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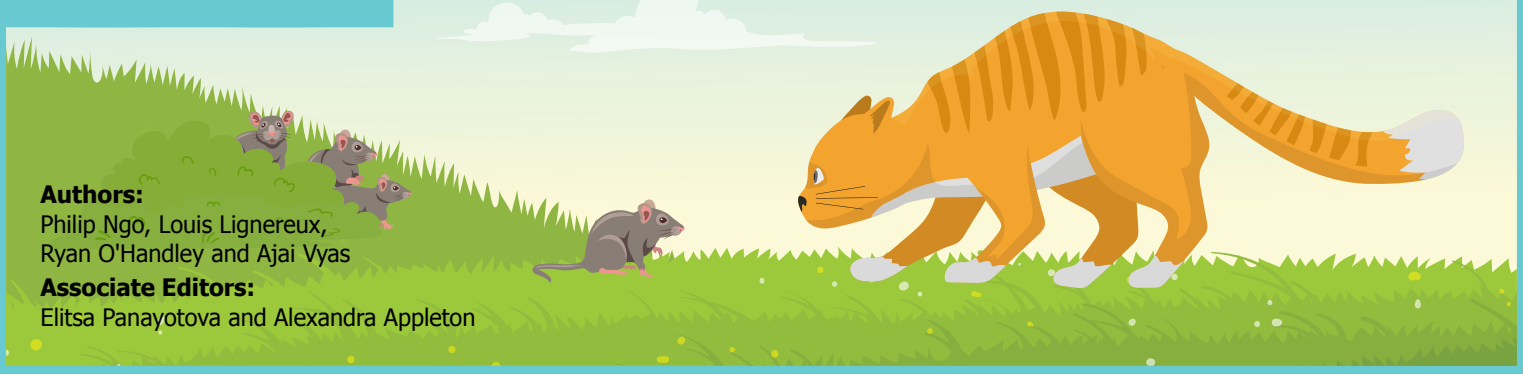
How do parasites affect mouse behavior?



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Abstract

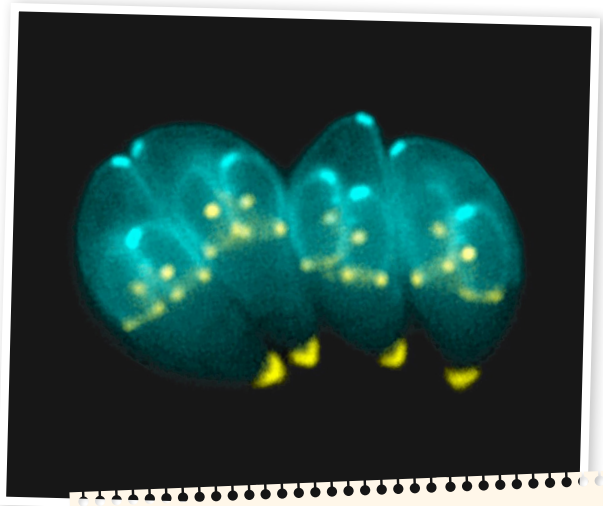
Have you ever heard of *Toxoplasma gondii*? It's a tiny parasite that can infect animals' brains. Moreover, it can change their behavior! We captured mice on Kangaroo Island in Australia and examined their brains. We searched for changes in the brain associated with infection. We found alterations in specific genes related to behavior in infected male mice. These changes made the mice less afraid of cats – their natural enemy! Interestingly, we observed no such changes in infected female mice. These findings help us understand how parasites might affect the behavior of the organisms they infect.

Introduction

Have you ever wondered why animals act the way they do? Their **genes** play a huge role in shaping their behavior. All the genes together act like a big book of instructions. They tell the body what to do and the mind how to behave. There are different versions of the same gene; each version comes from each parent. These variants can affect things like the color of the eyes or the texture of the hair. They can also affect memory and how the animals respond to their surroundings. Imagine these variants like having two apps on your phone for doing the same task, like for listening to music.

But here's the fascinating part: it's not just about having these genes. The environment around them can switch these genes on or off. Think about it like using one of the music apps for streaming and the other for listening to downloaded songs. If you have a good internet connection (environment), it is better to use the first one. Where there is poor internet connection (different environment), you prefer the other app. We call the on- and off-switches **epigenetics**. This is like an extra layer on top of genes that can also change how animals behave. For instance, when rat moms take care of their babies, it can change how their babies act when they grow up and become moms themselves. So, the environment plays a big role in behavior, too!

But there is something else that can change the way animals behave. **Parasites**! There's a parasite that lives in mice's brains – *Toxoplasma gondii*. Does it change their behavior? How? This is what we wanted to find out.



Dividing *Toxoplasma gondii* parasites.
Photo: Ke Hu and John M. Murray, CC-BY-4.0.

Methods

We went on an expedition to Kangaroo Island in Australia (Fig. 1). We set up special traps to catch mice. We placed these traps in various locations (both indoors and outdoors).

Then we took the mice we captured back to the lab and examined their brains. We focused on a specific part of the brain which processes emotions like fear and anxiety. We wanted to see if we could detect *Toxoplasma gondii*. This is a very common parasite that needs cats for survival.

Next, we looked into a specific gene in the mice's brains related to their behavior. We wanted to compare this gene in infected and non-infected mice. This allows us to see if the parasite has an impact on the mice's behavior.

Figure 1:
The location of Kangaroo Island off the coast of Australia.

Results

Male mice infected with *Toxoplasma gondii* showed changes in their brains. The infection changed the chemical nature of a specific gene that makes male mice bold and cocky when looking for a mate. These changes made them less afraid of predators like cats. Female mice did not show the same changes. This suggests that the effects of the parasite vary depending on sex.

Discussion

This study sheds light on the complex relationship between genes, parasites, and behavior. It's like solving a puzzle where each piece plays a crucial role in shaping animal behavior. And the environment is a big piece of this puzzle. This is why we observed mice in Nature instead of in the lab. After all, the threat of predators is real in Nature.

Just as the malaria parasite needs to go between mosquito and humans, *Toxoplasma gondii* needs to move between cats and the animals that cats eat. So, parasites in mice must get to cats if they are to complete their life cycle. That involves infected mice being eaten by cats. But not many mice like to be eaten! *Toxoplasma gondii* tries to solve this problem by making infected mice less afraid of cat **odors**. This of course is bad for the mice since they are more likely to be caught by a cat.

Yet changes were only present in some parts of the brain. Different areas of the brain have different jobs. So, the fact that only certain areas changed tells us something important. This could mean that the parasite targets specific parts of the brain that control certain behaviors or functions. But why does it affect males and females differently? We'll have to study them further!

Conclusion

Did you know that *Toxoplasma gondii* also infects people? According to some studies, up to a quarter of the people in the world have been infected at some point in their lives. This includes 11% of the population in the USA - that's around 40 million Americans! People usually get infected by eating undercooked (contaminated) meat. So, it's really important to cook your food well. And because cats are part of this parasite's life cycle, it's important to wash your hands often. Especially after touching cats!

Glossary of Key Terms

Epigenetics - a set of instructions that tells our genes when to turn on and off. It's like a switch that can change how our bodies work without changing our actual DNA.

Genes - instructions inside our bodies that determine things like what color our eyes are, how tall we will grow, and other traits we inherit from our parents. They're made of DNA, and they tell our bodies how to make proteins, which are like little machines that do different jobs in our bodies. Genes are passed down from parents to children, which is why family members often look alike or share similar traits.

Odor - a smell or scent.

Parasite - tiny organisms that live on or inside another living thing, called a host, and get their food and nutrients from them. They can be harmful to the host by causing diseases or taking away resources that the host needs to survive.

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Check your understanding

1 What are some factors that can shape animals' behavior?

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2 Why did we choose to conduct this experiment on Kangaroo Island instead of in the lab?

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3 Find out more about *Toxoplasma gondii*'s life cycle. Try to draw and explain it.

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4 We need to study the effects of this parasite further. But can you think of potential reasons why the effects of Toxoplasma gondii infection on behavior varies between male and female mice?

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