

November 2021

GEORGIA PATHWAYS

M A G A Z I N E



Joro Spider

A recent addition to Ga.

Entomology

A fascinating career in insects

Where is the Pain?

How medicine finds its way

Photo by Wayne Carley

The Technology Association of Georgia Education Collaborative (TAG-Ed) strengthens the future workforce by providing students with relevant, hands-on STEM learning opportunities and connecting them to Technology Association of Georgia (TAG) resources. Formerly the TAG Foundation, TAG-Ed is a 501(C)(3) non-profit organization formed by TAG in 2000. Later, the organization's name was re-branded to TAG Education Collaborative to facilitate our role as the leaders for K-12 STEM education in Georgia.

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Welcome to the November issue of Georgia Pathways.



TAG-Ed, the education and career development arm of TAG, is having a busy and productive year with its most notable offering for 2021 entitled “Pathways to Leadership”. P2L for short, this twelve month leadership development program has assembled a diverse group of vetted participants who are now in place, enjoying the benefits of mentors, C-level communications and unique networking opportunities not previously available to them.

These young professionals can stretch their ambitious business legs with direct contact to industry experts and executives in a variety of industries, many of which are Tech. in nature. The sheer opportunity to collaborate with the best and brightest experts Georgia has to offer is a life and career changing exercise that certainly benefits the participants, mentors and our state.

Being part of this cohort for twelve months provides in person and virtual meetings several times a month. The commitment of participants and influencers is sure to reap long term results that can only benefit everyone involved. TAG-Ed is grateful for the support and participation of a variety of experts from companies that include NCR, Bank of America, Home Depot, WarnerMedia, Honeywell, Kimberly Clark, Univ. of Georgia, Spelman College, the Bobby Dodd Institute, Worldline Global, United Distributors and Orkin Pest Control, with additional experts in the wings.

Under the leadership of TAG-Ed’s director, Heather Maxfield, the P2L program is just one of many exciting career and professional development opportunities slated for 2022 and beyond that will be visible on the TAG-Ed website moving forward. The variety of planned TAG-Ed programs will continue to focus on small group conversations, relationship building, one on one mentoring and unique professional connectivity that serve everyone in Georgia through the further development of professionals in nearly every industry we have.

Georgia Pathways Magazine continues to be the state’s platform for career development, education and Tech. information for every demographic in all 159 of our counties. From students and families planning career paths, to established professionals and retirees that have an interest in the health and future of their professions, monthly electronic issues provide something valuable and interesting for everyone.

Larry K. Williams
President
TAG / TAG-Ed

Larry K. Williams serves as the President and CEO of the Technology Association of Georgia (TAG) and President of the TAG Education Collaborative (TAG-Ed). TAG-Ed’s mission is to strengthen Georgia’s future workforce by providing students with relevant, hands-on STEM learning opportunities by connecting Technology Association of Georgia (TAG) resources with leading STEM education initiatives.

Study Finds Singing and Imagining Improvised Music Elicits Flow-Like Brain States

By Noelle Toumey Reetz

A research team at Georgia State University has identified how the brain changes when artists are in a state of “flow” and found that simply imagining improvised performances elicits the same flow-like brain states as when musicians are singing.

In the new study, published in the journal *Scientific Reports*, researchers recruited 21 advanced jazz musicians, who were prompted to vocalize or imagine one of the four scores from the Bebop era of jazz based on a standard 12-bar blues chordal progression while undergoing functional magnetic resonance imaging (fMRI). The multidisciplinary research team — which includes experts in mathematics, physics, music, neuroscience and computer science — then used the fMRI data to identify how a musician’s brain reconfigures connectivity depending on the degree of creativity required during jazz performances, focusing on two major brain networks: the default mode network and the executive control network.

“We estimated static functional network connectivity as jazz musicians were vocal-

izing, imagining, improvising or performing pre-learned, memorized scores,” said principal investigator Victor M. Vergara. Martin Norgaard, associate professor in the School of Music and co-author of the study, says the work provides new insight into the minds of expert jazz musicians at work.

“What’s so fascinating is that we saw very similar brain patterns and activity whether they were actually scat singing or just imagining an improvised performance,” said Norgaard.

The study builds on previous research demonstrating that subjects’ brains show lower functional connectivity during musical improvisation. The new findings reveal that improvisation is associated with a state of weak connectivity to the brain’s executive control network and to a feeling of “flow,” which allows unhindered musical creation.

“The executive control network is typically active in many tasks, including solving problems. The default mode network seems to be more active when a subject is in the resting state,” said Norgaard. “We

saw that when expert musicians are improvising, the brain is interfering less with their creativity.”

The study was conducted in collaboration with the Center for Translational Research in Neuroimaging and Data Science (TReNDS), which is supported by Georgia State, the Georgia Institute of Technology and Emory University. Vince Calhoun, founding director of TReNDS and a Distinguished University Professor in Psychology and Neuroscience, said the new study allowed researchers to observe widespread and richer effects of connectivity. It is the first analysis of whole brain connectivity during vocalized and imagined real-time production of creative output.

“The brain is highly dynamic, so mapping how brain function changes over time is a much more natural way to analyze the data and capture functional patterns linked to either behavioral conditions or to resting,” said Calhoun.

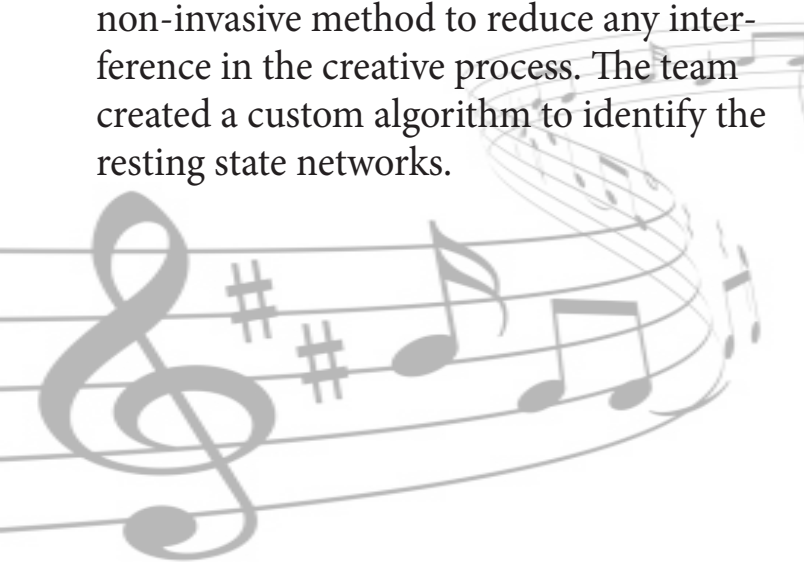
As part of the team at TReNDS center, Vergara and his colleagues were able to extract signals from the brain using a non-invasive method to reduce any interference in the creative process. The team created a custom algorithm to identify the resting state networks.

“Brain imaging produces vast amounts of time-varying measurements that are difficult to parse. Pattern recognition algorithms were necessary to pinpoint the relevant brain areas involved in the creative process,” said Vergara. “We then compared the different patterns to understand the differences between performing improvisation and pre-rehearsed music.” The study’s paradigm allows for the inclusion of expert jazz performers with many different instrument specializations, which suggests the results may be broadly applicable to all improvising musicians.

Future research could adapt the same paradigm to other activities where creation happens in real time — like in performing freestyle rap or spoken-word poetry and even playing sports — potentially identifying common threads in the creative process inside the human brain.

“Now there are more specific questions we can consider, like what changes are happening in the brain while someone improvises or which different networks are involved,” said Norgaard. “That’s called dynamic connectivity, and that’s what we’re hoping to research next.”

The research team also includes Robyn Miller, assistant professor of computer science, Mukesh Dhamala associate professor of physics and astronomy, as well as collaborators at Pennsylvania State University and Harvard Medical School.





“Joro” is settling into Georgia

By Beth Gavrilles / UGA

At almost 3 inches across when their legs are fully extended, they're hard to miss. While they're roughly the same size as banana spiders and yellow garden spiders, the distinctive yellow and blue-black stripes on their backs and bright red markings on their undersides are unique. Their enormous three-dimensional webs are a striking golden color and tend to be located higher off the ground than those of other spiders.

“We’ve been getting lots of calls and emails from people reporting sightings,” said Byron Freeman, director of the Georgia Museum of Natural History. “They seem to be really common in riparian areas and in urban areas around people’s houses, but they’re also in the deep woods.”

Joro spiders have spread widely since they were first spotted in Hoschton, Georgia, in 2013. They probably arrived by hitching a ride in a shipping container from China or Japan, according to Freeman. He and Richard Hoebeke, associate curator of the museum’s arthropod collection and a research professional in the University of Georgia College of Agricultural and Environmental Sciences department of entomology, confirmed the identity of those early arrivals based on genetic analysis in 2015.

Now, five years later, Joro spiders appear to have successfully established themselves in the area, with recent confirmed reports from as far afield as Blairsville, Georgia, and Greenville, South Carolina. But there is still much that remains unknown about them.

One important question is how they might affect the local ecosystem. Will they out-compete other orb weaving spiders? Will they reduce insect populations through predation?

“We don’t know what the impact is going to be,” said Freeman, a faculty member in the University of Georgia Odum School of Ecology. “Right now, we’re trying to learn as much as we can about them.”

So far, early observations indicate that Joros are coexisting with the area’s other orb weaving spiders, with webs close to, and in some cases even attached to, one another.

Prey and Predators

And Joro spiders also appear to be able to capture and feed on at least one insect that other local spiders are not: adult brown marmorated stink bugs, an invasive pest that can infest houses and damage crops.

In turn, Joro spiders are vulnerable to predators like mud dauber wasps and birds.

Freeman noted that dewdrop spiders, a kleptoparasite—as the name implies, they steal food from others—have been spotted in Joro webs. “They may be switching from what we thought was their principal host, the banana spider, to this new kind of orb weaver,” he said. He pointed out that banana spiders, a relative of the Joro, are native to the Caribbean and Central America. They were first recorded in the U.S. in 1862 and have since naturalized.

“My guess is that this will be no different than the banana spider, and I don’t know that we can assess what the effect of the banana spider has been at this point,” he said.

Another question Freeman hopes to answer is how the males find their mates.

Carried by the wind

Joro spiders travel by ballooning, letting the wind carry them on a strand of gossamer.

“The male has to drift in and find the female,” Freeman said. “Sometimes there’ll be four or five males on a web, sometimes there’ll be one, so the males are moving between webs. When you have a large population it seems feasible that a male could just drift from one spot to the next, but when you don’t have a lot of webs around, how does the male show up?”

Freeman is also conducting further genetic analysis to determine what causes some Joro spiders to have a different color pattern. While most have distinctive black and yellow striped legs, some have legs that are solid black. These black morphs have other physical differences that are only apparent when viewed under a microscope, and Freeman has determined that they are genetically distinct members of the species.

Despite their size, Freeman said that Joro spiders don’t pose a threat to people.

“All spiders have venom that they use to subdue prey,” he said. “If you put your hand in front of one and try to make it bite you, it probably will. But they run if you disturb their web. They’re trying to get out of the way.”



Here to stay

Freeman said that Joros can be shooed away with a broom if they're in a location that puts them too close for comfort. But as for removing them permanently, he compared such efforts to shoveling sand at the beach.

“Should you try to get rid of them?” said Freeman. “You can, but at this point, they're here to stay.”

If you spot a Joro spider—especially if you can provide a photo tagged with date and location—please contact Hoebeke at rhoebeke@uga.edu.



entomology

en·to·mol·o·gy

/,en(t)ə'mäləjē/

noun: entomology

- the branch of zoology concerned with the study of insects.

Entomology is the study of insects. More than one million different species of insect have been described to date. They are the most abundant group of animals in the world and live in almost every habitat. Insects have lived on earth for more than 350 million years. Entomology is crucial to our understanding of human disease, agriculture, evolution, ecology and biodiversity.

Entomologists are people who study insects, as a career, as amateurs or both.

The Royal Entomological Society supports entomology through its international scientific journals and other publications, scientific meetings and by providing a forum for disseminating research findings. The society also funds, organizes and supports events and activities for anyone that wants to learn more about insects and entomology through its outreach and education programmes.

Why study Entomology?

1. Insects are vectors of many serious human, animal and plant diseases across the world. Understanding the biology of insects is key to understanding the diseases that they carry and spread.

2. Over half of the two million living species described in the world are insects. If you're interested in global or local biodiversity then insects need to be studied.

3. Insects have been around for over 350 million years and have evolved solutions to many physical and chemical problems. Engineers are increasingly looking to insects for solutions in material science and chemistry. The more understanding we have of insects, the more we can put that understanding to use.

4. You can travel the world working on insects. Insects are found on all seven continents, even Antarctica.

5. Insects are hugely economically important in agriculture. They can be beneficial as pollinators and decomposers, or they can be detrimental as pests and vectors of plant diseases.

5. Insects are excellent models for physiological and population processes. For example, the common fruit fly, *Drosophila melanogaster*, has been used as a model species in genetic studies for years. Its short generation time, small size and the ease with which it can be reared in the laboratory makes it an ideal organism for such studies.

6. More species of insect have had their genome sequenced than any other group of multicellular organisms. Insects are an excellent model for studying the molecular basis of life.

7. Insects are everywhere. No matter where you live in the world or what language you speak, you will come into contact with insects.

Careers in Entomology

Students graduating with a degree in entomology can look forward to a wide variety of career opportunities.

Private Industry

- **Seed Industry:** Evaluate new lines of corn, soybeans, and other crops for susceptibility to major insect pests (both field and laboratory research). Insect rearing expertise is often needed to supply the insect pests for research.

Employers: Pioneer HiBred, Syngenta, Mycogen Seeds, and others/ Requirement: Entomology at the B.S., M.S., and Ph.D. levels

- **Agrochemical Industry:** Evaluate new crop protection chemicals against insect pests, as well as insects that are important pests of human health, veterinary health, forestry, household, turf grass, and other horticultural plants. Expertise in rearing insects is often needed for product testing.

Employers: Large multi-national corporations like Dow AgroSciences, Du Pont, Bayer Crop Protection, BASF, as well as smaller companies who specialize in insect repellents and specialty markets like S.C. Johnson and EcoSmart.

Requirement: Entomology at the B.S., M.S., and Ph.D. levels

- **Food Industry:** Insect pests of stored products are a major problem in the food and feed industries. Conduct pest management programs that include monitoring insect pests in their crops, both pre-harvest and post-harvest.

Employers: Green Giant, Quaker Oats, Del Monte, and others / Requirement: Entomology and/or horticulture at the B.S. and M.S. level



- **Crop Consultants:** Independent source of pest management services for corporate producers, cooperatives, and individual producers to help growers

minimize losses to insects, weeds, or diseases. Employers: Georgia Co-op, State of Ga. / Advanced Crop Management, and others / Requirement: B.S. in Entomology, Weed Science or Plant Pathology.

- **Urban Pest Control:** Control of insect problems is crucial to many types of institutions, including hospitals, schools, universities, hotels, nursing homes, and other governmental and private organizations. Urban pest control is commonly carried out by private pest control operators.

Federal and State

- **Military:** The Military employs and trains entomologists to protect troops from attack by insect pests, especially ones transmitting infectious diseases. Military facilities, vehicles, foods, and uniforms also need protection from insect pests.

Employers: Army, Navy, and Air Force. Requirement: Entomology at the B.S., M.S., and Ph.D. levels; often degree is completed while serving.

- **Federal Research Laboratories:** Government research utilizes B.S. and M.S. technicians to help carry out important agricultural, environmental, and health research projects. At the federal level, research labs are present around the U.S. conducting a variety of entomology-based studies. Employers: U.S. Department of Agriculture, National Institutes of Health, and U.S. Geological Survey.



Requirement: Entomology at the B.S., M.S., and Ph.D. levels.

- **State Departments of Agriculture:** State agencies that have responsibility for oversight of agriculture and land stewardship employ entomologists to monitor for newly introduced species as well as train and educate pesticide applicators.

State Departments of Natural Resources: Departments of Natural Resources are often concerned with invasive species including insects and other invertebrates. They also focus on protection of natural resources such as forests, lakes, and rivers, as well as the plants and wildlife that live there.

State, County, and City Departments of Health: Public health pests are of concern to governmental agencies that are responsible for protecting people and companion animals. Entomologists in these positions are often charged with making decisions about whether to spray, when to spray, and which chemical to spray as they evaluate potential public health threats.

Extension Services: Extension Services in many states provide information and services to their stakeholders. Some provide identification of insects, especially those impacting their environment or livelihood, pest management recommendations, and pesticide applicator training.

Federal and State Regulatory Agencies: Entomologists are involved in registration and/or enforcement of regulations, many of which involve insect pests or pesticides.

Training and research towards pest management is also conducted domestic and internationally. Quarantine and inspection services also employ entomologists. At the state level, entomologists inspect shipments of nursery stock, produce, livestock, pets, etc. that enter the state.

Employers: U.S. Environmental Protection Agency, U.S. Food and Drug Administration, and U.S. Department of Agriculture's Animal and Plant Health Inspection Service (A.P.H.I.S.)

Requirement: Entomology at the B.S., M.S., and Ph.D. levels.

- Academic Institutions: Education and training of students in entomology and related biological and agricultural sciences requires personnel trained in these fields. Universities, colleges, community colleges, as well as primary and secondary educational institutions benefit from teachers who are well versed in entomological sciences.

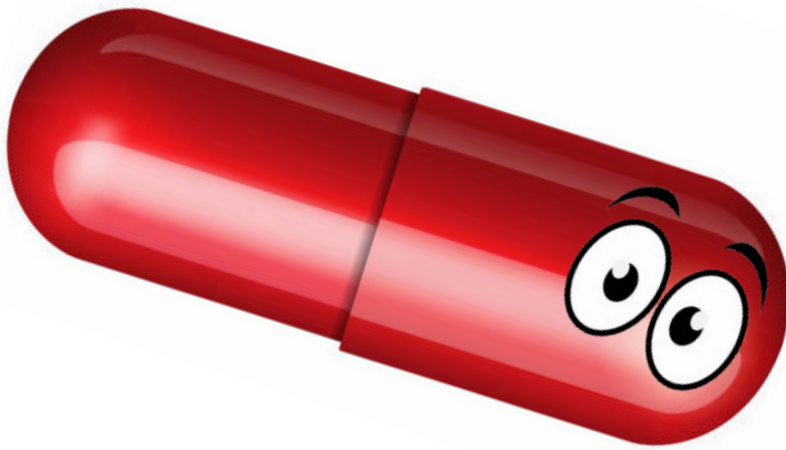
Non-Governmental Organizations

- Zoos, Botanical Gardens, Butterfly Houses: The recent popularity and proliferation of insect exhibits has created a demand for entomologists at every level trained in insect husbandry, as well as interpretation/presentation and appreciation of insects.



How Does Ibuprofen Know Where My Pain Is?

By Shoshana Steinmetz, PharmD



Medications exert their therapeutic effect in a variety of ways. Once absorbed into the body, every medication goes through a unique pathway that enables it to have the desired impact on the complex biological systems that are causing an unwanted symptom or illness. The way a particular medication interacts with the biochemical pathways in the body is called the medication's mechanism of action.

Some mechanisms of action are very well understood and have undergone a tremendous amount of scientific research to enable a comprehensive understanding of how they impact the intricate systems of the human body. Others, are more poorly understood. These medications are often utilized based on their ability to improve symptoms or successfully treat a disease even though scientists and physicians do not fully understand exactly how they work.

A medication's mechanism of action often involves interrupting the way a chemical pathway in the body is working. Generally, the goal of a medication is to either induce or inhibit a particular pathway. Inducing a pathway can result in increased production of molecules or enzymes necessary for biologic functioning, while inhibiting a pathway causes the natural processes to slow down or stop completely.



For example, patients with diabetes do not produce enough insulin which is necessary for glucose absorption. When a patient receives an insulin injection, they are inducing the process of glucose absorption that would not have happened efficiently without the help of the medication. As another example, clinical depression is known to be linked with decreased levels of a neurotransmitter called serotonin.

Therefore, many medications used to treat depression, inhibit the removal of serotonin from the neurologic pathways. This results in an increase in the amount of serotonin available and helps decrease the symptoms of depression. Based on understanding how various medications work in the body, and understanding the cause of a specific symptom or illness, health care providers can appropriately determine what medications can best resolve an unwanted symptom or a harmful disease.

Medications that are known to work in the body through the same or similar mechanism of action are usually organized into a single category called a medication class. This way, if a patient comes to the doctor with a specific symptom they want to control or an illness they want to treat, the doctor can assess the issue, and choose from the class of medications that will most appropriately resolve the problem based on the medication's mechanism of action.

Ibuprofen, also known by the common brand names Motrin or Advil, is classified as a non-steroidal anti-inflammatory (NSAID) drug. As the name suggests, these medications are used to reduce inflammation in the body. According to the labeling from the Food and Drug Administration (FDA), ibuprofen is indicated to relieve signs and symptoms of rheumatoid arthritis and osteoarthritis, relieve mild to moderate pain, fever, and to treat pain associated with menstruation.^{1,2} Off label, ibuprofen is also used to treat gout, an inflammatory condition characterized by an increase in uric acid crystallization resulting in severe pain and swelling often localized in the big toe; as well as pericarditis, a condition where inflammation is present in the membrane surrounding the heart.^{2, 3, 4}

How is ibuprofen able to treat pain and inflammation?

Pain is the result of a complex set of physiologic systems and can be influenced by biologic changes as well as social and psychological factors. The type of pain that is experienced as a result of a harmful stimulus such as extreme temperatures, a physical trauma, or a toxic chemical is called nociceptive pain.⁵ Once the nociceptors sense the presence of a substance that can be harmful to the body, that message must be passed on to the central nervous system (CNS) namely, the brain and spinal cord.

This pathway is referred to as the ascending

pathway since the sensory information is being carried from the periphery up to the brain.⁶ The message is sent through the release of neurotransmitters and then undergoes further processing in the brain itself. These processes involve intricate interactions between many types of neurotransmitters and receptors. Once the sensory information is processed, a message is sent along the descending pathway and ends in a conscious perception of the pain by the individual. While the process of pain perception is not well understood, it is known that psychological functioning plays a role in pain perception. For example, activities that are relaxing like meditation, or engaging in a distracting activity may reduce pain. In contrast, anxiety or depression can often amplify the patient's perception of pain.⁵

Not all types of pain are nociceptive in nature. Some types of pain are not induced by an external stimulus. Pain can result from peripheral nerve damage or an issue with the pain processing system in the CNS. These types of pain are sometimes classified as neuropathic, maladaptive, or pathologic and can be extremely debilitating for a patient despite the lack of physical injury or harm.^{5,6}

The processing of nociceptive pain starts when specialized nerve fibers are activated by the recognition that a particular stimulus may be harmful to the body. The nerve fibers that detect these changes are called nociceptors. Nociceptors recognize

a harmful stimulus by sensing changes that take place when the external stimulus induces the internal inflammatory process.⁵

Inflammation in the human body occurs as a result of immune system activation. When there is tissue injury from bacteria, excessive heat, trauma, toxins, or other foreign substances, the cells that are damaged will release inflammatory mediators. The release of these chemicals causes fluid from the local blood vessels to leak into the tissue and results in swelling of the injured area. This is an important part of the immune response because the foreign substance is now “trapped” in the injured part of the body and is hopefully blocked from doing further damage to the rest of the body.⁷

In addition to limiting the progression of damage, the body's inflammatory response is also what begins the process of tissue repair. It is important to note that inflammation is a crucial component of the healing process. Inflammation also leads to an increased sensitivity to pain, and can lead to feeling pain from a stimulus that would not normally cause pain, like a soft touch. This phenomenon is called allodynia.

As part of the inflammatory process, many chemical mediators are released from the bloodstream and gather at the site of injury. These chemical mediators are what signal to the pain receptors that the body was exposed to harmful stimulus.

One of the important molecules active in this pathway is arachidonic acid. Arachidonic acid is converted into prostaglandins through a chemical reaction involving the cyclooxygenase enzymes.^{7,6}

The formation of prostaglandins is associated with increased sensitization and tenderness. Prostaglandins activate the nociceptors and they in turn relay the message of pain and injury to the brain.⁶ Additionally, prostaglandins play a role in the development of fever by impacting the signal sent to the hypothalamus which is the area of the brain that regulates core body temperature.⁸ The primary mechanism of action resulting in the reduction in fever, pain, and inflammation seen with NSAIDs is inhibition of prostaglandin formation.² NSAIDs are able to stop the production of prostaglandins by inhibiting, or blocking the effect of the

cyclooxygenase enzymes which normally enable the conversion of arachidonic acid to prostaglandins.

This inhibition decreases the inflammation and can minimize pain. When ibuprofen is ingested, it does not only travel to the site of injury or pain. The inhibition of cyclooxygenase will happen throughout the body. While the inhibition of the cyclooxygenase enzyme is an important part of minimizing pain, fever, and inflammation, cyclooxygenase has other roles in the body aside from modulating pain. These other processes also get inhibited through the use of NSAIDs like ibuprofen. The inhibition of cyclooxygenase relates to some of the significant side effects associated with excessive NSAID use.

There are two forms of the cyclooxygenase enzyme called COX-1 and COX-2. COX-2 is the form that is primarily increased with the activation of the inflammatory pathway. COX-1 on the other hand, is involved in maintaining the protective mucosal lining of the stomach, as well as regulating platelet aggregation and kidney function. Ibuprofen, like most NSAIDs is considered non-selective. This means, ibuprofen inhibits both forms of cyclooxygenase equally. The result of this non-selective blocking is that along with the decreased inflammation and pain, patients taking NSAIDs often also experience reduced protection of the stomach wall and impaired blood clotting processes or kidney damage.⁹





These effects can sometimes be severe and dangerous. The FDA has included some of these side effects in a Boxed Warning included in the official labeling of ibuprofen. One warning is for the risk of clotting events that can lead to heart attack or stroke and the second is the increased risk for developing stomach ulcers.¹ Taking ibuprofen every so often to reduce fever, inflammation, or pain as needed is unlikely to lead to these significant adverse effects. However, taking ibuprofen daily for many years or taking ibuprofen along with other medications that can impact bleeding, clotting, risk of stomach ulcers or kidney function is not recommended unless under the direct supervision of a healthcare provider.



Within the NSAID class of medications, each medication has particular characteristics that make it unique. These characteristics result from the different chemical structures of the medications and their various dosage forms (immediate release, sustained release, injectable etc).

With regard to ibuprofen, there are some important pieces of information to keep in mind. Firstly, ibuprofen can be administered orally and intravenously. Orally, ibuprofen is available in tablet and capsule form as well as chewable and liquid formulations. This can be important for patients like young children who may be unable to swallow pills. The oral formulation will generally provide a reduction in pain symptoms within 30-60 minutes and the effect should last four to eight hours depending on the dose administered.

For the treatment of pain, adult patients should take 200 to 400 mg every four to six hours as needed or 600 to 800 mg every six to eight hours as needed. The maximum daily dose for adults is 3,200 mg. Children under 12 years old follow the dosing guidelines provided based on their weight and should be given the appropriate dose every six to eight hours. Children and adolescents between 12 and 17 can take 400 mg every four to six hours as needed with a maximum daily dose of 2,400 mg.² It is important that caregivers administering ibuprofen to children have an appropriately graded measuring tool like a medication syringe to ensure proper treatment and avoid an overdose.

Once absorbed into the body, medications function in a variety of ways. While the mechanisms of action of some medications are very well understood, others are poorly understood but are still utilized because of the positive effect they are known to have on symptom and disease management.

Medications generally work by either inducing or inhibiting a particular biochemical pathway. In the case of ibuprofen for reduction of pain, symptoms are thought to be primarily reduced by the inhibition of cyclooxygenase which effectively blocks the formation of prostaglandins. While this reduces fever, pain, and inflammation, it also can reduce protection of the stomach wall, impair kidney function and cause changes in the normal bleeding and clotting processes. It is important to be aware of the ***proper dosing*** guidelines for ibuprofen and to consult a healthcare provider with any concerns related to potential adverse effects.

Shoshana Steinmetz is currently the Drug Information Fellow at Touro College of Pharmacy. She completed her PharmD at Creighton University School of Pharmacy and Health Professions. Shoshana's professional interests include drug information, pharmacogenomics, academia, and education. She resides in New York City with her husband and three children.

***Consider a STEM Career
in Pharmacology.***

References:

1. Motrin. Package insert. Pfizer Inc.; 2007
2. Ibuprofen. Lexi-Drugs. Lexicomp. UpToDate, Inc.; 2021. Updated October 14, 2021. Accessed October 14, 2021. <https://online.lexi.com>
3. Gaffo AL. Clinical manifestations and diagnosis of gout. UpToDate. UpToDate, Inc.; 2021. Updated December 1, 2019. Accessed October 14, 2021. <https://www.uptodate.com/>
4. Imazio MI. Acute pericarditis: Clinical presentation, diagnostic evaluation, and diagnosis. UpToDate. UpToDate, Inc.; 2021. Updated April 16, 2021. Accessed October 14, 2021. <https://www.uptodate.com/>
5. Herndon CM, Ray JB, M. Kominek C. Pain Management. In: DiPiro JT, Yee GC, Posey L, Haines ST, Nolin TD, Ellingrod V. eds. Pharmacotherapy: A Pathophysiologic Approach, 11e. McGraw Hill; 2020. Accessed October 14, 2021.
6. Yam MF, Loh YC, Tan CS, Khadijah Adam S, Abdul Manan N, Basir R. General Pathways of Pain Sensation and the Major Neurotransmitters Involved in Pain Regulation. Int J Mol Sci. 2018;19(8):2164. Published 2018 Jul 24.
7. Immune Response. US National Library of Medicine: Medline Plus. Accessed October 13, 2021. <https://medlineplus.gov/ency/article/000821.htm>
8. Dinarello CA, Porat R. Pathophysiology and treatment of fever in adults. UpToDate. UpToDate, Inc.; 2021. Updated September 1, 2021. Accessed October 14, 2021. <https://www.uptodate.com/>
9. Solomon DH, Furst DE, Romain P. NSAIDs: Pharmacology and mechanism of action. UpToDate. UpToDate, Inc.; 2021. Updated July 30, 2021. Accessed October 14, 2021. <https://www.uptodate.com/>

The STEM of Agriculture

Agriculture is a STEM Career

By Wayne Carley



*A*griculture, or the science, art, or practice of cultivating the soil, producing crops, and raising livestock and in varying degrees the preparation and marketing of the resulting products, is critical to the American economy. Let's discuss Georgia.

Georgia's agricultural exports total \$73 billion, an increase of 3.4+ percent from 2018. Top commodities for export included: Broilers, Cotton, Eggs, Timber, Peanuts, Beef, Greenhouse, Dairy, Pecans and Blueberries. Georgia's agriculture industry is a major player in the state's economy – and for the U.S. overall – thanks to more than 42,257 farms and ranches.

Georgia is blessed with a climate that allows tremendous opportunities for farmers. Virtually any crop or animal can be grown successfully somewhere within the state. We're known for our sweet Georgia peaches, our peanuts and those delicious Vidalia Onions.

Farming is one of mankind's original jobs, and those who till the soil have always been stewards of the land. Georgia's farmers take pride in their work. In turn, they go to great lengths to protect their land and surrounding environments. Modern conservation and best production practices help to protect the land and grow safer, healthier crops. Georgia is not only a major contributor to the agriculture industry at home, but internationally



as well.

It is no wonder the Peach State has been named one of the nation's top agricultural producing state for the last five decades and includes thousands of jobs for the local agriculture and related sectors.

The *science, technology, engineering and math* required to be a farmer is vast and diverse. A short reflection of what it takes to grow healthy crops includes a broad understanding of soil minerals, herbicides and pest control, crop rotation, and meteorology.

The decision making process, or engineering, infiltrates every portion of farming. Technology has become deeply woven into agriculture, from robotic tractors, drone observations, remote electronic irrigation systems, and a variety of



computer software applications. Don't forget the math of all of the above and its critical accuracy that brings crops to market.

Changing eating patterns open many opportunities for agribusiness entrepreneurs as consumers are looking for new, interesting, and innovative food products. This growing diversity has created opportunities for agribusinesses that supply food products. Local foods, produce markets and non-GMO foods continue to grow in popularity across the state and nation, showing up in most restaurants.

As the population of Georgia and the world continues to grow, it is estimated

that there will be an additional 2.4 billion people on the planet in 2050.

To meet the needs of this growing population demand, Georgia farmers will have to produce more products than ever before. We will see a broader variety of food products that can be grown here. The growing world population will continue to provide opportunities for farmers across as well as the STEM applications necessary in every aspect of this endeavor.

Georgia agriculture and the STEM that is woven into it will pave the way to meet the needs of a hungry state, nation and globe.

On its own, the robotics market has been booming for some time now, with an estimated value of USD 23.67 billion in 2020. This is expected to reach a staggering 74 billion by 2026, and a respectable portion of this growth will be dedicated to agricultural robots.

Agricultural robots are specialized articles of technology that are capable of assisting farmers with a wide range of operations. They have the capability to analyze, contemplate, and carry out a multitude of functions, and they can be programmed to grow and evolve to match the needs of various tasks. Agricultural Robots can be used for an incredible number of tasks to ease the burden on the farmers. Their primary role is to tackle labor-intensive, repetitive, and physically demanding tasks. In recent years, however, robots are being used for various specialized chores as well that were previously only tackled by experienced farmers.

This includes the ability to pick out sensitive fruits and vegetables such as lettuce, strawberries and blueberries.

The camera on the “Vegebot” allows it to scan the lettuce and detect if the particular plant is ripe for harvesting or not. Once it decides that the plant is ready to be picked, it uses a second camera that’s placed near the blade of the robot to guide its actions and execute it to perfection. A machine-learning algorithm has also been utilized in the software of the “Vegebot” to help it detect the lettuce that is ripe and ideal for picking.

Farmers have started using drones for farming operations as they can operate longer than humans and reduce operational expenses. UAVs are also expected to be utilized on a large scale in field crops compared with other types of agricultural produce.

Precision agriculture, also called precision farming, refers to the way farmers manage crops to ensure efficiency of inputs such as water and fertilizer, and to maximize productivity, quality, and yield. The term also involves minimizing pests, unwanted flooding, and disease.



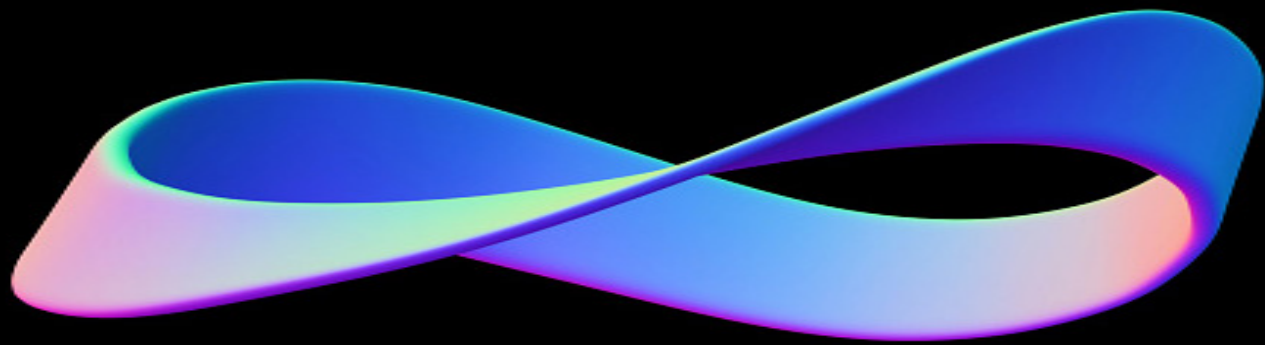
Drones allow farmers to constantly monitor crop and livestock conditions by air to quickly find problems that would not become apparent in ground-level spot checks. For example, a farmer might find through time-lapse drone photography that part of his or her crop is not being properly irrigated.

The process of using a drone to map or survey crops is a relatively straightforward one. Many newer agricultural drone models come equipped with flight planning software that allows the user to draw around the area he or she needs to cover. Then, the software makes an automated flight path and, in some cases, even prepares the camera shots.

Drones have revolutionized agriculture by offering farmers major cost savings, enhanced efficiency, and more profitability. By quickly surveying vast stretches of farmland, drones can map the property, report on crop health, improve spraying accuracy, monitor livestock and irrigation systems, and more.

The ability to collect and analyze this data in real time has tangible outcomes for farmers such as better crop yield, fewer resources expended on weeds and herbicides, and overall improved management decisions.





The Möbius Strip



The Möbius Strip is a real-life object. One of the most famous surfaces in mathematics, the Möbius (MeR-bee-us) strip can be constructed by cutting a long strip of paper, putting a half twist in it, and gluing the ends of the strip together.

The Möbius strip has several curious properties. A line drawn starting from the seam down the middle meets back at the seam, but at the other side. If continued, the line meets the starting point, and is double the length of the original strip. This single continuous curve demonstrates that the Möbius strip has only one boundary.

Cutting a Möbius strip along the center line with a pair of scissors yields one long strip with two full twists in it, rather than two separate strips; the result is not a Möbius strip. This happens because the original strip only has one edge that is twice as long as the original strip. Cutting creates a second independent edge, half of which was on each side of the scissors.

Everyone has been exposed to the Möbius strip on a daily basis, likely without realizing it. How? The universal recycling symbol is a Möbius strip! This Möbius strip has 3 half twists and can be better seen if you imagine that the tip of each of the 3 arrows is connected to the tail of the preceding one. Follow the surface of the object and you will find that it is, indeed, a Möbius strip.

The design for the universal recycling symbol was created in 1970. In light of increasing awareness of human-kind's impact on the environment, the Container Corporation of America sponsored a contest challenging high school and college students to create an artwork that conveyed the process of recycling. Gary Anderson, a 23-year-old college student, submitted a drawing of a 3-twist Möbius strip that is now the universal symbol of recycling. Anderson won a \$2,500 scholarship for his design.

Preparing for my Career

by Edmond R. Renkin

Young women and men are more than capable of pursuing any career path they wish, provided a few things are in place:

- Necessary long-term motivation to complete the quest.
- Financial access for higher education if that is required.
- Career availability and placement in their chosen career.

We see an ever increasing number of college graduates who cannot find a job in their degree field, forcing them to work in areas they are certainly over qualified for and less than fulfilling.

Asking a 10 year old what they want to do in life may sound logical, but in fact it's totally unrealistic. By the time they graduate from high school, their world will be a very different place; current jobs will not longer exist, new jobs that we cannot even imagine will emerge, technology will be light years ahead of where it is now, curriculum and higher education will be very different....and as is normal for every child and teen, their interests will change a dozen times or more.

So what is the solution?

As it has been throughout history, only time will tell, but we do have the power to “prepare” for probable futures.

Since it is suggested that our students will have an average of 3 different careers in the course of their work life, the most prudent course of action is to be as diverse and well prepared as possible in your skill set. As with finances, don't put all your eggs in one basket.

STEM skills and soft skills fill a vital role when considering diverse preparation for any career that comes our way. The decision making and problem solving of the **Engineering Method** will serve them well in life and work as they already use it without even knowing it.

They will adapt to new **technology** as a way of life as they do now, and those unforeseen technologies will be learned maybe “on the job” or in short-term preparation for a pending job opportunity.

Science as it is defined being the “systematic accumulation of knowledge” is happening now as they attend school and will continue as a lifestyle at home and work.

Mathematics, either basic or advanced, will become evident in time and be varied depending on student interest, curriculum requirements or in preparation for that dream career students are willing to make a sacrifice for.

With the thought of multiple careers in mind, if you didn't get it in middle school or high school or even college, and you're serious and really want it, you can go back to school or online and learn what you need. This is certainly one of the valuable benefits of the web and distance learning on your own time.

As we look at how few scientists and different kinds of medical jobs exist, we ask the question, "***What is everyone doing for a living?***"

Of the 50 million students in American schools this year, all will ask at some point, "***What job should I do?***"

STEM occupations as some would define them account for 5.8 percent of all jobs in the U.S. economy, but **STEM skills account for 100% of U.S. jobs.**

For a moment, let's put aside dreams and wishes and take a hard look at what most Americans do for work every day. Since not every student can be an astronaut, doctor or race car driver, what will our students do? Scientists and Engineers make up about 5% of the workforce so students and their parents should consider how to best prepare for every job scenario and the skills necessary.



For those dreaming of being a sports star, we have only about 18,000 professional athletes in the U.S. with an average career span of about 5 years. The expected number of high school graduates this year is about 3.5 million.

I truly believe that the 5.8% STEM occupation number is in error. I cannot find out how the Bureau of Statistics comes up with that percentage other than they have a random, narrow and inaccurate definition of STEM occupations. The numbers just don't add up. Is it possible the government is wrong? It wouldn't be the first time.

Is your career defined by the degree you received (if you have one) or by what you actually do everyday at work?

"If my degree is in accounting, but I work full time as an auto mechanic, am I an accountant or an auto mechanic?"

"If I have a degree in biology but work full time as a journalist am I a biologist or a journalist?"

I suggest that we identify STEM careers and occupations based on the daily use of the systematic accumulation of knowledge, the use of technology and its practical application, our daily problem solving and decision making per the engineering method and a level of math, from physicist to chef.

If we adopt this suggestion, virtually every career is a STEM career in practice, meaning that STEM skills should be important to every student and employer regardless of whether you attend a STEM school or chase a STEM degree. With 52% of college STEM degree students dropping out in the U.S., you just have ask questions about perception and preparation.

Is this an unreasonable train of thought or illogical?

As educators we are tasked with preparing students in as round a way as possible to be productive members of our society. We are also required to fulfill curriculum requirements for standardized testing (whether we agree with their value or not) because someone in their elected wisdom decided it was important. This includes filling jobs that "need" done, maintaining the quality of American life, providing for our families and as is our right, the pursuit of happiness.

Imagine a world with no trash collectors, no sewage treatment plant workers, no housekeepers in our 50,000 hotels to clean the toilets and wash laundry, stand on the assembly line all day doing the exact same thing.... in short, any of necessary jobs we can't live without but would rather not do.



Laundry service using high capacity industrial washing machines.

A recent survey asked people if they were happy to go to work in the morning. The answer was a rather emphatic “no.” Monster.com and market research company GfK conducted the study, which revealed that only 53% of Americans actively enjoy their jobs, and 15% actively dislike them. The rest were just unfulfilled in their work.

There are roughly 126 million employed Americans and here is what most of them do every day.

Here are the top 10 most common jobs in America:

1. Retail Salespersons

- Total number of jobs: 4.5 million

2. Cashiers

- Total number of jobs: 3.3 million

3. Educators

- Total number: 3.2 million+

4. Food preparation / serving workers

- Total number of jobs: 3.0 million

5. Office clerks

- Total number of jobs: 2.8 million

6. Registered nurses

- Total number of jobs: 2.7 million

7. Waiters and waitresses

- Total number of jobs: 2.4 million

8. Customer service representatives

- Total number of jobs: 2.4 million

9. Hand laborers and material movers

- Total number of jobs: 2.3 million

10. Secretaries /administrative assistants

- Total number of jobs: 2.2 million

Encouraging news is that each of these career fields, even if they are not considered glamorous, requires diverse levels of STEM skills and soft skills.

That being said, teaching and integrating STEM into the classroom of every subject is not wasted on anyone. All students will benefit from a better understanding of what STEM skills *“really”* are and why they are important regardless of their career choice.

Although the Tech Industry as a whole has high employment numbers, it's a bit deceiving in its definition covering dozens of different industries not normally thought of as “technical”.

High technology, often abbreviated to high tech (adjective forms high-technology, high-tech or hi-tech) is technology that is at the cutting edge: the most advanced technology available (for the moment).

As of the onset of the 21st century, products considered high tech are often those that incorporate advanced computer electronics. However, there is no specific class of technology that is high tech—the definition shifts and evolves over time—so products hyped as high-tech in the past may now be considered to be everyday or outdated technology. One thing our students can count on is.....*change*.

No matter what you teach, from basketball to banking,
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