Neuroscience at Hebrew University

Report of the Neuroscience Review Committee

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The Committee:

Larry Abbott	**Columbia University-**
Richard Axel	**Columbia University**
Cori Bargmann	**Rockefeller University**
Nancy Kanwisher	**Massachusetts Institute of Technology**
Nikos Logothetis	**Max Planck Institute - Tubingen**
Bert Sakmann	**Max Planck Institute - Heidelberg**

Chaired by:

Gerald Fischbach	**Columbia University**

Mission

The charge to the Review Committee from President Menachem Magidor was to evaluate the state of neuroscience at Hebrew University, to describe current areas of strength and to identify areas of opportunity for future growth. We did not attempt an exhaustive evaluation of each individual or each program. We were also asked to comment on the need for a new neuroscience building now under consideration.

Overview

It should be made clear at the start, that the Hebrew University neuroscience community has a glorious history and that many members of the current faculty are among the best in the world in their areas of interest. The remarkable students on all three campuses and the commitment to teaching are unsurpassed in our experience. The fact that the neuroscientists are embedded in one of the most renowned universities in the world with great strengths in biological, chemical, physical, and social sciences, provides extraordinary opportunities for growth in new, increasingly vital directions. The fact that the community is located in Jerusalem, one of the most intellectually exciting and beautiful cities in the world, will be an enormous attractant to new faculty who will help define the future of neuroscience in Israel and abroad. With proper resources, Hebrew University can take its place among a small number of elite institutions in the world who will define the future of neuroscience in the 21st century.

The review proceeded in two stages. First, the Chair of the Review Committee, Dr. Gerald Fischbach, visited the campus in September 2006 to gather preliminary information, and plan the formal review. Second, informed by that visit the entire Committee visited the campus from Dec. 17 to Dec .21, 2006. On both visits, interviews were conducted with neuroscience faculty, students and administrators located at the three main University campuses at Ein Kerem, Givat Ram, and Mount Scopus. The three campuses are separated by significant distances within Jerusalem. However, we considered neuroscience at Hebrew University as one entity.

We also developed an historical perspective about neuroscience at Hebrew University in conversations with Hanoch Gutfreund, Rami Rahamimoff, Izhac Parnas, and Alex Keynan

The Scope of Modern Neuroscience

The discipline of neuroscience is expanding at an astounding rate. The profound mysteries of the mind/brain continuum, together with practical advances in combating brain disorders have captured the attention and imagination of the very best students and scholars. Advances at many levels of analysis from single molecules to cognition and behavior in experimental subjects that range from simple invertebrates to humans have lured physicists, chemists, mathematicians, psychologists, physicians, economists, social scientists, and philosophers.

Some of the most profound questions facing societies around the world are now informed by brain science. Indeed, one may speculate that great universities will be judged over the next generation by what they contribute to our understanding of the normal and disordered human mind. This is an important moment in the history of Hebrew University. Our Committee, influenced by this grand view of modern neuroscience, has tried to chart a way forward that not only builds on current strengths but that will break new ground and that will ensure Hebrew University's international leadership role.

Areas of Strength

It is impossible to provide a complete review of the entire neuroscience faculty, even after intensive preparation and discussion. What follows are illustrative examples selected independently of the faculty of origin (Medicine, Life Sciences, and Social Sciences).

Computational and Theoretical Neuroscience. Hebrew University is a world leader in the area of Computational and Theoretical Neuroscience. In the mid and late 1980s, Daniel Amit, Hanoch Gutfreund and Haim Sompolinksy played a pivotal role in establishing advanced theoretical methods as a tool in neuroscience and, along with Moshe Abeles, they launched the Interdisciplinary Center for Neural Computation (ICNC). Under the current leadership of Idan Segev, the ICNC has grown into what is arguably the leading program in the world for education in computational neuroscience. Haim Sompolinksy, Idan Segev and Naftali Tishby are all exceptional researchers who would be included on any list of the leaders in the field.

Motor Control systems. The primate motor control group consisting of Eilon Vaadia, Hagai Bergman and Yifat Prut, is doing outstanding work on motor planning, execution and learning in non-human primates. Eilon Vaadia and Hagai Bergman are well established and respected in the field. Yifat Prut is beginning an ambitious and exciting program that involves simultaneous recording in the motor cortex and spinal cord. She is the only researcher in the world currently doing such work. This is a difficult task, and we urge the university to give her the time she needs to demonstrate what she can achieve. She has already submitted a paper with interesting results on correlations between cortical and spinal cord activity during arm movements.

Benni Hochner's work on control of octopus arm movements was highly regarded by the committee. Hochner provides a striking counterexample to a complaint often heard in Israel, which is that it is impossible to recruit postdoctoral fellows. Hochner has three international, highly trained postdocs. When the research in a lab is truly unique, the best people will come.

Cellular physiology. Following the important tradition of synaptic physiology established at Hebrew University by Rami Rahamioff and his colleagues, several groups are engaged in studies of synapse formation, function, and plasticity and of neural circuit function. Adi Mitzahi, Israel Nelken, Yossi Yarom, Baruch Minke and Yoel Yaari are among the strongest investigators in this area. We note that only two of these groups use molecular and genetic techniques to dissect synaptic function.

The committee was impressed with Nelken's scientific excellence and the energy of his students. Mizrahi is using state of the art optical and genetic tools to dissect the contribution of adult stem cells to the wiring of the olfactory bulb in mice. Specifically he studies the contribution of newly formed inhibitory neurons. He has begun to use two photon imaging and vsd-imaging *in vivo* to dissect sensory coding in the olfactory bulb and, more recently, in the auditory system. He is also studying mechanisms of epilepsy in a mouse-model. Yarom uses vsd-imaging and whole cell patch clamp recording *in vitro* to dissect cerebellar input-output relations in rodents. Minke employs an array of genetic, optical and electrical recording tools to elucidate the function of trp channels in photoreceptors of *Drosophila*, focussing on the coupling between rhodopsin activation and the generator potential. A recent important result is documentation of a new mechanism of adaptation involving the regulation of trp-channel density in the surface membrane by endo- and exocytosis. Yaari is dedicated to the elucidation of epileptogenic mechanisms in a mouse models of epilepsy. This is done within a very successful collaboration with an epilepsy-center in Bonn.

Developmental neuroscience. The University has a small but excellent group in the area of developmental neurobiology. Chaya Kalcheim's studies of lineage and fate determination among neural crest and muscle precursors are highly regarded. Avihu Klar has continued his important work on F-spondin and related molecules involved in axon guidance and neuronal differentiation. He is attempting to define molecules and processes that determine the decision an axon must make to remain on he same side of the neural tube as the parent cell body (ipsilateral) or to cross to the other (contralateral) side. Kalcheim and Klar benefit by the work of Nissen Benveniste in the Department of Genetics who is studying the maturation of human embryonic stem cells. Tamir Ben-Hur's studies of stem cells in repair of demyelinating disorders and in a variety of neurodegenerative disorders have great promise.

Neurological and psychaitric disorders. Human genetics and patient oriented research were discussed in several contexts. In addition to his fundamental studies of spike patterns in the striatum, Hagai Bergman is involved in efforts to improve deep brain stimulation in various movement disorders. This intervention, clearly a frontier in therapeutic intervention, may applicability to other disorders including intractable epilepsy in the near future.

Hadassah Hospital provides valuable resources for patient-oriented brain research. The large patient population of this tertiary referral center is one of the best in Israel. Director General Mor-Yosef emphasized the interest of the Hospital in funding basic biomedical research. In this regard, Hadassah is an invaluable partner of the University. The planned imaging center, which will include MRI and PET for humans and animal studies and which will be dedicated entirely to research, will be built in close collaboration with he Hospital. With proper leadership and support, this could become a valuable resource in Jerusalem and throughout Israel. As suggested below, research groups at Ein Kerem should have access to new shared resources in microscopy and molecular biology, and by support of the graduate program.

Active programs in the genetics of several brain disorders including schizophrenia, Creutzfeldt Jacob Disease and autism were presented. Populations within Israel and in the surrounding areas offer unique advantages for such studies.

Human Cognitive neuroscience. This is an area of notable strength at Hebrew University. Research on perception is particularly strong, with good integration of behavioral and neuroimaging methods. Researchers in this area span the Department of Psychology, the Faculty of Medicine, and the Faculty of Life Sciences, and they share methodologies (fMRI, behavior, MEG, ERP, etc.) Udi Zohari is expert in the area of human fMRI. His lab has contributed importantly to our understanding of the neural basis of visual object representations, and has made the remarkable discovery that primary visual cortex is engaged in language processing in blind individuals. More junior researchers who work in closely related areas, and who show great promise in human cognitive neuroscience, are Deouell (who studies spatial representations and perceptual awareness), Amedi (who uses fMRI and TMS to study plasticity in human visual cortex , and who has a very impressive publication record for his career stage), and Ahissar (who has done important work on perceptual learning and on the perceptual basis of dyslexia).

Behavioral work on human perception is also well represented, with superb senior leadership provided by Shaul Hochstein. Research in human cognitive neuroscience at Hebrew University is strengthened by interaction with those working in systems and computational neuroscience and in linguistics.

Other groups are involved in decision theory and social interaction theory. This is clearly a frontier area in neuroscience that will allow for expanded interactions between psychologists and systems neuroscientists working on decision-making.

Students and Education. The undergraduate Cognitive Science program, under the creative leadership of Oron Shagrir has rapidly become one of the most desirable and competitive at the University. It now enrolls 50 students each year. This program also has an exemplary record of sending students on to graduate schools. This program should be preserved no matter what reorganization of neuroscience is adopted.

Graduate students are the glue that binds together research labs, as evidenced by the many collaborations between labs at the same and at different campuses. The university attracts the best graduate students in brain science in Israel, and this is a resource to be celebrated. The ICNC offers an outstanding graduate program accepting 8 students per year with a total of about 60 students. They attract some of the very best graduate students at the University, and they have been awarded Center of Excellence status by the European Union twice in recent years. The first two years are filled with excellent courses dedicated to the establishment of a significant knowledge background, and only then can a student start his independent research at one of the laboratories.

Opportunities

New programs should build on areas of strength, but the University must move beyond current areas of excellence in the coming years. It is our opinion that the following approaches will be among those that lead to a more profound understanding of the normal and diseased brain and we urge you to consider them in all new recruiting efforts.

Quantitative analyses of neural circuits.

We recommend that the University should not simply attempt to catch up with the successes of the last decade, but should move beyond them to address the exciting prospect of precise structural and functional definition of neural circuits that control specific behaviors.

The descriptive stage of molecular brain science – the identification of molecules encoding ion channels, neurotransmitter receptors, cell fate determinants, and so on has reached a plateau phase. Genetic and molecular and electrophysiological tools should now be used for the *experimental manipulation of neurons and neural circuits.* The excitement of the future is the ability to molecular genetics to describe and to change neuronal circuits.

Molecular genetics has provided tools for neuroanatomy, neurophysiology, and the neural basis of behavior that supplement the classical tools in these disciplines. Genetically encoded tracers for synaptic connectivity that determine cell-to-cell adhesion and the movement of molecules throughout individual cells (e.g. synaptophlorins, reporters of signal transduction such as chameleons, and tracers of chemoreceptor trafficking), as well as genetically-encoded trans-synaptic tracers of connectivity (e.g. pseudorabies virus and wheat germ agglutinin) will be invaluable in tracing neural circuits. Molecules that reversibly or irreversibly activate or inactivate individual neurons or groups of neurons within specific circuits (e.g. tetanus toxin or Shibire toxin, and channelrhodopsin) will aid in the manipulation of circuits. Molecular biology tools for cell type-specific gene expression are critical elements of this approach. Recruiting visionary scientists who use these and related tools will, ultimately, lead to manipulation and monitoring of neurons in behaving animals.

A major effort in this area should be on *quantitative functional anatomy* of particular circuits that subserve particular behaviors and cognitive functions. For example, a clearer understanding of synaptic connectivity within cortical columns and within subcortical structures associated with mood and emotions is within our grasp. Methods for reconstructing these circuits include, but are not limited, to: high-throughput electron microscopy, confocal and multi-photon microscopy, laser-scanning photostimulation of individual neurons in intact brain slices, high-resolution calcium imaging, and fluorescent cell tracing and reconstruction. These methods are most effective when combined with excellent electrophysiology (essential for laser-scanning photostimulation) and will interact in the future with more sophisticated genetic technologies (see below). The generation of proteins that trace neural circuits and allow visualization of function by two-photon imaging, the construction of proteins that inhibit components of the circuit and the design of molecules that allow the controlled exogenous activation of circuits should be among the new goals of molecular neuroscience at the University. Data gained with these techniques will constrain models for the processing of information in neural circuits.

For the foreseeable future, these tools will be developed and used most effectively in genetically-tractable model systems such as mice, fruit flies, nematodes, and zebra fish. But, in the future, they will be used in primates. Currently this extrapolation is extremely expensive, equipment-intensive, and uncertain. We do not, therefore, recommend primates as the primary experimental system for molecular studies at the present time.

Similar conclusions emerge when considering developmental neuroscience at the University. With few exceptions (Klar and Kalcheim) Hebrew University has not participated in the major advances in neural development and should not try simply to catch up, but rather should look ahead to the next generation of approaches to studies of neurogenesis and synapse formation.

Computational and theoretical neuroscience should remain a central core of the neuroscience community because of its excellence and because of its ability to link and unify different experimental areas. The current theoretical group at the university investigates a wide range of topics in neuroscience, but as the experimental group expands and grows in new directions, appropriate new hires in theory covering these additional areas may be desirable.

Human & Non-Human Primate Cognitive neuroscience.

One important goal of neuroscience is to understand human cognition and behavior at a mechanistic level. This goal requires parallel efforts on at least three levels. First, we need a detailed characterization of the cognitive and behavioral phenomena to be explained; such a characterization can be obtained by careful behavioral investigation in human subjects. Second, we must understand how such phenomena can, in principle, be produced by neurons; this question can be elucidated by modeling neural circuits. Finally, we need to know how actual neural circuits work; this work generally cannot be done in humans, but is instead approached by electrophysiological investigations of simple nervous systems or of more complex primate brains.

The greatest challenge is to bridge across these three levels of investigation to construct a compelling explanation of cognition and behavior. It is here that human and primate neuroimaging play crucial roles.

Studies in non-human primates, particularly old-world monkeys, are critical for closing the gap between human cortex and neural mechanisms in model systems. They are an essential step in relating the genetic manipulation of circuits in lower forms to the human brain. Work with anesthetized and alert monkeys over the last 60 years has shown that the sensory and motor systems of this species are similar to those of humans. Specifically, in the study of the visual system, comparisons of the psychophysical data of humans and macaques have shown remarkable similarities in many capabilities, such as sensitivity to brightness, contrast, color vision, stereopsis, binocular rivalry, oculomotor behavior, etc. Several groups have demonstrated that the recognition and memory systems of the monkeys are also very similar to the human system.

These considerations suggest that it will be crucial to hire new faculty who conduct research on primates, including neurophysiology, behavior, and imaging. In terms of topic areas, this work could either build on existing or branch into new areas (e.g. neuroeconomics, decision-making). In either case, work on behaving primates should be synergistically connected to work on humans; integration of work across species will be possible via parallel studies using fMRI and behavior on both humans and nonhuman primates.

The biology of neurological and psychiatric disorders.
A third area that will explode in the coming decades is the study of neuropsyciatric disorders. Taken all together, brain diseases rank high on the World Health Organization's list of disabling illnesses. They represent the most significant public health problem of our time. Recent advances in human genetics and pathophysiology and in the creation of animal models have suggested new approaches to the understanding of neurological and psychiatric disorders. The identification of sporadic Alzheimer's disease as a proteinopathy involving aggregated beta amyloid peptides is one case in point. Other examples include the role of neurogenesis in repair following brain trauma, in cognitive disorders such as schizophrenia, mood disorders such as major depression and chronic anxiety. Studies of non-human primates have led to the elucidation of circuit function and transmitter action in the basal ganglia, and this, in turn has led to novel brain stimulation therapies in Parkinson's disease and other movement disorders. Similar studies have identified areas in the brain that modify intractable epilepsy, obsessive-compulsive disorder and refractory depression. Thus non-human primate research must be enhanced to secure the success of Hebrew University as a center for the study of higher brain function.

Recommendations

1. *Recruitment of New Faculty*
Hebrew University has lost distinguished faculty due to retirement or competition from other institutions. It is essential that the faculty be renewed and expanded. The University is at a critical moment when it can "fall back" by simply expanding existing programs or it can leap ahead anticipating novel approaches. The Committee strongly urges the latter driven by recruitment of 15-20 new, independent, principal investigators who work in one or more of the fields generally defined broadly as:

1. Analysis of neural circuits including molecular/genetic manipulations.
2. Studies of cognitive neuroscience in animals and humans.
3. Biology of neuropsychiatric disorders.

Set-up funds will be needed for the construction of laboratories to support the research of new recruits, comparable to those offered by other leading research institutes in Israel.

2. *A new Neuroscience Research Building*

It is inconceivable that the number of recruits recommended can be housed in existing space. To provide space for the new recruits and to maximize their chance for success, they should be located in a new, state-of-the-art research building. We believe that this building must be at the Edmund Safra Givat Ram campus. .

Givat Ram is the geographic center of the neuroscience community; it is the location of the National Library, and it is the home of superb ICNC neuroscientists, who have argued convincingly for renewal of the neurosciences throughout the University. It is also the home base of many of he undergraduate and graduate students enrolled in neuroscience programs. We agree with the theorists in ICNC who emphasize that close collaboration with experimentalists will increase the likelihood of truly novel approaches to circuit analyses.

To meet the urgent need for new research space as new faculty arrive, the Neuroscience Building should include about 8000 sq. m. of research space. This amount of space should accommodate 25 research groups allowing for a ratio of new investigators to relocated existing faculty of 2:1. This ratio will provide an appropriate mix of new vigor and experience that is necessary as new approaches are explored in the context of a complex institution such as Hebrew University embedded in modern Israel. Choice of existing faculty to move into the new building should be based on their ability to mentor and interact with the new faculty as well as on research excellence. We recognize that a building of this size will increase research space at Hebrew University by nearly 20%. But this is not recommended lightly as a luxury. It is essential for the transformational changes called for in this report.

The building will be home for a subset of the neuroscience community. It should also serve as a “headquarters” or “coordinating center” for the University-wide Neuroscience Institute described below. Therefore, the building should include gathering spaces, such as seminar rooms, and at least one large lecture hall.

3. *A Neuroscience Institute*

The Committee recommends the creation of a Neuroscience Institute. We see this Institute as an umbrella organization with three major functions.

1. The Institute should play a major role in the recruitment of neuroscientists to Hebrew University.
2. The Institute should be charged with improving communication and collaboration between groups located at the three campuses in Jerusalem.
3. The Institute should assume responsibility for coordinating and enhancing undergraduate and graduate neuroscience education.

Neuroscientists at all three campuses should be eligible to join the Institute. Membership should not be a symbolic gesture, but would provide access to common resources. Membership should come with obligations in teaching, research mentoring and committee work.

We see the Institute as a unifying force recognizing important contributions of scientists at Ein Kerem, Mt Scopus and Givat Ram. It would be a highly visible statement recognized throughout Israel that the whole is far greater than the sum of the parts. And as stated above, it is essential for the recruitment of the very best scientists and the advance of the broad intellectual effort of neuroscience.

A Director for the Neuroscience Institute should be appointed as soon as possible. The director should help shape Institute programs and should be responsible for their successful operation once created. The Director should be a scholar of international repute with proven administrative skills. We recommend a broad international search for the first Director.

The Director should report directly to the President of the University. The Director should control the budget of the entire Institute and space allocation in the new building. The Director should also set criteria for the appointment of new recruits, and give final approval for membership in the Institute.

Recognizing the precedent set by the Center for Rationality, we recommend that members of the Institute should also be members of one or more Departments in the University. Agreements must be negotiated regarding space allocation and teaching obligations within the parent Departments.

In regard to education, the new Institute should coordinate efforts but not replace or compete with the excellent undergraduate Cognitive Science program or the graduate ICNC program.

One area that might be improved is recruitment of international students to the neuroscience program. The fact that all courses are taught in Hebrew, presents a challenge in this regard. The committee suggests that this requirement be removed as part of a program of broadening graduate education.

Graduate teaching should not be “voluntary.” Faculty who teach in Neuroscience Institute programs should obtain partial relief from teaching obligations in their home departments. Shared positions between the brain science center and other programs should have explicit rules in this regard, enforced by the relevant Deans, to prevent exploitation of program members. Which dean?

4. *Research infrastructure.*

The Neuroscience Building should be equipped with crucial shared facilities. Light and electron microscopy are evolving rapidly. They are also expensive. A common microscopy facility with shared equipment would be the best way to provide up-to-date resources in many kinds of microscopy: confocal, multiphoton, spinning-disc, serial-section, time-lapse, patterned-light/high resolution. A PhD-level operator of such a facility who would train students in the use of the equipment and maintain the equipment at the state of the art should be considered.

The emphasis on molecular genetics calls for modern genomics and proteomics shared facilities. Additional facilities for small-animal housing and behavioral testing may be needed.

We recommend that studies of non-human primate cognition and behavior be included in the new Neuroscience Building. This will require construction of expensive animal facilities adequate for sophisticated surgery, post surgical recovery, and modern animal housing. It will also require that at least one large-bore, high field strength magnet be located in the new building. A small-bore magnet for imaging brains of small mammals will also be useful.

The environment at the new Neuroscience Institute could be ideal for promoting an ambitious approach that reaches beyond existing technologies based on advances in physics, chemistry, and neuroscience. Examples of these techniques might include novel measures of functional activity in MRI, MR spectroscopy, magneto- and electroencephalographic measures of brain activity, and others yet to be developed.

Currently there is no significant planning at Hebrew University for integrating new imaging modalities. The human-fMRI plan is an acceptable start, but it falls short of a greater vision that promises to offer insights into computations performed by the actual networks subserving perception or cognition. A multimodal approach is more necessary than ever for the study of brain function and dysfunction. Such an approach must include further improvements to MRI technology and its combination with other noninvasive techniques that directly assess the brain’s electrical activity (e.g. MEG). Only a tight coupling of human and animal experimentation will allow us to understand the homologies between humans and other mammals that are amenable to invasive electrophysiological and pharmacological testing. Investigations of the relatioin between hemodynamics and neural activity are needed. In addition, new methods that do not rely entirely on hemodynamics will be needed to improve temporal and spatial resolution. These include the development of MR-detectable smart probes that change magnetic properties as a function of the concentration of ions and molecules involved in neural signaling.

If primate research is to be conducted at Givat Ram, we recommend that the motor control group move there from Ein Kerem. The research of the motor control group is central to the research goals of the Institute. They currently maintain 10-15 monkeys, and they are limited by the animal facilities available at Ein-Kerem. Their experience in the conduct of science in Israel, their great expertise, and their intimate knowledge of the Ein Kerem community make it desirable to have them located close to new recruits at Givat Ram.

5. ***A Research Endowment.*** Beyond the shared equipment and the set-up money we recommend the creation of a research endowment that will support the most imaginative science and that will provide bridge funds for excellent faculty with a temporary gap in grant support. The endowment should be used to support neuroscience throughout the University.

Challenges

Money and Space. We recognize that these universal challenges are particularly acute in Israel at the present time. Our recommendations are made in the hope that funds can be raised and space made available. Beyond money and space, certain political issues present significant challenges that will require strong leadership on the part of the Director and the University administration.

Avoid Fragmentation. While it is important to locate new faculty and a few of the existing faculty in a new Neuroscience Building, it is also important to avoid creation of a two-tiered system leaving deserving scientist/educators with fewer resources and greater teaching loads. Such an outcome would inhibit essential collaborations across schools and departments. It will be important to open access to the Neuroscience Institute to all deserving, relevant faculty at the university. We envisage an center-surround organization that is prevalent at many outstanding academic centers outside of Israel.

The Psychology Department illustrates the problem. Members of Psychology expressed a strong desire to remain together as a unit. However, several programs within Psychology would benefit from closer association with scientists at Givat Ram and Ein Kerem. They feel in “exile” at the Mt. Scopus campus where they have limited access to experimental laboratories. The Committee feels that transferring the Psychology Department as a whole (about 1,000 m^2) would ultimately be desirable, and would follow the general evolution in the field of psychology from the social sciences to the natural sciences. However, moving the Psychology Department to the Givat Ram campus should be at the expense of space for new recruits in the new Neuroscience Building.

Location of Primate research. A decision must be made regarding the location of human and non-human primate research. As stated above, the ideal solution would be to locate primates in the new Neuroscience Building as they are integral to efforts to understand neural circuits involved in and simple behaviors and in cognition.

We recognize that a new Imaging Center is to be located at the Hadassah Hospital in Ein Kerem, and we understand that this facility is to be used entirely for research. If monkeys can be studied in these magnets, location of all primate research at Ein Kerem should be given careful consideration. One drawback of this location is that the animal facility will not be located in the same building.

A word about development of a modern MRI facility is needed. A typical human-scanner is well suited for the conduct of “off-the-shelf” measurements of brain function using fMRI, and will be of value to some research groups including Zohary, Bentin, Amedi, and Hochstein. Their research questions can be addressed using current technology. The same scanner can also be used for studies of non-human primates, including anatomical studies (e.g. to guide electrode placement) and functional studies (e.g. to identify activation foci as targets for detailed physiological investigation). In such a center, a qualified MR physicist with training in spectroscopy and MR imaging is absolutely necessary. In addition, an RF engineer familiar with single and multiple channel acquisition systems would be of great benefit; Finally, a technician is necessary for running daily experiments.

It is difficult but urgent to find a qualified physicist who is capable of pulse programming. Many of the excellent physics students at Hebrew University would qualify for training at one of the Centers in the USA or Europe. On their return, they should have some freedom for pure MRI research as this is compatible with their “service” role. In fact, they will probably recruit other students to combine MR research with optimization of applications.

Undergraduate and Graduate training. Hebrew University is regarded by most as the best graduate training in Israel, and they have had their pick of the very best students. However, this situation may not endure without added resources for students. Potential competitors are on the horizon (internationally and within Israel). Students must receive stipends that are competitive with other institutions.

Students in the Cognitive Science undergraduate program desire access to research labs. The Committee strongly endorses this effort as these superb students are a main source of neuroscience PhD candidates and hence, are vital to the entire research effort.

Time and pay for teaching neuroscience. Teaching must remain a crucial mission of the Neuroscience program. We were concerned faculty can now retire and retain their lab space, and recruit students. However such supported scientists are not required to teach after retirement. Because lab space is limited, this system might force all teaching onto junior faculty members who at the same time will not have adequate lab space. Exploitation of junior faculty in this way is a potential danger to the future growth of neuroscience at Hebrew University. Involvement in teaching and other educational responsibilities should be a requirement for membership in the Neuroscience Institute.

Acknowledgments

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We want to extend special thanks to Inbal Goshen whose attention to detail, broad knowledge of the Hebrew University neuroscience community, insights about the spectrum of research now underway, and passion about the future of that community were all enormously helpful.

Members of the Neuroscience Review Committee

Larry Abbott
Affiliation: Department of Physiology and Cellular Biophysics, Columbia University
Research Field: Mathematical modeling and analysis of neurons and neural networks.
* Member of the American Academy of Arts and Sciences.

Richard Axel
Affiliation: Department of Biochemistry and Molecular Biophysics, Columbia University
Research Field: Defining the logic of olfactory perception; how individual sensory neurons express a specific receptor and how the brain distinguishes which receptors have been activated.
* Member of the National Academy of Sciences, U.S.A.
* Member of the American Academy of Arts and Sciences.
* **Nobel Prize Laureate in Medicine 2004**.

Cori Bargmann
Affiliation: Laboratory of Neural circuits and behavior, Howard Hughes Medical Institute, The Rockefeller University.
Research Field: Nervous system development and behavior in the nematode *C. elegans*, as a tool to understand animal behavior, based on the interplay between its environment, its experience, and intrinsic properties of its neural circuits.
* Member of the National Academy of Sciences, U.S.A.
* Member of the American Academy of Arts and Sciences.

Nancy Kanwisher
Affiliation: Department of Brain and Cognitive Sciences, McGovern Institute, Massachusetts Institute of Technology.
Research Field: Characterization of the cognitive and neural basis of face and object recognition in humans using fMRI.
* Member of the National Academy of Sciences, U.S.A.

Nikos Logothetis
Affiliation: Department of Physiology of Cognitive Processes, Max-Planck-Institute for Biological Cybernetics, Tubingen.
Research Field: The characterization of neural mechanisms of perception and object recognition using fMRI, and the development of methodologies that will facilitate the study of the function, connectivity, and neurochemistry of the non-human primate brain in the context of behavioral paradigms.

Bert Sakmann

Affiliation: Max Planck Institute for medical research, Heidelberg
Research Field: The structure and function of the cortex as a basis for "Higher Brain Functions"
* Member of the National Academy of Sciences, U.S.A.
* Member of the American Academy of Arts and Sciences.
* **Nobel Prize Laureate in Medicine 1991**.

Chaired by:

Gerald Fischbach

Affiliation: Department of Pharmacology, Columbia University.
Research Field: Molecular control of the formation and maintenance of synapses, particularly the neuromuscular junction.
* Member of the National Academy of Sciences, U.S.A.
* Member of the American Academy of Arts and Sciences
* Member of the Institute of Medicine