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WISER WITH AGE? UNDERSTANDING AGING BRAINS

Ryan T. Daley[1,2*], *Jaclyn H. Ford*[1] *and Elizabeth A. Kensinger*[1]

[1] *Department of Psychology and Neuroscience, Boston College, Chestnut Hill, MA, United States*
[2] *Department of Psychology, Gordon College, Wenham, MA, United States*

YOUNG REVIEWERS:

ALANA
AGE: 15

KAI-NING
AGE: 10

EDEN
AGE: 15

MARIA
AGE: 13

POLINA
AGE: 15

Have you ever wondered if someone who is 72 uses their brain any differently than someone who is 27? What are the changes to the ways that our brains look and work as we grow older? What tasks get easier because of these changes, and which get harder? If you wonder about any of these things, keep reading—because these are the questions we will answer!

It is easy to see from looking at people of different ages that bodies change and grow as we get older, but did you know that our brains also change as we age? These changes can alter how older adults think about and remember things they see every day! If we were to compare the brains of a young adult (perhaps a 20-year-old) and an older adult (perhaps a 70-year-old), what differences would we see?

SLIGHT SHRINKAGE

If we look without any magnification at brain pictures taken using a method such as **magnetic resonance imaging (MRI)**, we can notice that the 70-year-old's brain looks slightly shrunken compared to the

20-year-old's brain. Ongoing research is trying to understand exactly *why* the brain shrinks, but we do know that not all parts of the brain shrink to the same extent. The two parts of the brain that shrink the most are the **frontal lobe** and the **temporal lobe** (Figure 1).

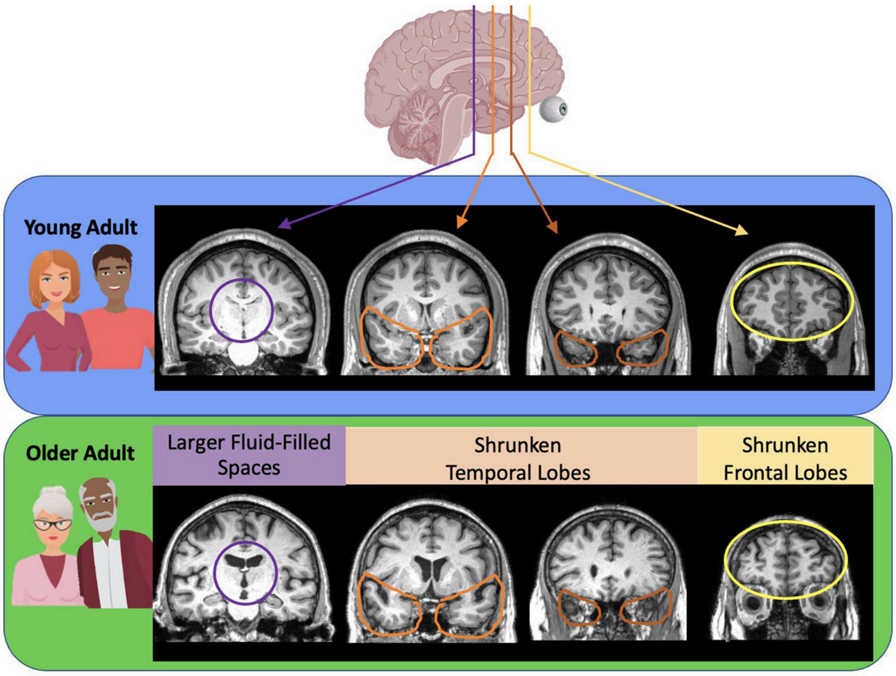

Figure 1

CHANGES TO THE BRAIN'S "WIRES" AND "WIRING MAPS"

If we use more specialized methods to see other characteristics of the brain, we might also notice changes in the connections that link various brain cells together. You can imagine the 20-year-old brain as having many sturdy, well-insulated "wires" that allow separate locations in the brain to communicate. The "wires" are delicate **nerve fibers**, surrounded by a fatty tissue (called **myelin**) that helps protect and insulate them. Similar to wires, these nerve fibers help brain regions communicate by passing electrical signals. You read that right: your thoughts and actions come from electrical currents in your brain! Some nerve fibers travel short distances, connecting neighboring cells, and other nerve fibers travel long distances, even connecting regions in the front of the brain to those in the back.

In the 70-year-old brain, the nerve fibers have less myelin protecting and insulating them. Those fibers also are less sturdy and, in some parts of the brain, there are fewer of them. If we could watch nerve fibers in action, we would notice that all of these age-related "wiring" changes result in messages traveling more slowly from one part of the brain to

MAGNETIC RESONANCE IMAGING (MRI)

An imaging method that uses bursts of radio waves within a strong magnetic field to create pictures of parts of the body.

Figure 1

MRI images of brains from young and older adults. Each picture shows a "slice" of the brain, with colored arrows indicating the locations of these slices. The brain tissue looks dark or light gray, while fluid-filled spaces look black. Compared to the young adult brain, there are more fluid-filled spaces in the older brain (purple circles). There is also more fluid around the outside of the brain, especially in the temporal (brown circles) and frontal (yellow circles) lobes. When less brain tissue fills the space inside the skull, there is more fluid—extra fluid is a sign that the older brain is slightly shrunken.

FRONTAL LOBES

Brain regions that sit at the very front of the brain, just behind the forehead. They are important for many brain functions, including the ability to plan, prioritize, and organize.

TEMPORAL LOBES

Brain regions that sit behind the ears. They are important for the processing of sensory information from the ears and eyes, and for remembering experiences and general knowledge.

NERVE FIBERS

The portion of a brain cell (neuron) that carries the electrical signal away from the main part of the cell (the cell body).

MYELIN

A fatty substance that surrounds, protects, and insulates nerve fibers and brain cells. By providing insulation, this substance allows electrical signals to travel more quickly.

another in the 70-year-old brain. Sometimes, messages even veer off and travel in unintended directions.

QUICK THINKING!

Because of these physical changes to the brain, there are differences in how young and older adults approach tasks and whether certain types of tasks are harder or easier to perform. As we get older, it becomes harder to respond quickly to something [1]. Maybe we need to swing a baseball bat in response to a fastball, or slam on our bicycle brakes when an animal runs out into the road. When we are older, our reaction times become slower—we can still swing the bat or slam on the brakes when we are 70, but we cannot perform these actions as quickly as we could when we were 20.

You now know that this slower speed happens because of certain changes to the nerve fibers that help messages flow from one part of the brain to another. As the visual cortex processes the image of the animal running across the bike path, the information is communicated to the motor cortex, which sends the signal to move your foot to brake. All that happens more slowly when we are 70 rather than 20.

WHO? WHERE?

Remembering proper nouns—the types of nouns that we capitalize, such as Cincinnati or Cleopatra—becomes more challenging in older age. Although everyone forgets names from time to time, a 70-year-old will forget an infrequently used name more often than a 20-year-old will—regardless if it is the name of a city, a book, or an acquaintance. Older adults also have more difficulty remembering who told them something, or where they learned a particular piece of information: was it in the newspaper, or did a friend tell them? No one is perfect at remembering these types of details, but errors increase with age.

These difficulties occur because of age-related changes to the frontal and temporal lobes. The frontal lobe, when connected to the temporal lobe, can be thought of like an orchestra conductor for the memory—helping many brain regions work in concert, so we can store new information in memory and later pull out the relevant details. As the frontal and temporal regions shrink, it is as if the conductor stops waving his baton high enough for the musicians to consistently see it. As a result, the actions of the rest of the memory orchestra fall out of coordination, and memory errors increase.

So far, we have given examples of tasks that become harder in older age—but not everything becomes harder [2]! Many things *improve* with age (Figure 2), and sometimes people can even use those improving abilities to make up for the abilities that are declining.

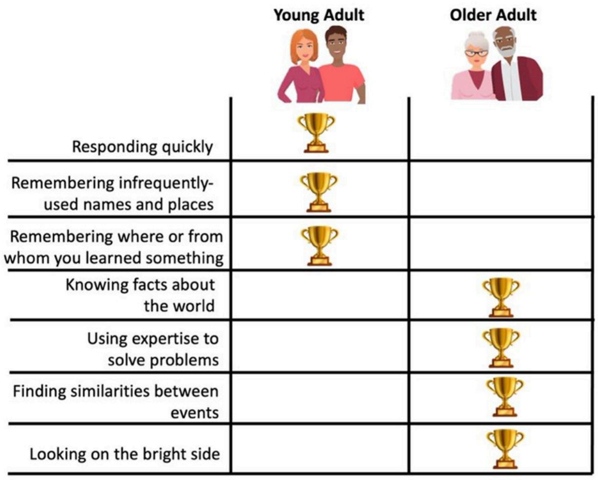

Figure 2

Figure 2

Trophies are assigned to the age group that performs a task best. You can see that the two age groups excel at different kinds of tasks.

EXPANSIVE KNOWLEDGE

Over a lifetime, people learn a lot about the world. Perhaps they have learned a lot about math, or The Beatles, or sewing, or cars—becoming experts on these topics. Through lifetimes of interacting with other people, older adults have also gained **expertise** in understanding others: they tend to be as good as or even better than younger adults at recognizing others' emotions and at feeling compassion for others.

EXPERTISE

Outstanding skill or extensive knowledge in a particular topic, usually acquired through practice.

This expansive knowledge can be used to reduce some of the challenges described earlier. For example, while a 70-year-old's brain may be working more slowly than a 20-year-old's brain, a 70-year-old who spent years as an accountant is still going to be fast at mental math because of the years of practice. This is similar to how, when you first learned to read, it took a lot of time to sound out each word and a lot of effort to connect the sounds to the words' meanings. But now, after years of practice, you can probably read these words without thinking much about it. That is the benefit of expertise.

SEEING CONNECTIONS BETWEEN EXPERIENCES

No matter our age, the **hippocampus** (which means "seahorse" in Latin) is an important brain region for memory. But as we grow older, we use this region differently. In younger adulthood, the hippocampus focuses on *separating* experiences in memory. For example, it helps us easily remember what happened on one family trip vs. another. In

HIPPOCAMPUS

A seahorse-shaped structure in the interior portion of the brain's temporal lobe that is important for learning and memory.

older age, it shifts to making us more likely to notice the *commonalities* between a current family trip and a past trip (Figure 3) [3].

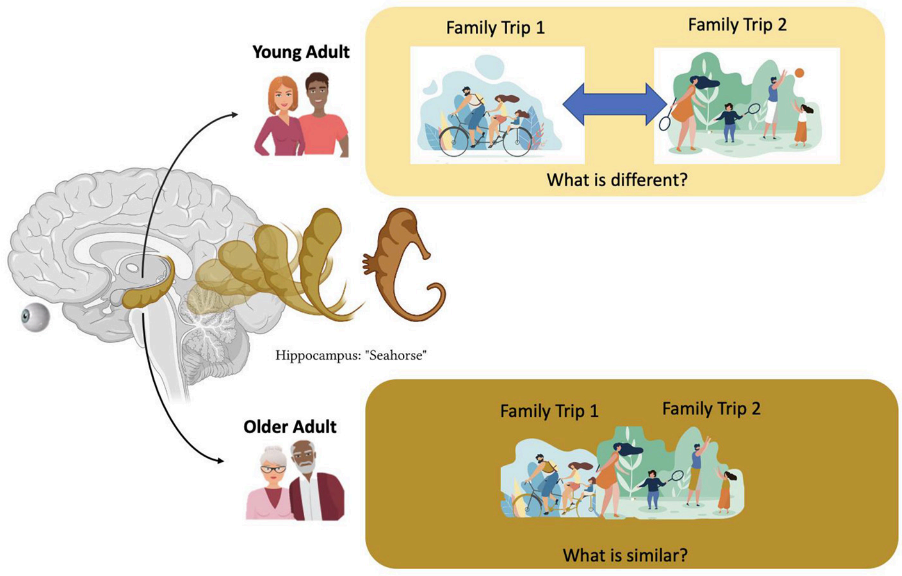

Figure 3

The way the hippocampus contributes to memory changes as people grow older. In young adults, the hippocampus spends much of its effort trying to *separate* events in memory, emphasizing the differences so that the brain can keep track of the specific experiences. In older adults, the hippocampus shifts to spending more effort finding the *overlap* between events, emphasizing the similarities (Image credit: Stephanie Chamberlain; created with BioRender.com).

In addition to changes in how the hippocampus works, the older adult brain is also more likely than the younger adult brain to have networks of cells that interconnect and merge. You might think of the messages in the older adult brain traveling along winding, interconnected city roads that can be used to reach multiple thought-destinations, vs. those in the young adult brain, which are traveling a high-speed interstate, with each exit leading to a particular thought-destination. The tendency for older adults' brains to use the same routes for multiple types of thoughts can make it easier to keep track of the overlap between situations. This ability to notice commonalities can be incredibly helpful, in part because it makes it easier to apply knowledge learned in one context to a new situation.

LOOKING ON THE BRIGHT SIDE

Older adults are particularly able to remember the good things that have happened in their lives and to focus on the positive aspects of experiences—even difficult ones. Ongoing research is examining the brain changes that make this happen [4]. The same changes that make it easier for older adults to see the connections between experiences may also make it easier for them to appreciate the good that can come from a negative event, such as how a challenge overcome at one point in life helped them to experience benefits later.

CONCLUSION

Older adult brains do not look exactly like young adult brains, and they do not work in exactly the same way. These differences affect the types of tasks that young vs. older adults perform best. While some tasks are performed best by the young adult brain, others are performed best by the older adult. One of the terrific things about families or workplaces in which young and older adults work together is that everyone can benefit from the unique strengths of young and older adult brains!

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YOUNG REVIEWERS

ALANA, AGE: 15
Hi, I am Alana, I am 15 and I like art.

KAI-NING, AGE: 10
My name is Kai-Ning and I am in grade 5 this year (2022). I enjoy learning new things and like to take on different challenges. When I grow up, I want to be an inventor! My favorite subject is math because it is very fun. In my free time, I love to read, play with Legos and figure skate. Even though I live in Canada, I visit my grandparents and extended family in Taiwan whenever I can!

EDEN, AGE: 15
Hi, I am Eden and I enjoy art, music, fashion, marine biology, law, and pharmacology.

MARIA, AGE: 13
I am a grade 8 student in Ontario, Canada. I discovered my passion for Neuroscience when I was in grade 5 and since then I have been learning more about the brain and how it functions. Two of my biggest dreams are to travel the world and become a neurologist. I love volleyball, gymnastics and listening to music. My favorite subject is Biology.

POLINA, AGE: 15
Hello! I am Polina and I am interested in cybersecurity, gardening, music, and theater. I love articles related to nature and particularly its weird phenomena, although any good article can catch my eye.

AUTHORS

RYAN T. DALEY

I have lived near Boston, Massachusetts my entire life. I was fortunate to grow up with all my grandparents nearby. As I grew older, I started noticing some of the different ways that my grandparents remembered and told stories from the past. This made me fascinated to learn more about how and why younger and older adults focus on different types of information. I conduct research to try to understand how we use information from memory to make decisions and judgments about other people. I am especially interested in how the relationships between memory, decisions, and judgments change as we grow older. When I am not doing research, I like to run and mountain bike. Always remember, you can never be too old to ride a bike! *daleyrb@bc.edu

JACLYN H. FORD

I grew up in a suburb north of Boston, Massachusetts before spending 9 years in the southeast for college and graduate school. After getting my Ph.D., I moved back to the Boston area where I am now a research assistant professor in the Department of Psychology and Neuroscience at Boston College. I have always been fascinated by how people think about the world around them, and by the fact that two people can have the same experience but remember it entirely differently! In my research, I design experiments that examine how people remember emotional events from their pasts and how they feel about those memories years later. I am particularly interested in how changes in the brain influence these memories. When I am not asking questions about memory, I enjoy spending time with my husband and our 5- and 7-year-old boys. We live near the ocean, so we spend as much time as possible at the beach, searching for shells and jumping in the waves.

ELIZABETH A. KENSINGER

I grew up in Kansas City, Missouri and now live in a suburb of Boston, Massachusetts, where I am a professor and researcher in the Psychology and Neuroscience Department at Boston College. Through my research, I answer questions about human memory, its connections to emotion, and how memory and emotion change as adults get older. I have been interested in science and in teaching for about as long as I can remember, although until college I had no idea that there was a branch of science dedicated to understanding the brain. One of the things I really like about being a scientist and professor is that there are so many different parts to the job: I get to design experiments; analyze data and think about ways to visualize the results; write about our discoveries; and teach others about advancements in science and about how to conduct experiments. When I am not doing these things, I most enjoy spending time with my husband and our 9-year-old daughter. We spend a lot of our time outdoors, sometimes at nearby parks and playgrounds, and other times driving a bit further to get to the beach or the mountains. If we are indoors, we are likely listening to music or creating it ourselves (we all play violin, and our daughter is just starting to learn flute).