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WHEN FAMILIAR FACES SEEM UNKNOWN: FACE BLINDNESS

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YOUNG REVIEWERS:

DANIELLE
AGE: 14

MAANYA
AGE: 12

NABHANYA
AGE: 9

Think about the people in your life whose faces you could pick out in a crowd. It might surprise you to learn that some people are unable to recognize faces—even the faces of people they see often like their friends, family, and teachers. This happens with a condition called prosopagnosia, which is also known as face blindness. Prosopagnosia affects one's ability to understand facial expressions, judge someone's age or gender, and follow where people are looking. The fusiform face area (FFA) is a part of the brain that is responsible for facial recognition. When the FFA is underdeveloped or becomes damaged, it can lead to prosopagnosia. Currently, there is no treatment for prosopagnosia, but people affected by this condition can practice relying on other cues like sounds and smells to help them recognize others. Researchers are looking into treatment options for people with prosopagnosia.

HOW DOES THE BRAIN PUT FACES TOGETHER?

Faces. Everybody has one, including you. By the time babies are 2−4 months old, they start to recognize familiar faces, such as those of their caregivers. By now, you probably have many faces that are familiar to you: family members, friends, teachers, and people who live and work in your community. How can we recognize which faces belong to people we know? How can we look at a face and tell when someone is happy or angry?

To do these things, we rely on a specific part of the brain that focuses on recognizing faces. This part of the brain is called the **fusiform face area** (FFA), and it is found in the **fusiform gyrus** (Figure 1). There are actually two fusiform gyrus regions in the brain, one on each side. The fusiform gyri are part of larger brain regions called the **temporal lobes**—also found on both sides of the brain. The fusiform gyrus helps us recognize faces and bodies. This area allows us to put difficult information together, kind of like building a puzzle, which comes in handy when we are trying to recognize the person in front of us. The FFA helps us to recognize whether we are seeing a face, to put parts of the face together to make a whole face, and to determine if the face is familiar or not. Scientists found the FFA using a brain-imaging technique called **functional magnetic resonance imaging** (fMRI) [1]. Using this technique, scientists saw the FFA "light up" when the person being imaged saw a face. The FFA reacts strongly to a wide variety of faces and helps determine who the face belongs to. The FFA reacts to the entire front of the face, to specific parts like the ears and lips, and facial curves like the cheekbones. The FFA puts the various parts of the face together to form a whole (Figure 2). Studies of the fusiform gyrus and its connection to recognizing faces are relatively new, and

FUSIFORM FACE AREA (FFA)

A part of the brain that is responsible for facial recognition. The FFA is located in the brain's temporal cortex, specifically within a part known as the fusiform gyrus.

FUSIFORM GYRUS

Section of the brain responsible for recognizing faces.

TEMPORAL LOBE

Part of the brain that processes feelings, language, and sight.

FUNCTIONAL MAGNETIC RESONANCE IMAGING (fMRI)

A way to look at brain activity to figure out which areas of the brain are active.
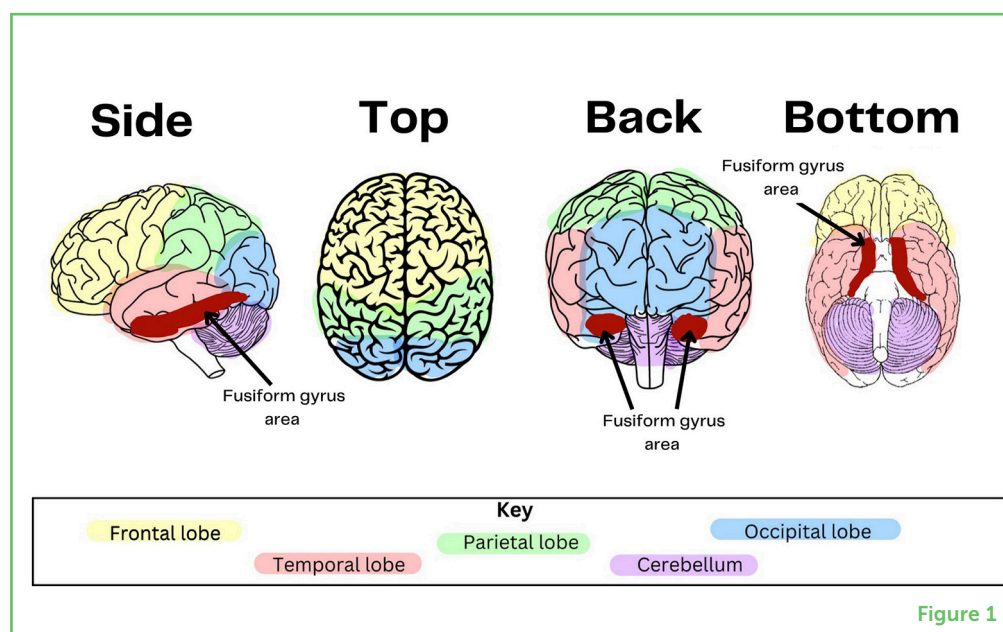
Figure 1

The dark red color shows the fusiform gyrus areas in the brain from the side, top, back, and bottom. Each major brain area is shown by the colors listed in the key. You can see that the fusiform gyrus is part of the temporal lobe [Figure credit: Palejwala et al. [2]].

Figure 1

scientists continue to work together to find out more about this area of the brain.

Figure 2
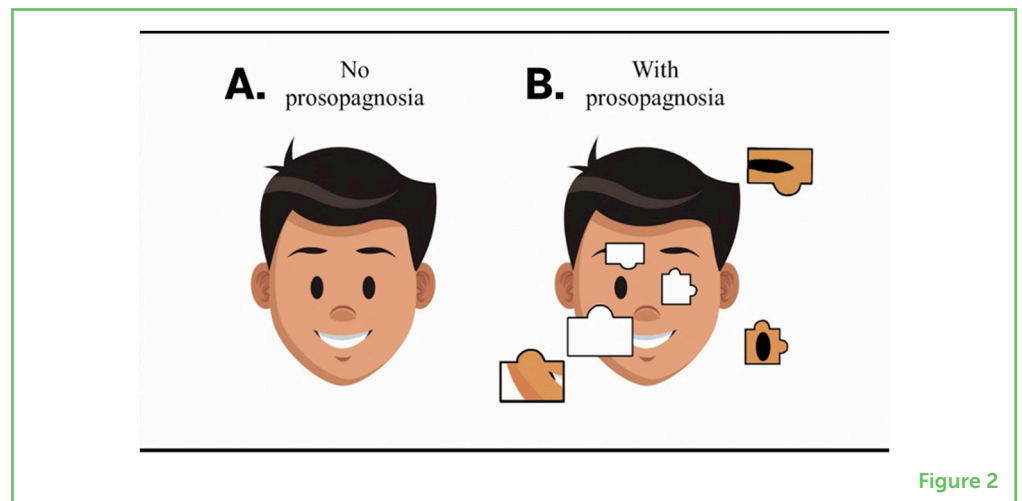
PROSOPAGNOSIA—FACE BLINDNESS

We take it for granted that the FFA will do its job so we can recognize faces, but this is not always the case. Around 2% of the U.S. population experiences **prosopagnosia**, which means they cannot recognize familiar faces [3]. Face blindness affects a person's ability to detect their caregivers' faces, friends' faces, and even their own faces. It is important to note that prosopagnosia does not affect the visual system. So, the people who have this condition can still see, they just cannot recognize familiar faces. This can be quite scary; however, those who have prosopagnosia can rely on other senses to recognize their loved ones such as remembering the way they move, recognizing their scents, or listening to their voices.

People with prosopagnosia are usually born with it, and it affects their ability to interpret facial expressions, judge someone's age or gender, or follow where people are looking. Those with this condition might also deal with other mental health issues, such as social anxiety or depression [3]. Social anxiety could happen when people with prosopagnosia are seen as rude because they cannot recognize others, for example. Depression may develop because some people with prosopagnosia have a hard time building bonds with others. Furthermore, prosopagnosia can also affect people's ability to recognize objects or places, making it hard to figure out where they are or where they want to go. This condition can affect people's daily lives quite a lot. Things that you find easy to do, like watching a movie, might be hard for a person with prosopagnosia because they find it difficult to recognize characters and understand the plot.

PROSOPAGNOSIA

A condition in which people cannot recognize familiar faces, including their own.

TYPES OF PROSOPAGNOSIA: HOW IS THE BRAIN AFFECTED?

Scientists have determined that there are two types of prosopagnosia: developmental and acquired. Scientists used to believe that prosopagnosia only developed after the brain was injured, but more recently they have found interesting cases in which people are born with this condition [3].

In **developmental prosopagnosia**, brain injury does not play a role. So, people with developmental prosopagnosia could be born with the condition, possibly because the FFA does not work the way it should. If people develop prosopagnosia when they are born, most do not even know they have an issue recognizing faces. This kind of prosopagnosia is currently believed to be linked to genes because several family members often have this condition [2]. Other types of developmental prosopagnosia happen when children do not develop the ability to recognize faces over time.

Acquired prosopagnosia occurs after a person's brain is hurt in an accident or when the brain changes due to aging. For example, prosopagnosia can occur from a traumatic brain injury, stroke, or in age-related diseases like Alzheimer's. This type of prosopagnosia is not very common, and those affected usually know they have suddenly lost the ability to recognize faces [2]. When children acquire prosopagnosia due to brain injury before their brains fully develop, they might not even realize that they cannot recognize faces as well as others can [3].

TREATMENT: HOW DO PEOPLE LIVE WITH PROSOPAGNOSIA?

Although prosopagnosia is often referred to as face blindness, individuals with this condition can still see the parts of every face they see. They can see the color of the person's eyes and the shape of their nose, but because they cannot piece together each element of the face, they find other ways to recognize their family members and friends. For example, they might pay close attention to the way certain people dress or style their hair, or the sounds of people's voices [4]. Just like knowing that your mom likes to wear dresses can help you recognize her from far away at the grocery store, people with prosopagnosia can use clothes as cues to recognize others. These cues can be tricky to rely on, since people often switch styles from one day to another, or get haircuts. Still, people with prosopagnosia learn to adapt to these changes.

Currently, there is no treatment for prosopagnosia; however, researchers are trying to better understand the condition so that a treatment may one day be possible. There *are* therapies that focus on

DEVELOPMENTAL PROSOPAGNOSIA

A type of face blindness that is often present at birth and likely related to genetic factors or issues with the structure or function of the fusiform face area.

ACQUIRED PROSOPAGNOSIA

A type of face blindness that occurs after an injury or due to age-related changes or diseases such as Alzheimer's.

strengthening the ability to recognize faces, however [3]. Despite the lack of treatment, those affected by prosopagnosia often overcome the challenges they face by using the strategies we have mentioned, or using their other senses. The downside is that these strategies cannot be applied to strangers or someone who is constantly changing, like a kid going through puberty who has dramatic voice changes.

CONCLUSION

The ability to recognize the faces of our loved ones is something that most of us take for granted. We might not even realize that, in the split second when we look at someone, our brains put together many pieces of information to process the person's face. The area responsible for making this possible, the fusiform gyrus, does so much for us—even if we do not realize it. Advances in technology constantly aim to make people's lives better, including the lives of people with prosopagnosia. For example, research is investigating the possible use of lasers to help reverse prosopagnosia in people who get it due to accidents [5]! These and other future advances may help people with prosopagnosia to recognize faces more easily, which may help them in many of their daily interactions with others.

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YOUNG REVIEWERS

DANIELLE, AGE: 14
Danielle is interested in the intersection between brain and computer. She applies deep neural network algorithms to better understand the computational basis of brain. She believes the Imitation Game is the best movie to show the importance of understanding the similarities between brain and computer.

MAANYA, AGE: 12
Maanya is a very highly creative individual with an inquisitive mind. She loves singing all types of music, playing her piano, creating music. She is also a Bharathanatyam dancer. During her free time she enjoys playing with her friends. She loves to take her dog for walking and playing. She currently lives with her parents and sister in India.

NABHANYA, AGE: 9
Nabhanya is a 9 year old girl who is currently in CE2, Ecole Elimentaire, France. She is highly fascinated by experiments in Science and Mathematics. She has won more than five medals in Science Olympiad, including Cyber and General Knowledge Olympiad. She has won one International Bronze medal in Maths (International Maths Olympiad, year 2021) in Cyber Olympiad. She loves art, music, and dance. During her free time she enjoys writing stories in her diary and reading Harry Potter Novels. She also likes playing with Lego toys. She currently lives with her parents in France.

AUTHORS

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I am a graduate of the University of Texas at Austin with a major in biology, a minor in business, and a pre-health professionals certificate. I enjoy healthcare-related research, serving my community, and feeding my desire to learn. I hope to pursue my Master's in Health Administration to continue my passion for improving the

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I am a University of Texas Austin graduate and have a passion for equitable education and healthcare. I enjoy learning about neuroscience and the various aspects of the brain that have not been completely explored. I hope to become a physician and deliver the highest quality healthcare to patients that come from marginalized communities. When I am not busy with work or school, I like to watch animated movies with my friends or read in my cozy room.

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I am an undergraduate student pursuing a major in international relations and global studies with a minor in Korean. I enjoy medical-related research and serving my community. I intend to pursue a medical career as a physician in the future. In my free time, I enjoy reading books and dancing!

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I am a principal investigator at the University of Texas at Austin. I have a bachelor's degrees in nutritional science and nursing from Michigan State University, and a Ph.D. from the University of Pittsburgh. I love working with young scientists and empowering them to actively participate in research. To learn more about my laboratory visit my publicly available website: https://nicoleosier.wixsite.com/osierlaboratory/ or follow @osierlaboratory on Facebook, Twitter, or Instagram. In my free time, I enjoy traveling the world. *nicoosier@utexas.edu