The Signal

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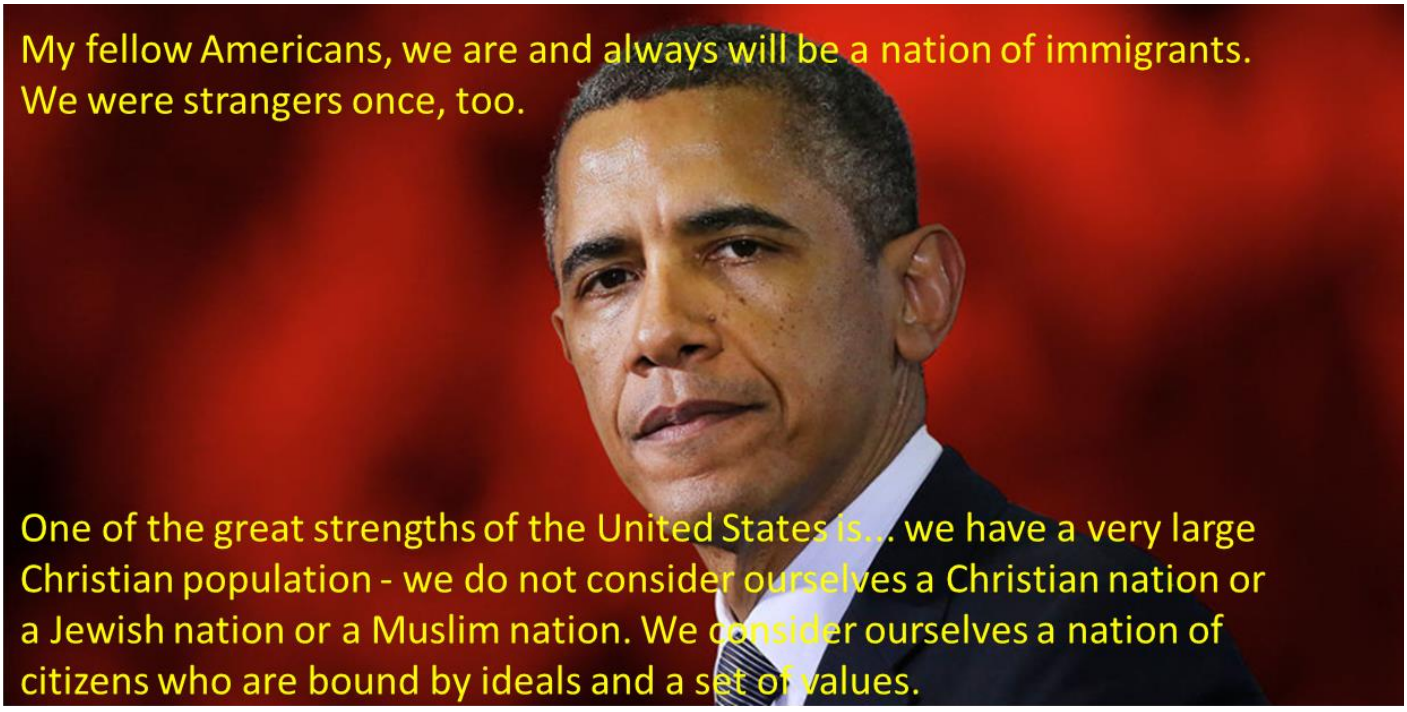

In less than two weeks, we have seen our country change from a globalist democracy to an isolationist fearful nation ruled by an autocratic one-party regime, which closes its borders to refugees and Muslims from countries, where the Trump corporation has no business interests.

As scientists we should be very concerned. Science knows no borders. The scientific community in the United States is one of the most internationally diverse communities in our country. Albert Einstein was an immigrant and a refugee from Nazi Germany. If he had been sent back to perish in the Holocaust, world history might have been changed dramatically.

The current administration is a closed group of family members, billionaires and a powerful political advisor who is a white supremacist. It should worry us. Autocratic regimes invariably despise the intelligentsia, and the increasingly institutionalized denial of climate change and attacks on the Environmental Protection Agency do not bode well for science in this administration. The ultranationalist rhetoric, intolerance to dissent and demonization of Mexicans and Muslims has eerie reverberations from 1930s Germany and it is disconcerting that the executive order to ban Muslims and refugees from seven countries was signed on International Holocaust Remembrance Day.

The scientific endeavor collectively seeks to improve the human condition. There is no room for bigotry and religious discrimination. If Einstein were alive today, he would agree that scientists must speak out against a religious ban for refugees and immigrants. We should remember the words of pastor Martin Niemöller, who resisted the Nazis and spent seven years in a concentration camp: "First they came for the communists and I did not speak out, because I was not a communist; then they came for the socialists and I did not speak out, because I was not a socialist; then they came for the trade unionists and I did not speak out, because I was not a trade unionist; then they came for the Jews and I did not speak out, because I was not a Jew; then they came for me and there was no one left to speak out for me….."

Robert Anholt

The opinions in this article are solely those of the author and do not reflect University opinion or policy.

Fragrant Expectations

by Joel Johnstun

The Keck Center began the semester with an engaging seminar by Dr. John McGann, entitled "Beyond bottom-up sensory processing: Learning and expectation can shape sensory input to the mouse brain."

McGann began by debunking the commonly held belief that the size of an organ is indicative of its function. For instance, human olfactory bulbs, which are small in comparison to the rest of the human brain, are often compared to mouse olfactory bulbs, which are much larger relative to the rest of their brains, to show that olfaction is more important to mice than humans. However, if size were all that mattered, then we could expect that humans would have a much more sensitive olfactory system, given that the absolute size of the human organ is several times larger than that of the mouse. Perhaps more to the point, a mouse's tongue takes up approximately the same space as its brain - but few argue that the tongue is more important.

Much of the seminar focused on the neural activity in the glomeruli in the olfactory bulb, which is the first site that top-down information from higher order structures meets with bottom-up sensory information from the axons of the olfactory sensory neurons (OSNs). There are many types of OSNs, which are defined by the single odorant receptor they express. Though OSNs which express the same receptor are more or less scrambled in the olfactory epithelium itself, their axons converge onto only a few glomeruli. This means that the neural activity of the glomeruli corresponds to a topographic map of the odorants; each odor elicits a distinct glomerular pattern that is recognizable even between individual mice.

Using sophisticated imaging techniques, McGann showed that glomerular activity was seen even when an odor was merely expected, but not smelled directly. Awake mice were submitted to a *light*, *tone*, *odor* pattern many times while their glomerular activity was monitored, and even though during the last iteration the *odor* was omitted (i.e. *light*, *tone*, __), the glomerular activity remained very similar to what was seen before. This effect was not seen in anaesthetized mice. Thus, top-down information of expectation from higher order brain structures drastically influenced sensory input.

Fear learning also influences the bottom-up information at this early processing stage. In this series of experiments there were three groups of mice: the paired group, in which the mice were conditioned to expect a mild electric shock after one odor (CS+) but not another (CS-), and two control groups which were either only exposed to the odors or only exposed to the shock. After conditioning, the paired group

Dr. John McGann

mice were shown to selectively freeze (a behavioral response associated with fear), when they were exposed to the predictive odor, thus demonstrating behaviorally that they had successfully coupled the CS+ odor (and not the CS- odor) to the shock.

When the glomeruli of the paired mice were visualized, the post-conditioning glomerular response to the CS+ odor showed a robust increase in magnitude compared to the pre-conditioning response, while the response to the CS- odor did not change. Importantly, this increase in glomerular response to the CS+ odor did not change the distinctive pattern characteristic of that odor. By repeating this experiment at multiple concentrations, McGann found that there was an increased response for all concentrations of the CS+ odor, even when trained on a single concentration. The odor- or shock-only control groups' results were as expected.

Because the CS+ and CS- odors evoked partially overlapping glomerular responses, McGann's team investigated what specifically happened to those glomeruli which responded to both. Was the magnified effect during the CS+ odor attenuated, given that they were also involved with the non-shock-associated odor? Or were their responses magnified to a greater extent? Unexpectedly, they found that those glomeruli *selectively* magnified their response to the CS+ odor, but not the CS- odor. This indicated that there was likely feedback from other parts of the brain.

Indeed, by locally applying chemical inhibitors to the amygdala (associated with fear) the glomerular responses to the CS+ odors were no longer magnified. However, the amygdala has no direct connection to the olfactory bulb, though some of its neurons synapse on the locus coeruleus, which sends extensive projections to the olfactory bulb. Applying inhibitors to the locus coeruleus also prevented the fear-associated glomerular response. McGann's team went further, though, and simultaneously recorded from the amygdala, the locus coeruleus, and the olfactory bulb (a technical feat!) to demonstrate that this is indeed a top-down pathway for sensory modulation. Finally, McGann showed that top-down modulation involves GABAergic inhibition of neurotransmitter release from primary olfactory sensory neurons, thereby completing the bottom-up and top-down interaction that modulates odor representations in olfactory bulb glomeruli.

Seminars

On **February 9**, 3:30 pm, Dr. Karen Carleton from the Department of Biology at the University of Maryland, College Park, will present a seminar, titled "QTL and gene regulatory networks for seeing through the eyes of a fish."

The seminar will be in 3503 Thomas Hall.

On **February 28**, 4:00-6:00 pm, the W. M. Keck Center for Behavioral Biology, in conjunction with the Comparative Medicine Institute, co-sponsors a professional development workshop, titled "**Writing to Publish**". The workshop features:

Dr. Gregory Copenhaver
co-Editor-in-Chief of PLOS Genetics

Dr. Peter Johnson
co-Editor-in-Chief of Tissue Engineering

Dr. Hillary Sussman
Executive Editor of Genome Research

Preregistration is required via the link https://ncsucvmce.eventsair.com/cemaster/cmi/Site/Register. The registration fee is $10 and the deadline for registration is February 20, 2017. Food and refreshments will be provided

For information contact Alix Berglund, akberglu@ncsu.edu.

The event will be held at the Hunt Library in the Duke Energy Hall.

On **March 9**, 3:30 pm, Dr. Marlene Zuk from the Department of Ecology, Evolution and Behavior at the University of Minnesota, will present a seminar, titled "Rapid evolution in silence: adaptive signal loss in the Pacific field cricket."

The seminar will be in 3503 Thomas Hall.

On **March 10**, 12:00 pm, Dr. Ann-Shyn Chiang from the Brain Research Center at National Tsing Hua University in Taiwan and the Kavli Institute for Brain and Mind at the University of California, San Diego, will present a seminar, titled "Mapping whole-body neural networks with synchrotron X-ray at single-cell resolution."

The seminar will be in 3503 Thomas Hall.

Of note…

Robert Anholt served on a study section to review fellowship applications for the National institute for deafness and other Communications Disorders (NIDCD).

Marcé Lorenzen gave a presentation entitled "Basic steps for developing genetic technologies in a non-model organism" as part of the Arthropod Genomics Workshop at the Plant and Animal Genomics meeting in San Diego.

Trudy Mackay served on the Scientific Advisory Board of the Department of Experimental Health Science at the Universitat Pompeu Fabra in Barcelona, Spain.

Heather Patisaul gave a talk at the University of Victoria entitled "Endocrine disruption in the developing brain: Emerging ideas and animal models".

Cassie Rhodes was awarded a GAANN Fellowship.

To contribute to The Signal, to be placed on our mailing list or for information about the W. M. Keck Center for Behavioral Biology, contact Dr. Robert Anholt, Department of Biological Sciences, Box 7614, North Carolina State University, Raleigh, NC 27695-7614, tel. (919) 515-1173, anholt@ncsu.edu.

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