

Oliver Sacks: The Mind's Eye

**Sight Reading**

- In January of 1999, Dr. Sacks received a letter from **Lilian Kallir**, a woman who claims that she was totally incapable of reading
- Lilian was 67 and a great pianist
- Her inability to read came when she was 61 and performing during a concert
  - She flipped the page and saw that she was unable to read the scores
- Her inability to read from sight began to worsen and she soon began to depend on her memory to perform certain performances
  - Some days she could read perfectly and others it was unintelligible
- In 1994 Lilian began to have problems reading words
  - Her ability to read was off and on but her ability to write was unaffected at this time
- This syndrome is called **“alexia sine agraphia”** which is the loss of reading abilities in a literate person
  - It usually follows a stroke but Lilian was the first case that Dr. Sacks saw that began with musical notation
    - He called it “musical alexia”
- A few years later Lilian found that she missed objects to her right so she gave up driving
  - She also began to forget people and failed to recognize her friends
  - Maybe her issues were neurological rather than ophthalmological?
- When getting tested, Lilian did particularly bad in the recognition phase
  - She could also only read words letter by letter and then put them together for the final word
- Similar to Sack's story, “The Man Who Mistook His Wife for a Hat,” she could see things but not recognize
- Weirdly, Lilian's speech comprehension, repetition, and verbal fluency were normal
- When a brain scan was done, they saw that she had diminished metabolic activity in her visual cortex (posterior part of the brain)
- Since her visuals were diminished she strengthened her auditory skills and learned to hear and reproduce music solely by listening
- When Lilian met Dr. Sacks for the first she handed him her portfolio
  - “Posterior cortical atrophy of the left hemisphere” is what all of the doctors told her and said that it was untreatable
- When Dr. Sacks examined her he found that she could match colors and shapes but not letters or numerals
  - She was now only seeing individual features of objects or pictures instead of the whole
    - Images weren't a blur to her they were a “mush”

- One time Lilian mistook Dr. Sacks's medical bag for her handbag and left with it
- Weirdered out by how Lilian could possibly live and fend for herself on a day to day basis, Dr. Sacks visited her in her home to see what it is like for her
- When tested with actual objects Lilian perceived things much better
- In her home, she had organized things by color, shape, etc. so that she knew where everything was
- When eating, Lilian would keep track of where the plates went so that she knew where to find them
  - She encountered an issue with this when having tea with Dr. Sacks
- Lilian soon developed an issue with recognizing and naming objects
- Dr. Sacks brings up PCA, better known as Posterior Cortical Atrophy
  - People with PCA tend to preserve elementary aspects of visual perception but they experience complex visual disturbances
    - PCA was first formally described by Frank Benson
- Lilian was very similar to Dr. Sacks's patient Dr. P., from "the man who mistook his wife for a hat"
  - They were both musicians and both developed severe visual agnosias while remaining remarkably intact in many other ways
    - They both had discovered ways around their problems so they could keep making music
- Dr. P coped with illness much different than Lilian
  - Dr. P was already in grave trouble when Dr. Sacks met him and he had even once mistaken his wife's head for his hat
    - Dr. P showed indifference into the fact that he was ill and often tried to compensate for the things that he could not see
      - Lilian, however, retained the ability to live well and even travel 9 years after her first issue
- Dr. P could only determine what things were by action
  - He could describe a glove but not identify it until it was on his hand
- Music became a way for Dr. P to cope with his illness and go on with his days
  - For Lilian, it did not
- Voices had become a special cue for Lilian
  - She was hyperattentive to voices as she was to colors and shapes
- In the supermarket, it was apparent to Dr. Sacks that Lilian had the whole floor plan of the store memorized
  - Dr. Sacks wore all red to make sure that she could find him easily if they were separated
    - Lilian was great at recognizing colors

- Dr. Sacks was shocked at Lilian's ability to recognize herself on a small cd but she could not recognize a large painting on the wall
  - How could she see a stretch cord without realizing it was sitting on a sofa?
- Lilian says that her father had a passion for clocks
  - She could not read the numerals on her wrist watch but could judge the position of the hands
- Due to her situation, Lilian felt that her musical memory had become stronger and more tenacious
- Leaving her own environment was very challenging for Lilian
- In August of 2001, Sacks visited her again and he noticed that Lilian's condition was deteriorating
- When comparing her kitchen to what it was two years prior, Sacks realizes that it is much more unorganized which has led to Lilian "losing things"
- Sacks was afraid that Lilian's ability to use her memory and cognition might also begin to deteriorate
- Ian McDonald was an example of a man who encountered musical alexia as a result of an embolic stroke but he managed to make a full recovery
- It was through art and music that Lilian learned to transcend her illness
- When Sacks visited Lilian again he saw that she was now in worse condition and lacked complete visual orientation
- The chapter ends with Sacks asking Lilian to play a song on the piano
  - After not playing for 2-3 weeks, she still managed to perform eloquently and ended her piece by saying, "All is forgiven"

### **Recalled to Life**

- This chapter discusses the story of **Patricia H.**, a mother, artist, and overall brilliant woman
- Patricia was known for being a little bit moody
  - One day depressed the next day jumping out of bed
- In 1991, her daughters became alarmed when she did not answer the phone for two days
  - They called the Police and entered her home to find her unconscious
  - She was in a coma and had suffered a massive cerebral hemorrhage
- After undergoing surgery to remove a blood clot on the left side of her head, she was unresponsive for 2 weeks until she suddenly came to her senses and asked for her daughter's diet Coke
- She was now paralyzed on the right side of her body and could no longer speak (express her feelings in words) as she had to make gestures
  - Her understanding of speech was also impaired so her condition was deemed **aphasia - loss of speech**
    - There are many different forms of aphasia and it is not common

- There is receptive and expressive aphasia and if there is both it is known as “global aphasia”
- Expressive aphasia in its mildest forms is characterized by difficulty of finding words or a tendency to use the wrong words, without compromise of the overall structure of sentences
  - Nouns tend to be especially affected
- Hughlings Jackson compared aphasics to dogs because he believed that some of them were incapable of even speaking to themselves in their heads
- Narinder Kapur details the time that he woke up globally aphasic
  - He explains that he was unable to understand what others said to him and he lost the ability to talk, read, and write
  - He explains how he saw himself as half of a man because he could only live in the present and could not think internally or even dream
- Jacques Lordat also gives some insight into what his aphasia was like after he suffered a stroke
  - He explains that he was no longer remember words and those that he could remember proved to be useless
    - He could no longer grasp the ideas of others as well
    - Inwardly he felt the same as ever
    - Thinking caused him no trouble whatsoever
    - His situation was very different from that of Kapur’s
- Patricia’s family was told that she would never be able to enjoy life again and would be a prisoner in her own body
  - Patients with aphasia tend to undergo “social rehabilitation” but the patient is pretty much being “recalled to life”
- Pat’s family was determined to give her a better life so they hired a nurse and brought her with them to daily activities
- After six months she was moved to Beth Abraham Hospital, in the Bronx, where Dr. Sacks first met her
  - The hospital was originally called the Beth Abraham Home for Incurables
    - Visitors to hospitals for the chronically ill are often horrified at the sight of the “incurable patients”
- When Dr. Sacks first met Pat she was very angry and frustrated
  - She was responding not so much to words but to the tone of voice, facial expression, and gestures
    - She could not respond to simple commands like “touch your nose”
- Pat became very frustrated that she could not speak and even worked herself into silence at the defeat of messing up words
- Her inability to speak was worse than her inability to move the right side of her body

- A year later Pat was doing much better and had developed ways to communicate
  - She was also happier
- Aphasics learn to compensate for their inability to speak and understand so they get better at understanding faces and gestures
  - They sometimes develop an enhanced ability to see through lying
    - Pat adapted by using mime and gestures
- Pat's speech pathologist learned that Pat could read certain words but just not whole sentences
- Her pathologist developed a lexicon for her (a special book characterized by words and ideas) and Pat would keep this by her side at all times
- By 1996, Pat's receptive aphasia had lessened and she was able to understand a little speech, though still unable to express herself in speech
- Even after five years, Sacks still noticed that Pat was showing a continuous improvement in her receptive powers, going against the belief that a brain injury stops healing after 12-18 months
- Many people who study language argue that there this "saying" and "showing" as well as "descriptive" and "depictive"
  - Pat had depictive powers as a result of her stroke
- In 1999 Dr. Sacks visited her again and was stunned by how far she had come
  - She told him about how she now capable of swimming and even pointed out the proper date to him
- In 2000 she showed Sacks the cover of a newspaper that depicted the Williams sisters, tennis players whom she loved
  - She had been a tennis player in her youth
- By 2002 Pat was able to use a few spoken words
  - This was through the use of familiar songs like "Happy Birthday" and "A Bicycle Built for Two"
- She carried a cassette with songs that could stimulate her to speak upon playing it
- Pat did not apply music to regain her ability to speak because she had put all faith into her mimetic powers
- Mimesis, the deliberate and conscious representation of scenes, thoughts, feelings, intentions, and so on, by mime and action, seems to be a specifically human achievement, like language
- Pat was thankful that her brain damage did not undermine her personality
- She was also thankful for her therapist who provided her with her lexicon book (her "Bible")
- Overall, Pat was happy because she was glad that she was alive
  - She does not see herself as a victim, but as one who has been blessed

- Pat was able to communicate and get her own things at the store with the assistance of others

### **A Man of Letters**

- In 2002, Sacks received a letter from Howard Engel, the Canadian writer known for his Benny Cooperman series of detective novels, describing a strange problem
  - Howard claimed that one day he went to pick up the newspaper and it seemed to have gone through an uncanny transformation
    - He could no longer read the words
    - It seemed like the words were in Korean
  - Howard then concluded that he had a stroke
    - Howard went inside and looked at books in other languages and concluded that all the books had an “Oriental” looking script
  - On the way to the hospital, he could not read street signs and couldn’t even read “Emergency Room”
    - After tests, it showed that he had undergone a stroke and that it had damaged a limited area of the visual parts of the brain, on the left side.
      - He forgot his name, his address, and everything in between
  - Over his time in the hospital, it also became clear that he had other visual problems besides his inability to read
    - He had difficulty recognizing colors, faces, and everyday objects.
    - He also had blind spots
    - Like Lillian, he was able to write but unable to read
    - He had **alexia sine agraphia** too
  - In the hospital, he was able to sign his name but could not read it
  - Heinrich Lissauer wrote about the idea of “psychic blindness” to describe how some patients, after a stroke, become unable to recognize familiar objects visually
    - **People with visual agnosia can have perfectly normal visual acuity, yet be totally unable to recognize or identify what they’re seeing**
  - **Alexia is a specific form of agnosia, an inability to recognize written language**
  - Oscar C. (Monsieur C.) was able to write fluently like Howard but could not continue if he was interrupted
    - Isolated letters did not make sense to him
    - Oscar was able to learn music by ear
      - Oscar was great at playing cards
      - When Oscar died, Dejerine did an autopsy and found two lesions in the brain
        - The older of the two had destroyed part of the left occipital lobe and was responsible for Oscar’s alexia

- Dejerine related alexia to the damage in the brain and thus created what he called a “visual center for letters” in the brain
  - This portion of the brain responsible for reading would be proven years later
- Stanislas Dehaene and his colleagues have been able to focus even more closely on what he calls the visual word form area or “the brain’s letterbox”
- Dehaene’s studies have shown the visual word form area can be activated in a fraction of second by a single written word, and how this initial, purely visual activation then spreads to other areas of the brain-- especially the temporal lobe and frontal lobes
- Howard Engel questioned how he would continue his life living with alexia
  - His whole livelihood and identity depended on his ability to read and write
- Charles Scribner Jr. had been in a similar situation to Engel 10 years prior when he consulted Sacks
  - Charles was also a man of letters
  - He presided over the publishing house established by his great-grandfather in the 1840s
    - As a result, his alexia interfered with his daily task of writing and reading
    - He developed visual alexia in his sixties
      - Scribner, as a result, moved to audiobooks
      - Scribner could write, but not read in the same way as Lilian and Howard
- For Howard, his alexia was only shown when he tried to read a book
  - When recovering in the hospital he was determined to read again even though he could not even recognize individual letters
- With time, Howard began to see an improvement in his reading ability
  - The letters began to look like English again instead of the Serbo-Croatian letters he had seen shortly after the stroke
- There are two forms of alexia:
  - 1.) A severe form which prevents even individual letters from being recognized
  - 2.) A milder form in which letters can be recognized but only one by one, not simultaneously as words
    - Howard obviously has moved to the milder condition of alexia
- He tried to regain his ability to read by slowly and laboriously forcing himself to decipher the names of streets and shops or the headlines of newspapers
- Each added letter to a word made it harder for Howard
  - The words ‘cat’ and ‘hippopotamus’ get understood at different rates in Howard’s mind
- Whatever language a person is reading, the same area of intertemporal cortex, the visual word form area, is activated

- In every human brain, there is a section in the dominant hemisphere for the recognition of letters and words
- **Wallace's Problem**
  - Alfred Russel Wallace (who discovered natural selection independent from Charles Darwin) became intensely concerned with the paradox of the human brain's many potential abilities -- lexical, mathematical, and so on-- abilities that would be of little use in a primitive or prehistoric society
- Wallace felt that natural selection could not explain the existence of potential powers that might become to manifest only with the development of advanced culture hundreds of thousands of years in the future
  - Wallace believed that God must've implanted these gifts into the human psyche
- Visual object recognition depends on the millions of neurons in the inferotemporal cortex, and neuronal function here is very plastic, open and highly responsive to experience and training
- Inferotemporal neurons evolved for general visual recognition, but they may be recruited for other purposes -- most notably reading
- Some studies have shown that our letters are based on the conglomerations of contours found in natural scenes
- We are able to read not by virtue of a divine intervention, but through a cultural invention and a cultural selection that makes a brilliant and creative new use of a preexisting neural proclivity
- 9 years after his stroke Howard was still unable to recognize many simple words at a glance
- Howard began to use a "memory book" to remember things while in the hospital and this forced him in a way to write every day
- Howard lacked internal imagery so he had to employ other methods for spelling
  - He would write a word in the air with his finger, letting a motor act take the place of a sensory one
- Howard started to move his hands as he read to feel the outlines of the words and sentences that were still unintelligible to his eyes
  - His tongue also began to move as he read because he traced the shapes of letters on his teeth or the roof of his mouth
  - In effect, Howard was reading by a sort of writing... he was reading with his tongue
- When released to his home, Howard began to regain his computer skills
- Howard decided that he would write a book about what it feels like to be out of the loop of life
  - This is something that he knew very well
- Howard chose to reintroduce his alter ego



- It would be the detective Benny Cooperman but it would be a Cooperman transformed: the great detective, waking in a hospital bed, finds himself not only alexic but amnesic as well
  - His powers of inference, however, are intact and enable him to stitch together disparate clues, to figure out how he landed in the hospital and what happened in the mysterious few days he can no longer remember
    - He had his editor read him the entire draft so he could rearrange things in his mind in the same way that Lilian arranged piano scores in her head
    - He published the book in 2005
- Howard Engel is still alexic, but he has found a way to remain a man of letters
  - His story is a testament to the dedication and skill of his therapists in rehab, his own determination to read again, and the adaptability of the human brain

### Face-Blind

- Our faces bear the stamp of our experiences and character
- The face is the first object to acquire visual meaning and significance
- Dr. Sacks talks about his personal struggles with recognizing faces
  - He also found trouble when trying to recognize places
- Dr. Sacks once had a meeting with his psychiatrist and 5 minutes after the meeting he was unable to recognize him
  - He once went out with his nephew and passed his house 4 times before recognizing it
- Sacks sometimes has trouble recognizing himself as well
- When Sacks went to visit his brother Marcus in Australia he found that his brother had the exact same difficulty recognizing faces and places
  - They both had a specific trait, a so-called prosopagnosia, probably with a distinctive genetic basis
- People with very severe prosopagnosia may be unable to recognize their spouse, or to pick out their own child in a group of others
- Jane Goodall's problems with prosopagnosia extended to recognizing chimpanzees as well as people-- thus, she says, she is often unable to distinguish individual chimps by their faces
  - She has issues with people who have "average" faces so she looks to find a specific detail on their face
- After writing about Dr. P's story, Sacks began to get emails and letters from people who had a similar scenario to Dr. P
  - Anne F. wrote to him describing her experiences
    - She believes that three people in her family have visual agnosias
      - She shares prosopagnosia with Dr. P

- She has no memory for where she put things unless she verbally encoded the location
  - Once things leave her hand they drop off the edge of the world into a void
- Joan C., another correspondent, had an unusual history in this regard: she had developed a brain tumor occipital lobe as an infant, and this was removed when she was two years old
  - It is apparent that her prosopagnosia was the result of either the tumor or the surgery
- In the last few decades, we have become very conscious of the brain's plasticity, how one part or system of the brain may take over the functions of a defective or damaged one
- People with prosopagnosia need to be resourceful and inventive, need to find strategies, ways of circumventing their deficits: recognizing people by an unusual nose or head, spectacles, or a certain sort of clothing
  - Many prosopagnosics recognize people by voice, posture, or gait
- Dr. Sacks may be unable to recognize a face but he can recognize specific things about a face
  - Large nose, chin, etc.
  - He also recognizes people by the way they move ("motor style")
- Sacks avoids large gatherings because his anxiety increases
- Toward the end of the 18th century, the anatomist Franz Joseph Gall proposed that all mental functions must arise from the brain -- not from the "soul"
  - He envisioned within the brain a collection of twenty-seven "organs," each responsible for a different moral or mental faculty
    - He believed that these facilities included what we would now call perceptual functions, such as the sensation of color or sound; cognitive facilities, like memory, mechanical aptitude, or speech and language; and even "moral" traits such as friendship, benevolence, or pride
      - For his beliefs he was exiled from Vienna
- Physiologist Jean-Pierre Flourens decided to investigate Gall's theory by removing slices of the brain in living animals, chiefly pigeons
  - He could not find any evidence to correlate specific areas of the cortex with specific faculties
    - Flourens, therefore, believed that the cognitive impairments his pigeons exhibited as he removed more pieces of cortex reflects only the amount of cortex removed, not its location, and what applied to the birds, he felt, probably applied to human beings
- Flouren's notion of the equipotential cortex dominated thought until the studies of Paul Broca in the 1860s

- Broca performed autopsies on many patients with expressive aphasia, all of whom, he showed, had damage to the frontal lobes on the left side
  - He stated, “We speak with our left hemisphere,” and the notion of a homogeneous and undifferentiated brain was put to rest
- Broca believed that he had found a “motor center for words” in a particular part of the left frontal lobe
  - This is today known as Broca’s area
    - This seemed to promise a genuine correlation of neurological and cognitive functions with specific parts of the brain
- In 1872, Hughlings Jackson described a man who, following a stroke in the right hemisphere, lost his ability “to recognize places and persons. At one time he did not know his wife.”
- Even by the middle of the twentieth century, many neurologists doubted whether the brain had category-specific recognition areas
- Joachime Bodamer coined the term, “prosopagnosia” in 1947
  - Is there a part of the brain designated to just recognizing faces?
- In 1955, the English neurologist Christopher Pallis published a beautifully detailed and documented study of his patient A.H., a mining engineer
  - One night he had suffered a stroke and awoke the next day with his visual world completely transformed
    - All the faces of his family looked the same
      - A.H., however, did not have object agnosia because he was still able to play chess and complete puzzles
- Virtually all patients who acquire prosopagnosia have lesions in the right visual association cortex
  - Abnormal activity in the fusiform face area has also been correlated with hallucination of faces
- Recognition of particular faces or objects is only achieved in the multimodal area of the medial temporal lobe, which has rich reciprocal connections not only to the fusiform face area but to other areas subserving sensory association, emotion, and memory
- Neurons in the medial temporal lobe are capable of encoding representations of individual faces, landmarks, or objects so that they can be easily recognized in a changing environment
- By six months babies are able to recognize different faces
- Natural selection may bring about the initial disposition, but experience and experiential selection are needed to bring about our cognitive and perceptual capacities to their full realization

- Elkhonon Goldberg believes that at higher cortical levels there may be much more in the way of gradients, where areas whose function is developed by experience and training may overlap into each other
  - He believes that modularity and gradients may thus coexist and complement one another
- Researchers have suggested that prosopagnosia is not purely a problem with face-blindness, but one aspect of a more general difficulty in distinguishing the individuals in any class, whether the class is of faces, cars, birds, or anything else
- The fusiform face area does not work in isolation; it is a vital node in a cognitive network that stretches from the occipital cortex to the prefrontal area
  - Face-blindness may even occur if the fusiform face area is intact
- Recognition of faces depends not only on the ability to parse the visual aspects of a face, but the ability to summon the memories, experiences, and feelings associated with that face
- Recognition is based on knowledge, whereas familiarity is based on feeling
  - Although both are lost in tandem with prosopagnosia, one can have familiarity without recognition or vice versa
- People with Capgras Syndrome no longer sense emotional familiarity when they see people's faces
  - Since the family member no longer gives off the warm feeling of familiarity, the Capgras patient will argue, they cannot be the real thing -- they must be clever imposters and counterfeits
- People with prosopagnosia realize that their problems with recognition come from their own brains
  - People with Capgras Syndrome remain immovable in their conviction that they are perfectly normal and it is the other person who is wrong
- Dr. Sacks has Congenital Prosopagnosia
- Nakayama and Duchaine have studied the psychological effects and social consequences of developmental prosopagnosia and topographical agnosia -- the special problems these conditions can create for an individual in a complex social and urban culture
- Severe congenital prosopagnosia is estimated to affect at least 2 percent of the population

### **Stereo Sue**

- Early neurologists never appreciated how the eyes each receive images that are slightly different
  - In the 1830s, Charles Wheatstone began to suspect that even though the brain somehow fused these images automatically and unconsciously, the disparities between the two retinal images were in fact crucial to the brain's mysterious ability to generate a sensation of depth

- He made pairs of drawings of a solid object as seen from the slightly different perspectives of the two eyes and then designed an instrument that used mirrors to insure that each eye only saw its own drawing
  - He called this a spectroscope from the Greek meaning, “solid vision”
- There are other ways of judging depth without stereo vision
  - Perspective
  - Shading
  - ‘Aerial’ Perspective
  - Motion parallax -- the changing experience of spatial relationships as we move around in the world
- The only way to perceive depth is with binocular spectroscopy
- As a kid, Sacks had a spectroscope and a pseudoscope
- Sacks was a big fan of stereoscopy
- Paul Romano
  - A 68 year old retired pediatric ophthalmologist
  - He had suffered a massive ocular hemorrhage, which caused him to lose nearly all sight in one eye
    - After a single day of monocular vision, his room became messy and he forgot where everything was
    - It was hard for him to see things in two dimensions
      - After nine months he finally recovered his stereo vision
- In the 1970s Sacks had his own experience with losing spectroscopy when he was put into a small hospital room after surgery
- The binocular cells in our visual cortex are necessary to construct a sense of depth from retinal disparities
  - Hubel and Wiesel showed, in animals, that if normal binocular vision was rendered impossible by a congenital condition, these binocular cells would fail to develop and the animals would permanently lack stereoscopy
- 5-10% of the population may have little or no stereo vision
- Wiley Post, the first man to fly around the world solo, did so with one eye
- Stereopsis - the perception of depth produced by the reception in the brain of visual stimuli from both eyes in combination; binocular vision.
- A hammerhead shark is an example of a hyper stereoscope
- Stereoscopy is highly advantageous to such animals, despite its costs:
  - The sacrifice of panoramic vision
  - The need for special neural and muscular mechanisms for coordinating and aligning the eyes

- The development of special brain mechanisms to compute depth from the disparities of the two visual images
- In 2004, Dr. Sacks received an unexpected letter from a woman named Sue Barry
  - She had grown up cross-eyed and here eyes did not work in tandem
    - They were always alternating
    - This was no disadvantage to her as she carried on her with her normal life without any restrictions
- Up until she was a junior in college, Sue believed that her vision was the same as everyone else
- She flunked every stereo vision test that she took when she was trying to educate herself on how she was different
  - Upon asking, all doctors told her that she had no hope of correcting her vision so she did not go any further at the time
- Living without the binocular vision did not bring about any other issues for Sue until her late forties
  - It became increasingly difficult for her to see things at a distance
  - Her doctor, Dr. Ruggerio, confirmed that she was seeing the world monocularly
    - She told Sue that her eyes were misaligned vertically
    - With a certain “prism” she was able to see properly
- Through an exercise known as the “Brock String,” Sue was taught how to fixate both eyes on the same point in space, so that her visual system would not suppress the images from one eye or the other by would fuse them together
  - The effects were immediate
    - She was able to see in 3-D and things finally had texture
- Sue was now able to enjoy stereo vision
  - Her life was made easier
- Dr. Sack was curious how she was able to make this transformation so he visited her one day
  - Dr. Sack brought a special stereogram that would determine how she sees perception
    - If she was seeing with one eye it would look like one plane but if seen stereotypically there were seven
      - She saw it as a flat plane
        - When Sacks told her that there were seven she looked again and could see them all
- When one looks into a stereogram, there are different binocular cues and monocular cues and each person sees things differently based on the different cues
- Dr. Ruggerio had gotten Sue to regain her stereo vision by causing her to achieve flat fusion

- With fusion exercises, Sue found that she was starting to perceive depth at greater and greater distances, where at first she had seen depth only close up, as with the steering wheel (started to pop out of the dashboard)
  - When she stopped doing the exercise she regressed quickly
    - She then started doing them religiously and continued to work on moving her eyes in harmony
- The purest test of stereo vision is the random-dot stereogram
  - Sue could finally complete these tests
- Elaborate autostereograms have been widely popularized in Magic Eye Books
  - The illusions are single images that one views without a stereoscope; but they contain horizontal rows of repeating patterns that are slightly different
    - At first glance, they all seem to be on the same level, but if one learns how to diverge and converge the eyes, letting each eye focus on a different row, then striking stereoscopic illusions appear
- Sue compares her journey to someone who was born color blind and was suddenly given the ability to see in full color
- Some people would not wish to have their life changed in the way that Sue did but she embraced her new opportunities and loves her new lifestyle
- We are still uncertain as to whether disparity-sensitive cell (the binocular cells specialized for spectroscopy) are present at birth
- Sue has found other people who also suffered from strabismus
  - **Strabismus - a visual problem in which the eyes are not aligned properly and point in different directions.**

### **Persistence of Vision (this chapter is comprised of journal entries along Sacks' journey)**

- While visiting the cinema in December of 2005, Dr. Sacks felt a strange feeling in his right eye
  - He noticed a blind spot and became frightened
- He visited the ophthalmologist to determine what the issue was
  - The doctor said that he saw pigmentation of the eye... a leading symptom of a hematoma, or a tumor
    - He immediately became scared
- He visited Dr. Abramson, a man who Dr. Sacks had taught back in the 1960s
- He examined Sacks eyes and they concluded that he has a **malignant tumor**
  - It was melanoma but his doctor assured him that it had little chance of spreading beyond the eye
- He would not be able to have the surgery until at least 3 weeks due to the approaching holidays
- Radiation would be easily get rid of his tumor but it was the location of the tumor that was bad

- Sacks greatest fear was that the hematoma had spread to other important parts of his body like the liver
- As it nears Christmas, Sacks realizes that he cannot read at all if he solely uses his right eye
- On Christmas day Sack journals that this is the darkest Christmas he has ever known
  - He wonders if in 2006 he will be pictured in the newspaper for people who died in the year
- One night Sacks discovers that the edema (swelling) tends to pool up when he lies flat so he has decided he will sleep with his head propped up
- By this point he is finding difficulty concentrating
- On January 5th Sacks journals that he is becoming impatient and angry with how long he has to wait for the surgery
  - He realizes that he managed to go 32 months without an eye exam... a mistake that he hopes will not cost him his life
- On January 9th he underwent surgery
  - The surgery was successful and Sacks awoke in a euphoric state
    - Six hours later he was laying in his bed and saw occasional sparkles, scintillations, in his right eye
      - He wondered if this was a result from the particles or rays emitted by the **radioiodine** hitting his retina
        - He thinks back to visiting his Uncle Abe's home and pressing his clock dials on his closed eyelids
          - He wonders if this played a role in his tumor
- Sacks started having retinal reactions to the radiation
  - He would see purple forms of starfish and daisies expanding outward from a multitude of points
- He discusses plans to remove the remaining malignant cells and awaits his next surgery to remove the radioactive plaque from his eye
- Sacks compares his scotoma (blind spot) to a window where he sees a vast genre of different creative things
  - He says that these visions must be constructed from his brain
    - When he looked at something and then closed his eyes he continued to see the image clearly
      - He wonders what is wrong with him that allows him to see these afterimages
- It is now January 12 and his radioactive implant is set to be removed on this day
  - He awoke from the surgery in grave pain
- On January 13 Sacks is back in his own home and feels sad to have left the hospital because he is alone now



- When looking out of his right eye he describes his vision as “fluid”
  - Everything is moving and distorted
- When reading the words are distorted
  - He is afraid that blindness has set upon him like a thief in the night
- Sack shares with us that his left eye vision isn't much better
  - As a kid he was punched and left with a cataract
    - His vision in the eye has been subpar ever since
- Since his retina is basically swimming his edema, his vision can be perfect one day and awful the next
- Sacks is sad that he is not allowed to swim until 2 weeks after the surgery because it was an activity that was so essential to his everyday life
- Sacks noticed that his vision for color was gone when he looked at a green tennis ball and did not see any color
- On January 25, Sacks sees improvements
- Sacks was having nightmares about his vision
- Dr. Abramson explained to Dr. Sacks that there would need to be a touch up lasering session but besides that he was free to go on with his normal activities
  - He could go back to swimming
- Abnormalities in color perception remained
- When he went to see Dr. Abramson in May he told Sacks that the edema was gone and that the tumor had begun to shrink
- Starting in July there was a gradual return of visual problems -- especially distortion and sensitivity to light
  - There was also some regrowth in an area of the tumor
- Sacks underwent another lasering session but this did not help
  - He stopped using his right eye and by May of 2007 his vision in the eye was 20/600
    - He couldn't read the biggest letter on the chart
- They scheduled a third lasering that would knock out the remaining tumor and possible the remaining central vision
- After the lasering Sacks vision was brutally impaired
  - He could only see the lower halves of people walking
- With both eyes open his vision is significantly better and he wishes he had done the lasering sooner
- His scotoma was huge so he had a massive blind spot
  - His scotoma could not only fill in color, but fill in patterns to so he had fun experimenting with this
- His scotoma was becoming good at filling in things

- His visual cortex was an averaging device, capable of sampling what was presented to it and making a statistically plausible representation of it
- After his lasering in June he was able to visualize his arms and legs with his eyes closed in better than he could have before
- He believes that losing vision his loss of central vision in his right eye was equivalent to having it covered by a postoperative patch, in terms of depriving the brain of perceptual information
  - His visual cortex was now in a heightened state
- One day he closed his eyes while walking in an intersection and still saw the whole scene in front of him
  - This was surprising to him because he usually had weak visualization skills
    - He loved testing this ability in Times Square
- Macdonald Critchley wrote an essay on types of “visual perseveration”
  - Paliopsia
  - Illusory visual spread
    - He claims that these two phenomena were analogous: one a perseveration in time, the other a perseveration in space
- Sacks was experiencing this cerebral phenomena
  - He supposed that retinal impairment has led to some abnormal excitation in his visual cortex
- In June 2007, Sack suffered from a sharp surge of hallucinations
  - He has simple hallucinations
- He sometimes sees checkerboards
  - Their size is based on how far away he is “projecting them” from
- He also sees tessellations composed of polygons
- He occasionally sees maps as well
- These hallucinations and perceptions are microscopically detailed and they have phenomenal clarity
- The most constant pictures are sticklike or occasionally curved patterns resembling letters or numbers
- On December 20, 2007, while in the gym, Sacks noticed a roughly circular black spot the size of a dime on the skin below his left shoulder
  - He questioned if it was skin melanoma that had metastasized from his eye
- He saw Dr. Bickers, his dermatologist the next day who assured him that the spot was nothing to be worried about
- Since he had been stereoscopic his whole life, Sacks now finds daily challenges that he must overcome
  - Grabbing things, stepping over curbs, steps, etc.
- Sacks has lost his fear of heights

- This is because he has lost depth perception
- Now that he sees in 2-D, Sacks sees everything as flat and depthless
  - Everything is on one plane
- After two years without stereoscopy, Sacks can now function pretty well
  - He can walk up and down stairs, pour wine, and shake hands
    - He can even bike and drive!
      - He can see through his perceptions of the 2-D world
- The only time sees in stereo is in his dreams
- His vision remained stable like this for two years
- On September 27, 2009, everything changed
  - It started off like any other day but his peripheral vision turned hazy
    - He went to the doctor and he learned that there was bleeding coming from the retina and the blood was now seeping into the back of his eye
- He was told that the blood would clear but for now he was practically blind in his right eye
  - To take his mind off things he played the piano and then took two sleeping pills and went to sleep
- He went for a walk with Kate, his assistant, the next day in the park and he was frightened by his newly established right blind spot
  - If it were not for Kate standing to his right he would've bumped into everyone
- Peripheral vision alerts us to unexpected movements on either side, and then central vision moves to target these
- Sacks is often frightened by the random appearance of things and people from his right side
- As far as Sacks' brain is concerned the right eye is no longer existent
- Sacks details the struggles of just simply walking on the sidewalk with a blind spot
- Sacks ends this chapter by explaining how metaphors like "out of the blue" and "out of nowhere" are actually applicable to his everyday life, as things come and go from his line of vision on a day to day basis

### **The Mind's Eye**

- Sacks asked the question as to what extent we are the authors of our own experiences
- In 1990, Sacks was sent an extraordinary book called *Touching the Rock: An Experience of Blindness*, by John Hull, a professor of religious education in England
  - Hull had grown up partly sighted, developing cataracts at the age of thirteen and becoming completely blind in his left eye four years later
  - In 1983, at the age of 48, he became completely blind
    - *Touching the Rock*, is the journal he dictated in the 3 years that followed
- In his journal, Hull talks about his journey to "deep blindness," where he could not even visualize things

- He lost the idea of seeing
  - He saw his blindness as a prerequisite for strengthening his other senses
- Even listening to rain brought on a new meaning for Hull
  - By strengthening his other senses, Hull came to feel a sense of intimacy with nature
- Some studies show that in those born blind, or blinded early, some areas of the visual cortex may be reallocated and used to process sound and touch
  - With reallocation of parts of the visual cortex, hearing, touch, and other senses in the blind can take on a hyperacuity that perhaps no sighted person can imagine
    - People like Bernard Morin and Geerat Vermeij have made significant strides in their fields even though they were both blind
- In 1970s, scientists began to believe that there may be a certain flexibility or plasticity in the brain
- Hull's situation was a great example of cortical plasticity
- Sacks was puzzled when many blind people wrote to him and said that they have not experienced anything like Hull and that they still have the ability to visualize
- A few years later Sacks received a letter from Australian psychologist Zoltan Torrey
  - Torrey had gone blind at the age of 21
    - Instead of switching from a visual to an auditory mode of adjustment, he moved in the opposite direction
      - He resolved to develop instead his inner eye, his powers of visual imagery, to their greatest possible extent
- He had become extremely successful at this and had developed a remarkable power of generating, holding, and manipulating images in his mind
  - So much so that he was able to construct a virtual visual world that seemed as real and intense to him as the perceptual one
    - He once redid the roofing of his house alone... while blind
- Torrey lost his vision when he loosened the plug in a vat of acid at the chemical factory where he worked
  - When told to "forget about sight and visualizing altogether" he could not comply
    - He wanted to know how a partially sense-deprived brain could rebuild a life
      - He wrote about all this in his book, *Out of Darkness*
- Unlike Hull, Torrey was able to use his visualization skills to the point of multiplying four digit numbers in his head
- Sabriye Tenberken's, *My Path Leads to Tibet*, tells of her travels, often alone, all over Tibet where blind people are often frowned upon
  - She has devised a form of Tibetan Braille, established the first schools for the blind there, and integrated the graduates of these schools into their communities

- Her imagination is essentially an artistic imagination, which can be impressionistic, or romantic
- Jacques Lesseyran was a French Resistance Fighter whose memoir, *And There Was Light*, deals mostly with his experience fighting the Nazis, but includes beautiful descriptions of his early adaptations to blindness
  - At first, he started to lose his visual imagery
    - Similar to Hull, he stopped trying to imagine what people looked like
    - He soon decided to construct and use an imaginary visual world more like Torrey's.
      - He came to identify himself as belonging to a special category, the "visual blind"
- Using his great visualization powers, Lesseyran became a brilliant student
  - He was an icon in the French Resistance as a result of his supernormal powers of visualization
- Dennis Shulman, a clinical psychologist and psychoanalyst who lectures on biblical topics, lost his eyesight by the time he entered college
  - He told Sacks an experience extremely unlike that of Hull's
    - Shulman still lives in a visual world even after 35 years of blindness
      - He has very vivid visual memories and images
- Arlene Gordon, another blind woman, tells of how different Hull's depiction is compared to hers
  - She is still very good with imagining colors
- When the visual cortex is no longer limited or constrained by any visual input, the visual cortex become hypersensitive to external stimuli of all sorts
- Torrey's adaptation was largely shaped by conscious motive, will, and purpose
- Lusseyrans was shaped by overwhelming physiological disposition
- Arlen's lies somewhere in between
- Hull's remains difficult to interpret
- Sacks became conscious of great variations in the power of visual imagery and visual memory when he was 14
  - His mother was a surgeon and a comparative anatomist who had a phenomenal memory
    - At a young age he could barely use his mind's eye
- His mother hoped he would become a surgeon like her but since he lacked visualization powers she knew this would not happen
- A mental image for Francis Galton was picturing a familiar person or place in the mind's eye; it was a reproduction or reconstruction of an experience

- In his book *Image and Reality: Kekule, Kopp, and the Scientific Imagination*, Alan Rocke focuses specifically on August Kekule, the man who was able to visualize the structure of a benzene molecule
  - Although chemical bonds are invisible, they were as real to Kekule, as visually imaginable, as the lines of force around a magnet were for Faraday
    - Kekule had an irresistible need for visualization
- Temple Grandin feels that she is a different type of visualizer
  - She thinks in terms of images (Thinking in Pictures)
  - She associates words with images (she associates Heaven to a staircase)
- People differ on the idea of imagery being an essential for thought
- Roger Shepard and Jacqueline Metzler asked subjects to perform mental tasks that required rotating an image of a geometrical figure in their minds -- the sort of imaginary rotation Sacks mother performed when she drew the lizard's skeleton from memory
  - From this they learned that mental rotation had a rate, it was continuous and steady, and it took effort, like any voluntary act
- Stephen Kosslyn proved that visual images were essentially spatial and organized in space like pictures
  - His work has proved immensely fertile, but the ongoing debate about the role of imagery continues, as Zenon and Pylyshyn and others have maintained that the mental rotation of images and "scanning" them could be interpreted as the result of purely abstract, nonvisual operations in the brain.
- Kosslyn and other found that mental imagery activated many of the same areas of the visual cortex as perception itself, showing that visual imagery was a physiological reality as well as a psychological one, and used at least some of the same neural pathways as visual perception
- Henry Head and Gordon Holmes showed that blind spots in exactly the same locations occurred in patient's mental imagery as well
- Ultimately, Sacks believes that visual imagery and visual perception are inseparable
- Kosslyn and others have gone as far as to say that visual perception *depends* on visual imagery, matching what the eye sees, the retina's output, with memory images in the brain
- We have visual images, models, and representations in the brain, images that allow visual perception and recognition but are below the threshold of consciousness
- The visual cortex, deprived of visual input, is still good neural real estate, available and clamoring for a new function
- Martin Milligan speaks of how people who are born blind have hypersensitive senses besides sight as a result
- There are different substitutions that allow for blind people to see the world (Canes, etc.)

- Bach-y-Rita has begun to use tiny grids of a hundred or so electrodes on that most sensitive part of the body, the tongue
  - The tongue has the highest density of sensory receptors in the body and it occupies the greatest amount of space in the sensory cortex
    - With this, his subjects could form a picture on their tongue
- There are now special cameras that allow blind people to see
- Giving sight to someone who has never seen may be impossible
- Do blind people have a “mind’s eye” or a “mind’s nose”?
- Milligan thinks that he has knowledge of the visual world, whereas Magee does not believe he does
- Congenitally blind children tend to have superior memories and be precocious verbally
  - Helen Keller’s writing startles one with its brilliantly visual quality
- To what extent can description, picturing in words, provide a substitute for actual seeing or for the visual, pictorial imagination?
- Arlene Gordon, after becoming blind in her 40s, found language and description increasingly important; it stimulated her powers of visual imagery as never before and in a sense, allowed her to see
  - When traveling with sighted people, she asks them questions and they each enrich each others experience
- Language can allow all of us, even the congenitally blind, to see with another person’s eyes.