Department of Psychology, Neuroscience & Behaviour
Description of Research Facilities

The department has extensive facilities for animal and human research. Major renovations to the Psychology building were done in 2002/2003. These renovations significantly improved the department's facilities for conducting animal and human research.

Systems Neuroscience

The most elaborate and expensive equipment is found in the Systems Neuroscience laboratories. Individual laboratories have general-purpose equipment such as pH meters, centrifuges, shaker tables, refrigerators, freezers, deep-freezers, gel-tanks, gel-readers, stereo-microscopes, osmometers, balances, and other typical laboratory measurement devices. More specialized equipment for behaviour and in vivo physiology includes – in addition to an intrinsic optical imaging suite – equipment for the recording and delivery of ultrasonic auditory stimuli, computers with associated control and data acquisition interfaces, stereotaxic instruments, surgical instruments, electroencephalography (EEG) equipment, anesthesia and life-support equipment, surgical operating microscopes, iontophoresis equipment, and other equipment for acute and chronic extracellular recording. Specialized equipment for in vitro physiology includes electrode pullers, microscopes, tissue sectioner, and other equipment for intracellular physiology, and (under construction) calcium imaging and flash photolysis in living brain tissue. Specialized equipment for neuroanatomical and other histological studies includes that for tissue sectioning and tissue processing, an automated microscope for computerized tomography, and other microscopes, digital cameras, and technology for digital image processing. Additional histology equipment available to all members of the department includes a slide incubation oven, vibratome, widefield microscope with cell-counting software, cryostat, and confocal microscope.

Dr. Becker runs the Neurotechnology and Neuroplasticity Lab, and her lab is equipped with EEG facilities and state-of-the-art computer technology to support her computational modeling and empirical studies of learning and memory. *Drs Becker, Roberts and Bruce* (associate member) are in the process of ordering equipment for their newly built, CFI-funded Hearing Technology Research Lab at McMaster's Innovation Park, which will include EEG systems, audiological testing equipment, and computers for simulation and analysis. *Drs. Bock, Brown and Hall* collect human magnetic resonance imaging (MRI) on a 3 Telsa research-dedicated scanner housed at St Joseph's hospital, and *Dr. Bock's* laboratory contains a 7 Tesla mouse MRI scanner, that also includes high-end workstations for running image processing pipelines. *Dr. Gillespie's* laboratory is equipped to perform patch-clamp electrophysiology (in living brain slices), extracellular single-unit electrophysiology (in vivo), tract tracing, immunolabeling, single-cell electroporation (cellular morphology), and 3D neuronal reconstruction. *Dr. Murphy's* lab houses and examines a library of rare and valuable post-mortem tissue samples from the human brain, as well as a collection of animal models of visual development. Additional histology equipment available to all members of the department includes a slide incubation oven, wide-field epifluorescence microscope, and cryostat.

Animal Facilities

The renovated animal facility is a state-of-the-art research centre comprising 20,680 square feet of space. It was built with a Superbuild grant and funding from other supporting granting agencies, totalling several million dollars The area houses a controlled-security-access animal holding space for a variety of live animals (rats, mice, gerbils, fish, bats, and cats), procedure rooms, a physiological optical imaging laboratory, two animal surgery suites, support facilities, water purification system, ice machine, automatic cage washing facility, and laboratories with all new mechanical heat/air controlled systems.

The University's Central Animal Facility provides animal caretakers and technicians. The facilities are inspected regularly by the Ontario Ministry of Agriculture and Food and by the Canadian Council of Animal Care, and are subject to random inspections by the Ontario Ministry of Labour, and provincial and municipal environmental and safety regulators.

Dr. Balshine, in addition to her field work in Lake Ontario and abroad, conducts carefully controlled experiments on social and parenting behaviour in her laboratory, where she houses dozens of experimental fish tanks. *Dr. Dukas* and his students carry out research incorporating advanced genetic and computer vision tools to study the mechanisms and evolutionary biology of cognition in a variety of insect model systems, including bees, fruit flies, wasps and grasshoppers. *Dr. Faure* houses bats in his laboratory and has equipment that allows him to conduct psychophysical tests to study prey detection in bats, acoustic playback experiments to evoke and manipulate acoustic and auditory behaviour, and sound recording and signal analyses.

Human Laboratories

All the labs in the department are heavily dependent upon computers. Computers dedicated to controlling experiments are major equipment items in the human research labs (Cognition and Perception, Development, and Social). The decision was made many years ago not to centralize computing, either for the on-line control of experiments or for data analysis. There are specialized computers for producing visual displays (including virtual reality displays) and auditory stimuli and music, cameras, photometers and polygraphs etc. The necessary calibration equipment is available, as well as sound-insulated and electrically-shielded rooms for the human labs doing auditory and/or electrophysiology research.

Of particular interest is the LIVELab, headed by *Dr. Trainor* and that is used in her research program and that of other faculty members in the department and beyond (including international researchers). The LIVELab is a unique research performance space. It has exquisite virtual acoustic control such that it can transform from the acoustics of a subway station to a concert hall with the flip of a switch. The multi-person EEG, physiology, motion capture and other systems are precisely synchronized to enable cutting-edge multi-faceted analysis of complex questions of human interaction related to music, social interaction, pedagogical practices, hearing, vision, movement, and learning (http://livelab.mcmaster.ca).

The department houses five human electrophysiology laboratories: one that is shared by *Drs. Bennett, Sekuler*, and *Shore*, and four more that are operated, respectively, by *Drs. Roberts, Schmidt, Shedden*, and *Trainor*. All of these labs are outfitted with state-of-the-art equipment to collect EEG, event-related potentials, and cardiac physiology. *Drs. Humphreys* and *Watter's* laboratory includes an EEG system, several eye-tracking systems, and sound-attenuated rooms for precise audio-stimulus delivery. *Dr. Roberts'* lab (co-directed with PNB Associate Member Ian Bruce, Faculty of Engineering) houses a full suite of equipment for measuring human auditory function (hearing thresholds to 20 kHz, otoacoustic emissions, middle ear reflexes, neural responses from the auditory midbrain) as well as access to cochlear modeling of neural data that can reveal hearing pathologies hidden from the clinical audiogram. *Dr. Feinberg's* laboratory is equipped to test the production and perception of vocal characteristics, as well as to create 3D images of faces and conduct psychophysical tests of face perception. *Dr. Trainor's* lab houses EEG equipment specialized for testing infants and special populations. The department has a number of eye-trackers, including in the laboratories of *Drs. Bennett, Rutherford, Sekuler, Shedden* and *Shore*. *Dr. Shedden* also has a laboratory (co-directed with Martin von Mohrenschildt, Faculty of Engineering) housing a custom-built full-motion simulator for driving and flying in virtual environments to measure a variety of responses (behavioural, EEG, eye-tracking) to

multisensory stimuli (visual, auditory, and 6 degrees-of-freedom motion) while participants operate large vehicles in realistic scenarios. *Dr. Goldreich's* laboratory probes human tactile perception with precisely controlled stimuli. It houses a mini 3D printer and a mini milling machine used to produce haptic and tactile stimuli, and a variety of computer-controlled motors and force sensors used to conduct tactile psychophysics research.

The 2002/2003 renovations to the human research facilities were paid for by funds from the University and the
Canada Foundation for Innovation. The renovations included: updating of communication wiring to all rooms of the entire research wing as well as new power panel upgrades; nine new laboratory rooms; two new classrooms; four new meeting rooms; upgrades to lighting systems; emergency power upgrades; electrical data lines; and a new security system in the research wing.

The Imaging Research Centre (IRC) at St. Joseph's Healthcare Hamilton provides the research community with access to cutting-edge imaging technology. Staffed with highly-trained personnel, the IRC conducts research spanning from clinical trials to basic science. The IRC is home to a state-of-the-art, research-dedicated 3T MRI scanner, and a PET/CT scanner that is used clinically and for research. The IRC serves as a nexus of imaging expertise, collaborating with researchers from across Hamilton and southern Ontario. Several PNB faculty members (*Hall, Brown, Becker, Bock*) run MRI studies at the IRC based on a user fee of $500/hour. These include functional MRI studies, anatomical MRI studies, and studies of brain connectivity using diffusion tensor imaging. Anatomical MRI's from the IRC have also been used in a number of electroencephalography studies in PNB in order to support source localization of EEG signals.