MEMORANDUM

To:       Executive Committee of Faculty Council (March 20, 2018)
          Faculty Council (April 11, 2018)

From:     Professor Julie Audet
          Chair, Engineering Graduate Education Committee (EGEC)

Date:     March 8, 2018

Re:       Adding PhD Degree Level to Collaborative Specialization in Psychology and Engineering

REPORT CLASSIFICATION
This is a major policy matter that will be considered by the Executive Committee for endorsing and forwarding to Faculty Council for vote as a regular motion (requiring a simple majority of members present and voting to carry).

ACADEMIC RATIONALE
The Department of Mechanical & Industrial Engineering is proposing to add a doctoral level to the existing Master’s Collaborative Specialization in Psychology and Engineering (PsychEng).

Since launching in September 2017, the PsychEng collaborative specialization has enrolled the expected number of graduate students from MIE, but fewer than expected from Psychology. Few graduate students in that department are able to fulfill more than the base requirements of coursework, a thesis and often, required teaching assistantships, all within a single-year intensive MA program. In contrast, PhD students in Psychology undertake an “outside” project, which presents an opportunity towards research that incorporates engineering and will facilitate the achievement of the collaborative specialization.

PROCESS AND CONSULTATION
The proposal has been written by MIE with input from the Department of Psychology and the Dean’s offices in the Faculty of Applied Science & Engineering and the Faculty of Arts & Science. It has been approved by the Engineering Graduate Education Committee, which includes the graduate chairs from graduate departments and institutes and graduate student representatives, and will be considered for approval by the Councils of both Faculties.

MOTION
THAT a PhD degree level be added to the existing Master’s Collaborative Specialization in Psychology and Engineering, effective September 2018.
University of Toronto

Major Modification Proposal
Degree Level within an Existing Collaborative Specialization

This template should be used to bring forward all proposals for adding a master’s or doctoral level to an existing graduate collaborative specialization for governance approval under the University of Toronto’s Quality Assurance Process. The University understands a Collaborative Specialization to be: “an intra-university graduate program that provides an additional multidisciplinary experience for students enrolled in and completing the degree requirements of one of a number of specified degree credit programs.”

<table>
<thead>
<tr>
<th>Collaborative Specialization</th>
<th>Collaborative Master’s Specialization in Psychology and Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proposed Degree Level to be Added</td>
<td>Doctoral</td>
</tr>
<tr>
<td>Lead Faculty / Academic Division</td>
<td>Applied Science &amp; Engineering</td>
</tr>
<tr>
<td>Dean’s Office Contact</td>
<td>Prof. Julie Audet, Vice-Dean, Graduate Studies</td>
</tr>
<tr>
<td>Supporting Unit Contact</td>
<td>Prof. Li Shu, PsychEng Collaborative Specialization Director</td>
</tr>
<tr>
<td>Version Date</td>
<td>March 8, 2018</td>
</tr>
</tbody>
</table>

1 Academic Rationale

This proposal is to add a doctoral level to the existing graduate Collaborative Specialization in Psychology and Engineering (PsychEng). In its pilot year, the PsychEng collaborative specialization has enrolled the expected number of graduate students from MIE (5), but fewer than expected students from Psychology (1-2).

Speaking with graduate students in the Department of Psychology revealed that few are able to fulfill more than the base requirements of coursework, a thesis and often, required teaching assistantships, all within a single-year intensive MA program. In contrast, PhD students in Psychology undertake an “outside” project, which presents an opportunity towards research that incorporates engineering.
2 Effective Date

September 2018

3 Participating Degree Programs and Names of Units

3.1 Current Participating Programs/Degrees

<table>
<thead>
<tr>
<th>Faculty of Home Program</th>
<th>Unit</th>
<th>Program name</th>
<th>Degree/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty of Applied Science &amp; Engineering</td>
<td>Department of Mechanical and Industrial Engineering (MIE)</td>
<td>Mechanical Engineering Industrial Engineering</td>
<td>Master of Applied Science (MASc)</td>
</tr>
<tr>
<td>Faculty of Arts &amp; Science</td>
<td>Department of Psychology</td>
<td>Psychology</td>
<td>Master of Arts (MA)</td>
</tr>
</tbody>
</table>

3.2 Participating Programs/Degrees at New Degree Level

<table>
<thead>
<tr>
<th>Faculty of Home Program</th>
<th>Unit</th>
<th>Program name</th>
<th>Degree/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty of Applied Science &amp; Engineering</td>
<td>Department of Mechanical &amp; Industrial Engineering (MIE)</td>
<td>Mechanical Engineering Industrial Engineering</td>
<td>Doctor of Philosophy (PhD)</td>
</tr>
<tr>
<td>Faculty of Arts &amp; Science</td>
<td>Department of Psychology</td>
<td>Psychology</td>
<td>Doctor of Philosophy (PhD)</td>
</tr>
</tbody>
</table>

4 Admission and Specialization Requirements

PhD applicants must be accepted into one of the participating graduate degree programs (PhD in the Department of Mechanical & Industrial Engineering or PhD in the Department of Psychology) before being accepted into the collaborative specialization.

In addition to satisfying the home degree admission requirements, applicants will provide a statement of purpose in which they describe their background or experience relating to engineering, psychology, and their intersection, and why they are interested in pursuing graduate studies in the PsychEng collaborative specialization.

It will be the applicant’s responsibility to find an appropriate faculty member for supervision and support of the corresponding thesis research; thus applicants will be expected to contact and meet with potential supervisors among the core faculty of the collaborative specialization during the application process. The supervisor will provide a letter of recommendation in support of the student’s application to the collaborative specialization. As part of this process, the supervisor and student may choose to engage a co-supervisor from the collaborating
department. Envisioned is a possible co-supervision arrangement between the home degree-program supervisor and another faculty member where the home degree-program supervisor has primary responsibility for academic and administrative matters (i.e., responsible for ensuring the student is advised on the rules and regulations of the home-degree-program thesis process). The home-unit supervisor may choose to support the student’s application through discussions with the PsychEng Collaborative Specialization Director, and when needed, the PsychEng Collaborative Specialization Committee. The final decision to admit the student into the collaborative specialization is up to the Collaborative Specialization Director and Committee.

Students at the doctoral level will take a two terms of 0.0-weight seminar course, APS1308 PsychEng Seminar Series – PhD level (CR/NCR), and complete two PsychEng half courses (totaling 1.0 FCE), at least one from the other participating department, as two of the electives within their home program course requirements. Further, as is normally the case for collaborative specializations, the thesis requirement for the home program will be focused on a topic in the area of PsychEng.

Upon certification by the Collaborative Specialization Director that all requirements of the collaborative specialization have been fulfilled, completion of the collaborative specialization will be noted on the student’s transcript.

Individual students are allowed to complete the collaborative specialization at both the master’s and PhD levels. While the course requirements for the two programs are similar, PhD students will take a PhD-level of the core seminar course that requires them to present more frequently and/or take a leadership role in seminar activities such as the discussion of research papers, and their research will be at a level appropriate to a PhD degree. Students completing the collaborative specialization at both the master’s and PhD level would not be able to take the same electives twice.

**Collaborative Specialization and Course Requirements**

All students at both the master’s and the doctoral levels will take a common, required 0.0 weight (CR/NCR) weekly seminar course, APS1305 PsychEng Seminar Series – Master’s level, or APS1308 PsychEng Seminar Series – PhD level for two sessions. Students may elect to attend subsequent years if they find the seminar helpful for research. This will help build community among the students in the specialization. The seminars will also be open to other faculty and students, to further build the PsychEng community. This will be the common learning element of the collaborative specialization, and will contribute towards the MIE seminar requirement for MIE students.

Presentations, workshops, and discussion will be used in the seminar course to introduce theoretical foundations, methods, and techniques related to PsychEng research. Topics may change from year to year and may include: hypothesis generation, concept and knowledge mapping, survey design, mixed methods, ethics approvals, facilitating workshops, proposal writing, and preparation of manuscripts.
Faculty will present their relevant research, and students will present their work at various points to obtain feedback, with more advanced students having increasing involvement. Students will deliver a seminar on their research topic during their first term, and after designing and carrying out one or more experiments with input from other seminar participants, they will present their research results in their second term.

In addition to the core seminar course, students will complete two elective half courses as part of their existing home program requirements, cross-listed by the partner department as required. These will be chosen from a subset of the existing courses within Psychology and MIE. At least one course must be from the non-home faculty, subject to exclusions.

**MIE Courses**

Several MIE graduate courses do not require extensive undergraduate background in engineering. Identifying these courses and admitting and advising psychology students will help them succeed in their MIE course.

Examples of suitable MIE/KMD courses include:

- MIE1070: Intelligent Robots for Society (Nejat)
- MIE1402: Experimental Methods in Human Factors Research (Chignell)
- MIE1403: Analytical Methods in Human Factors Research (Milgram)
- MIE1412: Human-Automation Interaction (Jamieson)
- MIE1415: Analysis and Design of Cognitive Work
- MIE1505: Enterprise Modeling (Grüninger)
- MIE1510: Formal Techniques in Ontology Engineering (Grüninger)
- MIE1720: Creativity in Conceptual Design (Shu)
- KMD2001: Human Centred Design (Chignell)

**PSY Courses**

**PSY1000 Directed Studies**

Under the direction of a two-person committee (one from each of the partner Faculties if appropriate), students in the first year of the master’s program will (a) complete a programme of prescribed reading in their general area of specialization (b) prepare a major paper, which will include a proposal for master’s-level thesis research, and (c) defend the paper to the satisfaction of the two-person committee.

In addition to PSY1000, all graduate psychology courses offered in the 5000 series will be available to all students in the collaborative specialization. As not all 5000-level courses are available every year, students must consult the program to determine the courses available each year. Courses not available to MIE students in the specialization include PSY2001, PSY3001 and PSY2002.
The list of available courses may change periodically, and students may take alternative courses that better meet their academic needs, with approval of their supervisor. The Director of the Collaborative Specialization will review the elective course list annually and modify it as needed. Students must select at least one elective course offered by the partner Faculty so as to broaden their educational experience.

4.1 SGS Calendar Copy

<table>
<thead>
<tr>
<th>CALENDAR ENTRY</th>
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<tbody>
<tr>
<td>Psychology and Engineering</td>
</tr>
<tr>
<td><strong>Lead Faculty</strong></td>
</tr>
<tr>
<td>Faculty of Applied Science &amp; Engineering</td>
</tr>
<tr>
<td><strong>Participating Degree Programs</strong></td>
</tr>
<tr>
<td>Mechanical &amp; Industrial Engineering – MASc and PhD</td>
</tr>
<tr>
<td>Psychology – MA and PhD</td>
</tr>
<tr>
<td><strong>Supporting Units</strong></td>
</tr>
<tr>
<td>Department of Mechanical &amp; Industrial Engineering</td>
</tr>
</tbody>
</table>

**Overview**
The Collaborative Specialization in Psychology and Engineering (PsychEng) is between the Department of Mechanical & Industrial Engineering (MIE) in the Faculty of Applied Science & Engineering (FASE) and the Department of Psychology (PSY) in the Faculty of Arts & Science (FAS).

Engineering involves the creative application of science to the design of systems, processes, structures and technologies. Psychology is a science that focuses on the mind and behavior of people and animals to understand individuals and groups across all levels of analyses, from the cellular to the cultural. The Psychology and Engineering Collaborative Specialization supports graduate students and faculty interested in contributing to the growing interdisciplinary scholarship at the nexus of psychology and engineering. Fields of study that may benefit from this collaborative specialization include, but are not limited to: human factors, design theory and methodology, artificial intelligence and information engineering, operations research, and robotics. This specialization strengthens ties between the two departments, and may propel research of interest to both beyond what is possible individually.

Upon successful completion of the master’s and/or doctoral degree requirements of the home department and the collaborative specialization, students receive the notation “Completed Collaborative Specialization in Psychology and Engineering” on their transcript and parchment.

**Contact and Address**
Web: http://gradstudies.engineering.utoronto.ca/collaborative-specialization-psychology-engineering-psycheng/
Email: psych_eng@mie.utoronto.ca
Telephone: (416) 946-3028
Fax: (416) 978-7753
Collaborative Specialization in Psychology and Engineering
Department of Mechanical and Industrial Engineering
5 King’s College Road
Toronto, Ontario M5S 3G8
Canada

Master’s Level

Admission Requirements
• Applicants to the collaborative specialization must first apply to and be admitted to a master’s-level graduate degree program in one of the collaborative departments. Next, application to the collaborative specialization requires:
  o Applicant statement of purpose that describes background experience relating to Psychology and Engineering, and motivation for pursuing graduate studies in PsychEng.
  o Supervisor letter of recommendation in support of student’s application to PsychEng.

Specialization Requirements
• Two (2) terms of APS1305 PsychEng Seminar Series (Master’s level)
• Two (2) half courses (1.0 FCE). Students must take two (2) PsychEng electives, one (1) of which must be from the non-home department.
• Thesis focused on a topic in the area of the Collaborative Specialization

Completion of Specialization Requirements
All students enrolled in the Collaborative Specialization must complete the requirements of the Collaborative Specialization, in addition to those requirements for the degree program in their home graduate unit. The Collaborative Specialization Director and/or Specialization Committee is/are responsible for certifying the completion of the Collaborative Specialization requirements. The home graduate unit is solely responsible for the approval of the student’s home degree requirements.

Doctoral Level

Admission Requirements
• Applicants to the collaborative specialization must first apply to and be admitted to a doctoral-level graduate degree program in one of the collaborative departments. Next, application to the collaborative specialization requires:
  o Applicant statement of purpose that describes background experience relating to Psychology and Engineering, and motivation for pursuing graduate studies in PsychEng.
  o Supervisor letter of recommendation in support of student’s application to PsychEng.

Specialization Requirements
• Two (2) terms of APS1308 PsychEng Seminar Series – PhD level
• Two (2) half courses (1.0 FCE). Students must take two (2) PsychEng electives, one (1) of which must be from the non-home department.
• Thesis focused on a topic in the area of the Collaborative Specialization
• Students who have completed the PsychEng Collaborative Specialization at the master’s level will take the core seminar course at the PhD level, which requires a higher level of participation, (i.e., present more frequently and/or take a leadership role in seminar activities such as the discussion of research papers), and take two (2) further (different) PsychEng electives during their doctoral
program, and their research will be at a level appropriate to a PhD degree.

**Completion of Specialization Requirements**

All students enrolled in the Collaborative Specialization must complete the requirements of the Collaborative Specialization, in addition to those requirements for the degree program in their home graduate unit. The Collaborative Specialization Director and/or Specialization Committee is/are responsible for certifying the completion of the Collaborative Specialization requirements. The home graduate unit is solely responsible for the approval of the student’s home degree requirements.

**Core Course**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>APS 1305</td>
<td>PsychEng Seminar Series – Master’s level (Credit/No Credit)</td>
</tr>
<tr>
<td>APS 1308</td>
<td>PsychEng Seminar Series – PhD level (Credit/No Credit)</td>
</tr>
</tbody>
</table>

**Elective Courses**

**Mechanical and Industrial Engineering**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIE 1070H</td>
<td>Intelligent Robots for Society</td>
</tr>
<tr>
<td>MIE 1402H</td>
<td>Experimental Methods in Human Factors Research</td>
</tr>
<tr>
<td>MIE 1403H</td>
<td>Analytical Methods in Human Factors Research</td>
</tr>
<tr>
<td>MIE 1412H</td>
<td>Human-Automation Interaction</td>
</tr>
<tr>
<td>MIE 1415H</td>
<td>Analysis and Design of Cognitive Work</td>
</tr>
<tr>
<td>MIE 1505H</td>
<td>Enterprise Modelling</td>
</tr>
<tr>
<td>MIE 1510H</td>
<td>Formal Techniques in Ontology Engineering</td>
</tr>
<tr>
<td>MIE 1720H</td>
<td>Creativity in Conceptual Design</td>
</tr>
<tr>
<td>KMD 2001H</td>
<td>Human-Centred Design</td>
</tr>
</tbody>
</table>

**Psychology**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>PSY 1000H</td>
<td>Directed Studies</td>
<td></td>
</tr>
</tbody>
</table>

Department of Psychology courses offered in the 5000 series (contact the department for exclusions)
4.2 Collaborative Specialization Requirements and Degree Program Requirements

<table>
<thead>
<tr>
<th>Participating program</th>
<th>Structure of requirements of participating program</th>
<th>How Collaborative Specialization requirements are accommodated within elective space</th>
<th>30% CS academic content for coursework only programs (indicate FCEs)</th>
</tr>
</thead>
</table>
| Doctor of Philosophy in Mechanical & Industrial Engineering | • 2.5 full-course equivalents (FCEs) where 0.5 to 1.0 FCE must be completed in the Department  
• Participation in the non-credit seminar course JDE 1000H  
• In Years 1 & 2 attend at least 70% of seminars that are part of the MIE Seminar Series SRD 4444Y MIE Seminar Series  
• Qualifying exam  
• Thesis | APS1308 - PsychEng Seminar Series – PhD level and 1.0 elective requirements can be completed within existing elective space | N/A |
| Doctor of Philosophy in Psychology | • PSY 3000H Research Project in Psychology, usually taken in PhD 1  
• PSY 3001H Scientific and Professional Psychology, usually taken in PhD 1  
• An advanced statistics course chosen from a list provided by the department.  
• 2 half courses  
• 4000H thesis proposal and oral exam  
• Thesis | APS1308 -PsychEng Seminar Series – PhD level and 1.0 FCE of CS requirements can be completed within existing elective space | N/A |

5 Degree Level Expectations, Program Learning Outcomes and Program Structure

Graduate students in a collaborative specialization will gain skills in acquiring and transferring knowledge from a significantly different, yet highly relevant field. Such skills will continue to serve them in their career, where they can continue to apply not just relevant information from
the complementary field of the collaborative specialization, but also other fields of relevance that may arise in their careers.

The collaborative specialization in Psychology and Engineering will provide students with access to multidisciplinary learning experiences relating to the intersection of psychology and engineering. The principal benefit to students will be an improved capacity to pursue, understand, discuss, critique and apply research at this intersection.

Students will primarily achieve this capacity through the independent pursuit of a PsychEng-related thesis supported by mentoring from an expert supervisor. This learning will be further supported by the completion of two or more related courses and immersion in a learning community. The course requirement provides graduate students in the collaborative specialization with background in the complementary field (engineering or psychology). They will then apply this background in their thesis work.

A collaborative specialization is intended to provide an additional multidisciplinary experience for students enrolled in and completing the requirements of a degree program. The requirements for a collaborative specialization are in addition to the degree requirements and are not meant to extend the student’s time to degree. Details on the degree-level expectations and learning outcomes for the Collaborative Specialization in Psychology and Engineering, beyond those of the home program degree requirement, are provided below.

### Table 1: Doctoral DLEs

<table>
<thead>
<tr>
<th>DOCTORAL DEGREE LEVEL EXPECTATIONS (PhD)</th>
<th>COLLABORATIVE SPECIALIZATION LEARNING OBJECTIVES AND OUTCOMES (In addition to the Doctoral DLEs)</th>
<th>HOW THE COLLABORATIVE SPECIALIZATION DESIGN AND REQUIREMENT ELEMENTS SUPPORT THE ATTAINMENT OF THE LEARNING OBJECTIVES AND OUTCOMES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EXPECTATIONS:</strong> This designator extends the skills associated with the Master’s Collaborative Specialization in Psychology and Engineering and is awarded to PhD students in the Collaborative Specialization in Psychology and Engineering, who have demonstrated:</td>
<td></td>
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</tr>
<tr>
<td>1. Depth and Breadth of Knowledge A thorough understanding of a substantial body of knowledge that is at the forefront of their academic discipline or area of professional practice.</td>
<td>Depth and breadth of knowledge in PsychEng is reflected in students who are able to:</td>
<td>The specialization design and requirement elements that ensure these student outcomes for depth and breadth of knowledge are:</td>
</tr>
<tr>
<td></td>
<td>• Convey concepts from home department to collaborating department researchers;</td>
<td>• The core seminar course provides breadth of knowledge by engaging students in different topics, frameworks, and methodologies in the non-home department. In addition to journal-paper critiques, students will explain their</td>
</tr>
<tr>
<td></td>
<td>• Articulate whether home department concepts are suitable for collaborating department research;</td>
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</table>

Major Modification Proposal: Adding a Level within a Collaborative Specialization
<table>
<thead>
<tr>
<th>2. Research and Scholarship (a) The ability to conceptualize, design, and implement research for the generation of new knowledge, applications, or understanding at the forefront of the discipline, and to adjust the research design or methodology in the light of unforeseen problems.</th>
<th>The specialization design and requirement elements that ensure these student outcomes for research and scholarship are:</th>
</tr>
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<tbody>
<tr>
<td>(Psychology students will better) understand the problem-solving focus of engineering thinking; (Engineering students will better) understand how to improve the effectiveness of their work by incorporating human aspects; Compare and appraise state-of-the-art research in non-home department for suitability to incorporate in home-department research (e.g., psychology students can assess which cutting-edge engineering methods are most relevant for their work); Adapt suitable concepts from non-home department to novel applications in home-department (e.g., engineering students can adapt concepts from social psychology to social robotics); Generate knowledge that incorporates and illustrates the value-added of non-home department concepts on home-department research (e.g., engineers working on energy efficiency can incorporate concepts from cognitive psychology to increase the effectiveness of energy-saving interventions.</td>
<td>The thesis provides further depth in non-home department material by applying it to a novel problem, possibly extending its boundaries (e.g., engineering students applying social-psychological concepts to novel situations may discover the limits of their applicability, as well as generate new insights about the psychological concept; The longer time of the PhD program allows students in both departments the space to more fully absorb and incubate new insights for both fields.</td>
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</tbody>
</table>
problems;
(b) The ability to make informed judgments on complex issues in specialist fields, sometimes requiring new methods; and
(c) The ability to produce original research, or other advanced scholarship, of a quality to satisfy peer review, and to merit publication.

<table>
<thead>
<tr>
<th>3. Level of Application of Knowledge</th>
<th>Application of Knowledge is addressed through the home degree program learning outcomes.</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>The capacity to:</td>
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<tr>
<td>(a) Undertake pure and/or applied research at an advanced level; and</td>
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<tr>
<td>(b) Contribute to the development of academic or professional skills,</td>
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<tr>
<td>students will be required to select and present review papers on topics from the collaborating department relevant to their thesis;</td>
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<tr>
<td>• The elective course in the collaborating department will further prepare students to incorporate concepts into their home-department research;</td>
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<tr>
<td>• Expert co-supervision and/or membership on the supervisory committee will guide and/or assess students’ implementation of concepts from the collaborating department in a research project and articulate research findings in a comprehensive, written dissertation submitted at the conclusion of the specialization;</td>
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<tr>
<td>• Collaborating department faculty member, will at the minimum, be on students’ thesis committee, which assesses students’ research design and methods and progress at least once a year.</td>
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<td>• Students will be encouraged to and guided on submitting a non-home-department conference/journal paper that combines elements of both fields;</td>
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<td>• Extra time in the PhD program allows students space/time to enable higher-level contributions at the PhD level.</td>
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<tr>
<td>4. Professional Capacity/Autonomy</td>
<td>Professional Capacity/Autonomy is addressed through the home degree program learning outcomes.</td>
<td>N/A</td>
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<td>----------------------------------</td>
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<tr>
<td>(a) The qualities and transferable skills necessary for employment requiring the exercise of personal responsibility and largely autonomous initiative in complex situations;</td>
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<td>(b) The intellectual independence to be academically and professionally engaged and current;</td>
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<td>(c) The ethical behavior consistent with academic integrity and the use of appropriate guidelines and procedures for responsible conduct of research; and</td>
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<tr>
<td>(d) The ability to evaluate the broader implications of applying knowledge to particular contexts.</td>
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<tr>
<td>5. Level of Communications Skills</td>
<td>Level of Communication skills is addressed through the degree program learning outcomes.</td>
<td>N/A</td>
</tr>
<tr>
<td>The ability to communicate complex and/or ambiguous ideas, issues and conclusions clearly and effectively.</td>
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<tr>
<td>6. Awareness of Limits of Knowledge</td>
<td>Awareness of Limits of Knowledge is addressed through the degree program learning outcomes.</td>
<td>N/A</td>
</tr>
<tr>
<td>An appreciation of the limitations of one’s own work and discipline, of the complexity of knowledge, and of the potential contributions of other interpretations, methods, and disciplines.</td>
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</table>

### 6 Assessment of Learning

Assessment of learning will occur both directly through formal mechanisms and indirectly.

Formal assessment will be based on:

- Academic performance according to course evaluation criteria in the elective half courses.
- A PsychEng-related research thesis and its defense through an oral examination.

Peer and instructor feedback based upon:

- Presentation of a research seminar in the seminar course.
- Presentation of final or interim research results in the seminar course.
7 Consultation
This proposal has been discussed with and is supported by the participating departments and Dean’s Offices, the Office of the Vice-Provost, Academic Programs, and the School of Graduate Studies.

8 Resources
The collaborative specialization’s core faculty members are available to students in the home program as advisors or supervisors. A core faculty member in the student’s home department will be involved in thesis supervision. Core faculty members contribute to the collaborative specialization through teaching of the elective courses, participating in the delivery of seminars, or supervising students. Some faculty may teach courses in the subject area of the collaborative specialization in the home program. Not all core faculty members are active in the collaborative specialization every year and, in many cases, simply may remain available to interested students. The initial list of core faculty members is available in Appendix B. Each participating degree program contributes to the collaborative specialization through student enrolments, although not necessarily every year.

The collaborative specialization will have a Director and a Collaborative Specialization Committee. Together they will be responsible for admitting students to the specialization and ensuring that the faculty associated with the specialization have the capacity to supervise all specialization students. Consequently, an assessment of supervisory capacity will occur twice: once when students are admitted to their home degree program, and once on their application to the collaborative specialization is approved.

The University finds that participation in a collaborative specialization should not normally add significantly to a faculty member’s supervisory load. For the most part, students in the collaborative specialization will continue to have their thesis supervised by a faculty member in their home program who also participates in the collaborative specialization.

See Appendix A for a list of core graduate faculty by participating program.

8.1 Faculty Complement
The collaborative specialization’s core faculty members are available to students in the home program as advisors or supervisors. If a student’s program includes a thesis, it is expected that a core faculty member in the student’s home department will be involved in thesis supervision. Core faculty members contribute to the collaborative specialization through teaching of the core course(s) and participating in the delivery of seminar series and other common learning elements. Some faculty may teach courses in the subject area of the collaborative specialization in the home program. Not all core faculty members are active in the collaborative specialization every year and, in many cases, simply may remain available to interested students. The list of core faculty members is available in Appendix A. Each participating degree program contributes to the collaborative specialization through student enrolments, although not necessarily every year.
Each collaborative specialization has a director and a specialization committee. Together they are responsible for admitting students to the collaborative specialization and ensuring that the faculty associated with the program have the capacity to supervise all program students.

The University finds that the participation in a collaborative specialization does not normally add significantly to a faculty member’s supervisory load. For the most part, students in the collaborative specialization will continue to have their thesis or major research project supervised by a faculty member in their home program who also participates in the Collaborative Specialization.

See Appendix A for a list of core graduate faculty and research synopses.

8.2 Administration

An Addendum to the Memorandum of Agreement will be signed after the participating Faculties approve the proposal.

9 Governance Process for a Major Modification

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<td>Development within Unit</td>
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<td>Approval of Graduate Units</td>
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<td>Report to Ontario Quality Council for information</td>
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Appendix A: Core Faculty Research Synopses

Note for proponents: Please provide a full list of all faculty who intend to participate in the collaborative specialization from each participating degree program. In each instance, provide two to four recent publications that show active engagement in the field.

Core faculty members are those who are eligible to teach and/or supervise in the Collaborative Specialization, as appropriate. Core faculty members must hold graduate faculty membership in one of the participating degree programs. The process of identifying a graduate faculty member as a collaborative specialization core faculty member is initiated by the faculty member or the Collaborative Specialization Director. Both the faculty member’s home graduate unit chair or director and the Collaborative Specialization Director must agree, as well as the faculty member involved. The Collaborative Specialization Director is responsible for maintaining records of agreements concerning assignment of core faculty members to the Collaborative Specialization. Formal cross-appointments to the graduate faculty are not required for core faculty members.

There must be at least one faculty member listed from each participating graduate program. Collaborative specialization students must have a core collaborative specialization graduate faculty member from the student’s home graduate unit as a supervisor, where a supervisor is required.

All teaching staff identified as members of the collaborative specialization are core faculty of the participating approved graduate programs and have been approved by the chair or director of their home unit for cross-appointment to the Collaborative Specialization. In bringing forward a proposal for a new Collaborative Specialization, the concern is that, in addition to being approved members of the graduate teaching staff, all proposed faculty be active in the area of the Collaborative Specialization. This list highlights peer review publications by the approved faculty members in the collaborative specialization area.

Participating Graduate Program Name

Participating MIE Faculty Members (All SGS full members)

1. J. Christopher Beck

http://www.mie.utoronto.ca/faculty/profile.php?id=10

My research interests that would benefit from the collaborative specialization focus on the planning and scheduling in human-centered systems. Engineers optimize systems subject to a set of constraints and an objective function. In systems where human interaction is increasingly mediated by information systems and even robots, the abilities, limitations, and desires of the people are often not understood, much less represented. The long-term viability these planning and scheduling algorithms depends on the ability to incorporate human psychological reality. I seek to develop richer human-centered models and develop mathematical optimization techniques that can reason about them. I have worked on three such human-centered systems.

Scheduling of Chemo-Therapy Treatment
We studied the scheduling of chemo-therapy appointments at a major Toronto cancer centre. Our models took into account the pattern of treatments different patients receive, the frequent changes in treatment due to patient condition, and the tasks of the staff responsible for scheduling. While we achieved schedules that increased traditional measures of quality such as throughput, we had no insight into whether the schedules were better from the perspective of the patients.


Planning and Scheduling of Autonomous Robots in Long-Term Care Homes

Given our aging society, computer and robotic technology is increasingly being developed to interact with and care for the elderly. As part of a long-term collaborative project, I have studied planning and scheduling of social robots in long-term care homes. While my collaborator (G. Nejat) has taken into account human factors in the direct human-robot interaction, there is no insight into psychological impacts of the daily schedules of the robots that we are producing.


Planning and Scheduling of Social Services: Non-Urgent Senior Transportation

Very recently, I have partnered with non-profit organizations that provide transportation services to seniors (e.g., to non-urgent medical appointments or adult day programs). While there are no publications yet, the same pattern as above is repeated: aside from some expressed preferences, there is no modeling of the psychological quality of the trips that the schedules create. Yet social psychological benefits, especially in the case of adult day programs, are a key goal of the service.

MIExxxx: Introduction to Computer Programming for Graduate Students

I teach an introduction to computer programming course for first-year engineering students. I could potentially modify this course to target graduate students who have never programmed before. Students would apply course concepts towards specific problems in their research. Such a course would prepare them to take more advanced programming courses needed to undertake their research.

2. Amy Bilton

http://www.mie.utoronto.ca/faculty/profile.php?id=152

Energy systems; water purification and desalination; design for the developing world; computer-aided design methods; design optimization under uncertainty; control system design.

My research interests that would benefit from the collaborative specialization include:

Design for the Developing World
We develop systems for clean water and energy in the developing world. Recent work has focused on the development of solar powered water desalination systems and solar powered systems to improve water quality for fish aquaculture.


Development of Computer-Based Design Methods

We developed computer-based design architectures which blend analysis methods conducted by skilled engineers and optimization methods to configure water and energy infrastructure. Recent work has focused on solar desalination systems and micro-grid optimization.


3. Mark Chignell

http://www.mie.utoronto.ca/faculty/profile.php?id=18

My research interests that would benefit from the collaborative specialization include:

Cognitive Distraction Due to In-Vehicle Technologies

This work examined the moderating effect of executive function abilities on the impact of cognitive distraction due to the use of in-vehicle technologies.


Social Interaction in People and Robots

This work explored the impact of technology-mediated social interaction.


Emotion Assessment During Interaction


Recently I have extended this work on affective interaction to the problem of measuring customer experience in relation to the technical quality of online video (research funded by TELUS and by an NSERC CRD). Recent papers in that topic area include:


Serious Games for Cognitive Assessment. Papers that we have published on this topic include:

Tong T, Chignell M, Tierney MC, Lee J. Engaging Elderly Adults with Interactive Serious Games as a Method for Cognitive Assessment. Journal of Medical Internet Research: Serious Games (in press).


I currently teach an undergraduate course in psychology for engineers (MIE 242) and I would be interested in creating a graduate version of the course that would be relevant to this collaborative specialization:

MIE14xx: Psychology for Engineers and Designers

This course is intended to provide a solid introduction to mind and brain for engineering students. In a world dominated by smart phones, and devices and software interfaces of all kinds, engineers and designers need a good grounding in psychology. The focus will be on understanding how mental processes are implemented in the brain. In addition to learning psychological principles, students will learn how to recognize psychological processes working in real world contexts. The topics covered are major ones in higher-level cognition and perception, and include: perception, object recognition, long-term memory, working memory, attention, executive control, emotion, and decision making.

4. Birsen Donmez

https://www.mie.utoronto.ca/faculty/profile.php?id=122

My research focuses on:

1) Understanding human behaviours, in particular attention allocation, and designing feedback to guide these behaviours for the domains of vehicle control (mainly passenger vehicles with some extensions to haul trucks and automated vehicles); healthcare settings; office settings
2) Understanding and supporting human evidence based decision making (such as based on historical evidence), in situations characterized by time pressure and uncertainty in emergency medical transport and in vehicle control
3) Identifying and implementing appropriate human-automation collaboration within feedback systems and decision support tools.

Given this focus, my entire research program would benefit from the proposed collaborative specialization. Below I list example publications for these three focus areas.

Operator Attention in Multitask Activities

Decision Support under Uncertainty


Human Automation Interaction


I currently teach a graduate course that would be relevant to this collaborative specialization:

MIE1413H: Statistical Models in Empirical Research

This course covers various statistical models used in empirical research, in particular human factors research, including linear regression, mixed linear models, non-parametric models, generalized linear models, time series modeling, and cluster analysis. For various observational and experimental data, students will be proficient in generating relevant hypotheses to answer research questions, selecting and building appropriate statistical models, and effectively communicating these results through interpretation and presentation of results. Basic knowledge in probability, statistics, and experimental design is required. The course will not focus on the design of experiments. In addition to homework assignments and exams, the students will review and critique journal articles and conference papers for the validity of the use of various statistical models. The students will work on a term long project of their choice and will be encouraged to relate this assignment to their current research projects. The examples used in class and the assignments will be drawn from human factors research. However, the students will not be required to use human factors data for their project.

5. Michael Grüninger

https://www.mie.utoronto.ca/faculty/profile.php?id=25

Research: Ontologies; semantic integration; process modelling; enterprise integration; semantic web; knowledge representation; mathematical logic.

As mentioned in the specialization rationale, there are numerous interactions between psychology and artificial intelligence within information engineering. The representation of common-sense knowledge for concepts such as time, space, shape, process, and physical objects, plays critical roles in both cognitive psychology and the implementation of enterprise information systems. Numerous applications support reasoning with this knowledge, and research about causal reasoning and scene recognition within cognitive psychology can form the basis for automated systems within advanced manufacturing.
Sample publications relevant to this collaborative specialization include:


Graduate courses I teach that would be relevant to this collaborative specialization are:

MIE1505H: Enterprise Modeling

To remain competitive, enterprises must become increasingly agile and integrated across their functions. Enterprise models play a critical role in this integration, enabling improved designs for enterprises, analysis of their performance, and management of their operations. This course motivates the need for enterprise models and introduces the concepts of generic and deductive enterprise models. It reviews research to date on enterprise modelling, including emerging standards and implementation technologies.

MIE1510H: Formal Techniques in Ontology Engineering

This course will explore theoretical techniques for the design and analysis of formal ontologies. Topics will include the design of verified ontologies, methodologies for proving properties about ontologies, and applications of classification theorems from mathematics. These techniques will be applied to ontologies that are currently being used in government and industry.

6. Greg A. Jamieson

http://www.mie.utoronto.ca/faculty/profile.php?id=27

My research interests that would benefit from the collaborative specialization include:

Modeling Appropriate Automation Reliance Behaviour

People using less than perfectly-reliable automated tools have to decide when to rely on these fallible tools. We are particularly interested in the effect of reliability disclosure. Our results show that disclosing automation reliability information to operators shifts their decision bias in the appropriate direction, but not to the extent deemed optimal (i.e., the sluggish beta effect). In addition, effectively designed displays of reliability can positively impact both sensitivity and decision bias.

Effects of Adaptive Automation Behaviours on Human Performance

Technology users are increasingly confronted with systems that respond to changes in context by adjusting the selection and timing of tasks delegated to the human, or by adapting the content and manner of interaction. Those changes can be triggered by the user state, by spatial or temporal cues, or by states or events in the system, mission, or environment. With the exception of adaptive function allocation triggered by user state (e.g., workload), little is known about the comparative effects of these triggers and behaviours. A new research program seeks to survey this adaptive automation space.
Sample publications relevant to this collaborative specialization include:


I currently teach/plan to teach graduate courses that would be relevant to this collaborative specialization:

MIE1412: Human-Automation Interaction

This course has two primary learning objectives. First, the students learn to analyze, synthesize, and evaluate canonical writings in the human-automation interaction literature. Second, they learn to value and characterize that literature in the context of their own professional, academic, or personal interests. The course is taught in a seminar format in two parts. In the first part, I lead discussions on foundational human-automation interaction literature, giving emphasis to contrasting claims expressed by past and contemporary researchers. In the second part, students plan and deliver a seminar on a topic of their choice. Finally, the students prepare an individual relevance assignment applying the course concepts to a topic of professional, academic, or personal interest. While many students write term papers, others have composed music, written a graphical short story, written and performed poetry and comedic scenes, and developed software.

MIE14XX: Human Factors Engineering

I have an agreement with my Associate Chair, Graduate and Department Chair to introduce a new graduate course in 2017-18. The course would provide an introduction to principles, methods, and tools for the analysis, design and evaluation of human-centred systems. Emphasis would be given to the consideration of the impacts of human perceptual and cognitive factors on the design and use of engineered systems, including shiftwork, workload, human error and reliability, and human factors standards. The target audience for the course is Masters of Engineering students across FASE programs. The course could also be made suitable for Masters-level students in Psychology by replacing the cognitive science elements with concepts in systems engineering.

7. Paul Milgram

http://www.mie.utoronto.ca/faculty/profile.php?id=35

Human Factors issues related to navigation, manipulation and control in 3D environments; human-machine interfaces for teleoperation; human factors issues in medicine, especially surgery and anaesthesiology; modelling of attentional workload.

Sample publications relevant to this collaborative specialization include:


G D'Egidio, R Patel, B Rashidi, M Mansour, E Sabri, P Milgram (2014) A study of the efficacy of flashing lights to
increase the salience of alcohol-gel dispensers for improving hand hygiene compliance, American journal of infection control 42 (8), 852-855

Current graduate courses I teach that would be relevant to this collaborative specialization include:

MIE1403H: Analytical Methods in Human Factors Research

This course is intended for people carrying out graduate level research in Human Factors. It covers a variety of techniques for recording and analysing empirical data. Topics to be covered include psychophysical methods, subjective scaling, questionnaires, signal detection theory, information theory, tracking and manual control modeling. There is no textbook for the course. Evaluation is based on a series of assignments related to the topics covered in class.

MIE5xx: Engineering Psychology and Human Performance

An examination of the relation between behavioural science and the design of human-machine systems, with special attention to advanced control room design. Human limitations on perception, attention, memory and decision making, and the design of displays and intelligent machines to supplement them. The human operator in process control and the supervisory control of automated and robotic systems. Laboratory exercises to introduce techniques of evaluating human performance.

Pre-requisites: MIE231H1 F/MIE236H1/STA286H1 or equivalent; MIE237H1 S or equivalent recommended

8. Goldie Nejat

http://aslab.mie.utoronto.ca/

My research interests that would benefit from the collaborative specialization include:

Human-Robot Interaction

Human-robot interaction (HRI) addresses the design, understanding, and evaluation of robotic systems which are used by people or work alongside them. These robots interact through various forms of communication in different real-world environments. Namely, HRI encompasses both physical and social interactions with a robot in a broad range of applications, such as physical and cognitive rehabilitation, tele-operation for surgery, surveillance and others. Through understanding these interactions we can better design robots to suit the functional, ergonomic, aesthetic, and emotional requirements of different user. One user group especially of importance in our research is the elderly population.

Social and Personal Robots

Our research in this area focuses on the development of human-like social robots with the social functionalities and behavioral norms required to engage humans in natural assistive interactions such as providing: 1) reminders, 2) health monitoring, and 3) social and cognitive training interventions. In order for these robots to successfully partake in social HRI, they must be able to interpret human social cues. This can be achieved by perceiving and interpreting the natural communication modes of a human, such as speech, paralanguage (intonation, pitch, and volume of voice), body language and facial expressions.
Publications on the aforementioned topics can be found at: http://aslab.mie.utoronto.ca/publications, including:


I currently teach a graduate course that would be relevant to this collaborative specialization:

MIE1070: Intelligent Robots for Society

This course introduces the design of intelligent robots – focusing on the principles and algorithms needed for robots to function in real world environments with people. Topics that will be covered include autonomy, social and rational intelligence, multi-modal sensing, biologically inspired and anthropomorphic robots, and human-robot interaction. Class discussions will centre on the interactive, personal, assistive and service robotics fields.


My research interests that would benefit from the collaborative specialization include:

**Identifying Metrics to Predict and Overcome Individual Tendency for Fixation**

Fixation is a term used to describe the state of being overly influenced by experience and existing examples in design. Our recent work has shown that Kruglanski’s Need for Closure scale can be used to predict tendency for fixation. Subsequent work aims to develop individualized interventions for overcoming design fixation.


**Identifying and Overcoming Obstacles to Personal Environmentally Conscious Behavior**

We aim to develop products that encourage sustainable behavior in consumers. Several social-psychological models of motivation are clearly relevant. Work proposed with Jason Plaks aims to apply (Higgins’) Approach vs. Avoidance to develop product design.

Publications: http://shulab.mie.utoronto.ca/publications/#environ include:


**Novel Methods for Identifying and Creating Object Affordances**

Recent work used “lead users” to identify novel product affordances to reduce resource consumption. In addition, we explored the “affordance of absence”, i.e., whether removing features from products and objects clarify
possible as well as required affordances.

Publications: http://shulab.mie.utoronto.ca/publications/

Identifying and Applying Analogies to Inspire and Explain Concepts

Past work focused on identifying biological analogies as sources of inspiration for designers. More recent work explored the use of analogies to explain concepts.

Publications: http://shulab.mie.utoronto.ca/publications/#bio

Methods to Increase Creativity in Designers

In addition to the above, our other work examined the use of language as stimuli in conceptual design, as well as the limitations of data collection and cognitive biases on the design process.

Publications: http://shulab.mie.utoronto.ca/publications/#creativity

Teaching relevant to the collaborative specialization:

MIE1720: Creativity in Conceptual Design

This course will present established methods that aim to enhance creativity during conceptual design. In addition, current research relevant to creativity and conceptual design will be incorporated. Students will select current research conducted at a variety of international institutions, identify limitations of reported results, determine and perform further research that can be conducted within a course, and report results. Established creativity methods will be presented during lecture. Knowledge of this material will be evaluated through written examinations. Skills in identifying, planning, conducting and reporting relevant research will be evaluated through oral presentations and written reports.

Participating Psychology Faculty Members (All SGS full members)

1. Morgan Barense
   Associate Professor and Canada Research Chair
   http://www.psych.utoronto.ca/users/barense/

As cognitive neuroscientists, we seek to understand how the brain enables the mind. That is, we want to know how biological mechanisms in the brain give rise to cognition. Our lab’s specific focus is on understanding how the brain supports memory, and how memory is affected by brain damage or disease. To answer these questions, we draw on the complementary strengths of multiple experimental modalities, including neuropsychological investigations of patients with memory disorders, the examination of brain activity with neuroimaging techniques (e.g., fMRI and EEG), eye tracking studies, and behavioural experiments in healthy individuals.

Why Does Brain Damage Impair Memory? Memory impairment is the most common and devastating result of neurological insult, yet we do not fully understand why damage to some parts of the brain so badly affects memory. We have suggested that some memory deficits may actually reflect a more fundamental impairment in creating precise representations of items and events. In short, we have suggested that perceiving a stimulus may be inextricably linked to subsequently remembering it. This view challenges long-standing notions that memory and perception are functionally and anatomically segregated. Instead, we suggest that they rely on shared neural representations and computational mechanisms.
Can We Use Cognitive Neuroscience to Develop More Effective Interventions for Memory Impaired Individuals?

We seek to apply recent advances in cognitive neuroscience to develop more targeted and evidence-based rehabilitative strategies based on how the brain supports memory. This research program involves the development of novel neuroscience-guided memory prosthetics for individuals with varying degrees of memory impairment, as well as characterizing the neurobiological effects of such interventions.

How Does the Brain Cope with the Massive Amount of Visual Information it Encounters in Everyday Life? The world can be visually overwhelming. Many objects in our lives look very similar to one another, yet we are still able to tell them apart and remember which is ours. We are working to understand the neural mechanisms that underlie this ability to resolve visual interference, and are characterizing how it may be impacted by brain damage or the earliest stages of dementia.

How Does the Brain Combine Information from Different Sensory Modalities to Create a Coherent Representation of a Multisensory Stimulus? When we think of a frog, we call to mind characteristics that are visual (it is green), motoric (it hops), tactile (it is slimy), and auditory (it goes “ribbit”) in a complex multisensory representation of a “frog”. Similarly, when engaged in conversation, we listen to what the speaker is saying but we also watch how the speaker’s mouth moves to utter the words. In this line of research, we seek to understand the neural mechanisms that underlie this fundamental cognitive ability, and how these mechanisms may be altered in conditions such as autism spectrum disorder.

How Does our Conceptual Knowledge about the World Affect How We Perceive It? We have asked how the act of perceiving superficial visual attributes of an object may be guided by – and inseparable from – the act of understanding what that object actually is. This research program focuses on how surface details of an item (e.g., its shape, sound, texture) give rise to semantically meaningful concepts. How does our brain distinguish between a pear and a lightbulb, despite being visually similar, while also grouping together a Great Dane and a Chihuahua, which are visually very different?

Sample Publications


Graduate Teaching

PSY5205HS Memory: The Cognitive Neuroscience of Memory

Memory is one of the most complex functions performed by the human brain. In this course we will consider prominent theories regarding the nature of memory and how the brain is able to perform this remarkable feat. We will survey current research in the field, focusing on controversial areas of inquiry. The goal of this approach is to provide insight into how details of experimental design can influence how theoretical models are developed.

2. Dirk Bernhardt-Walther

http://bwlab.utoronto.ca/research/

My research interests that would benefit from the collaborative specialization include:

Neural and Computational Principles of High-Level Sensory Perception
We employ neuroimaging (fMRI, MEG, EEG), psychophysics, eye tracking, and computational modeling to explore how people see and hear their real-world environments.

**Recent Publications:**

Heeyoung Choo, Jack Nasar, Bardia Nikrahei, Dirk B Walther (under review), Neural codes of architectural styles. [http://www.biorxiv.org/content/early/2016/03/16/044156](http://www.biorxiv.org/content/early/2016/03/16/044156)


**New Techniques for Analyzing Neuroimaging Data.** Recent publications include:


More publications at: [http://bwlab.utoronto.ca/publications/](http://bwlab.utoronto.ca/publications/)

**Teaching**

Functional MR imaging of the visual system

I will be teaching a graduate class on “Functional MR imaging of the visual system” in winter 2017.

3. Daphna Buchsbaum

[http://cocodev.psych.utoronto.ca/](http://cocodev.psych.utoronto.ca/)

As children grow up a major challenge they face is uncovering the world’s causal structure, including understanding the causes and consequences of other people’s behaviour. How do children learn these kinds of causal relationships, especially when the world presents them with sparse, ambiguous data or with multiple, conflicting sources of evidence? Are these sophisticated abilities unique to humans, or are they shared with other animals?

My research interests that would benefit from the collaborative specialization include:

**Using Social Knowledge and Statistical Cues in Causal Reasoning:** This line of work looks at children’s and non-
human animal's imitation of causal action sequences, examining how different kinds of learners decide which of the actions they see another agent performing are the ones that are necessary to bring about a desirable outcome. My colleagues and I developed a Bayesian analysis of causal inference from repeated action sequence demonstrations that makes behavioral predictions based on both information about statistics and about the actor’s knowledge and intentional stance.

**Action Segmentation and Causal Variable Discovery:** Infants are able to parse dynamic human action well before they are thought to have a fully developed theory of mind. This suggests that there may be low-level cues to intentional action structure available in human motion. In this line of work, I am developing a series of computational models that make very few representational assumptions about what is observed when watching videos of human action. To the extent that these models correspond to human segmentation judgments, and correctly recognizes actions, we will know that there are cues in surface level image changes that can be used to both segment and identify human behavior.

**Explore/Exploit Trade-offs In Inference:** Many computational algorithms face an explore/exploit trade-off, where faster, more efficient algorithms are also more likely to get stuck in local optima. Human learners may face a similar problem when exploring a hypothesis space of possible problem solutions. Ongoing experimental and computational work in my lab and others suggests that older individuals are more likely to exploit what they already know—quickly applying adequate but not necessarily optimal solutions—whereas younger children tend to explore hypotheses more broadly – and are therefore more likely to correctly discover unusual causal relationships, though they may also consider many incorrect solutions in the process.

**Learning from Majority and Cultural Evolution:** Recent work in developmental psychology suggests that children frequently conform to a majority, and computational models of cultural evolution have suggested that conformity can be a useful and adaptive social learning strategy. Yet, these models also suggest that high levels of conformity can make it difficult for innovations to spread, limiting cumulative culture. This work explores how children extend trust to informants based on the quality of their knowledge, and how they weigh this information against majority and minority opinions.

**Sample Publication:**


**Teaching:**

Recently approved computation in psychology UG course (eventually adapt for graduate students), starting 2017-2018 (or 2018-2019, depending on course scheduling)

4. Wil Cunningham

[http://socialneuro.psych.utoronto.ca/research.html](http://socialneuro.psych.utoronto.ca/research.html)

My primary research question concerns how the human mind creates representations of value. This ubiquitous act of assigning positive or negative valence is crucial for survival, whether it involves guiding behavior toward or away from an immediate significant object or anticipation of future rewards and punishments in goal pursuit. Attitudes (i.e., relatively stable ideas about whether something is good or bad) exert powerful influences on people’s evaluations (i.e., their current appraisals) and these, in turn, influence people’s choices (e.g., their choices of friends, careers, consumer products, and presidents). To better understand these processes, research in my lab takes a multi-disciplinary approach that attempts to integrate behavioral observations with neuroscience methods and theory. Incorporating knowledge regarding brain function into our understanding of attitudes and evaluations promises to lead to the refinement of theoretical models and generation of novel hypotheses. We have proposed...
an initial multilevel framework for understanding some of the core operating characteristics of the human evaluative system – *The Iterative Reprocessing Model*. We have recently expanded the model to understand how distinct emotional responses can emerge from more elemental computational principles.

The Structure of Evaluative Responses: The IR model proposes that the evaluative system is built upon multiple component processes that work in concert to make judgments about the world. These processes do not work in an all-or-none fashion, but rather, unique combinations of processes can generate qualitatively different evaluative outcomes. According to the model, stimulus representations (e.g., people, objects, or abstract concepts) initiate an iterative sequence of evaluative processes—the evaluative cycle—through which the stimuli are interpreted and re-interpreted in light of an increasingly rich set of contextually meaningful representations. The neural networks involved in evaluation are hierarchically arranged, such that a common set of processes continues to be involved in generating evaluations throughout the cycle, whereas additional processes come online at different points in the cycle. Whereas evaluations based on few iterations of the evaluative cycle are relatively automatic in that they are obligatory and may occur without conscious monitoring, evaluations based on additional iterations and computations are relatively reflective.


The Structure of Emotional Experience: Psychological constructivist models of emotion propose that emotions arise from the combinations of multiple processes, many of which are not emotion specific. These models attempt to describe both the homogeneity of instances of an emotional “kind” (why are fears similar?) and the heterogeneity of instances (why are different fears quite different?). We propose the iterative reprocessing model of affect that suggests that emotions, at least in part, arise from the processing of dynamical unfolding representations of valence across time. Critical to this model is the hypothesis that affective trajectories—over time—provide important information that helps build emotional states.


I currently teach the following graduate courses that would be relevant to this collaborative specialization:

PSY2001HF Design of Experiments: The General Linear Model

This course is designed to introduce the student to the General Linear Model and two of its most common expression: Analysis of Variance and Multiple Regression. Additionally, student will be asked to familiarize themselves with some of the current theoretical issues in realm of data analysis itself, e.g., the value of testing the null hypothesis.

5. Katherine Duncan

http://www.duncanlab.org

My research interests that would benefit from the collaborative specialization include:
Optimizing fMRI Data Processing and Analysis Approaches

Functional magnetic neuroimaging (fMRI) plays a central role in our investigation of the neural basis of learning and memory. Developing tailored neuroimaging analysis tools is essential for this work. For example, we have previously developed new approaches to measuring functional interactions between brain regions and approaches to measuring the neural reactivation of specific memories. We also plan to optimize automated noise reduction algorithms for task-based fMRI data and develop multivariate approaches to characterizing dynamic shifts in brain ‘states.’


Adaptively Modulating Memory Formation and Retrieval

Drawing on the physiological effects of neurochemicals, we developed a framework for predicting how the salient events known to trigger the release of these neurochemicals influence specific aspects of cognition. For example, we have identified memory processes that are facilitated by recent exposure to novelty and others that are facilitated by recent exposure to familiarity. Because these behavioral manipulations are simple to administer and lead to remarkably reliable cognitive outcomes, they could be readily developed into educational and training technologies that evoke memory states that target specific learning outcomes.


Identifying How Different Forms of Learning and Memory Guide our Decisions

People’s choices are often guided by their past experience. The discovery of neurally distinct forms of memory, such as habits and memories of distinct events, raises questions about how different forms of memory interact to influence decisions. Our work aims to characterize how these memories guide our actions, at both computational and neural levels, and to identify factors that arbitrate between the uses of each.


I will be developing the following graduate course that could be relevant to this collaborative specialization:

PSYxxxx: Cognitive Dysfunction in Neurological Disorders:

This course will offer an in-depth examination of the cognitive dysfunction found in neurological disorders, including Alzheimer’s disease, Parkinson’s disease, and Schizophrenia. The course will focus on how cognitive impairments relate to current neuropsychological models of the disease. A better understanding of neurological disorders and their associated cognitive profiles could inspire the development of compensatory technologies.

6. Susanne Ferber

http://www.psych.utoronto.ca/users/ferber/

My research interests fall within the realm of Cognitive Neuroscience. The long-term goal of my research is to understand the cognitive and neural processes that support awareness of perception. As such, my work speaks to issues regarding the basic principles of the neural representation of visual perception and visually guided action. To
examine the relationship between awareness and perception, my research program comprises diverse methodological approaches, such as the investigation of cognitive impairments in neurological patients (e.g., patients with spatial neglect or simultanagnosia), cognitive experiments in healthy individuals, and the examination of brain activity with modern neuroimaging techniques (fMRI and ERP).

Sample publications relevant to the collaborative specialization:


7. Amy Finn

http://finnlandlab.org/

My research interests that would benefit from the collaborative specialization include:

Understanding How Brain Development Influences Learning and Memory: We are interested in the fact that changes in core memory systems happen at different rates, something that is tied to and possibly even caused by ongoing brain development. Our work seeks to understand what asynchronies in the developmental profiles of core memory systems means for learning across domains, especially for language learning and learning measured in educational contexts. To understand these dynamics better, our work has so far investigated the development of memory systems focusing largely on working memory, procedural memory (“knowing how” or unconscious/experience-dependent learning) and declarative memory. This work would be greatly enhanced by collaboration with engineering to inform the mechanism of how changes relate to different outcomes in learning.

Understanding How the Environment Shapes Learning: It is commonly presumed that early or accelerated development of memory systems, especially working memory, is desirable. (Indeed, the goal of many training programs is to improve memory in children.) However, this practice might impact the operation of other memory systems in unpredicted ways: decreasing working memory demands can facilitate the formation of procedural memories (“knowing how” or unconscious/experience-dependent learning) and declarative memory. This work would be greatly enhanced by collaboration with engineering to inform the mechanism of how changes relate to different outcomes in learning.

Understanding Why Adults Cannot Learn Language When Children Can: Language is perhaps the only known learning feat in which adults are worse than children. Why? This exception in learning may hold important clues about how the maturing mind and brain trades off between developmentally programmed strengths and limitations in learning. Our work has explored three factors that may contribute to adult’s poor learning relative to children. Counterintuitively (at least at first glance), these are all aspects of adult-cognition that underpin their success in other areas. These include adults’ (1) larger knowledge base, (2) mature, language-specific neural networks, and (3) mature executive functions and declarative memories.

Sample publications from http://finnlandlab.org/publications/


Graduate course relevant to this collaborative specialization:

PSY5220HS: Developmental Cognitive Neuroscience: This course will ask how changes in the developing brain can influence theories of cognitive development. We will ask whether and how methods in human neuroscience can help our understanding of cognitive development. To this end, we will explore the utility of human cognitive neuroscience methods in pediatric populations. We will then ask how these methods, and neuroscience more broadly, can inform classic debates about 1) the role of nature versus nurture, and 2) how neural plasticity influences developmental change in variety cognitive domains. These areas will include perception, object representation, navigation, number, concepts, memory, executive function, categories, language, and social cognition among others. This course will ask how findings in developmental cognitive neuroscience can, do, and/or should influence medicine, education and the law.

8. Michael Mack, Cognitive Psychology and Neuroscience

http://macklab.utoronto.ca

Several of my research interests stand to benefit from PsychEng collaborative program:

Characterizing the neurocomputational mechanisms of successful learning

Concepts organize the relationship among individual stimuli or events by highlighting shared features. Often, new goals require updating conceptual knowledge to reflect relationships based on different goal-relevant features. Yet, how these concepts are formed and updated in the brain when goals change remain an open question. In this work, our aim is to characterize how the hippocampus organizes and updates object representations to reflect changing conceptual knowledge. By combining computational modeling of classification learning with representational similarity analysis of fMRI data, we have demonstrated that neural representations in the hippocampus reflect concept organization.


Linking computational models and the brain

Formal computational models make testable predictions about the unobservable algorithms and representations that underlie cognition. Similarly, functional neuroimaging reaches beyond behavior to characterize cognition at the level of neural mechanisms. Yet, a critical barrier in cognitive neuroscience is a lack of robust methods for linking models and brain. A central aim of our research is developing new approaches that combine computational modeling with advanced fMRI measures. One example of this aim is the development of a novel technique to select among competing models of category learning using neural pattern information analyses. The key idea
underlying this approach is that if a formal cognitive model represents the true nature of learned knowledge, continuous measures of that model’s state during learning should be reflected in trial-by-trial brain states. Comparing the degree of consistency between brain and model states across a set of competing models enables one to pinpoint which theory is most consistent with both behavioral and neural responses.


**Determining how rapid perception can be leveraged to optimize decision making**

We are endowed with a marked ability to rapidly map perceptual information onto semantically-rich knowledge. Yet, current real-world systems for rapid decision-making that rely on visual information (e.g., disposing of unwanted items into landfill vs. recycling bins) fail to leverage this ability. In this work, we are combining elements of visual design with theories of visual cognition to best optimize real-world applications for our rapid perception.


9. Elizabeth Page-Gould

[http://page-gould.com](http://page-gould.com)

Research at the Social Psychophysiological Research & Quantitative Methods Laboratory (SPRQL) focuses on how social interactions between strangers and friends affect the way people think about and approach the world, particularly within the domain of intergroup relations. The lab specializes in multi-person, longitudinal, psychophysiological, and behavioural data collection across both laboratory and field settings. The lab also specializes in advanced statistical analysis and quantitative innovation. Both the research conducted in SPRQL and the training environment the lab offers represent a unique combination of advanced research methods from social psychology, psychophysiology, and statistics.

Lab projects either cut across the domains of social psychology, psychophysiology, and quantitative methods or can be focused within one domain. The primary question that drives research in SPRQL is how social interactions with friends and strangers affect our attitudes and behaviour towards people who are different than us as well as personal health and achievement. The ultimate goal of this research is to understand successful diverse societies: how can people with different backgrounds and perspectives work together to build communities where everyone has a chance to thrive? By combining laboratory experiments with longitudinal field studies, we are able to examine social interactions in controlled settings while situating this knowledge in the messiness of interactions that occur in the real world. In addition to this primary research question, the lab also conducts basic psychophysiological and quantitative methods research, such as (a) uncovering the function and processes involved in physiological synchrony between people engaged in social interactions, (b) exploring the unclear relationship between stress hormones and subjective stress, and (c) developing methods for harnessing the full power of linear models for point estimation and prediction.

The lab takes a multi-method approach to answer these complex questions, frequently combining self-report surveys, physiological measurement, and behavioural observation within the same study. We combine these methods to capture a rich picture of the nuanced and complex social world in which we live.


Teaching relevant to the collaborative specialization:

PSY2002HS Design of Experiments II

This course will provide a practical introduction to advanced statistical methods used in modern psychological research. Specifically, the course will cover the following topics: (1) Path analysis and Mediation; (2) Multilevel modelling, also known as HLM; (3) Non-gaussian statistics and bootstrapping; (4) Bayesian Hypothesis Testing; (5) Factor analysis, including exploratory factor analysis/principal components analysis, confirmatory factor analysis, and cluster analysis; (6) Structural Equation Modelling; and, (7) Time-based analysis like time series, lagged regression, and latent growth curves. The course will place a strong emphasis on practical application, such that every class will include demonstrations, electronic copies of sample syntax in SPSS and R, and brief computer-based data analysis exercises. You will also learn to be an active consumer of quantitative psychology articles, as well as develop generalizable strategies for statistical reporting. You will only need to be familiar with one of the following statistical packages: SPSS, R, or SAS. The course will have a final project where you will be required to use one of the analyses you learn in class to analyze your own data or public data and then write methods, results, and discussion sections that describe your findings. You will also be expected to complete lab assignments that involve conducting analyses on example datasets in the statistical software package of your choice. The goal is for you to leave the class with an understanding of when and how to apply each of the statistical techniques you learn. Knowledge of these modern statistical tools will increase the flexibility of your research designs and the statistical rigour with which you analyze your data.

10. Jason Plaks

http://plaks.socialpsychology.org/

My research interests that would benefit from the collaborative specialization include:

Leveraging Psychological Principles of Motivation to Create Products that Encourage Environmentally-Conscious Behavior

In partnership with L. Shu and others, we aim to develop products that encourage sustainable behavior in consumers by capitalizing on well-established theories and principles of human motivation. One specific line of work aims to apply Regulatory Focus Theory (Higgins, 1998; Plaks & Higgins, 2000) to tailor products to match
users’ approach-related or avoidance-related tendencies.

**Methods to Increase Creativity in Designers**

Much recent research in the psychology of motivation has focused on increasing worker creativity. Two particular well-regarded research programs, Regulatory Focus Theory (Higgins, 1998) and Lay Epistemics Theory (Kruglanski & Webster, 1994), have reported ways to increase creativity in undergraduates on a range of problem-solving tasks. In partnership with L. Shu and others, we aim to apply these principles toward product designers in particular, to address the problem of design fixation (known as “stereotypy” in psychology).

**Sample publications relevant to the collaborative specialization:**


**I currently teach a graduate course that would be relevant to this collaborative specialization:**

PSY5432HF Advanced Topics in Social Psychology III: Motivational Theories in Social Psychology

This course involves reading and discussion of seminal articles on motivation in the social psychology literature. A key emphasis will be on how motivation and cognition mutually influence each other to produce behavior. At an abstract level, this course will explore such key issues as: the influence of emotions, values, and desires on one’s thought; goal setting and goal pursuit; self-regulation and self-control. At a concrete level, this course will investigate such key topics as achievement motivation, social comparison, persuasion, and emotion.

**11. Jay Pratt**

[http://www.psych.utoronto.ca/users/pratt/](http://www.psych.utoronto.ca/users/pratt/)

My research interests that would benefit from the collaborative specialization include:

**Hand Position Influences Attention and Perception**

The human attention/perceptual systems have a reciprocal relationship with the action systems. Our research has shown that placing the hands near visual stimuli bias processing in the magnocellular visual channel and the dorsal (action) pathway while placing the hands away from visual stimuli biases processing in the parvocellular visual channel and the ventral (object perception) pathway. These hand position effects can be found in attention, vision, and eye movements.

**Top-Down and Bottom-Up Control of Visual Attention**: The ability to successfully select important visual information, and ignore distracting information, relies on the moment-to-moment balance to bottom-up (reflexive) and top-down (volition) attention process. Our research has shown several modulations of this balance of processes; object-based attention is reflexive in some situations but volitional in others, the onset of motion and animate motion are reflexive, and the temporal prioritization of events is under volitional control.

**Conceptual Information Guides Attention and Vision**: Bottom-up and top-down attentional processes have traditionally been viewed as a dichotomy, but our research has shown that they are better conceived as ends of continuum, and attention can be oriented to object and/or locations in space by what we have termed “conceptual cues”. These cues, such as uninformative arrows, directional words (left, right), temporal words (past,
future), divine words (god, devil), and numbers (1, 9) orient attention is an automatic manner but do not involve peripheral events (i.e., they are neither entirely bottom-up nor top-down).

**Ideomotor Theory: Understanding the Relationship of Thought and Action:** When we begin to plan an action, we fundamentally change the manner in which we attend and perceive objects and events in the visual field. For example, we have shown that planning a limb movement in a specific direction reduces the capture of attention by events moving in the same direction, and that people can learn an association between a response and a top-down attentional filter so that, for example, planning a left response will only allow attention to be allocated to red items.

**Motor Control Processes in Guided Limb Movements and Saccadic Eye Movements:** The planning and production of limb and eye movements require the optimization of motor programming and on-line control processes. We have shown that it is possible to violate Fitts’ Law by providing structured visual information during motor programming, that saccadic eye movements – long considered entirely ballistic in nature – are sensitive to on-line control processes, and that heavily practiced video game players learn complex movement patterns more efficiently than non-video game players.

**Sample publications relevant to the collaborative specialization:**


**Teaching that would be relevant to this collaborative program:**

PSY5204HF Attention and action: Then and Now: Pratt

This seminar will examine current research in the areas of visual attention and action (motor control) in the context of some of the classic research papers in the respective fields. The topics covered in include attentional capture, attentional control sets, inhibition of return, the gap effect, action-based attention, object-based attention, and component submovements of rapid aimed limb movements.