Darwin’s Happy Birthday at the NC Museum of Natural Sciences

Charles Darwin could not have been happier about his birthday celebration this year at the North Carolina Museum of Natural Sciences. Educational organizations from all over the state presented a kaleidoscope of exhibits featuring animal and plant diversity, natural selection and adaptive evolution. Members of the Genetics Program and the W. M. Keck Center for Behavioral Biology participated with several creative booths, which were visited by hundreds of visitors of all ages in the large jam-packed museum. Noteworthy was the exhibit, which brought to live adaptations in beak structure among Darwin’s finches, where differences in beak sizes were simulated with different size clothespins, which visitors could use to try to collect different sizes and shapes of seeds and insects from a tray. The Robert's lab brought attention to the rapid radiation of cichlid fishes. Children could color fishes, which were then scanned into a computer and animated to swim in a reef landscape on a high definition screen.

The many events at the Museum showed that after two centuries and counting, Darwin is still going strong!
Comfort Foods and Stress

by Eugene Cheung

On February 11, 2016, the W. M. Keck Center for Behavioral Biology hosted Dr. Mary Dallman of the University of California, San Francisco. Dallman is one of the world’s leading experts on stress biology, with critical discoveries and contributions on the relationship between the endocrine stress response, metabolism, and feeding behavior. Her seminar was entitled “Stress, comfort foods, and the hypothalamic-pituitary-adrenal axis”.

Dallman opened her seminar by describing the fundamental aspects of the endocrine stress response. Under acute stress, corticotropin-releasing factor is synthesized and secreted in the paraventricular nucleus of the hypothalamus. Corticotropin-releasing factor prompts the production of adrenocorticotropic hormone, which stimulates the secretion of corticosterone (studied in Dallman’s rodent model) in the adrenal gland. Corticosterone then acts on the pituitary gland to inhibit further secretion, while also mobilizing energy stores. Dallman emphasized the adaptive properties of glucocorticoids, particularly in instances of fasting and nutritional-deprivation given their function as energy mobilizers and catabolic hormones.

While having made substantial contributions to understanding stress, metabolism, and feeding behavior, Dallman’s segue into this particular area of stress biology largely coincided with attempts to elucidate the interactions between glucocorticoids and addictive behaviors. In these initial experiments, she demonstrated a dose-related effect of glucocorticoids on the amount of sucrose consumed. These results were repeated in a similar study using lard instead of sucrose. At the time, Dallman posited that this interaction was likely due to the known effect of glucocorticoids on the salience and motivation pathways in the nucleus accumbens shell.

In following studies, Dallman discovered that it was not the action of the nucleus accumbens that modulated glucocorticoid activity during chronic stress. Rather, it was the inhibitory effects, similar to those of corticosterone, that consumption of high carbohydrate foods (i.e., sucrose, lard) incurred on corticotropin-releasing factor. In humans and animals, studies have demonstrated a clear shift towards choosing more “palatable” foods with increases in stress. In laboratory contexts, acute stress has been shown to induce increased intake of such palatable foods regardless of whether an individual is hungry or has no homeostatic requirement for caloric intake.

While elevated glucocorticoid levels increase intake of palatable foods, it is critical to note that glucocorticoids also incur a stimulatory effect on insulin synthesis and secretion. Dallman found that insulin asserts staggering effects on food choice during acute and chronic stress. In diabetic adrenalectomized rats (treated with streptozotocin), administration of corticosterone resulted in intake of low sugar/low fat chow when presented with low and high sugar/fat options. In contrast, administering both insulin and corticosterone to diabetic adrenalectomized rats restored intake of high sugar/high fat chow. In tandem, controlled corticosterone and insulin treatments appear to reveal interactions in the context of energy balance and stress response.

Given the current obesity epidemic in the United States, Dallman stresses the critical importance of continued exploration of the interactions between stress, metabolism, and feeding behavior. Albeit that her laboratory has since her retirement concluded all experimental work, Dallman’s contributions to our understanding of stress biology have laid a profoundly important foundation and framework on which future endeavors can build.
Ba-ba-ba-bum. Even the most casual listener can recognize Beethoven's Symphony no. 5. Or how about the saxophone and overdriven guitar ba-da-ba-bum of Born to Run by Springsteen and the E-Street Band? Chances are both of those songs evoke something inside your head. Your neurons fire and you can immediately recall both melodies, both driving rhythms. Maybe even days gone by of teenage romances and sophisticated evenings in full tuxedos. Despite such familiarity we know strikingly little about music and the brain.

Folks gathered at Chateau Mackanholt on March 2nd to discuss the state of neurological research on humans and music. Attendees ranged from classically trained musicians pursuing graduate degrees to folks who only play the radio.

We know quite well how the brain perceives sound. As sound waves enter our ears they travel a complex neurological path through the cochlea, cochlear nuclei in the brain stem, the inferior colliculus and up to the auditory cortex. Along the way the auditory system parses the sound into its component parts. Then our brain reassembles these pieces within the auditory cortex to produce a recognizable signal.

Think back to Beethoven’s no. 5 for a moment. Every time you hear that piece a spatial and temporal process begins. As the sound waves leave the speakers or orchestra playing them they must travel to your ears. These waves arrive at your ears at different speeds and at different times both because of the speed at which different frequencies travel, but also because your left and right ears are spatially separate. Yet, the speed at which your brain parses that information makes the music seem instantaneous.

For musicians the nature of music involves quite a bit of neurological gymnastics. Beyond the auditory cortices, a violinist’s brain puts the premotor, motor, and frontal cortices to work. This moves the fingers, arm, and memory into action to reproduce everything from Mozart’s Violin Concerto no. 3 to the lines that helped Johnny hold on to his soul in The Devil Went Down to Georgia.

The discussion turned to the components of music. The host, and discussion leader, Robert Anholt provided a matrix by which to judge a series of classical songs the group listened to. The Anholt Musicality Matrix proposed music falls along a two axes. First, it lies along a spectrum of melodious to rhythmic. A second axis places the timbre of the music from happy to sad. After the beautiful duet from Bizet’s Pearl Fishers and the contrasting rhythmic opening notes of Carmina Burana this matrix provided the first of many lively exchanges. One observer noted, “Melody and rhythm are intrinsically linked. While rhythm...
may not stand at the front it remains present.” While some nodded in agreement, others believed that either rhythm or melody takes precedence in a tune.

Where does this all come from? Music seems so intrinsically human. It allows us to express our joy and sadness, march young men into war, or relax by a fire on a cold evening.

Humans are not alone in producing rhythms or melodies. Most mornings we can hear birds singing. In the spring many animals use some form of music to court potential mates. For example, male stoneflies drum their abdomens against the substrate. The metronomic drumming must be good if he is to obtain a female.

Even Darwin thought about music: “The perception, if not the enjoyment, of musical cadences and of rhythm is probably common to all animals, and no doubt depends on the common physiological nature of their nervous systems.”

Despite all of this neurological complexity we still know little beyond what parts of the brain light up when enjoying or playing music. The fact of the matter is, if one suffers from a musia (a.k.a. tone-deafness) this is unlikely to have life threatening consequences.

A number of conditions surrounding music have been reported. Some people hear or see colors when listening to music. Others find music excruciating to listen to.

It turns out that some of our knowledge comes from patients with disorders of the brain. Take SM, a woman who suffers from Urbach-Wiethe disease leading to complete bilateral degeneration of the amygdala. She does not experience fear or anxiety, but interestingly enough cannot recognize scary or sad music either.

For people to remember melodies long- and short-term memory and learning processes must come into play. These processes likely involve the hippocampus.

As it stands we still have a lot to learn about music. It guides us down the isle during marriage. We mourn with it in the company of loved ones lost. We celebrate life’s little victories and crushing defeats with music. All of this involves the incredible processing power of our brains. Maybe it has come time to understand what is going on upstairs when those notes float through the air.

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**Seminars**

On March 17, 3:30 pm, Dr. Marina Picciotto from the Department of Neuroscience and Pharmacology at Yale University School of Medicine, New Haven, CT, will present a seminar, titled “Effects of nicotine and nicotinic receptors on behaviors related to depression and aggression.” The seminar will be in 101 David Clark Laboratories.

On March 17, 7:00 pm, Dr. Marina Picciotto will present a Science Café talk at the North Carolina Museum of Natural Sciences as part of Brain Awareness Day, titled “The many faces of smoking: the effects of nicotine on brain and behavior.” The talk will be at 7:00 pm in the Daily Planet Café of the Nature Research Center.

On March 17, 6:00-8:30 pm, members of NC State’s W. M. Keck Center for Behavioral Biology will host Brain Awareness Day at the North Carolina Museum of Natural Sciences.

**Grants**

Desiree Unsell received a Ruth L. Kirschstein National Research Service Award (NRSA) Individual Pre-doctoral Fellowship (F31) from the National Institute of Aging to study the genetic architecture of Drosophila lifespan.

Ashley Chin-Baarstad received a postdoctoral fellowship from the National Science Foundation for studies on the epigenome of polygenic sex determination.

**Publications**

The following publications from the W. M. Keck Center for Behavioral Biology has appeared in print:


Of Note…

**Robert Anholt** served on an NIH study section to review predoctoral and postdoctoral fellowships for the National Institute for Deafness and Other Communication Disorders (NIDCD).

**Brian Langerhans** was interviewed by New Scientist magazine. He also presented a workshop on Geometric Morphometric Analysis in Biology at East Carolina University.

**Leslie Sombers** presented a poster at the Winter Conference on Brain Research in Breckenridge, CO, on real-time striatal measurements of oxidative stress and dopamine in the dyskinetic rat during chronic L-DOPA treatment for Parkinson’s disease. She also won first place in the Smitty Stevens Snowboard Race at the conference for the fourth time in a row.

**Leslie Wilson** won an NCSU Chemistry Graduate Scholars Research Assistantship.