The UCSD Dynamic Learning Center
Executive Summary

BACKGROUND:

Learning is an active, dynamic behavior that emerges from interactions between the developing brain of a child and a social world. Until recently not enough was known about the brain to help guide educational practice. This is rapidly changing as new discoveries are made about the brain and new techniques are available for probing the learning brain. We propose to bring together a collaborative team of researchers, educators, and communicators who will bring basic science into classrooms and, conversely, use the classroom as a living laboratory to inform and guide the basic science.

The focus of our center is on the **Temporal Dynamics of Learning**. Successful learning critically depends on the fine scale structure of the timing between stimuli, response, and reward. The brain is exquisitely sensitive to the temporal structure of sensory experience: at the millisecond time scale in the auditory system, at the second time scale in reinforcement learning, at the minute time scale for action-perception adaptation, and at the day to week time scale for consolidation and maturation. Despite the relevance of time to all aspects of learning, action, and neural coding, the temporal dynamics necessary for flexible and adaptive learning has only recently become a focus in educational settings. In five years time, we plan to make the Dynamic Learning Center a focal point for the study of the role of time in learning, and the characteristics and function of brain dynamics at multiple time scales that are involved in successful learning and retention. In this effort, we are partnering with the Preuss School, whose students and teachers we will bring into our labs, the San Diego Supercomputer Center, which will house Data grids for sharing data among ourselves, CalIT2, which will house the administrators and our motion capture facility, and The Science Network, which will make our research public by broadcasting programs aimed at promoting interaction between scientists, teachers and the public concerning this new area of research.

We believe that a **collaborative research model**, involving interdisciplinary teams, is the only appropriate one. In pursuing our goal, we have developed **research networks** that combine researchers in machine learning, psychology, cognitive science, and neuroscience, molecular genetics, biophysics, mathematics, and education to focus on a single set of issues from multiple perspectives. We are
explicitly not suggesting groups that meet and tell each other about their research. Rather, we are suggesting groups that *synchronize their research* by running parallel experiments in animals, people, and theoretical models.

We have created four research networks that we believe carve the problem up into manageable chunks, and to limit the size of the networks to where everyone can sit around the same table. The four networks are: (1) the Sensorimotor network, headed by Dan Feldman in Biology; they will study the fine temporal dynamics of synaptic learning as well as motor learning; (2) the Interacting Memory Systems Network, headed by Andrea Chiba of Cognitive Science and Neuroscience, which will study the timing of interactions among memory systems; (3) the Perceptual Expertise Network headed by Isabel Gauthier and Tom Palmeri of the Vanderbilt Psychology Department; they will study the time course of how representations come online in perceptual expertise, such as face processing; and (4) the Social Interaction Network, headed by Javier Movellan of the Institute for Neural Computation, their focus is how time affects interactions between children and adults in educational settings, and how these processes can be implemented in a social robot, RUBI.

The network structure of the center was inspired by the success of the Perceptual Expertise Network. In its five years of existence, it has expanded collaborations among its researchers in an exponential manner, rapidly moving the science of perceptual expertise forward. The experience of researchers in this network will be available to facilitate the collaborative growth of the other three networks. At the same time, establishing synergistic interactions between these four networks is much more realistic and efficient than if we were to try to get more than 50 individual laboratories to interact within a single homogeneous center.

Cross-Cutting Resources:

Four cross cutting resources will be developed by our group and will subsequently be made available to others at the University and to the larger research and educational community.

The first of these resources will be a motion capture facility, centered in CalIT2. One use of this facility will be the high-resolution capture of the fine scale timing of interactions between a teacher and students from Preuss in a one to one teaching context. Analyses of such interactions will serve as a model for our educational
social robot RUBI. RUBI has been making regular appearances at Early Childhood Education Center, and has captured the hearts of the toddlers there, as well as implemented the California standard in teaching them colors and numbers.

The next resource is the Brain Dynamics Facility, headed by Scott Makeig of the Swartz Center for Computational Neuroscience. He will make his state of the art algorithms and hardware available for center members to study simultaneous EEG and fMRI; these measurement of brain function are complementary - the first gives fine scale temporal resolution, the second, very high spatial resolution.

The third resource is a Data Sharing Facility. This facility will be comprised of two integrated resources. The first will be a database providing managerial oversight, data-sharing, and longitudinal evaluation. This effort will be directed by Mark Appelbaum. Mark Appelbaum has experience providing these facilities for a number of research efforts. The second will be a data GRID to be used as a large scale data repository and analytical resource for the community. In collaboration with the San Diego Supercomputer Center, their Storage Resource Broker middleware will be modified to allow cutting-edge analytical capacity for large-scale data mining. This will be designed to suit the needs of our interdisciplinary community. Reagan Moore will direct the data GRID facility. Reagan and his group have lead over 30 collectives in establishing their GRIDS and, in doing so, have gained a strong international presence.

The fourth is the Education and Outreach Center, led by Paula Tallal of Rutgers and Terry Sejnowski.
In addition to participating in outreach, by augmenting our own academic advancement office, we have established partnerships (with Jensen Learning Corp. and Scientific Learning Corp.) for reaching thousands of high school teachers. The most visible component of the Outreach Center will be The Science Network, a new television network aimed at being "the CSPAN of Science", providing a forum for town hall meetings between policy makers, scientists, teachers, and the public. They have already produced several programs including a town hall meeting on stem cell research.

DELIVERABLES:
The center expects to deliver specific products to the community. The Science Network is intended to grow to disseminate information from all of the Science of Learning Centers and ultimately be used as a vehicle to educate and affect public policy. The data GRID will be designed such that it will be scalable to provide services to the entire Science of Learning Community. This center should serve as
a data-sharing model for other interdisciplinary communities as well. The existing reading remediation product, FastForWord, developed by Paula Tallal and colleagues will be enhanced and expanded according to our research findings. Let's Face It, a face and emotion recognition training system for autistic children will be further developed. RUBI the robot will be enhanced by our findings and replicated for use in multiple educational settings.