Waging war against a duo of degenerative diseases

Brandeis research focuses on cures for Alzheimer’s and ALS

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Humans and fruit flies are not all that different.

The complex mechanism that allows our brains and nerves to function works in the fruit flies underneath Avital Rodal’s microscope. And those flies may just hold the key to unlocking a cure for Alzheimer’s disease and ALS.

Rodal, an Assistant Professor of biology at Brandeis University whose work is supported financially by the Brandeis National Committee’s “Sustaining the Mind” campaign, has modeled human diseases in fruit flies, using the same genetic mutations that cause neurodegenerative diseases, such as Alzheimer’s and ALS (amyotrophic lateral sclerosis), also known as Lou Gehrig’s disease, in humans. The devastating effects are almost immediate: “These flies have a drastically shortened life span. The normal flies live about 60 days and these flies will live for four days and stop being able to climb and move even sooner,” she said.

Rodal studied at Massachusetts Institute of Technology and University of California, Berkeley, and came to Brandeis two years ago because “it is a really unique environment for doing science. For this size of a university, we have an incredibly strong life-sciences community here. We have one of the top-ranked Ph.D. programs in the country in neuroscience. For a small community where everybody knows each other and everybody interacts, we’re also an incredible powerhouse,” she said.

At the moment, there is no known cure for ALS or Alzheimer’s. Although scientists and therapists from a wide variety of fields are working on helping people live their lives with disability caused by both diseases, “in terms of a cure that reverses the effects of the disease, there really isn’t anything,” said Rodal.

While Alzheimer’s and ALS are both degenerative, incurable diseases, they are also very different. Whereas a person with Alzheimer’s may be expected to live 10 years, someone diagnosed with ALS has two to five years on average. (Stephen Hawking, the famous cosmologist and theoretical physicist, is one notable exception.) Alzheimer’s tends to affect the elderly, but ALS does not age-discriminate so much and could develop in someone at a young age. The main difference, however, “is the type of neuron that’s dying. So, in ALS it’s your motor neurons that innervate your muscles and in Alzheimer’s disease, it’s [other types of neurons in your brain],” Rodal explained.

Without motor neurons, there can be no movement in the body. Motor neurons are responsible for everything from running, to picking up a fork, and even to involuntary actions, like swallowing and breathing. Right now, there is only “one therapy that people use that slows the progress of [ALS]. At best, it can extend your life for six months, so it’s really almost ineffective,” said Rodal.

Since the neurons in the brain that are responsible for memory, rather than the motor neurons, are affected in Alzheimer’s disease, its symptoms are quite different – the primary effects include significant cognitive damage, such as memory loss, impaired thinking and judgment functions, even changes in emotional behavior and personality.

Whether a person loses the capacity to move his fingers or remember the name of his child, what is happening on a molecular level is the dying out of neurons in his brain or spinal cord. “Let’s say the neuron that is innervating your finger, that connection is disrupted, because the whole neuron just shrivels up,” Rodal explained.

The motor neuron has a long axon that goes all the way down a person’s arm from the spinal cord. When that axon dies, then the body of that neuron back in the spinal cord is likely to die, as well. The loss of neurons makes it impossible for the brain to send signals for cognitive functioning or for the spinal cord to send signals to the muscles that enable body movements.

When neurons send electrical signals to the muscles to contract and move, at the same time, “the muscle is also sending a different kind of a signal – a chemical signal back to the neuron to tell the neuron that it’s doing a good job and to continue doing what it’s doing,” said Rodal.

Those types of chemical signals are called “growth factors” – they not only stimulate growth, they also tell the neuron to keep surviving – and when Rodal manipulates the neurons in the fruit flies and growth factors are no longer doing their jobs, the neurons will die.

“We’re more interested in what’s gone wrong rather than studying what leads to the disease, and then trying to correct what’s gone wrong – our approach is much more to treat the effects. What we’re trying to do is rescue the normal function of these growth factors,” said Rodal.

When the neuron receives the growth factors, they get pinched inside the neuron in a membrane-bound compartment that moves all the way up the neuron to the spinal cord or the brain, which can be up to a meter long. Rodal and the scientists in her lab focus their research on helping those movements along to restore them to a healthy state in neurodegenerative diseases.

If Rodal’s lab is on the right track, she hopes to identify some targets for new drugs that aren’t available now.

“Your only try new things and test them; developing therapies is all about testing lots of ideas … so what’s really important in terms of research is people who have good ideas and the ability to carry them forward and test them out,” said Rodal.

BNC’s $3 million campaign “Sustaining the Mind” does just that. It supports researchers as they test out their ideas in neuroscience research, “mainly because of the connection to neurodegenerative diseases and how important that is to many of our members,” said Janice Fineman, Executive Director of BNC. The volunteer organization now counts 25,000 members whose primary mission is to raise funds for the university.

Since its founding, BNC has raised $126 million to support the Brandeis library, scientific research and scholarships for students, “so we can train the future scientists of tomorrow,” Fineman added.

With BNC’s help, Rodal and other researchers at Brandeis are bridging connections between what they are discovering in their microscopes and helping people fight devastating diseases and live longer, healthier lives.

“It’s very motivating to think that you could potentially help people,” said Rodal. “There are a lot of bright people who are working in this field. [And] because people are motivated … there are a lot of exciting and interesting discoveries going on, all over the world.”