OLIVER SACKS: IN THE BRAIN AND ON THE BIKE

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How do we study the human brain? What role do people's life stories have in diagnosing neurological conditions? How do we connect modern medicine with questions of social significance? Explore these questions through the life and writings of Oliver Sacks, one of the greatest chroniclers of neurological stories of the 20th century.

Imagine meeting a doctor with a friendly manner and a white beard, who smiles genially at you from across the table. You tell him that you have been suffering from blinding headaches ever since you were struck by lightning and are consulting him on a friend's recommendation. The doctor asks if you have noticed any other changes in yourself since the incident. You hesitate, but something in his manner invites your confidence. You tell him how you have recently discovered an irresistible taste for classical music and how this surprises you because it is something you never particularly liked until you were hit by lightning. You expect the doctor to express disbelief or disinterest. Instead, his interest sharpens. He asks more questions about your new-found musical taste than about your headaches. You discuss Bach and Debussy. He listens attentively, furiously taking notes all the while. The session seems to end too soon. He writes out a prescription for your headache. You thank him and leave his office. A few months later, you receive a handwritten letter from the doctor asking for permission to include your experience in a collection of case histories featuring people with interesting stories around music. You write back giving him permission, but request anonymity. He agrees. A year later, you walk by a bookstore and notice a new book on the shelves titled 'Musicophilia'. It is authored by Oliver Sacks, your doctor (see **Fig. 1**). Your story is prominently featured in the book, but you are relieved to see that your name is not mentioned in it.

The clinician and chronicler

"Being a physician involves much more than handing out diagnoses and treatment; it involves one in some of the most intimate decisions in a patient's life."—Oliver Sacks.

Oliver Sacks was a neurologist—a medical doctor who specializes in understanding

Box 1. Introducing the brain:

The human brain may look like a lump of grey tissue, but it is what has made our species capable of communicating in thousands of languages as well as of creating cultures, cities, and the stock market. It can also be the site of life-changing conditions, like depression, schizophrenia, or dementia.

How do we introduce children to the structure and functions of this amazing organ and its many parts? Here are three ideas:

- Try out some of the fun and kid-friendly activities and experiments listed here:
  - Neuroscience for Kids: https://faculty.washington.edu/chudler/neurok.html.
  - Neuroscience resources to help teachers teach about the brain: https://ntp.neuroscience.wisc.edu/for-teachers/.
- Explore the nature of the brain in relation to how we teach and learn (see **Activity Sheet I: Brain Plasticity**). You can find some such resources here:
  - Neuroplasticity: What Does It Mean for Educators: https://www.n2y.com/blog/neuroplasticity-for-educators/.
  - Teaching resources for development of metacognitive, transferable, and well-being skills: https://www.apa.org/ed/precollege/topss/teaching-resources.
  - BrainU—Neuroscience for teachers and their students: https://brainu.org/.
- Children may enjoy seeing a brain preserved in formalin. This may be possible to arrange through a visit to a local hospital museum.

the workings of the brain, especially when it malfunctions or displays unusual functions (see **Box 1**). As the fictionalised account suggests, he is the kind of doctor you would have consulted if you lived with a puzzling neurological condition. Sacks is also one of greatest chroniclers and communicators of neurological stories of the 20th century. The human brain was his laboratory and writing about it was his passion. He explored the many mysteries and marvels of the brain in 14 books published over 45 years. For example, in 'Migraine', his first book, Sacks investigates the brain's ability to produce blinding headaches. In 'Hallucinations', he focuses on the brain's ability to produce visions of objects that do not exist. And in 'Musicophilia', Sacks explores the fantastic universal ability of the human brain to create, process, and appreciate music. His books have been translated into over 25 languages.

Sacks was also an inveterate collector of stories of people's brains and their lives. Rather than list the diagnostic criteria for the various neurological conditions he encountered in his practice, Sacks recounted life stories—his patients' and his own. He was clearly moved by the people he met during his years as a clinician. They appear in Sacks' stories not merely as medical marvels or as clinical 'objects' for diagnosis, categorization, and treatment, but as real people. The empathy with which Sacks' captures the events of their lives give his stories a quality that you rarely see in standard case histories. For example, in 'The Twins', Sacks describes the numerical gifts of a pair of twins he met at a state mental hospital and observed for some time in the 1960s and 70s. One of their gifts was the ability to identify prime numbers, seemingly through intuition. Sacks discovered this ability when he heard them exchanging 6-digit numbers with each other. When he made note of these numbers and looked them up in a book of mathematical tables, he found that they were all primes (see **Box 2**). In a

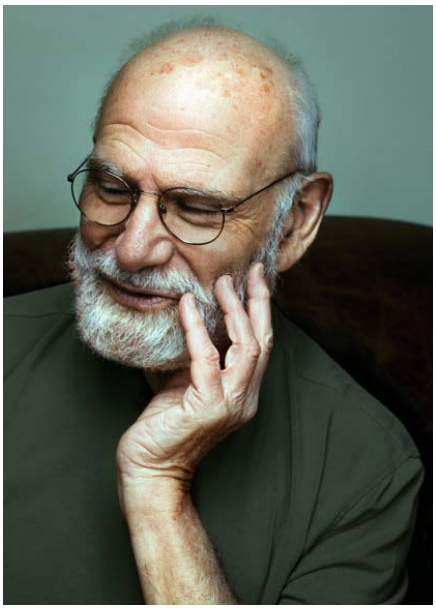


Fig. 1. Oliver Sacks in 2013.

Credits: Maria Popova, Wikimedia Commons. URL: https://commons.wikimedia.org/wiki/File:Oliversacks.jpg. License: CC-BY-SA 3.0 Unported.

Box 2. Identifying prime numbers:

Share the story of the twins with children who are familiar with prime numbers (excerpts can be found here: https://empslocal.ex.ac.uk/people/staff/mrwatkin/isoc/twins.htm). Encourage them to start from zero and identify progressively larger prime numbers. Give them some time to attempt this using any approach that they can think of on their own. Invite them to share their approach with the class.

Then, introduce your students to the 'Sieve of Eratosthenes' (details can be found here: http://www.geeksforgeeks.org/sieve-of-eratosthenes/). Ask them to use this method to identify the largest possible prime they can come up with and record the time it takes for them to do this. Contrast this with the amount of time the twins in Sacks' case study took to identify very large primes. (It took the twins 'half a minute or more' to identify 8-digit primes, 'at least 5 minutes' to identify 9-digit primes, and '5 minutes' for 12-digit primes). Invite students to share their opinions on whether this time difference strengthens or weakens the possibility that the twins were identifying these numbers intuitively. Encourage peer discussion around student responses and the arguments they offer to support them.

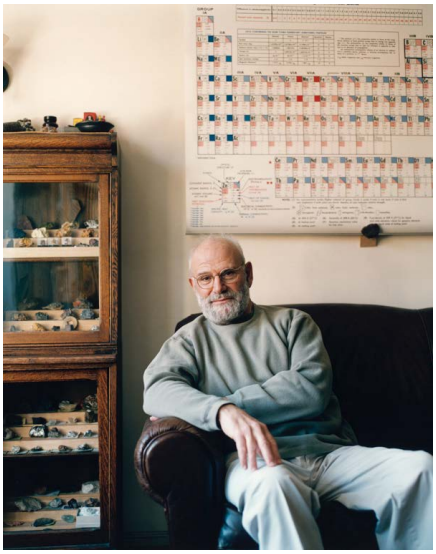


Fig. 2. Starting from the early years of his life, Sacks had a lifelong fascination for the periodic table.

Credits: The Oliver Sacks Foundation. URL: https://www.oliversacks.com/wp-content/uploads/2022/03/oliver-sacks-1.jpg. License: CC-BY-SA 3.0 Unported.

moving passage, Sacks describes how these numbers were part of the close emotional connection the twins shared. By the time Sacks wrote about them, the twins had long been separated. They had been released from hospital and enrolled into a programme to help them develop skills to integrate into society. They had also lost their numerical gifts. Was separating the twins the right thing to do? Sacks leaves it to his readers to ponder about society's approach to people with such neurological conditions. Through such detailed and humane medical descriptions, Sacks brought remarkable depth to his ability to connect modern science and medicine with questions of social significance.

Sacks was a pioneer in popularising the study of the brain. Vilayanur Subramanian Ramachandran, another acclaimed neurologist and popular writer, has spoken of the strong impact of Sacks' writings, particularly in *"connecting seemingly unconnected disciplines and inspiring students to take up medicine and neurology"*. Atul Gawande, a doctor who writes about ageing and death, cites the humanity in Sack's writings as his inspiration to start writing for non-academic audiences.

The empathetic observer

Sacks' fascination for the brain and his sympathy for those suffering from neurological conditions may have sprung from his own life experiences, some of which he shares in his books. The third of four sons of a Jewish doctor couple, Sacks was born in London on July 9, 1933. He describes the early years of his life in his memoir 'Uncle Tungsten', in which he also expands on what turned out to be a lifelong fascination with chemical elements and the periodic table (see **Fig. 2**). This book is instructive in highlighting the role of free exploration and questioning in a child's attempt to understand their world (see **Box 3**). At the age of six, Sacks and his younger brother Michael were evacuated from London and sent to a boarding school to distance them from wartime bombing. Meagre rations and harsh punishments made this a difficult experience for both. Returning to London at the age of ten, Sacks developed an interest in chemistry. Soon after, though, he came to share his parents' interest in medicine. In the early 1950s, after the war ended, Sacks chose to study medicine at Oxford University. Initially choosing to qualify as an obstetrician, his shift to neurology was influenced by interactions with two teachers, who appear in his autobiography titled 'On the Move: A Life'. Sacks remembers these teachers with *"affection and gratitude"*. While he credits one of them for having taught him to be observant and intuitive, he credits the other for inspiring him to look for possible physiological mechanisms underlying a particular set of behaviours.

As a clinician, Sacks' role was to diagnose neurological conditions and arrive at a course of medication best suited to treat them. His first-hand experience of his brother's mental condition may have influenced Sacks' approach towards people with other neurological conditions. Diagnosed with schizophrenia as a teenager, Michael struggled with meeting the demands of society. Writing about this period, Sacks shares how he grappled with understanding his brother's condition and a sense of failure in not being able to help. He also shares how medication helped reduce some of the more debilitating psychoses and

Box 3. Sacks' fascination for the periodic table:

"Oh, I carry a periodic table in my wallet. I love it very much. It stands for order, stability—but it also stands for imagination and mystery. And some of the elements get very, very complicated, as you go above 92 and sort of relativistic and other considerations come in. For example, you cannot understand, on the basis of the periodic table, why gold is gold. It is a very simple question. In fact, it turns out to be a very deep question. And I am not mathematical enough to tell you the answer. But it involves both quantum physics and relativity."— Oliver Sacks.

You can read more about Oliver Sacks' fascination for the periodic table here:

- Oliver Sacks: My Periodic Table: https://www.nytimes.com/2015/07/26/opinion/my-periodic-table.html.
- The strange case of Dr Oliver Sacks: https://www.smh.com.au/lifestyle/the-strange-case-of-dr-oliver-sacks-20150831-gjbbdd.html.

If you are introducing the periodic table to students, here are some exercises that are inspired by how Sacks related to chemical elements:

- Ask students to choose element names for themselves, their friends, and family members. Invite them to share reasons for their choice.
- Sacks uses the example of Bismuth to ask why some elements are 'ignored' by humans. Share this example and ask students to look at the periodic table to identify some properties that they think would make some elements more 'popular' than others.

hallucinations that Michael experienced (see **Box 4**). This may have led Sacks to find validity in the use of medication to treat neurological conditions, but it did not stop him from questioning it. For example, in 'Witty Ticcy Ray', Sacks documents his use of medication to treat Ray, who had Tourette's syndrome. People with Tourette's syndrome display sudden, repetitive, non-rhythmic physical movements (motor tics) and utterances (phonic tics). According to Sacks, Ray was excessively impulsive, and showed *"tics, jerks, mannerisms, grimaces, noises, curses, involuntary imitations, and compulsions of all sorts"*. While medication seemed to control Ray's symptoms, it also took away his spontaneity and changed his personality so much that Sacks often wondered who the real Ray was. Similarly, in 'Awakenings', Sacks documents his efforts to use a newly found chemical called L-Dopa to awaken a series of patients, at Beth Abraham Hospital in New York, who had been in a coma-like state for over forty years. He observed that the drug was successful not only in awakening his patients, but also in restoring their mobility. However, its effects lasted only for brief periods, after which the patients returned to their earlier or even more *"unstable states"*. Describing the reactions of the briefly awakened patients to the world around them and their varied behavioural responses to the drug, Sacks raises profound questions about the meaning of awakening and the nature of healing. Published in 1973, initial reactions to this book were not encouraging. But when it was made into a movie, Sacks became well-known in the United States (US) where he had resided since 1961.

Sacks travelled extensively, but was particularly fascinated by islands. Always on the lookout for interesting observations, he would rarely go anywhere without a notebook and pencil. For example, in 'The Island of the Colorblind and Cycad Island', he shares two unusual stories about island populations. In the first of these stories, he comments on the prevalence of achromatopsia among the inhabitants of the Pingelap and Pohnpei islands in the Pacific Ocean. People suffering from this genetic condition lack retinal cones, which are responsible for colour vision and vision in bright light. Thus, one symptom of this condition is partial or complete colour blindness (see **Box 5**). Those with complete colour blindness can only perceive black, white, and shades of grey. Globally, 1 in 30,000 people is affected by this condition. In contrast, nearly 8% of the population of 3000 people on the Pingelap and Pohnpei islands suffered from this disorder. Sacks suggested that the higher prevalence of this condition on these remote islands may be connected to a typhoon in 1775, which left only 20 of its inhabitants alive. While the population of these islands has grown in subsequent decades, half of it carried the gene for achromatopsia. Sacks' second story is related to the occurrence of a neurodegenerative disease, called Lytico-bodig disease, on Guam—another remote island in the Pacific Ocean. Due to the death of their brain cells, people suffering from this condition showed symptoms of dementia—slowly losing their ability to remember, think, and make decisions. This impeded their capacity to perform everyday activities. Detailed medical investigation showed high concentrations of a neurotoxic chemical in the brains of people who died from this disease. Sacks proposed that it was this neurotoxin that caused the disease. Further investigation revealed that this neurotoxin was also present in high concentrations in the fruit of a cycad species that is common in Guam. How did the neurotoxin make its way to humans? Possibly through a species of fruit bats that fed on the cycad fruits and were, in turn, hunted and consumed by the islanders. Interestingly, the disease has disappeared over time. This could be related to a decline in the numbers of cycad-eating fruit bats due to overhunting. Sacks' detailed observations and descriptions of these two conditions have been useful in provoking questions and hypotheses—both of which play an important role in science, particularly in testing and rejecting invalid ideas.

The intensity Sacks brought to his work with the brain matched that with which he approached physical activity. For example, he was a champion weightlifter, but pursued this hobby so obsessively that it left him with numerous injuries. Similarly, his passion for speedy bike rides and adventure meant that he suffered many accidents. Sacks describes one such near-fatal accident in his 1984 book 'A Leg to Stand On'. On an overcast summer

Box 4. How are hallucinations different from illusions?

Often, people confuse hallucinations with illusions. While illusions are misinterpretations of the sensory stimuli (what we can see, hear, taste, feel, and smell) that we receive from something in our environment, hallucinations involve experiencing something that does not exist. For example, if we mistake a rope lying on the ground for a snake, it would be an illusion. If, on the other hand, we saw a snake on the ground when there was nothing there, we may likely be hallucinating. Both phenomena can blur the line between perception and reality.

To introduce your students to the difference between the two, share some common (yet fascinating) examples of optical illusions with them (see **Activity Sheet II: Optical Illusion**). Some of these can be found here:

- Optics for Kids: https://www.optics4kids.org/optical-illusions.
- Visual Phenomena & Optical Illusions: http://www.michaelbach.de/ot/.

Encourage your students to share their own explanations for this phenomenon. Use this discussion to highlight key differences between illusions and hallucinations.

morning in 1974, Sacks was trekking up a mountain in Norway when he encountered a big bull. Alone and afraid of being attacked, Sacks bolted. In his fear, he imagined the bull giving chase. This caused him to slip and fall from a cliff, leaving him with a badly broken leg. Concerned that he would not be found, Sacks made a makeshift cast for his broken leg and tried to hobble back. Luckily, he was rescued by a pair of hunters. However, a leg surgery in London left him with a strong sense of his leg being alien to him. Known technically as Body Integrity Identity Disorder, this is a condition in which people lose a sense of belonging for certain parts of their body. Sacks found 'A Leg to Stand On' difficult to write because he himself was the subject of this study. This book won critical acclaim for highlighting the intimate relationship between mind and body.

Parting thoughts

Sacks died on August 30, 2015, at the age of 82, due to complications from ocular cancer. Even as he lay on his deathbed, Sacks could not resist the urge to tell a story. He wrote a piece for the New Yorker magazine, sharing his memories of a fish dish that his mother used to make when he was a child. In this article, he is seen coming to terms with the inevitable end of a lifelong journey of curiosity, discovery, and deep empathy with people under his care. In his words, *"I cannot pretend I am without fear. But my predominant feeling is one of gratitude…I have been a sentient being, a thinking animal, on this beautiful planet, and that in itself has been an enormous privilege and adventure".*

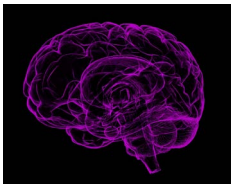
Box 5. Introducing colour blindness:

You can watch an animated version of Sacks' investigation of colour blindness on the Pingelap islands here: https://aeon.co/videos/how-the-island-of-the-colourblind-made-oliver-sacks-rethink-normal.

You can introduce your students to red-green colour blindness by using the Ishihara colour blindness cards. These cards are available here: http://colorvisiontesting.com/ishihara. You can use this activity to start a discussion on how our eyes detect colour. Coupling this with an exploration of physical models of the brain can help students understand visual processing in the brain.

You can also introduce students to the inheritance of colour blindness using a simple family tree (or pedigree chart). Share how a typhoon wiped out most of the population of humans on these Pacific islands. Starting with a few survivors, show how island populations can quickly become interrelated by marriage between relatives. Invite students to consider the possibility that only one of the initial survivors had total colour blindness. Use pedigree charts to demonstrate how this possibility can result in a high prevalence of total colour blindness in just a few generations.

Key takeaways



- Oliver Sacks was a neurologist with a keen interest in investigating puzzling brain conditions. He was also one of the greatest chroniclers and communicators of neurological stories of the 20th century.
- Sacks used stories from his own life as well as detailed and humane medical descriptions from those of his patients to connect modern science and medicine with questions of social significance.
- His case studies are remarkable in presenting patients not as clinical objects of investigation, but as real people with complex life stories.
- Sacks's work and experiences open us to both the mysteries of the brain and the possibilities of relating to the subjects of scientific and medical investigation with curiosity, empathy, and care.

Notes:

1. This article was first published in i wonder…, June 2016, pp. 109-111. The original draft can be found here: https://publications.azimpremjiuniversity.edu.in/1281/. The version included in this issue has been reviewed and modified for school teachers. It includes new material, two new figures, and two activity sheets.

2. Source of the image used in the background of the article title: The human brain. Credits: sbtlneet, Pixabay. URL: https://pixabay.com/illustrations/brain-human-anatomy-anatomy-human-1787622/. License: CC0.

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Biography

ACTIVITY SHEET I : BRAIN PLASTICITY

What to do?

Trial	Dominant Hand (Question)	Time I	Non-dominant Hand (Answer)	Time II
1.				
2.				
3.				
4.				
5.				
6.				

- In the table above, write a question with your dominant hand in one row of the column to the left. Then answer the question with your non-dominant hand in the adjoining row of the column to the right. Time yourself.
- Try this exercise 3-4 times more.
- Remember to time yourself in each of these trials.

Observe:

- In Trial 1, how different is your handwriting in the left column from that of the right column? What about in Trial 4 or 5?
- Does your handwriting in the different rows of the left column change with each new trial? Does the time you take to write out your question increase or decrease?
- What about your handwriting in the right column? Does it change with each new trial? Is your writing faster or slower in Trial 4 than Trial 1?

Think about:

- Did you face any challenges in writing with your non-dominant hand? If yes,
  - Did this increase or decrease with each new trial?
  - Did you use any strategies to adapt to the challenge? Tell us about it.
  - Do you think that you became better at meeting this challenge in each new trial?
- What about your experience of writing with your dominant hand? Was it different in any way from your experience of writing with your non-dominant hand?

Discuss:

In this exercise, you tried to work with a new motor skill (writing with your non-dominant hand).

- Do you think it is possible for the brain to adapt to this? Share your reasons.
- How do you think the brain adapts to the requirements of this new skill? Share some observations.
- Does trying the exercise more than once (practice) help the brain get better at this skill? Tell us why you think so.
- Can you think of some real-world situations in which knowing about the flexible and adaptive nature of your brain can help you?

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Contributed by:
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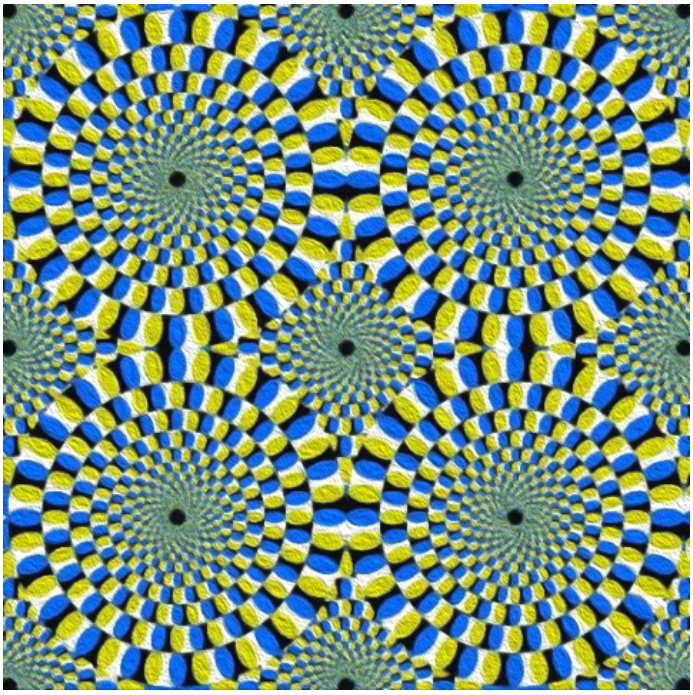
Azim Premji University

Biography

ACTIVITY SHEET II : OPTICAL ILLUSIONS



An example of an optical illusion.

What to do?

- Look at the image above with both eyes open. Does it appear to be moving or still?
- Close your left eye. Look at the image again. Does it appear to be moving or still?
- Close your right eye and look at the image with your left one. Does it appear different in any way?

Think about:

- How different does the image appear to you when you see it with one eye versus when you see it with both eyes?
- Do your classmates perceive the image in the same way as you?

Discuss:

- Is the image really moving? Or is this just how it appears to you? How do you know?
- Why do you think the image appears to be different from what it really is?
- Can you think of a real-world situation where an illusion of this kind can confuse you?

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