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2014 Research at Andrews

Andrews University

Luana Greulich

paired with teacher/student directed or student directed instruction) were recorded across the five main areas of reading. The instruction was shown to be of consistently high quality to rule out the possibility that students were being identified as "at-risk" due to poor instruction.

The students were assessed for their needs and then separated by criteria based on prior research into the appropriate tier according to either the typical or dynamic model. The instruction in the Tier 2 and 3 intervention groups was also videotaped and coded for quality to measure fidelity of instruction. The research team routinely assessed students as the school year continued.

Greulich met with administrators on a regular basis to go over data from the assessments and intervention sessions. Once it was clear that students were not progressing, she worked with the administration to get the children into a referral system where they were assessed for special education services. Typically, children with learning difficulties do not receive services until the 3rd or 4th grade, by which time many will have developed avoidance behaviors. In a follow-up study, Greulich examined the behavior exhibited during intervention sessions of "at-risk" students. A surprising result was that marginal non-responders exhibited avoidance behaviors (such as shame, hopelessness and anxiety) to a much greater extent than the very low non-responders.

In 2004, the reauthorization of the Individuals with Disabilities Education Improvement Act (IDEA) mandated that public schools identify children who may have disabilities or be in need of special education services. This has sparked widespread use of Response to Intervention programs that start at the kindergarten and 1st grade level. RtI has been implemented at all grade levels, including high school, but the RtI needs are quite distinct at these different levels. Currently, there is no consistent criteria that is used for RtI. Researchers are trying to develop an assessment system that is consistent across the board and takes into consideration the differences between elementary and secondary needs with RtI.

The data collection was completed in 2012, and Greulich and her colleagues have shifted their focus to publishing their results. Since 2007, the research group has published 16 articles in journals such as *Reading and Writing: An Interdisciplinary Journal*, *Journal of Learning Disabilities*, *Exceptional Children* and *Early Childhood Research Quarterly*. While most of the research team has moved on from Florida State, they have been able to continue collaborating thanks to email and Skype. The study has been extended for another five years to follow these students longitudinally to assess their writing skill development, under the direction of the principal investigator, Dr. Young Suk-Kim.

Greulich is continuing her research interests with RtI and following up with Young-Suk Kim to extend Greulich's dissertation that was just published in *Journal of Learning Disabilities* in a special two-part RtI edition. Locally, Greulich is now working with the Berrien Regional Education Service Agency (RESA) to provide quality field experience for her special education courses working with students of all disabilities in the surrounding school systems. Greulich also hopes to work with the Berrien Springs School System, which has a unique special education population. Sixteen different languages are spoken in the Mars and Sylvester Elementary Schools of Berrien Springs, and Greulich wants to know how this impacts the special education and English language learners. "We have a lot of students who come to the school that might appear to need special education, when in fact English is their second language," she says.

In the future, Greulich would like to establish a research center at Andrews University that would attract grants and implement significant changes in the community. "It could be a center where our graduate students could come and learn how to do research in a way that would set them up for a doctorate," she says. One of the main goals of her research projects is to give back to the teachers, providing them with fresh ideas for instruction and piloting programs for the students. "That's what I appreciated about our grant," she says, "we were out with the teachers and the students working together."

Cricket to Cricket

Cricket Calling Songs and Neuronal Behavior

Thousands of crickets have lived and died in the Andrews University Department of Biology. If one were to stand still in Price Hall and hear the high chirp of a cricket, it is probably not a stray, outdoor cricket lost in the maze of biology classrooms and offices. In all likelihood, it is a lab cricket that has ventured outside of the plastic bin where it was raised.

Every Tuesday, a new shipment of *Acheta domesticus*, also known as the house cricket, arrives from Fluker's Cricket Farm in Louisiana. The crickets are placed in a temperature- and light-controlled chamber until they have molted. A student, or "cricketeer" as the undergraduate cricket researchers call themselves, then examines the newly-molted insects and picks out the females, which are easy to spot because of the long ovipositor, or egg-laying organ, that extends from their abdomen. The females are placed in separate bins until the researchers are ready to begin an experiment.

As an Andrews biology professor, John Stout first started researching cricket behavior in the 1970s. In the 1980s, the research focus was expanded to include the neurophysiology of the crickets. The research continued to grow as faculty members Gordon Atkins and David Mbungu became interested in the project.

More than 30 journal articles have been published by the research group in journals such as the *Journal of Comparative Physiology A*, *Physiological Entomology* and the *Journal of Experimental Zoology*. Since Stout began his research, the main focus has been to understand the auditory system of crickets. While his research has been primarily concerned with female crickets, David Mbungu has begun working

Benjamin Navia explains the "cricket treadmill" to a student.

with male crickets as well, further expanding the research possibilities.

Undergraduate and graduate students have also been involved in the project. Over 50 honors theses and 26 biology masters theses have come from this project. One student, Benjamin Navia, came back to Andrews after pursuing graduate work and picked up where he left off with his six-legged friends. When John Stout retired, Navia joined the biology faculty and has continued conducting research on crickets. He also mentors undergraduate biology majors Re'jeanne Greene and Karis Kang on how to conduct the experiments and collect data.

According to Navia, there are a number of reasons why crickets are important. "When we do science," he says, "we attempt to explain natural phenomena. In the process of looking for answers, we must have a model we can use to test our hypothesis." Enter the crickets.

Crickets exhibit acoustic communication. In other words, male crickets chirp a specific kind of calling song to attract females. The song has a set of syllables for each chirp and females respond to the song by moving in the direction of the sound in what is called "phonotactic behavior." The fact that they are able to respond to sound (phonotaxis) means that they have a nervous system. The nervous system is simple, nothing as complex as the human nervous system which contains somewhere around 85 billion neurons. Whereas a single human neuron cannot easily be examined, researchers can study a single cricket auditory neuron. This "enables us to perform meaningful experiments when attempting to study and describe a nervous system," says Navia.

The goal of Navia's research is to understand the underlying neuronal mechanisms that allow female crickets to respond to a specific calling song. A female responds to a male calling song by walking towards it, which is observable. However, not all females respond positively, indicating that there is a preference in the quality of the song.

Crickets' "ears," or tympanic membranes, are on their two front legs. They walk toward a sound in a zigzag motion, rather than in a straight line, depending on which leg picks up more sound. Navia, and the undergraduate students who work with him, can track the movement by placing a cricket on a specially made "cricket treadmill." The cricket's back is attached to a small rod with a bit of wax, leaving its legs free to move. It is then placed on a foam ball that rotates as the cricket moves. Sensors detect the movement and track it on a computer program. A speaker in front of the ball plays a computerized calling song composed of three chirps, which the female cricket then responds to.

If the female responds by walking toward the sound, she is then placed tummy up on a block of wax. Using a microscope, Navia or a student researcher finds the auditory nerve and attaches a suction electrode to it, close to the neuron. The calling song is played again and a computer records the neuronal response.

"It was initially thought that cricket pho-

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notaxis was a fixed behavior," says Navia, "in other words, that the female cricket would always respond the same way to the calling song of a male." But there is variability in the behavior and recent studies have shown that female crickets do not always respond in the same manner. "Some females are very selective in terms of what call they respond to within that range of variation, while others tend to be more unselective and may respond to a wider spectrum of calls. A third group may only respond to calls that fall on either end of the range." This variation is called "phonotactic plasticity" and is likely regulated hormonally and neuronally. A 2010 article by Stout, Navia, Atkins and others in *Physiological Entomology* concluded that age contributes to a reduction in syllable period selectiveness.

Navia is currently studying the role of the L3 auditory neuron in cricket phonotaxis. His experiments so far have demonstrated that the neuronal response is more positive when the three-chirp calling song has a period of 50–70 milliseconds between syllables. While the crickets still respond when the period time is lengthened or shortened, the specific range of 50–70 ms provokes the most significant response.

Navia tracks the responses in histogram software, which enables him to see where the greatest number of spikes in neuronal activity occurs. If the syllable period is longer or shorter than 50–70 ms, the number of spikes remains the same for all three syllables within the chirp. If the syllable period is 50–70 ms, the first syllable elicits the greatest number of spikes and steadily decreases for each following syllable within that chirp.

The results will soon be submitted for publication in a manuscript that Navia is working on titled "Selective Processing by the L3 Prothoracic Auditory Interneuron in Response to Model Calls in the Cricket *Acheta domesticus*."