Ant-Tree symbiosis art exhibit

An important part of being a basic research scientist is disseminating our discoveries to a broad audience in effective and meaningful ways. Multimedia art exhibits have the potential for high public engagement by appealing to curiosity, aesthetics and emotion. Attempting such an exhibit is Parque das Aves, a bird park and sanctuary situated near the iconic Iguazu falls in Southern Brazil.

The local ecosystem, the Atlantic rainforest is facing a deforestation crisis and Parque das Aves is shifting their entire focus towards its conservation and education. Their new focal point is the Cecropia tree because of its countless fascinating and ecologically important interactions with other organisms in the ecosystem. They are dedicating a massive new enclosure to educate visitors about these relationships. The enclosures entrance will feature one of the Cecropia's tree's most interesting relationships: its mutualistic symbiosis with Azteca ants. Trees provide food and hollow stems for the ants to live in and ants protect the plant from herbivores and vines. Our goal is to convey the concept.

Cecropia trees have a mutualistic relationship with ants. This may seem like a simple concept but new information in an unfamiliar format can be overwhelming. So, we must first determine how best to guide visitors through the experience to maximize lasting absorption. To inform the entrance design before it's built, we created a three-stage temporary *walk-through* test exhibit combining illustrated *video footage*, interactive sculptures and live organisms. The visitors *enter* the exhibit *off* the main trail and enter a closed pavilion with a series of four large TVs, each playing a different short loop that I filmed to cover key aspects of the mutualism.

“The Cecropia tree lives in the Atlantic rainforest… the Azteca ants live in the tree… the tree feeds the ants…the ants defend the tree…”

Next, they enter the space with the interactive Cecropia sculptures. Trees *light up with* the activity patterns of ants, taken straight from real behavioral data. The light pattern reacts if you shake the tree, again based on the ants’ response to vibrational disturbance data taken from the field. The lights represent the ants patrolling and defending their tree.
From there, visitors enter an open area with living, *potted* Cecropia plants that
I grew from seedlings, where they can observe Azteca ants patrolling, feeding on
and entering their trees.
Shortly after joining back with the main trail, we gave them an *incredibly* short open-ended survey: what was the theme of the exhibit.

We tested several methods of guidance that fell into two categories: a human mediator or video and text signage. We separated survey responses into different categories based on the level of absorption: “mentioning something unrelated”, “mentioning ants or plants only”, “mentioning both ants and plants” and “mentioning the core target concept”, the ant plant mutualism. Overall absorption was high with 15 percent of people mentioning the ant plant mutualism and 85 percent mentioning some combination. While the differences in absorption between guidance methods was not statistically significant by chi-squared test, we found that video and text signage without a human mediator to be slightly more effective at communicating our target concept.

Allowing the visitor time and space to explore an art exhibit on their own seems to be an extremely effective science outreach format. Informed by this test exhibit, the final designs

for the permanent exhibit are *being polished* and construction awaits pending the conditions of the current global pandemic.

Animal-to-human disease transmission (focus on text in black for presentation)

At a Maryland country fair in 2017, the prize pigs were *not looking their best*… Farmers reported feverish hogs with inflamed eyes and running snouts. But while fair officials worried about the pigs, the Maryland department of health was concerned about a group of sick *fairgoers*. Some had pet the pigs, while others had merely been near their barns; but soon, 40 of these attendees would be diagnosed with swine flu.

More often than not, sick animals don't infect humans. But when they do, these cross-species infections, or viral host jumps, have the potential to produce deadly epidemics. So how can pathogens from one species infect another, and what makes host jumps so dangerous?

Viruses are a type of organic parasite infecting nearly all forms of life. To survive and reproduce, they must move through three stages: contact with a susceptible host, infection and replication, and transmission to other individuals. As an example, let's look at human influenza.

First, the flu virus encounters a new host and makes its way into their respiratory tract. This isn't so difficult, but to survive in this new body, the virus must mount a successful infection before it's caught and broken down by an immune response.
To accomplish this task, viruses have evolved specific interactions with their host species.

Human flu viruses are covered in proteins adapted to bind with matching receptors on human respiratory cells. Once inside a cell, the virus employs additional adaptations *to hijack* the host cell's reproductive machinery and replicate its own genetic material.
Now the virus only needs to suppress or evade the host's immune system long enough to replicate to sufficient levels and infect more cells. At this point, the flu can be passed on to its next victim via any transmission of infected bodily fluid.

However, this simple sneeze also brings the virus in contact with pets, plants, or even your lunch. Viruses are constantly encountering new species and attempting to infect them.
More often than not, this ends in failure. In most cases, the genetic dissimilarity between the two hosts is too great. For a virus adapted to infect humans, a lettuce cell would be a foreign and inhospitable landscape. But there are a staggering number of viruses circulating in the environment, all with the potential to encounter new hosts. And because viruses rapidly reproduce by the millions, they can quickly develop random mutations.

Most mutations will have no effect, or even prove to be detrimental; but a small proportion may enable the pathogen to better infect a new species. The odds of winning this destructive genetic lottery increase over time, or if the new species is closely related to the virus' usual host. For a virus adapted to another mammal, infecting a human might just take a few lucky mutations. And a virus adapted to chimpanzees, one of our closest genetic relatives, might *barely* require any changes at all.

It takes more than time and genetic similarity for a host jump to be successful. Some viruses come equipped to easily infect a new host's cells, but are then unable to evade an immune

response. Others might have a difficult time transmitting to new hosts. For example, they might make the host's blood contagious, but not their saliva.

However, once a host jump reaches the transmission stage, the virus becomes much more dangerous. Now gestating within two hosts, the pathogen has twice the odds of mutating into a more successful virus. And each new host increases the potential for a full-blown epidemic. Virologists are constantly looking for mutations that might make viruses, such as influenza, more likely to jump.

However, predicting the next potential epidemic is a major challenge. There's a huge diversity of viruses that we're only just beginning to uncover. Researchers are tirelessly studying the biology of these pathogens. And by monitoring populations to quickly identify new outbreaks, they can develop vaccines and containment protocols to stop these deadly diseases.