimer disease and behavioral and neuropsychiatric disease .The area of the color vision is other interesting aspect of combined activity of neurons with fundamental computation in many different areas of the brain . The next entity of the retina to visual cortex is retinal prosthesis systems resulting from the development of several different novel surgical and engineering system,good results have demonstrated partial visual restoration,with improvement in both coarse objective function and performance of everyday tasks. The field of visual restorative therapy is rapidly advancing and holds great promise for the introduction of real, measurable treatments of blinding conditions in the near future. After the retinal prostheses many progress being made in other strategies, such as optogenetics, stem cells, and gene therapy, and this is the advanced form of treatment for profound vision loss.Prosthetic devices with regenerative medicine technologies, in the form of 'biohybrid' implants is a hopeful time for blind peoples. [37,38,39,40.]The future is more complex and sweet regarding the processing and intercommunication of visual system with other brain areas and finally the field of computational neuroscience has made enormous progress over the last decades and will be boosted by the flow of the new data gathered at multiple scales,from behavior to synapses,and integration of Studies in biological vision have always been a great source of inspiration for design of computer vision .[41]

## CONCLUSION

Visual system is considered to be an important system in the next decades From the aspect of artificial intelligence,learning and behavioral disorders ,neurotransmitter research,artificial vision ,so this system has a bright future in the field of medicine,as the focus in this field is promising in the future of sciences.

 

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