



## ATTENTION: YOUR BRAIN'S SUPERPOWER

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### YOUNG REVIEWERS:



ALYSSA  
AGE: 15



ANANYA  
AGE: 11



OHAD  
AGE: 9

Have you ever searched the pages of a *Where's Waldo*<sup>®</sup> book and found it difficult to find him? Your eyes jump around the page scanning for his red-and-white striped shirt, but all you seem to find are other funny characters. Maybe you keep getting distracted by a big green monster that does not look anything like Waldo. After you finally find him, you realize that you looked right at Waldo many times without noticing him. Do not worry! In this article, we explain that this is *not* because you are a bad detective, but because of the way the brain works when we pay attention.

Attention refers to the ability to focus on one thing while ignoring other things [1]. As you read the words on this page, you are shifting your attention from one word to the next, while ignoring all the others. You do the same when you look at a *Where's Waldo*<sup>®</sup> book, shifting your attention from one silly character to the next, while trying to ignore all the others. Your search ends when you realize that the character you are currently looking at and paying attention to is Waldo.



[3]. The first neurons respond to simple features (like red things or round things). Later, other neurons combine these features into whole objects (like an apple). When you choose to attend to a specific feature like “red,” neurons in your brain that detect red things will send stronger signals and neurons that detect blue things send weaker signals. In this way, attention boosts the brain signals related to the features you are interested in. Early signals that receive a boost by attention are more likely to be combined together, which allows you to recognize the object you are focused on. So, attention acts like a glue, binding together the responses of neurons corresponding to the features that make up the object you are looking at.

An important point is that you have some control over all of this. Look at Figure 1 again and try to find the pink pig. As you do this, you could choose to start searching on the right side of the picture, you could choose to look only at pink objects, or you could start at the top and work your way down. Give your superpower a try. But be careful! Many **distractors** grab your attention because they are similar to what you are looking for. As you search for the pig, you may find yourself looking at many other pink objects, such as the whale on the right side of the picture. This is not surprising, because the pink whale will still cause early neurons that like pink to send along their signals. This explains why the designers of Where’s Waldo® put many similar-looking items on the page that you may mistake for Waldo, like other people wearing red-and-white striped sweaters.

### DISTRACTORS

Features or objects that direct our attention away from the thing we are looking for. Everything in a messy drawer that is not the scissors you are trying to find is a distractor.

### POP-OUT

When features or objects noticeably stand out among other things, such as a red pen among lots of yellow pencils in a messy drawer.

## YOUR ATTENTION MAY BE DRAWN TO CERTAIN PLACES OR OBJECTS

Now consider Figure 2A. Can you find the apple? You probably did so very easily. This is because the apple is the only red object in the picture, making it very different from everything else. In the brain, the neurons responding to the red apple produce signals that are very different from the signals produced in response to everything else in the picture. When this happens, your attention is automatically drawn to the apple, strengthening and binding those brain signals and making the apple very easy to see quickly. Scientists who study attention call this effect **pop-out**. What is important to remember is that pop-out happens automatically, whether you want it to or not.

Visual search is very easy when the thing that grabs your attention and pops out is what you are looking for. However, pop-out can also be distracting and make it harder to find what you are looking for. Try to find the apple in Figure 2B. Did you feel your attention being drawn to the large pink star? Although the apple is still pretty easy to find, it was probably a little harder than it was in Figure 2A, which does not have the star.

## Figure 2

Can you find the apple in these pictures? **(A)** Does the apple “pop out” of this image? Finding the apple is easy when it has unique features, such as its red color, compared to the distractors. **(B)** Were you distracted by other objects in this image? The bright pink shooting star also pops out and grabs your attention, making the apple harder to find.

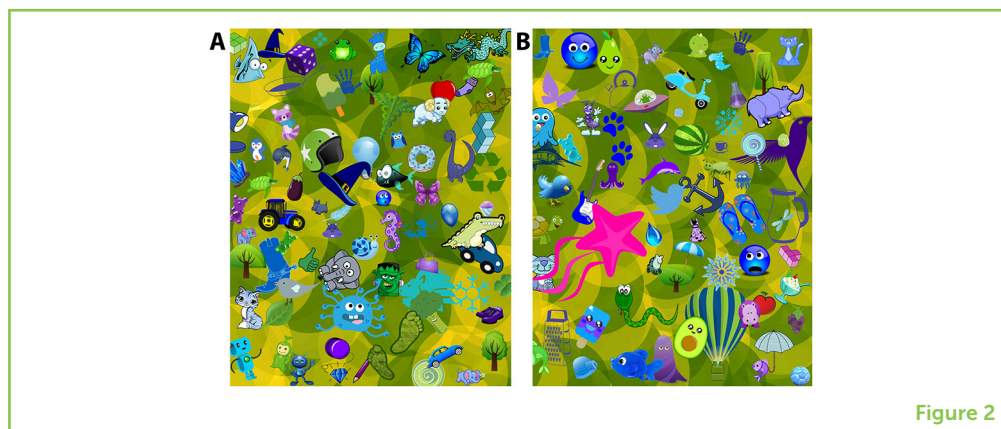


Figure 2

The key point to remember is that you will automatically pay attention to any object that looks very different from the things around it. This can happen because the object has a unique color (like the apple) or is very large (like the pink shooting star). Things that are moving are also likely to grab your attention, which is why people often wave their arms in order to get someone to notice them. If you think about your daily life, you can probably come up with many examples of things that grab your attention, even if you do not really want them to.

## ATTENTION CAN BLIND YOU TO OTHER THINGS

Like any good superpower, it is important to remember that, “With great power comes great responsibility.” You must be careful with your attention superpower. Although it can help you find what you are looking for, it can also make you miss important stuff. Let us think again about searching for an apple. When you try really hard to focus your attention on red things, blue things may go unnoticed, as long as they do not stand out in other ways. If neurons that like blue are being quieted by attention, then their weak signals may not influence other parts of the brain. When you are trying to find a red apple, this is a good thing. But it also means that you may completely miss seeing something important that happens to be blue. Scientists call this **inattention blindness**.

Researchers Daniel Simons and Christopher Chabris created a famous demonstration of inattention blindness, in which people watching a short movie clip failed to notice a dramatic surprise that appears in the middle of the clip [4].

In the movie **(Video 1)**, two teams pass basketballs back and forth to each other, with one team wearing white t-shirts and the other wearing black. Simons and Chabris showed the video to research participants and asked them to count passes between players in the white t-shirts. In the middle of the video, while the balls are being passed around, a person dressed in a black gorilla suit walks

## INATTENTIONAL BLINDNESS

The failure to see an unexpected feature or object because our attention is entirely focused elsewhere.

## VIDEO 1

A video demonstration of inattention blindness, inspired by the original study by Simons and Chabris. When counting how many times the team wearing white t-shirts pass a ball, approximately half of viewers will fail to see unrelated and even dramatic events.



through the group of players. To correctly count the passes, the participants needed to attend to the players wearing white t-shirts, while ignoring all the dark-colored features—so they often did not see the gorilla, even when it turned toward the camera and pounded on its chest! Imagine being a participant in this experiment. You watch a short video and do the pass-counting task. It is all very easy and maybe somewhat boring. When the video ends the scientists ask, “Did you see the gorilla?” You would probably say, “Gorilla?... What gorilla?!?!” Inattentional blindness demonstrates an important point about the way our attention superpower works. The more we focus our attention on one thing, the less likely we are to notice other, unexpected things.

## WHY ATTENTION MATTERS

After reading this article we hope that you understand three important concepts about paying attention: (1) You can choose what you pay attention to and try to ignore everything else; (2) your attention may be drawn to certain places or objects, even if you do not really want it to be; and (3) if you are attending to one thing, you can be completely unaware of other things, even if you are looking right at them! Understanding how attention works and when it fails is very important because attention is a critical part of many everyday tasks. For example, if you are really interested in the article you are reading, you may not notice your sibling enter the room. But you will probably look up if they stub their toe and cry out in pain. Understanding how our attention works can also help us design safer and more effective environments. For example, fire trucks are brightly colored and have a loud siren to capture your attention, even if you are focusing on something else. Finally, your ability to use and control your attention, like any hero’s superpower, can improve with practice. Simple mindfulness techniques, such as focusing on your breathing for a few minutes each day, can help you have better control of attention, which can improve your overall mental health [5].

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## YOUNG REVIEWERS

### ALYSSA, AGE: 15

I love math and science, but also love fashion. I am a girl who loves pink but also astrophysics. My hero is Nancy Grace Romanis, who was the first woman to earn an executive position at NASA. I hope to also work for NASA one day.



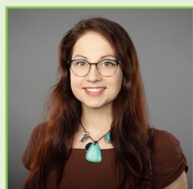
### ANANYA, AGE: 11

Ananya is a curious 11-year old girl who loves everything about nature and science, especially the human body. She has been a very observant child since the beginning and wants answers. She enjoys traveling with her parents to different parts of the world, loves to help her mom in the kitchen, goes on hikes with her father and loves Russian math. She wants to be a physician like her grandparents when she grows up.



**OHAD, AGE: 9**

Hi, my name is Ohad, I like reading and playing soccer. My favorite food is pasta but I also like pizza. My favorite subjects at school are math, science, and computer. I really like to learn new languages. I do not only know English. I also know and am almost fluent in Hebrew, a language mainly spoken in the country Israel.

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I study attention in the Caplovitz Vision Lab at the University of Nevada, Reno. I love sharing my passion for neuroscience with others through outreach work at local schools and venues, as well as conducting Jr. Peer Reviews for Frontiers for Young Minds. In my free time, I enjoy the outdoors and reading. \*taucua@nevada.unr.edu

**STANIMIRA SEEKINS**

I recently graduated from the University of Nevada, Reno with a Bachelor of Arts in psychology. Currently, I am pursuing a DPT to become a physical therapist. Outside of school, I am in the Army National Guard and I love being active. I have a three-legged cat named Felix and I love Disneyland.

**STEPHANIE HUNTAMER**

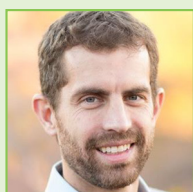
I have a Bachelor of Arts degree in psychology from the University of Nevada, Reno. I am currently completing a Master of Science in psychology of mental health at the University of Edinburgh in Scotland. For fun, I like to snowboard and travel with my family.

**TESS WHITE**

I am a graduate of the University of Nevada, Reno with my bachelor's in psychology and French. I currently manage a lab at Brown University that studies human navigation in virtual reality. I enjoy studying attention and visual search. I drink copious amounts of tea and I have a love for narwhals.

**GIDEON P. CAPLOVITZ**

Dr. Caplovitz is a cognitive neuroscientist who researches the principles and neural mechanisms that underlie how we visually experience the world. He has been researching the brain since 1998. He has received funding for his research from the National Science Foundation and the National Institutes of Health and is currently an Associate Professor of psychology and Director of the Cognitive and Brain Science Graduate Program at the University of Nevada, Reno.

**RYAN E. B. MRUCZEK**

I am an Assistant Professor at the College of the Holy Cross. I study how the brain allows us to quickly and easily recognize the objects we see. I love spending time with my family and listening to audiobooks about science and nature.