INCUBATOR

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In this Issue:

Machine Perception Lab Shows Robotic One-Year-Old on Video

The world is getting a long-awaited first glimpse at a new humanoid robot in action mimicking the expressions of a one-year-old child. The robot will be used in studies on sensory-motor and social development – how babies "learn" to control their bodies and to interact with other people.

Diego-san's hardware was developed by leading robot manufacturers: the head by Hanson Robotics, and the body by Japan's Kokoro Co. The project is led by University of California, San Diego full research scientist Javier Movellan.

Movellan directs the Institute for Neural Computation's Machine Perception Laboratory, based in the UCSD division of the California Institute for Telecommunications and Information Technology (Calit2). The Diego-san project is also a joint collaboration with the Early Play and Development Laboratory of professor Dan Messinger at the University of Miami, and with professor Emo Todorov's Movement Control Laboratory at the University of Washington.

(cont on page 2)

Different faces of Diego-san: video of robo-toddler shows him demonstrating different facial expressions, using 27 moving parts in the head alone.

Baby Diego, cont from page 1

Movellan and his colleagues are developing the software that allows Diego-san to learn to control his body and to learn to interact with people.

“We've made good progress developing new algorithms for motor control, and they have been presented at robotics conferences, but generally on the motor-control side, we really appreciate the difficulties faced by the human brain when controlling the human body,” said Movellan, reporting even more progress on the social-interaction side. “We developed machine-learning methods to analyze face-to-face interaction between mothers and infants, to extract the underlying social controller used by infants, and to port it to Diego-san. We then analyzed the resulting interaction between Diego-san and adults.” Full details and results of that research are being submitted for publication in a top scientific journal.

While photos and videos of the robot have been presented at scientific conferences in robotics and in infant development, the general public is getting a first peak at Diego-san's expressive face in action. On January 6, David Hanson (of Hanson Robotics) posted a new video on YouTube.

“This robotic baby boy was built with funding from the National Science Foundation and serves cognitive A.I. and human-robot interaction research,” wrote Hanson. “With high definition cameras in the eyes, Diego San sees people, gestures, expressions, and uses A.I. modeled on human babies, to learn from people, the way that a baby hypothetically would. The facial expressions are important to establish a relationship, and communicate intuitively to people.”

Diego-san is the next step in the development of “emotionally relevant” robotics, building on Hanson's previous work with the Machine Perception Lab, such as the emotionally responsive Albert Einstein head.

The video of the oversized android infant was picked up by the popular online technology magazine, Gizmag, with a Jan. 7 article titled

Javier Movellan with an earlier version of the robot.

“UCSD's robot baby Diego-san appears on video for the first time,” written by Jason Falconer.

In his article, Falconer writes that Diego-san is “actually much larger than a standard one year old – mainly because miniaturizing the parts would have been too costly. It stands about 4 feet 3 inches (130cm) tall and weighs 66 pounds (30kg), and its body has a total of 44 pneumatic joints. Its head alone contains about 27 moving parts.”

The robot is a product of the “Developing Social Robots” project launched in 2008. As outlined in the proposal, the goal of the project was “to make progress on computational problems that elude the most sophisticated computers and Artificial Intelligence approaches, but that infants solve seamlessly during their first year of life.”

For that reason, the robot's sensors and actuators were built to approximate the levels of complexity of human infants, including actuators to replicate dynamics similar to those of human muscles. The technology should allow Diego-san to learn and

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“[Diego-san] brings together researchers in developmental psychology, machine learning, neuroscience, computer vision and robotics.”

— Javier Movellan

Baby Diego, cont from page 2

autonomously develop sensory-motor and communicative skills typical of one-year-old infants.

"Its main goal is to try and understand the development of sensory motor intelligence from a computational point of view," explained principal investigator Movellan in a 2010 Q&A with the Japan-based PlasticPals blog. "It brings together researchers in developmental psychology, machine learning, neuroscience, computer vision and robotics. Basically we are trying to understand the computational problems that a baby's brain faces when learning to move its own body and use it to interact with the physical and social worlds."

The researchers are interested in studying Diego-san's interaction with the physical world via reaching, grasping, etc., and with the social world through pointing, smiling and other gestures or facial expressions.

As outlined in the original proposal to the NSF, the project is "grounded in developmental research with human infants, using motion capture and computer vision technology to characterize the statistics of early physical and social interaction. An important goal is to foster the conceptual shifts needed to rigorously think, explore, and formalize intelligent architectures that learn and develop autonomously by interaction with the physical and social worlds."

According to UCSD's Movellan, the expression recognition technology his team developed for Diego-san has spawned a startup called Machine Perception Technologies (MPT). The company is currently looking for undergraduate interns and postgraduate programmers. "We like UCSD students because they tend to have a strong background in machine learning."

The project may also open new avenues to the computational study of infant development and potentially offer new clues for the understanding of developmental disorders such as autism and Williams syndrome.

As noted in the Gizmag article, Diego-san won't be the only child-like robot for long. This spring Swiss researchers will demonstrate their nearly 4-foot-tall Roboy robot toddler (with a face selected via a Facebook contest!).

The above story is reprinted from materials provided by UCSD News Center.
The original article was written by Doug Ramsey.

Links

Machine Perception Laboratory	http://mplab.ucsd.edu/wordpress/
Kokoro, Co., Ltd.	http://www.kokoro-dreams.co.jp/english/
Hanson Robotics	http://hansonrobotics.wordpress.com/

Media Coverage

gizmag - **"UCSD's robot baby Diego-san appears on video for the first time"**

UCSD News - **"Machine Perception Lab Shows Robotic One-Year-Old on Video"**

Phys.org - **"Machine perception lab reveals robotic one-year-old (w/ video)"**

SALON - **"Robot toddler could unlock secrets of human development"**

FOX News (video) - **"Robot baby learns how to express human emotions"**

Research Collaboration Praised by the Army

success story highlighted in CaN CTA report

This month, the Army is conducting a review of its basic research activities. Of all the activities across the Army Research Laboratory (ARL)'s directorates, the only success story being highlighted is the effort by Cognition and Neuroergonomics Collaborative Technology Alliance (CaN CTA). The following is an excerpt from the report:

"The past five years have seen an explosion in the research and development of systems that use online brain-signal measurement and processing to enhance human interactions with computing systems, their environments, and even other humans. These neuroscience-based systems, or "neurotechnologies," are poised to dramatically change the way users interact with technology."

"A team of researchers in the Army's CaN CTA recently published a special section, "Neurotechnological Systems: The Brain-Computer Interface," comprised of four manuscripts that appeared in the special 2012 Centennial Celebration issue of the Proceedings of the IEEE — the most highly-cited general interest journal in electrical engineering, electronics, and computer science."

"In this special section, researchers from UCSD, the National Chiao Tung University (Taiwan), and the Army Research Laboratory, collaborated closely to define a vision of the evolution of the measurement capabilities, the analytic approaches, and the potential user applications, for the future of neurotechnologies in the coming decades. The involvement of CaN CTA researchers in this special section gave the Army an opportunity to help shape the future of a critical technology development domain, and demonstrates the recognition of the Army as a leader in this emerging field."

List of Articles in the Special Section

Liao, L-D., Lin C-T., McDowell, K., Wickenden, A. E., Gramann, K., Jung, T-P., Ko, L-W., and Chang, J-Y. (2012) *Biosensor technologies for augmented brain-computer interfaces in the next decades.* Proc. IEEE, 100, 1553-1566.

Makeig, S., Kothe, C., Mullen, T., Bigdely-Shamlo, N., Zhang, Z., and Kreutz-Delgado, K. (2012) *Evolving signal processing for brain-computer interfaces.* Proc. IEEE, 100, 1567-1584.

Member Spotlight - Gabriela Cruz

Bridging neuroscience and occupational science

Can you tell us a bit about your background and how you decided to work with Dr. Scott Makeig?

I'm from Chile, and my background is in occupational therapy. Occupational therapy focuses on helping people to re-engage with their meaningful activities and life roles, which may have been affected because of social, physical, psychiatric or neurological problems. Currently, I'm dedicated to study cognitive rehabilitation and traumatic brain injury.

My first contact with electroencephalography (EEG) was during my master studies at the Universidad de Chile. My thesis was about sleep and memory in rats. However, my main interest is cognition in humans and how to complement rehabilitation and clinical work with neuroscience. I went on to the University of Glasgow in Scotland to pursue a PhD with Jonathan Evans, who is a really good neuropsychologist and works specifically in rehabilitation of executive functions while utilizing new technologies. He is very focused in applying his research to clinical work. I decided to go there, because I thought he could help me bridge neuroscience and clinical work. I started my first EEG experiments with humans in Kerry Kilborn's laboratory. EEG is very suitable for clinical work, and I think it has a big potential for rehabilitation .

I met Scott Makeig at a workshop in 2011. I knew about him before, because I had read his papers and liked all the work he had done. I talked to him about some experiments that I wanted to do but couldn't because of the limitations of the EEG technology I was using at Glasgow. In a classical EEG setting, you have to sit in front of a computer, trying not to move except for the fingers – a situation very different from real life. I told him I would like to experiment in a more realistic setting, and he said that would fit very well with MoBILAB, the Mobile Brain/Body Imaging laboratory being developed at UCSD .

How long have you been at UCSD?

I arrived in December 2012, so I have been here for a little more than a month. So far, I've been working with a group of people, including Makoto Miyakoshi and Tomas Ward. The first experiment we're trying is a very simple one with stroke patients, to see if it's possible to use the MoBILAB for clinical population. After that, the idea is to start more complex experiments that involve the study of memory, executive function and motivated actions. I'm mainly interested in prospective memory, which is what my PhD is about.

(cont on page 6)

Gabriela "Gaby" Cruz

Gabriela Cruz, cont from page 6

What is prospective memory?

Prospective memory is the ability to execute an intended intention after a delay. For instance, we're having this interview now, but you may have to make a phone call later. So you store that intention now, and later, at an appropriate moment, you have to be able to retrieve that intention and perform it. It involves the ability to remember the content of an intention and identify the proper moment to perform that intention, like a mental to-do list. Some people with brain injuries struggle with this, although it can happen to healthy people

"In the MoBILAB, we're experimenting in an environment involving movement and more real-life situations. I think that is the future for EEG studies."

as well, particularly when there is too much to do. My plan here is to analyze the data I collected in Glasgow in a prospective memory paradigm and start new experiments that explore neural correlate of prospective memory function in ecological conditions.

How long are you planning to be at UCSD, and how do you like San Diego?

I will be here until August this year. I'm in the third year of the four-year PhD program, so I have to go back to Glasgow and finish.

I really like San Diego so far. The city is spread out, so the first thing I realized was that I needed a car to get to anywhere from where I'm living. I have a bicycle now, though, so I cycle to most places around university. It's great, because there's a lot of nature, and you don't really feel like you're inside a city. I love the beach and the fact it's always sunny. It's quite different Scotland; Scotland is beautiful, but it's also very cold and dark, especially in the winter.

What is your plan after the PhD?

I don't know yet, but I would like to continue to connect research and clinical work. I'll maybe do a post doc abroad and then I'll go back to Chile to contribute to the development of occupational therapy and neuroscience in my country. Most of the research in occupational therapy comes from the United States and Europe. I would like to support the research in my country, particularly in the field of cognitive rehabilitation.

I'm also interested in continuing to close the gap between experimental research and daily life. Although memory and executive functions are essential in daily activities, clinical and psychological tests often do not really measure the performance in real life. For example, you may be able to perform a memory test and do very well, but you may be very bad at remembering daily events – or vice versa. I think that assessments and experimental approaches commonly used in neuroscience should start to be more ecologically valid. Because most experiments need to be very controlled, they're often very simplified real-life phenomena; but for the same reason, they're also very different from real life. In contrast, in the MoBILAB, we're experimenting in an environment involving movement and more real-life situations. I think that is the future for EEG studies.

Gabriela Cruz (at the Univesity of Glasgow)

http://www.psy.gla.ac.uk/staff/index.php?id=GC001

MoBI Laboratory

http://sccn.ucsd.edu/wiki/MoBI_Lab/

Faculty Spotlight - Howard Poizner

Untangling Parkinson's disease through virtual reality

Newsletter editor Tomoki Tsuchida sat down with Dr. Howard Poizner, Professor Emeritus of Rutgers University and director of the Poizner laboratory at UCSD. We had a chance to talk about his virtual reality laboratory and his diverse research interests across many disciplines.

Can you tell us a bit about the path that brought you here to UCSD?

There was a lot of interest in PD (Parkinson's disease) within the Center. There was research going at the molecular level, the systems level and the behavioral level, and thus the Center provided an excellent multidisciplinary environment to study PD. I had been studying human motor disorders caused by stroke or PD. Over time, my interest in PD gradually deepened, and became a very strong focus in my laboratory.

After fifteen years at Rutgers, I decided that I wanted to return to San Diego. I had been at the Salk Institute for 12 years before moving to Rutgers, and still felt San Diego to be home. So I decided to take early retirement at age 55 (I'm now Professor Emeritus) and to move back to San Diego. I called Terry Sejnowski who I knew from my days at the Salk Institute and asked if either Salk or UCSD would have interest in a motor neuroscience lab. I had an NIH grant on PD and would continue that research. He said he directed an Institute at UCSD, INC, and told me to come on over.

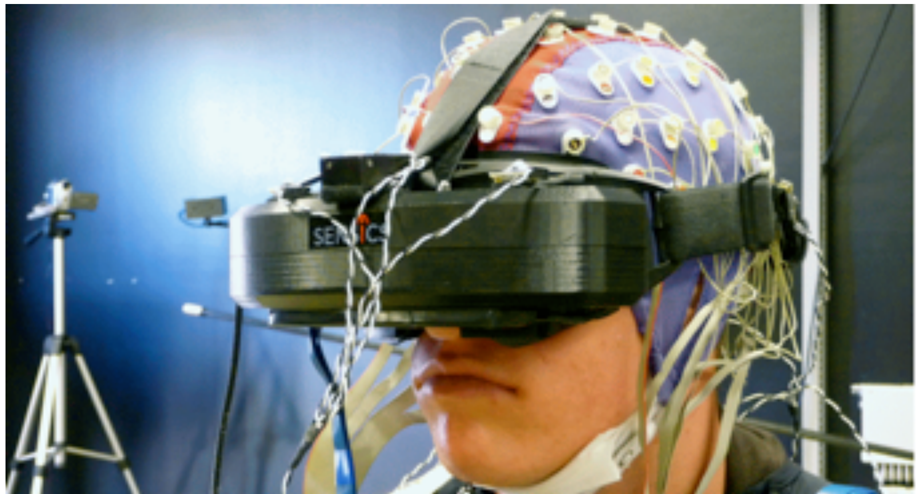
You direct a laboratory with one of the most sophisticated virtual reality environments in the world. Can you describe the facility and how that relates to your main research goals?

The role of that facility is two-fold: it's both my lab and serves as a core facility that I direct for TDLC (NSF Temporal Dynamics of Learning Center, Gary Cottrell, PI). We have what as far as I know is a unique facility in the world capable of simultaneous recording of full-body motion and EEG while subjects freely move about in large-scale immersive virtual environments. The environments are highly immersive, and allow us to address questions of how the brain acts when people actually move, as opposed to when someone is stationary with their head fixed in place as is typically done.

Creation of virtual environments is crucial for experimental control since they provide powerful experimental control. The timing of events and the feedback given to the subject is completely controlled; the repeatability is exact, the measurements are very precise; and all of the data streams are synchronized through custom scripts that we've written. So we can record people's brain activity concurrently with their head, body, and limb motions as they move through locations, grasp virtual objects that have different weights and textures, learn to adapt to perturbations in the environment, make decisions and so forth. Thus, we can simultaneously study such things as the neural mapping of space in humans, learning and memory, and the cortical dynamics underlying motor control. I feel that these technological developments open up entirely new possibilities for investigating the cortical substrates of cognition and of motor control. We've recently published a detailed description of our system that goes through the various system components, their spatial and temporal precisions, how all of the devices are integrated, and give some sample applications (Snider, J. et al., in press).

What are some of the projects you're working on currently?

In one set of projects, we want to understand how the brain acts in the high dimensional world, that is, how it governs our actions in environments in which the brain actually evolved to act in. This issue has been somewhat neglected in neuroscience, yet is critical to understanding how humans deal with complex, novel problems. We're fortunate to have an Office of Naval Research MURI (Multidisciplinary University Research Initiative) center grant to study this issue.



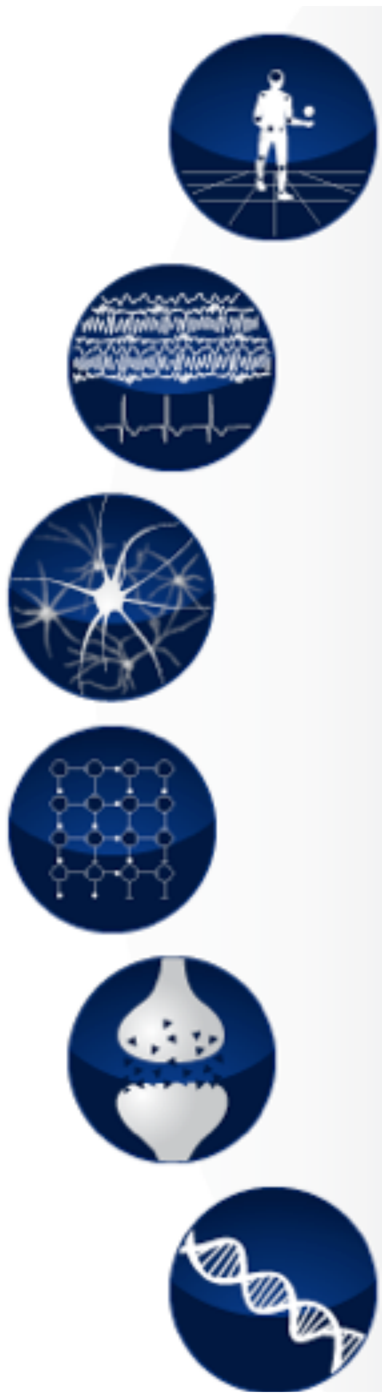
The goal of the grant is to better understand the brain bases of a type of learning known as unsupervised learning. Unsupervised learning hasn't been studied nearly as intensively as has reinforcement learning or supervised learning, such as classroom-type learning. In unsupervised learning, you learn as you go about interacting with the world, without being explicitly taught, or reinforced. It's commonplace in complex, novel environments, and allows one to be able to generalize and act flexibly in novel situations.

We have a vertical platform of studies underway in the MURI grant. At the neurobiological level, Gary Lynch at UC Irvine is conducting cellular studies in rats. He has rats explore a new environment with objects located in various locations in the space. He then brings the rats back the next day and sees how the animals re-explore the environment after he has switched around the locations of some of the objects from the previous day. Rats spend more time exploring what has changed in the environment, showing that they had remembered the environment from the previous day. Gary then examines their brains and can map the synapses that have changed in the hippocampus from that one unsupervised learning experience. In essence, he is providing a picture of a memory engram. Very remarkable work.

In my lab, we conduct parallel experiments to Gary's, but in humans using our virtual reality-brain recording system. We have subjects freely explore a virtual room that has a variety of objects scattered throughout the space. The virtual room is the same size as the lab they are in, so subjects don't run out of physical space. We don't instruct the subjects to learn or remember anything, but just have them explore the space. And, just like the rats, we bring them back the next day, but unbeknownst to them, we have altered the locations of a subset of those objects from what was seen the day before. Thus, for the first time, we are able to look at what happens to brain dynamics when subjects are freely exploring and learning a spatial environment in an unsupervised fashion. We found that there is a relationship between the theta rhythm (neural oscillations at about 3 to 7 hertz) recorded over midline posterior parietal cortices, and the locations in space that the subject walked through providing a neural map of space. Moreover, the degree of structure in these maps produced when subjects explored the space on the first day predicted their memory performance when they were brought back in the environment on the second day. We are very excited about these findings as they are the first report of memory-related neural maps of space in humans during active spatial exploration. Joe Snider, a project scientist my lab, is the first author of a paper currently under review on these findings. Eric Halgren from the Department of Neurosciences is an important collaborator on the project as well.

"The virtual reality-brain recording system is becoming key to our being able to do the type of experiments that will allow us to really understand how the disease acts."

At another level in the platform of studies of the MURI is a project directed by Tom Liu, the director of UCSD's fMRI center. Among other things, Tom's group has been working on understanding resting brain state activity. When you're at rest, your brain is not silent, but there are lots of brain networks that are active. There are indications that the nature of the activations in these resting state networks can predict certain kinds of learning and memory performance, although unsupervised learning and memory has not been studied.



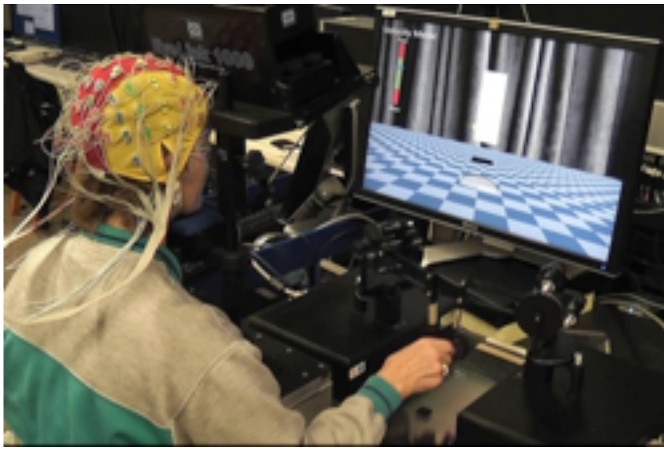
MURI and NIH grants allow for a vertical platform of studies.

To address this issue, we brought back the subjects that had participated in our spatial exploration and learning experiment to undergo resting state fMRI brain scans in Dr. Liu's lab. In resting state studies, subjects are just quietly resting in the scanner with their eyes open. We wanted to see whether individual characteristics in brain activity at rest predisposed individuals to have differing memory performance in the unsupervised learning and memory experiment I just described. This still is an ongoing study, but we are finding a strong relation between patterns of activation in individuals and their memory performance that was measured many months earlier in the spatial learning experiment. Activations in dorsal striatal areas turned out to be particularly predictive of the memory performance.

Interestingly, striatal areas are known to be very important in motor learning and recently have been shown to predict performance in certain video games by Art Kramer at University of Illinois. Tom's group now is looking at connectivity measures in the same dataset, that is, how strongly are two or more regions functionally connected. How dorsal striatal regions are functionally connected to other brain regions in the resting state may give us additional clues to which brain areas may be mediating the individual differences in memory performances.

At still another level, Ralph Greenspan at the Kavli Institute for Brain and Mind is doing genetic studies in flies to get at basic neurobiological mechanisms of attention and brain oscillations. In fruit flies, one can perform rapid genetic manipulations that allow you to tease apart some candidate genes that could be important for learning and attention. Once he has identified these, the genes can then serve as a springboard to take a look at the mammalian species, even humans. Those are some of the layers within the MURI center grant.

We also have a NIH grant on Parkinson's disease. We're still very much engaged in that endeavor, and the virtual reality-brain recording system is becoming key to our being able to do the type of experiments that will allow us to really understand how the disease acts. One major question involves the roles of the circuits between basal ganglia and cortex that we know are dysfunctional in PD. We are investigating their roles in motor control and learning, and how different therapeutic modalities alter the functioning of these circuits. We are not only interested in learning about PD and its therapies, but also in understanding the neural control of movement. PD and its therapies provide a natural occurring window into these affected circuits and using standard PD therapies, we can reversibly alter the functioning of these circuits to probe the system.



The grasp coordination experiment (pictured left) combines haptic robots, eye tracking system and EEG to measure brain activity in virtual reality.

We focus primarily in reaching and grasping motions — naturalistic behaviors that we all do. With virtual reality, we can have you reach and grasp for virtual objects and provide visual feedback at very specific points in time; we can alter that feedback from what you normally would get; we can perturb objects that you're trying to grasp at particular points during your reach for the object. We also use our haptic robots to give people a sense of actually feeling the virtual object. So, for example, if you are grasping a virtual wooden block, you would actually feel the block.

One sense of modality that we don't usually think about a lot is proprioception. That is, if we close our eyes, we know where our hands and arms are in space and how they are moving. Sensors in the joints and muscles provide the relevant input to the brain. Proprioception is critical to motor control and seems to be impaired in PD patients. So, one thing we have been studying is the nature of proprioception in PD patients, and how therapies such as deep brain stimulation to the subthalamic nucleus within the basal ganglia alters proprioception. We can reversibly turn the stimulator on and off to alter the functioning of basal ganglia-cortical circuits and see how that affects a particular function, such as proprioception or reaching and grasping. We can do the same thing with dopamine medications.

Summarizing a variety of experiments, we're finding that, in certain situations, PD patients do show pronounced proprioceptive deficits. We're in the process of completing the data analysis, but it seems that deep brain stimulation does not provide a major reversal of these deficits, although it may in fact reduce the variability or uncertainty of within that sense modality.

With respect to reaching and grasping, we've hypothesized that PD patients show at least two different aspects of movement deficits. One relates to what I'll call intensive aspects of movement — peak speed or peak amplitude. Another is a more coordinative aspect of movement, including joint coordination. We've further hypothesized that dopamine replacement does not act uni-dimensionally across these deficits. It is quite good at improving the intensive or scaling aspects of movement, but is not very good at reversing coordinative deficits. In one experiment, we had PD and control subjects reach for, grasp, and lift a virtual object that could be positioned in different orientations with respect to simulated gravity. The objects also had different weights. We found that dopamine replacement therapy significantly increased the speed with which they PD patients reached to grasp these objects, but it did not increase the ability of the patients to coordinate the hand and the arm required to lift the object along its oriented axis. When patients lifted against the gravity and had to maintain the object's orientation, PD patients on or off dopamine therapy were very much impaired, even though their speeds during the reach improved with therapy.

In a subsequent experiment, we are looking at how PD patients on and off dopamine medications respond to a visual perturbation of an object during their reach. For example, subjects may be reaching to grasp a virtual rectangular block oriented lengthwise, when it suddenly rotates 90 degrees part way through the reach. How do patients adapt to this alternation? Is the adaptation of their movements smooth, or do patients have to start over and reprogram the movement entirely? And how does providing vision affect their ability to adapt? In this experiment, we've also recorded EEG concurrently with hand, arm and eye movements. In collaboration with Claudia Lainscsek and Terry Sejnowski at Salk, and Manuel Hernandez and others in my lab, we're using new signal processing techniques developed by Claudia and Terry to analyze the nonlinear dynamics inherent in the EEG time series. We're excited about these new methods, as they promise a fresh approach to the understanding alterations in brain function during complex behavioral tasks in PD.

So the virtual reality environment can really make it easy to tease apart different aspects of Parkinson's disease.

Yes, it really allows for flexible experimental control. In one experiment, we've recorded eye movements, reaching movements, and EEG while healthy individuals reach to or look at spatially directed targets. Since the temporal dynamics of EEG has not been systematically investigated with respect to movement, we have measured movements that are directed to different spatial locations, either by the eye or the hand or by both effectors moving together. Steve Hillyard in the Department of Neurosciences has been working with us closely on this project, and with Markus Plank a postdoc from the lab we've examined various spatiotemporal EEG characteristics during motor planning of the eye or the hand to a spatially directed target.

We've uncovered some fascinating motor-attention related components of the event-related potentials (ERPs) during motor planning. For example, the amplitude of an attention-related potential recorded over right parietal cortices was strongly modulated during the planning interval according to which upcoming movement was being planned. Moreover, the amplitude of this component, and indeed of even earlier visually-related components, significantly predicted the accuracy of the movement that was about to happen in the near future. What may be even more interesting, however, is that we're uncovering what seems to be novel motor planning related ERP components. One would never have seen these components using traditional EEG paradigms in which limb and eye movements were avoided.

Working closely with Todd Coleman in the Department of Bioengineering and Cheolsoo Park a postdoc who worked jointly in our labs (see Fall 2011 issue of Incubator), we've been attempting to classify the EEG during the motor planning interval of this experiment, to see how well spectral features of the EEG could predict which of the various movements was being planned. Cheolsoo brought to bear a relatively newly developed signal processing technique that allowed him to decompose the EEG into a set of independent frequency modes. Importantly, this technique is data-driven, that is, the different frequency modes uncovered are intrinsic to the data, rather than being the predefined frequency bands that we most commonly use. Cheolsoo found that one of these frequency modes, which mostly overlapped with the traditional gamma band, was able to significantly classify the EEG during the planning interval in terms of which of the various movements would be forthcoming. He also found that this technique produced higher classification rates than the standard signal processing methods. So, these analyses both inform us about the information content in the EEG relevant to planning spatially directed hand and eye movements, and demonstrates the feasibility of a new mode of signal processing for such analyses.

We have a number of other studies underway, but this gives you a sense of our research directions.

It is amazing how broad a research effort you're leading, with collaboration from both within and outside of the INC.

The collaboration is very important. The colleagues here at UCSD are tremendous, and the depth and breath of disciplines represented is large and essential to our research.

Poizner Lab http://inc.ucsd.edu/~poizner/

References

Simultaneous neural and movement recordings in large-scale immersive virtual environments. Snider, J., Plank, M., Lee, D., Poizner, H. *IEEE Trans. Biomed. Circuits Syst.*, in press.

INCEVENTS

NEUROENGINEERING SEMINAR SERIES

01/28/13	**Kyeong-Sik Min**	Memristor models, read/write circuits, and neuromorphic applications
03/04/13	**Patrick Mercier**	Electrochemical Energy Harvesting from the Inner-Ear
03/11/13	**Victor Gruev**	Spectral Polarization Focal-Plane Sensing for Functional Neural Imaging

CHALK TALKS

01/17/13	**Zeynep Akalin Acar**	Forward and inverse EEG source analysis
02/14/13	**Joaquin Rapela**	Predictive neural modeling: from spikes to behavior and back
02/28/13	**Anthony Lewis**	Locomotion, perception and neurorobotic models
03/14/13	**Tatyana Sharpee**	Neural responses to natural stimuli
03/28/13	**Sascha du Lac**	Neural mechanisms of behavioral learning
04/11/13	**Eric Halgren**	Brain imaging of human language perception
04/25/13	**David Kleinfeld**	Brainstem sensorimotor oscillators
05/09/13	**Miroslav Kristic**	Extremum seeking and learning in adversarial networks
05/23/13	**Katja Lindenberg**	Non-equilibrium thermodynamics

SPECIAL EVENTS

02/08/13 - 02/09/13

TDLC All-Hands Meeting

03/12/13 4 PM

Barbara Oakley (Oakland University)

"How to learn more deeply and creatively: concrete tools from neuroscience and from zombies"

SDSC East Annex, South Wing

04/01/13 4 PM Rockwood Lecture

Dmitri Mitya Chklovskii (Howard Hughes Medical Institute)

SDSC Auditorium

More information: http://inc.uscd.edu/events.html

Awards, Honors, and Collaborations

Tzyy-Ping Jung

-- will be a featured innovator in the upcoming newsletter from the UCSD Technology Transfer Office. Congratulations, Tzyy-Ping!

More information: http://invent.ucsd.edu/info/innovators.shtml

inc at a glance

INC Research Groups and staff

Institute for Neural Computation (INC)
http://www.inc.ucsd.edu
Terrence Sejnowski and Gert Cauwenberghs, Co-Directors
Shelley Marquez, Executive Director

Swartz Center for Computational Neuroscience at INC
http://www.sccn.ucsd.edu
Scott Makeig and Tzyy-Ping Jung, Co-Directors

Machine Perception Laboratory at INC
http://mplab.ucsd.edu/
Javier Movellan, Marian Stewart Bartlett, and Glen Littlewort, Principal Investigators

Temporal Dynamics of Learning Center (TDLC) Motion Capture/Brain Dynamics Facility at INC
http://inc.ucsd.edu/~poizner/motioncapture.html
Howard Poizner and Scott Makeig, Co-Directors

Office of Naval Research (ONR) Multidisciplinary University Initiative (MURI) Center
http://inc.ucsd.edu/~poizner/onr_muri/
Howard Poizner, UCSD (PI); Gary Lynch, UCI (Co-PI); Terrence Sejnowski, Salk Institute/UCSD (Co-PI)

Mobile Brain Imaging Laboratory (MoBI) at INC
Scott Makeig, Principal Investigator

Poizner Laboratory at INC
http://inc2.ucsd.edu/poizner/
Howard Poizner, Principal Investigator

Dynamics of Motor Behavior Laboratory at INC
http://pelican.ucsd.edu/~peter/
Peter Rowat, Principal Investigator

Data-Intensive Cyber Environments (DICE) Group at INC
Wayne Schroeder, Principal Investigator
http://diceresearch.org/DICE_Site/Home/Home.html

Corporate Relations and Industrial Partnership Program:
Shelley Marquez <smarquez@ucsd.edu>

International Exchange Scholar Program:
Tzyy-Ping Jung <jung@sccn.ucsd.edu>

Newsletter Editor:
Tomoki Tsuchida<ttsuchida@ucsd.edu>

Webmaster and Information Technology:
Luis Palacios <lpalacio@crl.ucsd.edu>

For general inquiries, contact:
Luisa Flores <m2flores@ucsd.edu>