# Why Do Giraffes Have Long Necks?

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Anyone who has seen this majestic creature in the wild, nibbling away at the top of an acacia tree, has to marvel at the wonder of evolution. The giraffe's long neck is a perfect adaptation to the animal's natural habitat. Clearly the giraffe evolved this uncommon and helpful trait in order to reach those nourishing leaves. That's how natural selection works.

If you're a 6-year-old.

As appealing as this explanation is, it shows a complete misunderstanding of the concept of adaptation by natural selection, a key concept in the theory of evolution. What's wrong with the 6-year-old's idea is not its focus on the neck's function. It's the mistaken notion that an individual giraffe, by its own effort and action, can transform its essential nature in a beneficial way.

In fact, natural selection for long necks is not a goal-directed transformation, and it does not take place in a single giraffe's lifetime. It is in reality a very gradual change in the frequency of long necks in the species—a change that takes place because some giraffes who have that trait survive and reproduce more successfully in their world. The crucial point is that the change takes place not in an individual giraffe, but in a large population of giraffes.

We know this, because we're educated adults, but it's a difficult concept for young children. That's because kids, until tutored otherwise, operate according to intuitive causal theories of the world—theories that emphasize design and purpose and intention. Kids are natural explanation seekers, and their intuitive theories are actually helpful in much everyday reasoning. But these cognitive biases can lead them to misconstrue complex ideas like natural selection.

That's in part why we don't try to teach kids such biological concepts. We wait until they are older and more cognitively mature. But this may be a serious error, according to psychological scientist Deb Kelemen of Boston University. According to Kelemen and her colleagues, if kids' intuitions about the biological world are allowed to go uncorrected, they may coalesce and become deeply entrenched—so that they are more difficult to alter when teenagers learn about evolution later on.

Standard practice today is to teach younger children about some of the building blocks of natural selection—the idea that food is essential to survival, for example, or the fact that traits vary within a species. Kelemen is saying that we should not pamper our kids intellectually. Even though the integrated concept of natural selection is complex and counterintuitive, she believes that it's better to begin familiarizing kids with it early—while their commonsense (but scientifically flawed) theories are still fragmentary. She and her colleagues—at BU and the University of Toronto—have developed classroom materials to do this.

Meet the pilosas. Pilosas are fictional mammals, and in the storybook that Kelemen and colleagues have

created for classroom use, these creatures are going through a sudden die-off due to extreme climate change. Insects—the pilosas' normal food source—have been driven underground, into deep, narrow tunnels, and the narrative tells a story of rapid natural selection and survival. Each page of the story adds a new biological fact, and taken together they show how pilosas went from having widely varying trunks to predominately thin trunks. Along the way they learn how climate change can alter habitat and diet, how food can affect health and reproduction, how traits are passed on, and so forth.

This is pretty heady stuff for 5- to 8-year-olds—the age of the kids the scientists studied. They wanted to see if kids this young have the capacity to learn a basic (but accurate) explanation of adaptation. So they pretested the children's understanding of the basics of natural selection, and then re-tested them again after they read about pilosas. They assessed both their understanding of basic biological facts—the link between food and health—and their ability to integrate these facts into a coherent explanation of adaptation. The central question was similar to the giraffe question above, only it was about the fictional pilosas: Why do pilosas have thin trunks?

The scientists made the exercise challenging for the kids. They gave them no feedback, and the questions were deliberately structured to elicit inaccurate, cognitively biased answers from the kids, such as: Pilosas evolved long trunks so they could reach the insects underground. They wanted to set the bar high, to see if the kids could put aside their intuitive (but wrong) ideas about design and intention.

And they did. As reported in an article to appear in the journal *Psychological Science*, the children showed substantial learning about the concept of adaptation within a species. This was true even for kids who were weak on basic biological facts to begin with. What's more, the children—even the youngest ones—were able to generalize the concept to other animal populations. Even the youngest kids learned a lot about evolution, although the 7- and 8-year-olds were remarkably good at suppressing their commonsense, but mistaken, theories of the natural world.

These findings suggest that perhaps current educational practices need to be revisited. Most schools now teach evolution only when students are 13- to 18-years-old, but many high school students never grasp these ideas. Indeed, many college students, and even biology teachers, have a poor understanding of natural selection and related ideas. It may be that waiting merely solidifies the cognitive habits that hinder such learning. Since 6-year-olds are natural born theorists, why not take advantage of that?

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