



INTERNATIONAL SOCIETY FOR NEUROETHOLOGY

Newsletter
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INTERNATIONAL CONGRESS

Dear colleagues:

It is now only a few weeks until the Sixth International Congress of Neuroethology in Bonn, Germany. If you read the program (www.zoologie.uni_bonn.de/ICN2001) you will agree that we will have a highly attractive meeting which covers the entire range of neuroethology. Each day starts with exciting plenary lectures, among

them the Walter Heiligenberg memorial lecture given by Carl Hopkins and a lecture sponsored by the Company of Biologists given by Alexander Borst. On Tuesday morning the awardees of the

Young Investigator Award will be presenting their prize_winning research. During the conference no less than 16 symposia in two parallel sessions will compete for your attendance. The oral presentations will be completed by two exciting evening lectures, one given by Dean Hamer on "The role of inheritance in human behavior" and the second by Gerhard Roth on "Evolution of brains and evolution of consciousness."

For those of you who want to present your most recent data we will offer a daily possibility for ad hoc presentations. We will have two social events. The first is the "poster party" on Tuesday evening where you have the chance to view more than 400 posters and _ if you have the time _ to enjoy food and wine. The second event will be an evening cruise on the river Rhine with buffet.

By the way, posters will be on display throughout the conference and can be viewed daily between and after the talks. We look forward to welcome you to the Sixth International Congress of Neuroethology in Germany and hope that in addition to the scientific program you will find some time to enjoy Bonn and its beautiful surroundings. Have a safe trip.

The local organizing committee.
Professor H. Bleckmann, Chair

LISTSERV ANNOUNCEMENT

We have found that our membership e-mail list is not completely accurate. Keeping up a list is difficult since people sometimes move or change e-mail addresses without notifying all their correspondents, and especially the listservs they may be using. Thus, we would like to ask that all ISN members check their ISN E-mail addresses directory at <http://www.neurobio.arizona.edu/isn/isn.memdir.htm>. If you have any corrections, please send them to JohnHildebrand at jgh@neurobio.arizona.edu

NEUROETHOLOGY AT THE UNIVERSITY OF MARYLAND, COLLEGE PARK

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Neuroethology has a strong presence at the University of Maryland, College Park (just outside of Washington DC), with labs studying vision, hearing, motor systems, neuroanatomy, and neuroendocrinology. The program started slowly, with Bill Hodos first on the scene in the 1960's, followed by Mary Ann Ottinger in the 1970's. Bob Dooling, William Hall and Arthur Popper took positions at Maryland in the 1980's, and in the single year of 1990, Avis Cohen, Catherine Carr and David Yager all moved to Maryland. By this time, there was a critical mass of neuroethologists, and this has stimulated further growth: In the past six years, another five neuroethologists have joined the Maryland faculty.

Daphne Soares

Neuroethology is more than a collection of labs at Maryland; it's a vital component of a larger interdisciplinary graduate training program in Neuroscience and Cognitive Science (NACS), which serves a group of more than 30 talented graduate students and supports colloquium series and symposia. The NACS Program at the University of Maryland includes over 70 faculty members from 14 different departments

across campus, and more than a dozen of the NACS faculty are neuroethologists.

The NACS Program offers a specialized track that emphasizes comparative neurobiology, evolution and behavior. There are several neuroethology courses and seminars, as well as a weekly meeting for students, postdocs and faculty to share their research ideas and data. In addition, Maryland's neuroethology group thrives on collaborations across labs. Examples of collaborations include comparative studies of ultrasound detection in bats, insects and fish, optomotor responses in birds, structure of the alligator ear, hormonal control of vocal learning in birds, predator-prey interactions in bats and mantises. Participating research labs are in the Biology, Psychology, Animal & Avian Sciences Departments, as well as the Institute for Systems Research.

Below are brief descriptions of the research programs of the neuroethology core training program faculty:

Catherine Carr (sound localization in barn owls)

Present studies in the Carr laboratory address how time coding arises during the development of the avian auditory system, how timing information is preserved and

improved in the CNS, and how temporal coding circuits evolve. The analysis of temporally ordered inputs is integral to processing both sound localization and communication signals such as speech. Many of these studies are collaborative and take advantage of the resources of the NIH and other area research facilities.

Avis Cohen (motor systems in lamprey)

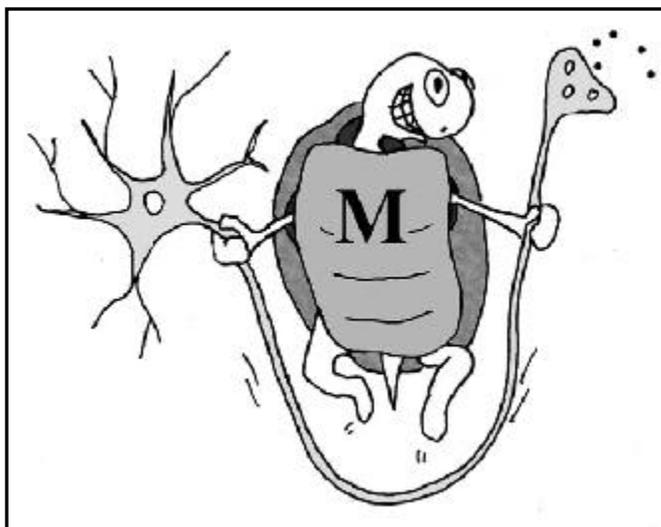
Avis Cohen's group focuses on how systems work. The model used is the lamprey and its locomotion. Her group

combines physiology, anatomy, behavior and modeling to understand how the levels of organization of the animal/environment interact to produce an adaptive motor pattern. Recently Avis has begun to investigate the use of Very Large Scale Integrated (VLSI) circuit techniques as a modeling tool. Avis is one of directors of the annual Workshop on Neuromorphic Engineering at Telluride, Colorado.

Robert Dooling

(auditory perception and vocal learning in birds)

Robert Dooling's research examines the perception of complex sounds by birds to understand such phenomena as vocal learning, the return of auditory function



following hair cell regeneration, whether speech is special, and the evolution of mechanisms of hearing. His research group takes a comparative approach, seeking to identify both specializations (i.e. unique to a species) as well as the general biological principles, which are capable of organizing and maintaining a complex, learned vocal communication system.

William Hall (neuroanatomical studies of song systems in birds)

William Hall's research utilizes animal models of communication to understand the neural basis of human language learning. His current work aims to elucidate neuroanatomical changes occurring in the forebrain of nestling budgerigars, which underlie the emergence of auditory_vocal learning ability during early post_hatch development.

Janet Halperin (learning and aggression in fighting fish)

Janet Halperin's research aims to develop biological models of learning that can guide neuromorphic robot design. Biological predictions about learning and motivation are tested against behavioral experiments on aggression in a simple vertebrate, the Siamese fighting fish. As a spin_off of creating fish with modified aggressiveness, she tests theories about how animal aggression evolved.

William Hodos (comparative vision in birds)

William Hodos's laboratory investigates the vision of different bird species, by studying the optics of their eyes, the anatomy and physiology of their retinas, and the neurons and pathways of their central visual system. These approaches are combined with psychophysical studies of avian vision to gather a better understanding of how these animals process visual information

William Jeffery

(evolution of eye development in fish)

William Jeffery's lab studies the evolution of developmental mechanisms. They use molecular, cellular, and genetic approaches to investigate embryonic development in two animal systems: ascidians and teleost fishes. The teleost *Astyanax fasciatus* is used to study the evolution of eye development, one of the few cases in which the ancestral and derived developmental states are available for comparative analysis in the same species.

Cynthia Moss (spatial perception and sensorimotor integration in echolocating bats)

Cindy Moss's research program is directed at understanding auditory information processing and sensorimotor integration in vertebrates. In her lab, the echolocating bat serves as a model system for a neuroethologically_based study of hearing and spatially guided behavior. Behavioral studies focus on perception and action for the analysis of auditory scenes.

Neurophysiological experiments examine the functional organization of the bat's superior colliculus.

Mary Ann Ottinger (hormonal control of behavior in birds)

Mary Ann Ottinger's current research is focused on two areas: 1) the neuroendocrine basis for aging as it impacts reproduction and 2) the effects of endocrine disrupting chemicals on development and reproductive function in birds. In the first area, studies have concentrated on characterizing the process of aging in a Japanese quail model system. In the second focus area, understanding endocrine, neuroendocrine, and behavioral consequences of endocrine disrupter exposure in birds is critical, especially with the identification of sensitive stages in the life history.

Arthur N. Popper (evolution of hearing in vertebrates; hearing in fish)

Arthur Popper's research emphasizes questions of comparative hearing in vertebrates, with particular interest in the structure and function of the auditory system of fishes. This work involves research on how the fish auditory system fits into the scheme of evolution of the vertebrate ear. Current investigations include behavioral studies of hearing capabilities, mechanisms of sound source localization, and evolution of sensory hair cells in vertebrates. Recently, Popper and his group have demonstrated that some herring_like fishes can detect ultrasound and that this has evolved for the detection, and avoidance, of echolocating dolphins, which are a major predator on these species. New experiments are aimed at understanding the mechanisms of ultrasound detection.

Kerry Shaw (evolution of acoustic communication and sexual selection in insects)

Kerry Shaw's research aims to explain how new species evolve, and involves three facets: the genetic boundaries between populations and species, the forces that promote diversification, and the evolution of behavioral and morphological traits. She studies the cricket genus *Laupala*, especially the features of mating systems such as acoustical communication and serial spermatophore production, the genetic basis of such traits, and historical replication of sexual selection, the probable cause of speciation. With 37 species endemic to the Hawaiian archipelago, *Laupala* offers an exceptional model to test hypotheses regarding the role of behavior in speciation.

Todd Troyer (computational studies of song development in birds)

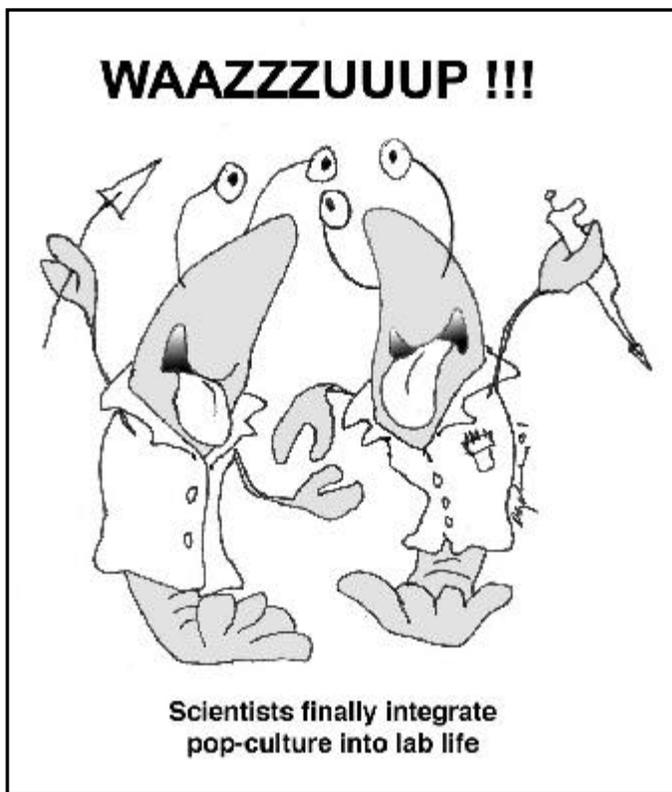
The major focus of Troyer's lab is the development and refinement of bioinformatic tools that allow fine_grained, quantitative analyses of song development. These tools will be used to examine song learning in two closely related species of estrildid finches, focusing on interactions between syllable learning, sequence learning,

and the development of the rhythmic structure characteristic of adult song. Analyzing data of this complexity requires the construction of functional models; machine learning and advanced statistical techniques will be used to evaluate the ability of competing models to account for the behavioral data. This modeling overlaps with the second focus of the lab, combining computational modeling and in vitro neurophysiology to explore the local circuit mechanisms underlying temporal behavior.

David Yager (evolution of auditory function in insects)

Hearing in many insects is critical for finding mates, in interactions with competitors, and in detecting approaching predators. Yager's research focuses on the neuroethology of hearing in the praying mantis, an auditory cyclops with a single ear located in the ventral midline between the last pair of legs. One set of projects

in the lab uses neurophysiological and anatomical techniques to study the peripheral and central neural components of this unique auditory system, particularly an identified, giant interneuron. Another goal of the lab is to use developmental and comparative techniques to determine the origin of the mantis ear, possibly as part of a very ancient mechanoreceptive system. Because they hear only ultrasound, both lab and field projects are underway to look at interactions between mantises and hunting bats.



With our active and diverse group of neuroethologists, we are pleased to announce a new NIMH Training Program in Neuroethology: Neurobiology, Evolution and Behavior. Please visit our website <http://www.bsos.umd.edu/psyc/neuroethology> and contact the directors, Catherine Carr (cc117@umail.umd.edu) or Cynthia Moss (cmoss@psyc.umd.edu) for more information.

“FIELD” BEHAVIOR

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USING THE VERNACULAR, OR MY SHORT CAREER IN TELEVISION

Philosophus, a wise man lamenting the difficulty of understanding science and thereby the world of Nature around him, is quoted by the narrator in "The Dulness (sic) of Science" (Nature, Volume 1, #2, November 11, 1869) as follows: "There was another thing he told us-a thing of the highest importance. 'The priests of Science', he said, 'must consent to use the vernacular, before they will ever make a profound impression upon the heart of humanity; and when they have learned to do this, let them not fear the sneers of their deacons who will call their teachings sensational.'"

Daphne Soares

Taking this to heart, I've been on television three times and on radio twice. I guess I wasn't much of a hit, since I never was asked back. Still it wasn't my fault that the earpiece microphone kept falling out on the interview for the Canadian Discovery Channel, revealing a most unusual tic in which I poked my finger in my ear and wiggled it at irregular, roughly 30 second intervals (luckily most of this was cut from the fine piece that aired on Canadian television on April 16, 1996). That wasn't quite as bad as the time that Ethan Signer was being considered for a regular science program on Boston network television. As a pilot they asked him to appear on a Sunday morning family program to do a preview of his prospective show. He asked if I would join him as his guest: foolishly, I agreed. It was to be on synaptic

transmission. I prepared a series of visually exciting slides to be used to illustrate my responses to his questions and we both showed up at the studio, eager and ready to wow the audience. Powder coated so our noses wouldn't shine, we met the director who said she would use large cards to cue us about when to start, speed up, slow down, pause for a commercial and wrap it up. She didn't mention that she would be sitting behind my left shoulder, out of my line of site, and only partially visible to Ethan. She also didn't mention that she would decide how long each slide would be shown, anticipating that her

Then there was the 20/20 interview (aired February 23, 1996). At the time, People for the Ethical Treatment of Animals (PETA) had launched an all out attack on the lobster industry because of the "inhumane" way that lobsters were cooked and the excruciating pain associated with their being boiled alive. The attack was a key part of an effort to stop people from eating meat and fish organized by the Vegetarian Campaign Coordinator of PETA. The "lobster liberation" campaign involved purchasing lobsters from supermarkets and fish stores all over the country, flying them to New Hampshire, transporting them by Federal express to Maine, where they were released in a shallow cove by a PETA member who with an "OK Sweetie, Bye" farewell tribute watched the animals tail flip off into the sunset. The campaign attracted national attention and the interest of the producers of 20/20 because prominent TV personalities like Mary Tyler Moore had become involved. Moore, in a widely advertised move that achieved further notoriety by being featured on the TV show "Ellen," had offered \$1000 for the liberation of Spike, an 18 pound lobster being auctioned off by a California restaurant. Rush Limbaugh offered \$2000 to eat Spike: the matter was resolved by the restaurant owners not selling Spike at all, but instead cashing in on their new celebrity lobster by prominently placing him in a designer display tank.

To enhance their campaign, PETA spokespeople appeared on television and published and distributed literature containing misstatements about the social biology of lobsters, comparing them closely to humans. Just like us: "lobsters carry their young for 9 months, caring for and nurturing them"; "lobsters are extraordinarily sensitive creatures that march claw in claw along the bottom of the ocean"; "lobsters take long-distance seasonal journeys and can cover 100 miles or more each year"; and "lobsters are sensitive beings who struggle against death," "scream" and "feel a great deal of pain when cut or cooked ." The more flagrant of these claims were easy to dismiss. For example, lobsters carry their 10,000 or so fertilized eggs for 9 months as an accident of the cold water temperature in New England during the winter months, when development of the embryo ceases. At elevated temperatures, lobsters hatch out in as little as 1 to 1.5 months. Moreover, when hatched and released from the swimmerets of the mother,

audience couldn't bear to look at a static image for more than 10 seconds. We did have a monitor to the right of us so that we actually could see what was being broadcast. So picture this: the director is behind my left shoulder, the monitor to my right, and slides are zipping through at an enormous rate not dependent in any way on what I was saying. With my head swinging from side to side, I resembled an elephant spraying cool water on its back and talking gibberish (most elephants can't talk at all) while images of neurons and synapses subliminally flashed by. Ethan didn't get the network show.

fry quickly swim towards the surface with the mother trying to eat as many as she can of this tasty snack. So much for the maternal instincts of lobsters. It also was difficult to see how lobsters could "scream" without vocal chords: more than likely, the heat-mediated escape of air trapped within the carapace accounts for the sounds sometimes heard from pots in which lobsters are being cooked. I only can suppose that the annual migrations of palinurid (spiny lobster) species, which are not seen in *Homarus americanus* which is the main commercial source of lobsters, was interpreted as the "seasonal trips of 100 miles" by PETA, supposedly like humans going on their summer vacations. The pain issue, of course, was more difficult to address, and it is what 20/20 focused on (see below). The saddest part of this is that the campaign was working since several southwestern supermarket chains had removed lobster tanks from their stores, and since 20/20 was willing to profile the topic.

The interview was at the New England Aquarium, where we maintain a lobster rearing facility. Lynn Scherr was to fly to Logan Airport and take the water shuttle to the Aquarium, where the producers and a local professional film crew were waiting. While awaiting her arrival, I asked the 20/20 producer of "lobster liberation" why she showed so little interest in our research. I thought that the audience of millions who watch shows like 20/20 might actually be interested in learning things about the world around them (me trying to reach Philosophus), and that 20/20 could serve a wonderful teaching role if the show focused more on the biology of lobsters and not solely on the "do they feel pain" issue. She promptly replied that they were a "news magazine" whose role was not to educate the public. Also during the wait, I was saddened when the Public Relations Officer of the aquarium asked that I not mention the name of the New England Aquarium during the interview. She was worried that PETA might picket the Aquarium after learning that we had a rearing facility there, and that the subsequent publicity might frighten off the thousands of visitors who come to the Aquarium every week.

I was prepped for the interview by son James, who at the time was the director of a community access television station in California. James had been burned a week earlier when network news interviewed him about a new show that appeared on his channel in which the host

started the program by taking off his clothes. He was asked, as the director of the station, whether he felt any obligation to stop such a show from appearing on the air. His reply was that his job was not to be a censor, but he quickly added that pornography was not allowed. Of course, his qualifying remarks about pornography were cut by the producer of the network news show. Scientists are notorious in that we cannot say anything without qualifying remarks, so son James took on the task of teaching me to reply to questions in "soundbites" that could not be edited. "Wrong Dad," he enjoyed saying in our role reversal as I offered one after another of the kinds of wooly responses scientists usually give to simple questions. Eventually I learned how to respond, but I can tell you that this makes interviews extremely stressful, in that you must fully form an answer to a question before you reply, and when you reply all qualifiers must be omitted.

The actual interview lasted an hour and another half hour was spent videotaping the larval, juvenile, egg-bearing and blue lobsters held in our rearing facility. I was sure the blue lobster would appear on the show, and it did. The 1.5 hours was reduced to 2 minutes of actual air-time. During the interview, if the occasion allowed, I tried to inject bits of humor to my responses (when a lobster I was holding grabbed its antenna with the cutter claw--L.S. "Doesn't it hurt?"-- E.K. "I'd imagine it would let go if it did"; or L.S. "Don't you get attached to these animals?"--E.K. "only if they grab me with their claws") but these all ended up on the cutting room floor. OK, they weren't that witty, but I suspect that only interviewers are allowed to appear clever on shows like 20/20.

In response to the question of whether lobsters feel pain, I said that we didn't know. I added that since pain is a perception we often don't know whether people feel pain either, unless we ask them, and that pain thresholds vary greatly among individuals. I mentioned that pain is a higher cortical function in humans and that there is no structure resembling a cortex in the lobster brain. In response to questions about the many minutes of suffering and struggling by lobsters to get out of pots of boiling water, I mentioned that neurons in the lobster brain cease to function at temperatures above 27 degrees Celsius (about 80 degrees Fahrenheit) and that in boiling water the brain would quickly reach that temperature. I felt it highly unlikely, therefore, that the banging around in the pot was struggling to escape and instead suspected that heat-induced contractions of the massive tail and limb musculature of already brain-dead animals was the cause. In case people were still worried about the suffering issue, however, I mentioned that after cooling an animal on ice to anesthetize it, the brain of a lobster could be immediately destroyed with a scissors cut between the eyes. I recognized at the time that these

answers might not set everyone's mind at ease, but they were an attempt to deal honestly with the issues raised and they were far more accurate than the unsubstantiated claims of the PETA people that lobsters are sensitive creatures who feel excruciating pain. I also recognized then that in taking a very public stand on these issues I might be subjecting myself, members of my laboratory and even my family to retaliation.

I feel strongly that the abuse of science and scientific facts to justify ideological and political aims must be challenged wherever and whenever it is seen. In the not too distant past scientific "facts" were used towards eugenic ends, for ethnic cleansing, to classify races as inferior, to categorize individuals as inherently violent, and for a myriad array of lesser crimes against humankind. Even now, religious groups with their truly "false prophets" have succeeded in dictating the teaching of creationism on an equal footing with evolution in schools, and even worse in textbooks, and are attempting to restrict or eliminate the use of stem cells with their promise of becoming the greatest technology ever developed by science to fight and cure human disease. Scientists have a responsibility to "use the vernacular" and to communicate the substance, meaning and significance of their work to the public in accurate and non-sensational ways. This was an issue 140 years ago, and it remains one today. We bear this responsibility not only because taxpayer dollars and the Federal treasury support our work, but because our greatest advocates can and will be an educated populace.

There are many relatively easy ways that busy scientists can reach the public, including visits to sons and daughters schools to talk about science, making oneself available when students or politicians visit campuses, responding to phone inquiries from journalists, writing letters to the editors of newspapers, being willing to testify at local, state or national levels to legislatures on important science related issues, and appearing on network TV or radio talk shows. And who knows, perhaps one of you will be the next Carl Sagan and have an even more successful career as a television personality than I did.

SCIENCE AND MUSIC: CHOICES AND CONNECTIONS

Jelle Atema

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When he asked me for a biography, Art Popper wanted me to focus on the connection between my scientific and musical life. Thus, what follows is a reflection of the

unanticipated polyphony of competing themes, their early roots, and their constant elaborations with time. Perhaps it will interest students who face similar conflicts of career choice to see just this case history.

In my Dutch high school I wanted to be a renaissance man: music, poetry, theater, science, and athletics. My mother disapproved of my artistic career plans and found that biology was a good choice because "you can always teach." One can understand her advice knowing that I come from a family of teachers on both sides. In addition during family vacations my mother had seen that I would spend most of my time exploring the French forests tracking and observing animals without ever getting lost and duetting with the birds on little flutes I made from hollow weeds.

At the University of Utrecht I was most impressed by the laboratory of Ad Kalmijn, then assistant (professor) under Sven Dijkgraaf. As Ad's teaching and research assistant, I experienced intense hands-on, close-up questioning and learning, the model for my own courses later. He even made me *teach* a course in electromagnetism! By his example Ad became my "guru." His passionate devotion to scientific rigor set my standard of performance; his demanding generosity to his students motivated us to spend long hours in the lab taking meticulous and respectful care of animals and equipment. I never saw Ad unwilling to share his time and knowledge with anyone as long as they were seriously interested in learning. My participation in his research made me familiar with electroreception and water motion detection and I was drawn into the Uexkullian sensory world of underwater animals. I realized later that the scientific methodology that appealed so much to me had come from Dijkgraaf's teacher, Karl von Frisch, who when I visited him, was delighted to learn that the young generation was still inspired by his pioneering work.

Meanwhile, throughout my student life and to the occasional exasperation of Ad Kalmijn, I had become more and more involved in flute performance with various orchestras and ensembles. Major support came from fellow students who were outstanding amateur musicians. My closest musical partner there, law student

and pianist Hein van Rooyen, later became artistic director of the Amsterdam Concertgebouw Orchestra. I overcame my stage fright during a tour of "the provinces" by accidentally getting slightly drunk: I never played so passionately! Then a solo performance with the harpist of



the Concertgebouw Orchestra led me to the Summer Academy in Nice, where I met my second "guru," Jean-Pierre Rampal, who was rapidly becoming the best known flutist of the 20th century. I studied with him for three summers and learned much more than flute playing. Like Ad in science, Jean-Pierre set exacting standards of professionalism and was passionate about his work. "When you accept to perform you owe it to your audience to give it all you have at that moment....and of course you are technically fully prepared." I always thought that one could wake him up in the

middle of the night, stick a flute in his face, and a fountain of golden notes would emerge effortlessly. The pure joy of Jean-Pierre's presence was infectious: the man just loved to play and loved to share! He, too, was immensely generous to his students. He considered all his students junior colleagues. His example continues to inspire me.

After my first summer in Nice I premiered the Martinu sonata in live broadcast on Dutch radio. I toured in Holland and Denmark. The most exciting performance in Holland was in the Concertgebouw as soloist with the National Student Chamber Orchestra. I also became a member of a professional quintet and started teaching flute to supplement my graduate student income. Approaching my doctoral exams in biology I was unsure of my future career. Could I make it as a solo flute performer or would I end up in some orchestra while teaching disinterested kids? If all things failed would it be better to be "a second rate flutist or a second rate scientist?"

The politics of the Dutch flute world and an American postdoc invitation helped me decide between science and music. Based on my sensory work in Kalmijn's lab, biologist John Bardach invited me to join his fish chemoreception group at the University of Michigan. A week after my Dutch "doctorandus" degree in sensory biology and physics I flew with my wife and two very young boys to Ann

Daphne Soares

Arbor: at age 25 our first airplane flight! It was in the heady days of campus protests; I loved the atmosphere of energy and renovation. I found a musical and generally cultural environment that supported my love for music and performance. I was soon incorporated in amateur and professional musical circles and started performing regularly. "America" turned out to be different from the cowboy pictures I had in my mind and within a year I looked for ways to stay in this exciting country. John gave me enormous freedom to do whatever project I wished as long as it helped in understanding chemical sensing in catfish. A chance observation made me switch from electrophysiological work on taste nerves to behavioral observations on catfish social behavior and brain lesions to understand the functions of smell and two different senses of taste.

The most curious sensory aspect of catfish is the enormous exaggeration of the external (facial nerve innervated) taste system. A century ago during summers in Woods Hole Judson Herrick exploited this feature to describe the neuroanatomy of catfish taste. His 1905 paper served as the blueprint for my (Ph.D. 1969) lesion studies, which confirmed the predictions of his work. I found that the facial taste system innervating taste buds all over the fish's skin is essential in guiding the animal through an odor field (plume) to its food and that the vagal taste system innervating the mouth is essential in the control of swallowing. Olfaction plays no obvious role in feeding. This year (2001) I applied the same brain lesion to another catfish species joining a study by Kirsten Pohlmann and Thomas Breithaupt in Konstanz, Germany, on the role of chemo and hydrodynamic senses in tracking live prey in the dark.

Understandably, I had become somewhat obsessed with the distinction between aquatic smell and taste and the selection processes that led to their evolution. I realized that I needed to know much more about the physics of odor dispersal and the behavioral functions and physiological filter properties of the different receptor organs. That meant behavioral ecology, sensory physiology, fluid dynamics and the comparative study of different phylogenetic lines. For a naïve young scientist, that sounded like a worthwhile career challenge. So I did not hesitate when the Oceanographic Institution in Woods Hole offered me an assistant scientist position with a new initiative to "study chemical communication in the sea." They even built a new seawater shore lab to my specifications while I started looking for a marine model to be my guide in the exploration of this new challenge. My goal was to see the water world through chemical sensors as do so many animals. I chose lobsters for several practical reasons including size, ease of

neurophysiological recording, exoskeleton for attachment of electronic devices, easy local availability and post-experimental taste quality. While I and others in my lab have studied chemosensory biology now in many different aquatic animals such as snails, larval reef fish, nautilus, seastars and tuna, the lobster has remained the central model tying together receptor properties, fluid dynamics and behavioral ecology.

I expected great science but not cultural exuberance in Woods Hole. Once again I was proven wrong. That little ocean science village turned out to have a century-old tradition of active cultural life. After one year I played in two different woodwind quintets and several ad hoc string ensembles. I became first flute and later assistant conductor of the Cape Cod Symphony, soloed with them and taught over a dozen flute students per week. For some time I also conducted the Falmouth Chamber Orchestra, one of my most powerful musical experiences. I performed in many countries, including at the Shanghai Conservatory (while teaching a course in aquatic chemoreception). Some of the finest performances I remember were with the superb musicians of the Cape and Islands Festival and for the MBL centennial with Rampal and the Colorado Quartet both in 1988. For my birthday, composer Ezra Laderman wrote a flute quintet, which I performed with the Colorado Quartet in 1991. And through it all there were the Woods Hole Library concerts organized and often played by my cellist friend and physical oceanography colleague Bill Simmons.

That first summer in Woods Hole (1970) I found behavioral evidence for sex pheromones in lobsters, a novel discovery then worthy of a *Nature* article. Now, thirty years and dozens of student collaborators later, we have described a rich tapestry of chemical signals that serve to connect lobster social organization and orientation. At first we were misled by *Bombyx*, the silk worm moth, which then was the only known serious pheromone model. We expected male lobsters to act like moths and track pheromone plumes competing for pheromone-exuding females waiting in shelters ready to molt and mate. For several years we failed to make good progress until observational studies in large aquaria and in the field (carried out during a long collaboration with Elisa Karnofsky and a team of students and technicians) demonstrated the natural context of pheromone communication.

Meanwhile I transferred my position "across the drawbridge" and joined the Boston University Marine Program. There, electrophysiological studies by my students Chuck Derby, Bruce Johnson, Paola Borroni and many others, joined and later led by my long time postdoc and collaborator Rainer Voigt, showed the range of

chemical compounds and tuning specificity of chemoreceptor cells in the different antennae, legs and mouthparts of lobsters. Behavioral and lesion studies (Chuck pioneered the elegant and now well-established distilled water lesion!) showed a curious similarity with catfish leading to a renewed discussion on the function of "smell" and "taste." We also discovered that while receptor cells respond best to single compounds, lobster behavior requires the specificity of complex mixtures and thus the input of a pattern of receptor cells.

During a sabbatical in Regensburg, Germany, I rediscovered the gill currents of crustacea described originally by Friedrich Brock in the 1920's. This added an important piece to the chemical communication puzzle: controlling the sending and receiving of chemical signals. These "information currents" became the subject of many beautiful studies including the recent work by my former postdoc Thomas Breithaupt and his students visualizing urine release itself. My student Dan Lindstrom succeeded in making a urine catheter for lobsters. This technique opened up a long series of studies on urine signalling by Christa Karavanich (individual recognition), Paul Bushmann (dominance and sex pheromones; nephropore gland), Thomas Breithaupt (urine signalling linked to aggression) and several undergraduate students.

I always wanted to know the rate of encountering odor molecules during odor orientation behavior so that we could relate it to our electrophysiological work on adaptation and temporal filter properties of receptor cells and, ultimately, tracking behavior of lobsters. We started this plume structure work in 1980, just when – it turned out later – John Murlis was watching soap bubbles blowing in the wind on a sunny beach in Crete to measure airborne plume dispersal. In dramatic contrast, Bruce Bryant and I measured dye plumes in our dark basement gutter of the Loeb laboratory in Woods Hole. When I related my dissatisfaction with the spatial resolution of our optical methods to Tom Finger he introduced me to Greg Gerhardt, who used electrochemical microelectrodes to measure dopamine diffusion in rat brains. Within weeks Greg and I were in Woods Hole using his high-resolution technique for "oceanographic" plume measurements with dopamine as a tracer for odor dispersal. In one afternoon we had the first publishable results. When Paul Moore joined the lab we used the method to probe the 3-D fine structure of a simple jet plume. We described plume statistics and potential stimulus features, particularly onset slopes of odor pulses, which could be used to detect spatial gradients. The onset slope results matched receptor filter properties obtained at the same time by my student George Gomez. George used the high-resolution of electrochemical methods for

his still unique thesis research on the temporal filter properties of antennular chemoreceptor cells, including their flicker fusion rate. Current PhD student, Erik Zettler, is now completing the project of describing the temporal dynamics of lobster olfactory cells, started with Rainer Voigt, by testing their slope discrimination properties with controlled concentration slopes.

Initially with Paul Moore and later with Frank Grasso, Jennifer Basil and Rainer Voigt, we attempted to find out what information lobsters extract from turbulent odor plumes. Jenny accomplished the heroic task of outfitting lobsters with a pair of electrochemical "odor sensors" positioned next to their olfactory receptor organs. From the lobster's walking track and bilateral odor sensor records we could correlate turning behavior with odor pulse encounters. Equally important, we saw that a lobster walking upstream does not destroy fine-scale plume structure as we had feared. This suggested to us the hypothesis that lobsters use the coincident measurement of odor and local flow to perform "Eddy Chemotaxis." We are now analyzing the hydrodynamic receptor properties of the antennule, the logical place for such coincidence detection. At least the biomechanics of the whip-like antennule support frequency discrimination over three "octaves" of water motion: a low-frequency cochlea.

My colleague Larry Madin helped me realize my dream to visualize and measure chemical dispersal in the ocean when he invited me along on a Johnson-Sealink cruise to St. Croix. We made an underwater odor (dopamine tracer) plume a few meters above the sea floor at 400-meter depth. With a microelectrode at the tip of a long boom ahead of the submersible we cruised up the plume following our "subnose" and recorded bursts of dopamine concentration thus establishing in principle the potential of this method for underwater monitoring and guidance applications with underwater robots. Our current robot work, started in collaboration with Tom Consi at MIT, and now led by Frank Grasso, is aimed at deriving designs for chemical and hydrodynamic sensors as well as plume tracking algorithms from lobster sensory biology. "RoboLobster" is a wheeled robot in a large flume. When implemented on submersibles, ROVs and AUVs we will be able to explore the underwater odor world as I dreamed about it when starting my research career in Woods Hole.

My interests in science and music have been largely parallel tracks competing for time and concentration. This has forced me to focus intensely and to switch focus quickly. Both endeavors require passion and commitment. While most inspiring to me personally their

link was generally no more than providing a flute concert for friends and colleagues at a scientific meeting.

However, many parts of my disparate tracks have come together in my interests in the origins of humanity and (thus?) music. I learned about Pleistocene flutes from science writer John Pfeiffer 15 years ago. The oldest preserved musical instruments are bone flutes dating back as far as 53,000 years. This so far oldest flute remnant is likely Neanderthal. My knowledge of music, flutes and flute making combined with a highly skeptical scientific attitude led me to conclude that some of these very old instruments were probably fipple flutes similar to our "recorder." They are easy to play. But in contrast to transverse flutes and panpipes their construction requires several steps of insight and technological evolution thus suggesting a much older flute culture preceding these recorders. Studying various bone flutes I reconstructed three of them according to the recorder model, the Neanderthal flute from an authentic, partially fossilized cave bear bone donated by the University of Vienna. I let these reconstructed flutes guide me in musical improvisation just as I did as a boy in the forest using little weed flutes. While the sound capabilities of any of these flutes do not allow us to determine what scales our ancestors liked to play, we can hear the range of possibilities. One my recorded examples has now been playing for years in the American Museum of Natural History in New York. When I played one of these instruments by flackering candle light in front of the rock paintings of the beautiful cave of Fond de Gaume in the French Dordogne area, the audience of cave personnel was transported back in tears to their ancestors. So was I.

MEETINGS AND COURSES

The 2nd Workshop on "**Interface between Systems Brain Science and Neuroethology**" supported by "Comprehensive Study of the Brain" Project of Grant in Aid for Scientific Researches of Ministry of Education, Culture, Sports, Science and Technology of Japan will be held in Okazaki, Japan, October 31-November 2, 2001. This workshop is a follow-up of the successful one previously held in Sendai, 1999, and will provide an intensive seminar course to graduate students, postdocs, and young researchers who are interested in neuroethological approaches to brain functions and structure. Speakers include K. Arikawa, K. C. Catania, I. Fujita, A. Iriki, E. Ito, R. Kanzaki, M. Konishi, M. Metha, A. Nieder, M.V. Srinivasan, and Y. Oda. Access to the venue (Okazaki Conference Center), time schedule, and other information will be available soon at an internet site: <http://brain.nips.ac.jp/index.htm>. Those who are interested in the workshop, contact Kiyoshi Aoki at k_aoki@hoffman.cc.sophia.ac.jp. Secretariat for Tokyo District "Comprehensive Study of the Brain" Project Kiyoshi Aoki, Life Science Institute, Sophia University Tel & Fax: 81_3_3238_3490 E_mail: k_aoki@hoffman.cc.sophia.ac.jp.

The 13th annual **Karger Workshop** will be held on Friday, November 9, 2001 and the J.B. Johnston Club meeting will be held Saturday, November 10, at the Clarion Hotel, San Diego, CA. The Karger Workshop will address the topic "Evolutionary Convergence as a Tool in Neuroscience ." In 1991, the workshop topic was "Homology as a Tool in Neuroscience." We believe that in our quest to uncover important homologies (continuities) across taxa, we sometimes overlook the value of convergence, which may tell us a lot about how the nervous system processes information. Speakers will include Curtis Bell, Catherine Carr, Heather Eisthen, Jon Kaas, Kiisa Nishikawa, and Harold Zakon, with special guest Greg Wray. The regular meeting of the J.B. Johnston Club will feature short presentations on a variety of topics in comparative neuroscience. Additional information is available at <http://www.creighton.edu/jbjc/news.htm>.

MATERIAL FOR FUTURE NEWSLETTERS

We welcome material for future newsletters for a variety of different sections each issue. Advertisements for positions (faculty or student) are limited to 150 words. Announcements of new books (copyright 2001) *written or edited by ISN members* should include the full citation

information (including ISBN) *plus* a 40-50 word description of the book. (Note, if an ISN member only contributed a chapter this is not appropriate for inclusion). These should be submitted no earlier than one month before the next issue (July, 2001)

We also welcome announcements of future meetings, discussion material about research areas or topics of interest to neuroethologists, and similar types of material. Please contact Arthur Popper before submission to determine length.

All material must be submitted electronically, and preferably as an attached file to an e-mail. Send all material to Art Popper.

NEW BOOKS BY ISN MEMBERS

ECOLOGY OF SENSING. By Friedrich G. Barth and Axel Schmid (eds) (2001), 341 pp, 100 figures; Springer (ISBN 3_540_66901_9), hardcover, ca. \$110 US. Knowledge of the relationship between sensory systems and ecology is of fundamental importance for an understanding of animal behavior. The 16 chapters of the book exemplify the diversity of the constraints and opportunities associated with the sensation of stimuli representing different forms of energy.

GRADUATE AND POSTGRADUATE POSITIONS

Postdoctoral Position in Computational Neuroscience available immediately to analyze neural network models of chemotaxis behavior in the nematode *C. elegans*. Model networks, constrained by anatomical and electrophysiological data, will be optimized by neural network training algorithms to reproduce chemotaxis behavior of real worms and tested by real and simulated neuronal ablations. Previous training in modeling, electrophysiology, or math/physics a plus. CV and cover letter to: Dr. S. Lockery, job@lox.uoregon.edu or Institute of Neuroscience, 1254 Univ. Oregon, Eugene, OR 97403. <http://chinook.uoregon.edu>. AA/EO/ADA.

Position in Auditory Perception in owls. A position for a graduate student (BAT IIa/2) to study neural correlates of auditory perception is immediately available at the Lehrstuhl fuer Zoologie/Tierphysiologie of the RWTH Aachen. The project is supported by the VW_foundation, and is a continuation of our work on precognitive and cognitive components in barn owl audition (Poganiatz et al., JARO 2001, 2: 1), Poganiatz and Wagner, J. Comp Physiol. 2001 (published online), Kempter et al. PNAS

2001 (98:4166)). Specifically, we plan to examine neuronal mechanisms of sound localization in awake, behaving owls by using the virtual space technique to study the cocktail_party effect and binaural masking. For further information see our homepage on the internet (www.bio2.rwth_aachen.de), contact or send inquiries and applications to Prof. Dr. Hermann Wagner, Lehrstuhl fuer Zoologie/Tierphysiologie, RWTH Aachen, D_52074 Aachen, Kopernikusstrasse 16, e_mail: wagner@bio2.rwth_aachen.de.

Postdoctoral Position in Visual Perception in owls. A postdoctoral position (BAT IIa) to study neural correlates of visual perception is immediately available at the Lehrstuhl fuer Zoologie/Tierphysiologie of the RWTH Aachen. The project is supported by the German Research Council (DFG) and is a continuation of our work on precognitive and cognitive components in barn owl vision (Nieder and Wagner, Nature Neuroscience 2: 660 (1999), Nieder and Wagner, J. Neurophysiol. 83:2967 (2000)). Specifically, we plan to examine mechanisms of stereo vision in awake, behaving owls, and we want to use our technique of recording with a telemetric system (Nieder: J. Neurosci. Meth. 101: 157 (2000)) to study neural correlates of behavior under free_flight conditions. It is expected that the successful candidate develops her or his research program. For further information see our homepage on the internet (www.bio2.rwth_aachen.de), contact or send inquiries and applications to Prof. Dr. Hermann Wagner, Lehrstuhl fuer Zoologie/Tierphysiologie, RWTH Aachen, D_52074 Aachen, Kopernikusstrasse 16, e_mail: wagner@bio2.rwth_aachen.de.

Postdoctoral Research Associate to join in the investigation of the neurotransmitters, circuitry and functionality of the gustatory_mediated reflex system in goldfish. These fish utilize a specialized oropharyngeal organ to sort food particles from inorganic substrate material taken in the same mouthful (see Finger 1997 Acta Phys. Scand. 161, Suppl. 638: 59_66). Techniques to be utilized include immunocytochemistry, in situ hybridization, field potential and single cell physiology, and functional imaging. For further information, please contact: Dr. Thomas Finger, Dept. Cell & Struct. Biol., Univ. Colorado Health Sci. Ctr., 4200 E Ninth Ave., Denver CO 80262. e-mail: tom.finger@uchsc.edu. UCHSC is AA/EOE.

Postdoctoral Position January 2002, **Sensory Neuroethology**, Woods Hole, USA. The laboratory of Prof. Jelle Atema has a postdoctoral position available for

2.5 years starting January 2002. The NSF funded research is focused on determining the hydrodynamic mechanosensory function of lobster antennules with electrophysiological and behavioral techniques. The work is part of a large program including fluid dynamics and robotics designed to understand the multisensory navigation signals that can be extracted from underwater odor plumes. Electrophysiological expertise preferred. Inquiries and applications: Dr. Jelle Atema, Professor and Director, Boston University Marine Program, Marine Biological Laboratory, Woods Hole, MA 02543, USA, Phone: 508_289_7499, FAX: 508_289_7950, e_mail: atema@bu.edu

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