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Illusions in Motion V5: The Void

"Objects in our visual world do not come with a convenient code according to, say, shape or color, with the function of the visual cortex being nothing more than that of deciphering or analyzing that code."

- **Semir Zeki, 243**

Ray Kurzweil, an American inventor and futurist, predicts that scientists and researchers will decode the brain by 2030 (Kurzweil 1). Kurzweil bases his prediction on his singularity theory, which states that technology is exponentially increasing so fast that humans will have to catch up with technology in order to match the new era of artificial intelligence (Kurzweil 1). Decoding the human brain will be the breakthrough of artificial intelligence because artificial brains will be inside robots (Kurzweil 1). These robots will become super intelligent machines that can surpass human intelligence (Kurzweil 1). Kurzweil's prediction is made by creating mathematical models on diminishing sizes of computer chips (Kurzweil 1). He also suggests programming techniques like the neural net model and evolutionary algorithms to create the artificial brain (Kurzweil 83). I think Kurzweil is merely scraping the surface of the human brain where there lies a deeper intuitive concept underneath than just its technicality. Thus, no matter how fast technology is growing, the human brain will not replicate an artificial brain unless psychologists and physiologists work with neuroscientists and engineers. This is because all of these specialized fields naturally depend on each other.

The dominant conflict shared by physiologists, psychologists, engineers and neuroscientists is pattern recognition. Computers and robots still cannot reach the human brain's ability to recognize illusionary patterns automatically (Zeki 2). For instance, the famous illusion, Kanizsa triangle **(Zeki, 3)** contains empty, white spaces in contrast with black lines. The brain will connect the points between the white and black spaces to recognize the triangle and its upside down triangle. The robot is not able to solve such illusions. This is because human memory, as Kurzweil mentions, is a scattered pattern of strengths between neurons (83). This tension of distributed memory is in a synapse, a place where neurons transfer electrical signals to other cells (83). The neurons do not memorize every little detail of pattern recognition because the connection between neurons forms generalized information. Kurzweil claims that this lack of physical storage is visible when we can't precisely remember every experience with objects but we can still have general thoughts about them (83).

In order to solve the pattern recognition conflict, those who desire to make the artificial brain must understand the functions of the brain as a whole. Despite the lack of physical storage, the brain functions well even though thousands of nerve cells are lost every hour (83). Ray Kurzweil denies the existence of a strong neuron that commands other neurons (84). The generalized experiences of memory permit balanced connections to not depend on a hierarchical organization of functional specialization. Generalized data are stored in other areas of the brain that don't function with specificity. Such areas are outside the visual cortex. Functional specialization in the brain has been suggested since the mid-19th century (**Zeki, 73**). Zeki mentions that the brain specializes in visual functions like motion, depth, color and form throughout the visual cortex, which is located in the occipital lobe, the back of the brain (73).

The visual cortex's anatomical structure is made purposely to connect to the human eye. The eye is the direct opening for light to enter through each visual cortex of the brain's left and right hemispheres (Wikipedia, 3). In order to imitate the brain, biological and intuitive processes of the human eye and its relation to the visual cortex must be replicated first. To do this, it is crucial to connect back to the phenomenon that physiologists, psychologists, engineers and neuroscientists have trouble figuring out for centuries: pattern recognition. Pattern recognition is a fluid dynamic that does not function within limits, like a series of given formulas. This is because pattern recognition pertains to natural processes that shift between disorder and order. This shift creates sensations that respond back by traveling from the brain's world and to the visual field.

In the visual field, pattern is detected instantly by the eye. The biological structure of the eye's retina, a light sensitive tissue that projects the visual output from the brain, facilitates the visual field to transfer signals into neurons (Zeki, 64). The retina functions like a camera's film. At a technical perspective, the eye sees the pattern in three dimensions while the brain understands the image in flattened two-dimensional views. Semir Zeki, professor of neuroaesthetics in University College London (Wikipedia, 3), stresses that the brain's knowledge is gained through vision, stating that "seeing *is* understanding" **()**. This phrase should pave a path for pattern recognition to be remade automatically like robots and intuitively like humans. Imitation of pattern recognition becomes successful when the eye sees the object instantaneously without thinking. Then, the image of the object is transferred into the visual cortex where it understands the object not as a technical object, but as a lively object. Visual cortical area of motion (V5) in the visual cortex is the key to imitating pattern recognition because the visual world outside the brain is dynamic and always changing.

The automatic recognition of pattern implies that the neuron's signals travel linearly from the first cortical area of V1, through V2, V3, V3A, V4 and finally reaching motion V5, the end of the visual cortex. This transfer of signals is not initiated by communicating separately between nonadjacent cortical areas, such as between area V2 and motion V5. This transfer creates the information of motion. It is not about any data that motion V5 chooses to process. It is about the characteristics of the visual world that stimulate data to be driven into V5 (Zeki, 75), creating biased data. Biased data marks the evidence for function specialization in the visual cortex. In cortical area V1, the first area where the stimulation from pattern recognition begins, specializes in selecting direction that implicates a certain angle (Zeki, 75). V1 is important to motion because V1 and motion V5 both depend on each other. V1's component direction must be processed first before motion V5 creates the overall motion based on intricacies of V1's directions (Zeki,)

The stimulation of data increases when orientation selective V1 and motion V5 work together. Zeki describes their conjunction by labeling orientation selective V1 cells as component motion and motion V5 cells as overall motion **()**. For example, an object moving towards a 3:00 direction, cortical area V1 utilizes its cells made up of small receptive fields to limit the eye's vision **()**. V1's receptive cells do this by creating imaginary boundary conditions, such as the shaded diamond in Fig. 26.1 **()**. This shaded diamond allows V1's small receptive fields to focus on specific movements enabled by individual components that control directionality **()**. After V1's orientation selective cells processes the specific movements, the information is then transferred through cortical middle zones, V2, V3, V3A and V4. V1's data finally reaches motion V5, which transmits the overall motion, the motion that our eyes sense in the real world **()**. Orientation selective V1 and motion V5 must contain systems that solve pattern recognition in the visual cortex. These special systems result in illusionary motions that are hidden throughout the visual cortex. I suppose such illusionary motions are embedded between the directional detail in V1 and the general view of direction in V5.

As proven in motion V5's cell response to basic direction and in V1's cell response to specific direction, specificity in function must interact with generalization within a certain extent. I believe that functional specialization throughout the entire visual cortex responds to the brain's broad systems. This broad system, an essential characteristic for pattern recognition, reiterates that the brain acts intuitively when sparked by series of visual stimuli. This sensation of intuition acts outside the visual cortex by sending signals based on the nerves' immediate impulse. These signals travel to the visual world where it stimulates the matter that makes up the visual pattern. This stimulation creates an electrical impulse in the visual field that circulates back into the visual cortex.

It is evident that V1 and V5 represent dominant visual mechanisms where motion is created. But motion can also be destroyed. As Dr. Vilayanur S. Ramachandran believes, vision-related diseases that involve a destruction of an area (20), like motion V5, will create a better understanding of the visual cortical area V5 and its relation to the visual cortex. In order to understand the destruction of motion, one must define motion. Motion consists of two different types of data that are located in orientation selective V1 and motion V5. Spatial frequency, the change in distance of movements between an object (Wikipedia, 3) and objects within the same axis, is mostly stimulated by orientation selective V1. Measured in cycles per degrees, spatial frequencies are also repetitions of a constant distance (Wikipedia, 3). High spatial frequencies imply that there are quick changes in close details, such as the edges of the visual field (Wikipedia, 3). In contrast, general information, like general orientation and proportions, about the visual field is indicated by low spatial frequencies (Wikipedia, 3). Temporal frequency is the physical movement over a period of time. Motion V5 is stimulated mostly by temporal frequency because temporal frequency is the speed of an object that moves towards a certain direction at particular moments (Wikipedia, 3).

Motion is specifically destroyed in a syndrome called Cerebral akinetopsia (Zeki, 82). Based on Zihl's famous case study of a motion-blind patient, a 43-year old woman can only experience objects with a lack of external moving force (Zeki, 82). The patient has difficulty pouring a cup of coffee because she expresses that the coffee appears "to be frozen like glacier." **(82)** She also describes her experience of walking across the streets (82). The car seems to be far away and then she visualizes the car is almost near her (82) as if time swifts by faster than the speed of light.

The patient's lack of perception in motion represents her disability to precisely collide time and space almost simultaneously (Zeki, 159). The patient's destroyed V5 area is the world where time and space are successfully stopped. This is evident when she sees a "frozen glacier" **(82)** when she pours a cup of coffee. Time and space in destroyed motion V5 of the brain becomes subtlety functional when movement in the visual field produces a change of distance within the closest range possible (Zihl, 1628). The closest range is when the patient herself is in motion. She visualizes an automatic rush, the implied motion of the car. Although the car is technically still, it is not frozen. The implication of motion is produced when gross motion, motion that is secured in certain areas of the brain, activates (Zeki, 281). This activation occurs when displacements between movement reaches close to zero degrees per second (Zihl, 1634).

Zihl reveals that although the motion-blind patient is very weak at determining overall motion, she is better than normal people at detecting apparent motion (1634). His conclusion is based on experiments resulting in a minimal displacement of 0.09 degrees for motion-blind patient (1634). 0.09 degrees is greater than the minimal displacement for normal vision, which is 0.007 degrees (1634). Experiments were conducted in a series of randomized patterns of dots with minimal displacement (1634). Apparent motion is created when these dots flash so rapidly that it is difficult to decipher which dot flashes first, second and so on (1634). Apparent motion is stimulated by very small displacements in space over an immediate time period such that each movement is made right after another movement (1634). Now place the same dots that stimulate apparent motion into the Kanizsa triangle. Almost 90% of these flashing dots function in voids in contrast with the physical lines of the triangle. This implies that the brain's world sees pattern recognition as negative space, matter that makes up the universe.

Let's determine pattern recognition in relation to destroyed motion V5. Since the motion-blind patient is extremely good at apparent motion, it also means that she excels in finding order in pixels of higher resolutions. Higher resolutions are the details of pattern recognition whereas motion V5 needs a general resolution that direction selective V1 processes from the visual field. Motion V5 configures a common single direction because the visual field's resolution is simplified by V1. In addition, detecting higher resolutions quickly at certain moments also means that the patient's direction selective V1 area is better than a normal individual's.

How different does the motion-blind patient's visual cortex perceive negative space? The contrast of the visual field clarifies the visual field based on its opposing qualities, such as color, texture, depth and thickness. Since negative spaces move in the visual field, the motion blind patient will see negative space like a normal person, but will be difficult to see the movement. In addition, contrast is dynamic because it strengthens the visual cortex's knowledge by clarifying the differences of the visual field. Zihl concludes that the contrast required in determining the specific direction of motion is greatly increased in higher temporal frequencies for the motion blind patient (1636). As the temporal frequency increases in a particular direction, the patient's contrast sensitivity increases, allowing her to see the direction (1636). The patient can see the direction of movement because the frequency creates a movement temporarily.

Like V1 and motion V5, spatial frequencies and temporal frequencies are directly dependent on each other. This is proven when the motion-blind patient fails to match a best fit sine curve for contrast sensitivity at two adjacent peaks of the wave in terms of spatial and temporal frequency (Zihl, 1631). The patient's direction selective V1 is fully functional because her apparent motion focuses on spatial frequencies that produce an immensity of directions. Spatial frequencies stimulates orientation selective V1 because spatial frequencies repeat cycles at certain angles, which are directions. She doesn't simply compile directions in V1 like those of undestroyed V5, but she also configures these directions within a very short period of time. This time period should be faster than those of a normal individual's because her motion V5 is not working. Thus, her visual cortex depends on V1 to create a new path that does not send most of the directions to motion V5. This might be the reason why the patient's temporal frequency of approximately 80 Hertz matches the best fit sinusoidal wave for contrast sensitivity (Zihl, 1631).

Why can the motion-blind patient only perceive motion within a short period of time and within a longer range of time intervals? It is because her cortical area V1 has an illusion system that is almost still, implying specific direction selective cells. Since V1 works while motion V5 does not, V1 acts abruptly and terminates when the stimulation is not strong enough to initiate the process of data in V1. This means that apparent motion creates such illusions in V1, illusions that do not repeat throughout the entire visual cortex because of a malfunction in motion V5. These illusions are stimulated by intuitive thinking outside the visual cortex because this stimulation occurs shorty in sporadic moments.

Although it is clear that orientation selective V1 works, the patient's V1 does not produce the final movement of direction. The physiology of the visual cortex is designed for stimulated data to travel linearly, passing all cortical areas adjacently. Orientation selective V1 contains receptive cells that respond to motion at lower velocities (Zihl, 1628). On the contrary, motion V5 reacts to higher velocities because V5 contains larger receptive cells (Zihl, 1628). V1's specific directions of data that moves at lower velocities must pass through motion V5, where apparent motion is created. That question lies in how motion V5 can create apparent motion when motion is severely damaged.

Based on the fact that the patient is not able to see moving directions at a velocity above 6 degrees per second (Zihl, 1628), the connection between V1 and V2 might be damaged. Cortical area V2 has larger receptive fields that respond to direction than those in V1 (Zeki, 67). This is because some of the cells in orientation selective V1 and V2 react to movement (Zeki, 67). Motion V5 produces the final motion but orientation selective V1 initiates the movement **(Zeki)**. Since her perceived velocity works below 6 degrees per second, she will be able to see moving directions at 0.01 degrees per second. This goes back to why the motion-blind patient is extremely good at detecting higher spatial frequencies. Her higher spatial frequencies work within displacements close to 0 degrees (Zihl, 1633). Likewise, she also detects physical movement close to 0 degrees per second.

How can she achieve finer detail of the visual field only within the range of 0 degrees at short periods of time? 0 degrees pertains to one direction or orientation, the horizontal line. For normal functionality, orientation selective V1 needs a bunch of varying directions to focus on the visual field in order to transfer that focus to motion V5 **(Zeki).** I think V1 can focus within boundaries consisting of a minimum of three directions close to 0 degrees because V1 is stimulated by bodies of empty matter in the visual world. Since these bodies are invisible, the eye's retina is not able to detect these bodies. Therefore, these bodies are understood as *still* by direction selective V1.

The visual world is three-dimensional so the environment surrounding the visual object also stimulates the visual cortex. The environment, which is 85% of the visual field, holds these empty bodies of matter. Still matter stimulates V1 and motion V5 so greatly that it organizes the movement in their receptive fields. If this is not the case, how can V1 control the timing of when to release its varying directions to motion V5 to validate? Movement is easily detected when it is still. Therefore, stillness of the visual field, which is both its environment and its object, strengthens orientation selective V1 so that the motion blind patient can still see the motion from V1. This can only be successful within very low velocities for the patient because motion V5, the organizer who's stimulated with a wide range of low and high velocities, is destroyed.

What does this mean for normal vision? Each neuron in direction selective cells of V1 in normal vision is responsible for detecting apparent motion, which contains an infinite number of dots that form lines to create random directions. The random directions work together precisely with general directions in motion V5 to create an implication of motion. In the brain's world, motion is not literally labeled as motion. The brain understands through the processes of illusion. Then, the last section of motion V5 will confirm the final motion as the overall motion – the general direction.

The illusion is still motion, the necessary stimulation for movement to travel back into the visual world. There are intricacies that stimulate motion because motion is almost still. Motion is a shift between moving and stationary actions. Negative space in empty bodies is more of a stationary action in the visual field. One only needs to decipher still motion in terms of negative space in order to solve pattern recognition. This is because still motion is the intricacy of the visual cortex's cortical area V5. Embracing the ideology that "seeing is understanding", decoding the intricacies of visual cortex will create a natural and intuitive system of vision. This is the system that one should follow when replicating the brain after imitating pattern recognition in the visual cortex.

The visual cortex is the mini-brain of the biological eye. The left and right hemisphere of the brain is essentially the left and right eye, which is connect to the visual cortex, the processor of information like the brain. In fact, one does not need to imitate the entire visual cortex to create the mini-brain of the human eye. Orientation selective V1 and motion V1 are needed to replicate the visual cortex because V2, V3, V3A, and V4 all share similarities with V1 and V5. The only difference is that their receptive fields become larger as their cortical area reaches to motion V5 **(Zeki,).**

I want to stress the creation of motion V5 and its destruction because Zeki and Kurzweil both mentioned the creation of a known model and its destruction. These individuals come from such different specializations. Zeki analyzes the physiology of the brain in terms of neurasthenics while Kurzweil invents robotic machines using programmatic algorithms and mechanisms. I think it is important to put the two of their phrases together, "vision created, vision destroyed" **(Zeki,)** and "encryption created, encryption destroyed" **(Kurzweil, 87).**

Kurzweil mentions that encryption will be destroyed when the quantum computer dominates programming (115). Quantum computing travels the code as instantly (115) as the stimulation of cells in V1 and motion V5. This new coding technology is very good at transmitting randomness (115) like the natural randomness of pattern recognition in visual cortex. Quantum computation makes its own decisions on which random fibers to match by first initiating unsettled bit states of "0" and "1" (115). When the quantum computer understands the nature of coding itself, it then resurrects encryption by creating known states of "0" and "1" (116). Encryption is born again and it cannot possibly be decoded because the resurrection of encryption happens momentarily once (116).

Motion V5 is now destroyed in the visual cortex. Let's imagine the destruction of motion V5 in terms of Kurzweil's quantum computing model that destroys encrypted coding. Motion V5 can either be still or moving, 0-bit or 1-bit. In the quantum computing model of motion, motion V5 is still and moving at simultaneous times. It is crucial to conceptualize that still movement in motion V5's computing model, a 0-bit, barely moves. How does motion resurrected itself by quantum computation? Motion V5 cannot follow Kurzweil's model because the visual cortex is random and consistent. The delicacy designing an imitation of motion V5 relies on creating a natural receptive field that is stimulated by the tension between still and moving states.

Now destroy pattern recognition in the visual world. The destruction of pattern recognition doesn't need the quantum model because pattern recognition exists everywhere by nature. Its destruction creates its opposite character, nothing or empty spaces, within a bare minimum. If motion V5 is stimulated by the absence of pattern recognition, it will validate my hypothesis. My hypothesis states that the visual cortex understands the visual world through voids and empty spaces and not the physical pattern itself. The destruction of pattern recognition connects back to the destruction of motion. If my hypothesis is correct, then one need to create precise voids that are individual in character and material to stimulate the cells of destroyed motion V5. It is important conceptually destroy V5 while performing experiments of void stimulation on motion-blind patients.

There is a significant relationship between destroying parts of the artificial brain and resurrecting its parts. This is the technique one should follow in order imitate the artificial brain as a whole. There lies a deeper consciousness that I believe can be deciphered. Individuals who specialize in artificial intelligence must invent intelligence by precisely conceptualizing the brain as a natural series of intuition. The brain is not a machine dominated by technology because we will not be able to think for ourselves if that is the case. The physiology and natural science of the brain is what makes Homo sapiens human. The answer to decode human intelligence is not technical. The answer lies in abstraction of the psychological realm of spiritual and biological forces.