

WHAT CAN THE EYES TELL US ABOUT SCHIZOPHRENIA?

Shelby O'Leary¹ and Michael C. Hout^{1,2*}

¹Department of Psychology, New Mexico State University, Las Cruces, NM, United States

²Department of Kinesiology, New Mexico State University, Las Cruces, NM, United States

YOUNG REVIEWERS:



ANDREW

AGE: 9



CHARLES

AGE: 11



JOONSOO

AGE: 11

Have you ever had an imaginary friend? If you ever have, you probably did not physically see or hear them outside of your imagination. Unfortunately, some people see and hear things that are not actually real. This can be a feature of a mental disorder known as schizophrenia. There is much scientific interest in studying mental health, and scientists have many tools at their disposal to investigate disorders like schizophrenia. One of the ways psychologists study how the brain works is by using an eye-tracker—a device that has a camera and a computer and can determine where a person is looking. People diagnosed with schizophrenia often show unusual patterns of eye movements that give scientists clues about how the disorder works and affects patients. This information also gives medical professionals a valuable tool by which to diagnose their patients.

SCHIZOPHRENIA

A chronic brain disorder that includes symptoms such as hallucinations, delusions, disorganized speech, and more.

DIAGNOSIS

The identification of an illness or mental disorder based on an individual's symptoms.

SYMPTOM

An unusual (and potentially unpleasant) feeling or experience that a person has, which could be a sign of a disease or condition.

HALLUCINATION

Sensing something that is not actually there, such as seeing imaginary people or hearing imaginary voices.

DELUSION

Untrue judgements and beliefs, even in the presence of opposing evidence.

PSYCHOLOGICAL THERAPY

A type of treatment for psychological disorders that uses talk therapy to help someone cope with troubling emotions, thoughts, and/or behaviors.

WHAT IS SCHIZOPHRENIA?

Schizophrenia is a serious mental illness in which the **diagnosis** includes an abnormal perception of reality. Simply put, people affected by schizophrenia sometimes experience the world in unusual ways. This disorder requires lifelong treatment, and depending on the intensity of the disorder, it may significantly impact the person's ability to live their life as they might like. A combination of **symptoms** are usually present in schizophrenia but can vary widely from person to person. People with schizophrenia often perceive imaginary things. These are known as **hallucinations**, and they are situations in which the person can see, hear, smell, taste, or feel things that do not exist. An example of a hallucination might be hearing or seeing someone that is not actually present.

People afflicted by schizophrenia also sometimes experience **delusions**, which are untrue beliefs that the individual finds extremely difficult to change, even when there is direct evidence that their belief is wrong. An extreme example of this might be thinking that someone else is controlling what they do, say, or even think. Another common symptom schizophrenics may experience is disorganized speech. Have you ever had one of those days when you just could not quite think straight? A day when the ideas were all jumbled up in your head because you might not have gotten a good night's sleep, for instance? Well, this can happen quite often to people diagnosed with schizophrenia. It can sometimes be difficult for them to organize their thoughts, and because of this, it can be hard for them to stay on topic when they speak, or to speak in clear sentences. Instead, they may jumble their sentences or utter an incoherent sentence that is difficult for others to understand.

Thankfully, it is rare for children or teenagers to show symptoms of schizophrenia. People usually have their first schizophrenic experiences in their 20s. However, this illness is different for each individual and shows up in many ways, meaning that not everyone will have the exact same symptoms. Treatment for schizophrenia varies from person to person, but the treatments that have been shown to work the best are **psychological therapy** and medication [1]. Psychological therapy is extremely important because it helps keep people steady on their treatment plans and makes sure they continue to take their medicines, which can help lessen their symptoms.

WHAT IS AN EYE-TRACKER AND WHAT DOES IT HAVE TO DO WITH SCHIZOPHRENIA?

So how can we study schizophrenia to learn more about it? Well, one of the many ways psychologists can learn more about how the brain works is by using a device called an eye-tracker (Figure 1). Studies on eye movement behaviors (that is, how and why the eyes move

in various situations) have been used to investigate mental illnesses since the early 1900s [2]. An eye-tracker does not hurt the person or significantly impact the body in any way. It consists of a camera that takes really good pictures, sources of light that allow the camera to see the eye well, and computing capabilities that collect all the data and figure out where the person is looking. In [Figure 2](#), notice that the main focus is centered around the pupil (the dark spot at the center of the eye). Pictures of the pupil (taken lots of times over and over again) are the data the computer uses to determine a person's eye position and eye movements. The eye position can tell researchers precisely where the person is looking and for how long. And their eye movements can tell us precisely how fast or slow, and how "jerky" or smooth, the eyes are behaving as the person looks at things.

Figure 1

This is the usual experimental setup for an eye-tracker known as the EyeLink 1000 [3]. You can see the computer screen, the eye-tracker camera, and a chinrest. There is also a light source that makes it bright enough for the camera and eye-tracking machinery to collect accurate information.

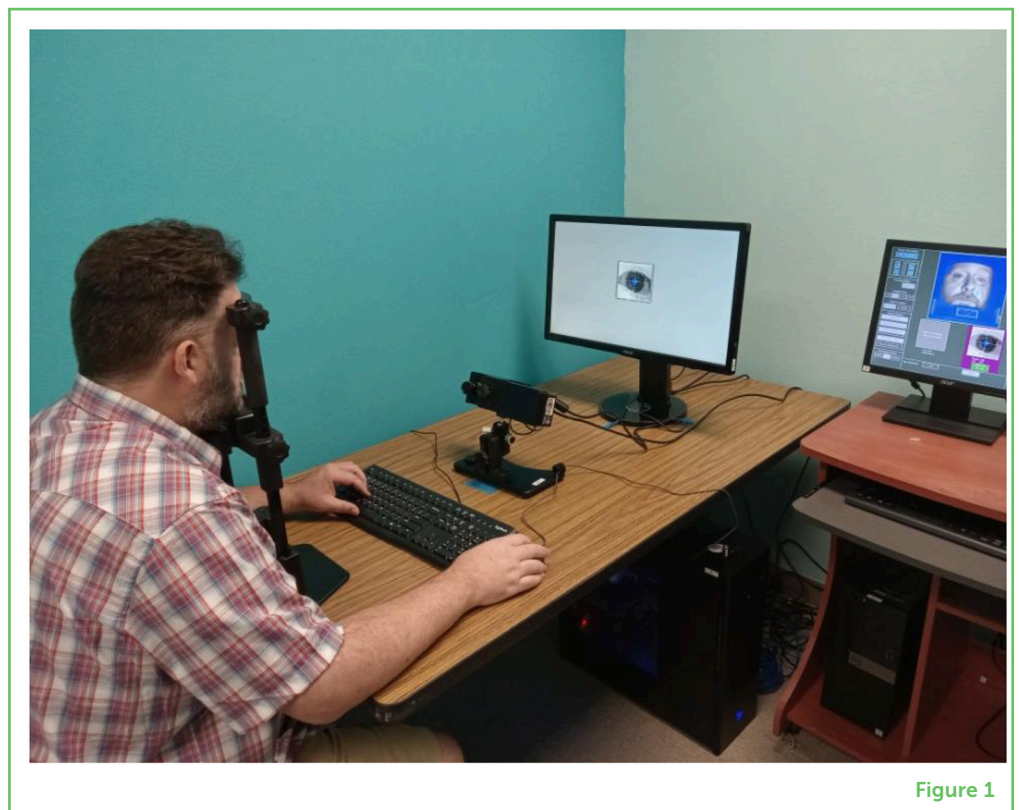


Figure 1

SACCADES

A type of eye movement that involves rapidly shifting the center of gaze from one point in space to another; often described as a "jerky" eye movement

The most common types of eye movements that all people make are very fast and "jerky". That is, the eyes do not move smoothly, despite the fact that it might feel that way. You probably do not feel like your eyes make jerky movements, but because of eye-trackers, we know that eye movements typically are not smooth at all. Instead, when we look at things, our eyes "jump" from focusing on one area of the world around us to another, in rapid succession, several times a second! These types of eye movements are known as **saccades**, and they are extremely common as we go about our daily activities. For example, if you walk into the grocery store to buy some fruit, you might look at the apples, then the oranges, then the bananas, and maybe you will even shift your gaze over to the kiwis. You scan all the options in the fruit

Figure 2

Eye-trackers use cameras that measure the light bouncing off of the person’s eyeballs. The two sets of crosshairs here show what an eye-tracking system looks for to figure out where someone is looking. The spot where the two yellow lines cross is the center of the pupil, which is used to determine how the eye is rotated (and therefore, in what direction it is pointed). In green is the location of corneal reflection; that is, the way the light bounces off the outside part of the eye and is directed back to the camera. These two bits of information allow an eye-tracker to figure out where someone is looking.

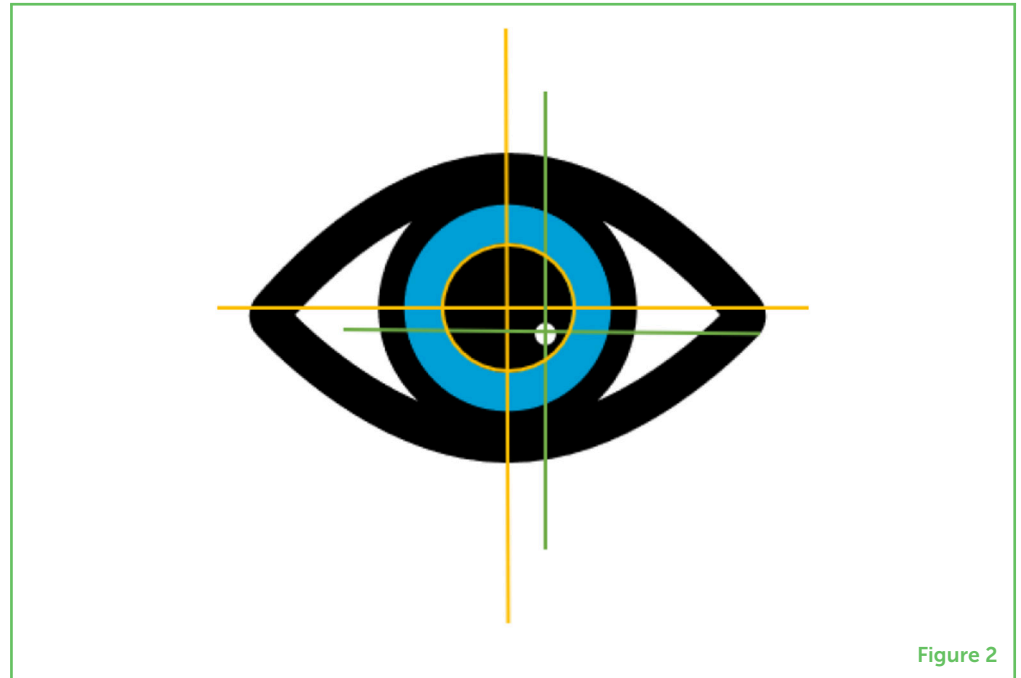


Figure 2

aisle, while independently looking at each type of fruit one at a time before shifting your gaze to the next one (if you want to read more about how and why the eyes move the way they do, check out our other [Frontiers for Young Minds article](#)).

However, despite how common they are, jerky saccadic eye movements are not the only type of eye movements that a person can use to perceive the world. **Smooth pursuit eye movements** are movements used to track an object that is moving. When this type of eye movement occurs, the eyes do not jump at all—instead, the object the person is tracking is stabilized in their view as it moves across the visual field. For example, while playing catch, you must closely watch the ball as your friend throws it to you. This smooth and constant visual attention to the ball is important because it gives you the opportunity to hopefully catch it (instead of getting hit by it)! You naturally and fluidly watch the movement of the ball as it leaves the other person’s hand, flies through the air, and makes its way to you. Importantly, smooth pursuit eye movements do not jump or jerk at all, and they only take place when a person is tracking an object in motion. Otherwise, it is impossible to make your eyes do this!

WHAT CAN RESEARCHERS LEARN FROM EYE-TRACKING?

Studies on saccades and smooth pursuit eye movements can tell psychological researchers a lot about how the brain functions. Scientists can create experiments in research labs and present them on computer screens to gain more information about the different ways that people look at and experience things. Additionally, by looking at

SMOOTH PURSUIT EYE MOVEMENTS

A type of visual tracking that involves the eyes moving smoothly (rather than in a “jerky” fashion) and that occurs only when the person is actively tracking a moving object.

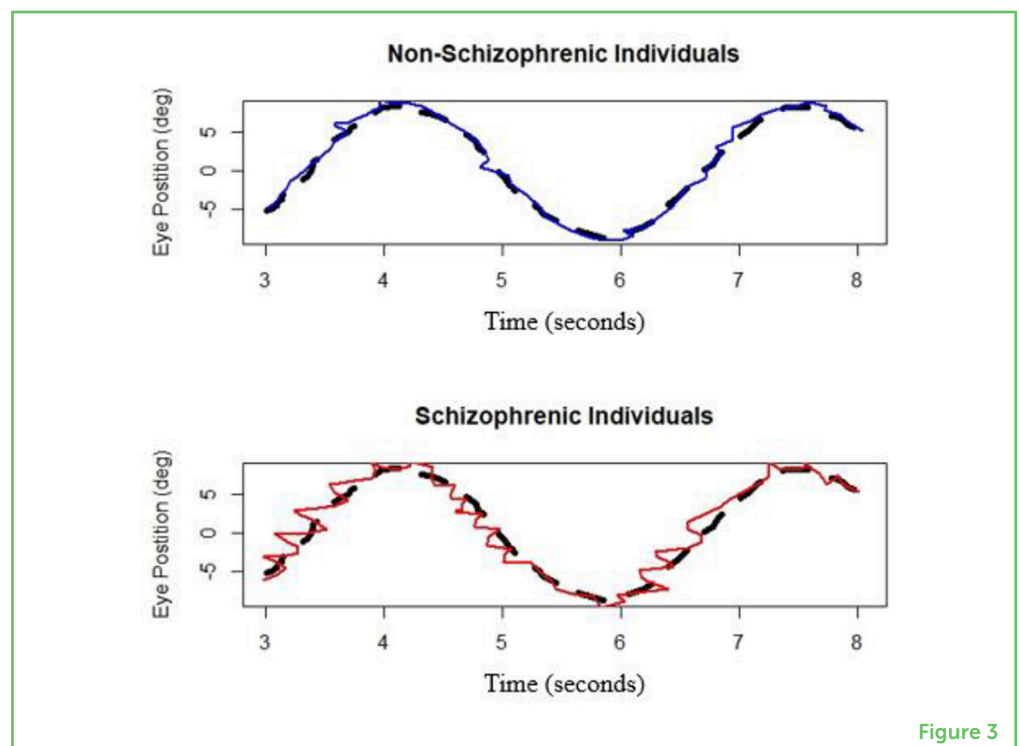
what people *fail* to look at, scientists can explore what aspects of a visual scene go unnoticed by an observer.

One way that schizophrenia has been studied is by using what is called a smooth pursuit task. In this experiment, individuals with or without schizophrenia view the task on a computer screen while their eye movements are collected and compared. In a typical smooth pursuit task, the participant sees an object on the screen (such as a circle or square) that is constantly moving around. The participant is asked to watch the movement of this object. The same task is shown to people with and without schizophrenia, so that any differences in behavior or eye movements can be attributed to the presence or absence of the mental disorder. The eye-tracking data collected while people perform this task have shown that schizophrenics have worse smooth pursuit eye movements.

With the eye movement measurements collected from smooth pursuit tasks, researchers can tell the difference between individuals afflicted by schizophrenia and people without the disorder [4]. As seen in [Figure 3](#), most people can follow the target smoothly using their smooth pursuit eye movements. By contrast, those with schizophrenia are less able to keep up with the speed of the object and instead they tend to use saccadic eye movements that lag behind and then catch up afterwards, over and over again [2]. This suggests that schizophrenia may impact parts of the brain that control smooth pursuit eye movements. This is especially important because it means that these brain areas may be operating differently in those afflicted with schizophrenia.

Figure 3

These graphs show what eye-tracking results might look like in a smooth pursuit task. The dotted line shows an object slowly moving around on the computer screen. The blue and red lines show where the participants are looking, from 3 to 8 s. The closer the red or blue line is to the dotted line, the closer their vision is to the object. As you can see clearly here, the patients with schizophrenia tend to perform much less well on this task.



DETECTION AND DIAGNOSIS IN THE FUTURE

The scientific findings from smooth pursuit tasks help scientists and medical professionals understand the differences in how people with schizophrenia perceive the world. Advances in schizophrenia research are especially important because they can help scientists improve the tools used to detect schizophrenia in patients, making diagnosis easier. For example, software could be developed to assist medical professionals in detecting schizophrenia [5]. Faster diagnosis can often lead to faster treatments and better patient outcomes! Detection software based on eye-tracking could also be used to check previously made schizophrenia diagnoses, to ensure their accuracy. Overall, while you might not think that schizophrenia has anything to do with vision, it turns out that eye-tracking research can be an extremely helpful tool to study and improve our understanding of schizophrenia.

REFERENCES

1. Patel, K. R., Cherian, J., Gohil, K., and Atkinson, D. 2014. Schizophrenia: overview and treatment options. *P and T* 39:638–45.
2. Morita, K., Miura, K., Kasai, K., and Hashimoto, R. 2020. Eye movement characteristics in schizophrenia: a recent update with clinical implications. *Neuropsychopharmacol. Rep.* 40:2–9. doi: 10.1002/npr2.12087
3. EyeLink 1000 Plus. *Fast, Accurate, Reliable Eye Tracking* (n.d.). Available online at: <https://www.sr-research.com/eyelink-1000-plus/> (accessed July 31, 2024).
4. Tomer, E., Lupu, T., Golan, L., Wagner, M., and Braw, Y. 2020. Eye tracking as a mean to detect feigned cognitive impairment in the word memory test. *Appl. Neuropsychol. Adult* 27:49–61. doi: 10.1080/23279095.2018.1480483
5. Ales, F., Giromini, L., Warmelink, L., Polden, M., Wilcockson, T., Kelly, C., et al. 2021. An eye tracking study on feigned schizophrenia. *Psychol. Inj. Law* 14:213–26. doi: 10.1007/s12207-021-09421-1

SUBMITTED: 07 August 2023; **ACCEPTED:** 25 July 2024;

PUBLISHED ONLINE: 08 August 2024.

EDITOR: Yangming Ou, Harvard Medical School, United States

SCIENCE MENTORS: Stefanie Perrier and Hee Yeon Im

CITATION: O'Leary S and Hout MC (2024) What Can The Eyes Tell Us About Schizophrenia? *Front. Young Minds* 12:1274188. doi: 10.3389/frym.2024.1274188

CONFLICT OF INTEREST: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

COPYRIGHT © 2024 O'Leary and Hout. This is an open-access article distributed under the terms of the [Creative Commons Attribution License \(CC BY\)](#). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

YOUNG REVIEWERS

ANDREW, AGE: 9

I am 9 years old and in the third grade. I like to play outside a lot, and I also enjoy sports like playing hockey. I love science, and right now in my science class, we are learning a lot of new things, including about food chains. I find it interesting to learn more about the brain too.

CHARLES, AGE: 11

I am 11 years old and in the fifth grade. I enjoy going outdoors, playing video games, and playing hockey. I like science and math a lot, and right now in school, we are learning about states of matter in science class. I also enjoyed reading this scientific article and learning more about brains and new ways to study them.

JOONSOO, AGE: 11

I like math and playing chess. I am very good at playing table tennis. When I grow up, I want to be an architect who designs buildings like Antoni Gaudi (Spain) did. I like reading books about history.

AUTHORS

SHELBY O'LEARY

Shelby O'Leary is a master's student at New Mexico State University, concentrating in cognitive psychology with a focus on exploring auditory and visual perceptual systems and their interactions. Alongside her psychology-related projects, she is pursuing a minor in statistical analysis and working toward advancing her expertise in the field of data science. Outside of school and work, she enjoys preparing smoked meats, studying philosophy, traveling, attending live music events, and studying classic films.

MICHAEL C. HOUT

Michael C. Hout is a Professor in the Departments of Psychology and Kinesiology at New Mexico State University, where he is also the Associate Dean for Research in the College of Health, Education, and Social Transformation. Additionally, he is an Associate Editor at the journal *Attention, Perception, & Psychophysics*. His research focuses primarily on visual cognition (including search, attention, eye movements, and memory) and the development of new methods, tools, and stimuli to be used in experimental research. He has won several awards for research and teaching, including the *Rising Star* award from the *Association for Psychological Science*. In his limited free time, he enjoys walking his dog, reading, hiking, and going on road trips with his wife. *mhout@nmsu.edu

