

# Psychology as a Science

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## Psychology as an Academic Discipline

What is scientific psychology? Most people know that psychologists study mental functioning, but comparatively few appreciate the scope of modern psychology or know what psychologists actually do. There is good public awareness of the roles of psychologists in clinical and mental health settings, also in schools and the workplace, but much less knowledge of psychologists as laboratory scientists. This report aims to give a brief account of psychology as an academic discipline, to differentiate science and practice in psychology, and to illustrate how fundamental and applied problems are interdependent. Finally, the report outlines the *needs* of psychology as a scientific discipline, if it is to continue to flourish in Canada and to address major problems presently facing Canadian society.

Psychology is the study of mind, brain, and behaviour. As an academic subject originating in mental philosophy, it gradually evolved into an independent discipline in the late 19th century as it became clear that the mind and its products could be studied and measured experimentally. As examples, early researchers set up experiments to study the factors affecting reaction time and those determining the loss of information from memory. The study of mental *experience* was gradually replaced by an emphasis on human and animal *behaviour* in the early 20th century. "Mentalism" was rejected as being unscientific, and the behaviourist school focused instead on measuring changes in stimuli and corresponding changes in responses. In time this approach was also seen to be quite limited, as it ignored both the experiential aspects of mind (feelings, attitudes, emotions, aspirations) and the physiological correlates of mental experiences and overt behaviours. The development of information technology by electrical engineers and communication theorists in the 1950s provided psychology with a new metaphor (mind as a communication channel) and also a new system of measurement (the flow of information through the organism). The study of cognition--perception, attention, memory, learning, language, thinking, and reasoning--evolved naturally from these ideas, and experimental research on these topics has grown exponentially over the last 40 years. At the same time, research on animals has shifted from laboratory-based studies of learning mechanisms to a broader "ethological" consideration of animals in their natural environments, including studies of their foraging, mating, navigation, and social interactions. Other major branches of contemporary psychology--developmental, social, personality, and clinical--have evolved along similar lines.

Two further developments in the last 30 years have led to important advances in the field. The first is an increasingly sophisticated use of measurement and experimental control of behaviour, thus bringing psychology closer to being a lawful science. The second is the recent rapid progress in the brain sciences. Traditionally, "physiological psychology" explored the neural bases of sensation, perception, learning, motivation, and emotion in humans and animals. Today, new technologies in genetics, immunology, neuropharmacology, and neuroimaging have literally revolutionised this area of research, as described in greater detail in subsequent sections.

In sum, present-day academic psychology is focused on understanding the individual's feelings, motives, thoughts, and actions. This understanding incorporates findings from studies of human and animal development, the neurosciences and ethology, and the study of abnormal behaviour in clinical and social settings. Psychology's focus on the single individual is enlarged and enriched by also studying individuals in groups, an important area in social psychology. Recently, cognitive psychologists interested in modelling various aspects of behaviour mathematically or by computer models have joined forces with linguists, philosophers, and computer scientists to form the new subdiscipline of Cognitive Science. In a parallel development, human experimental psychologists collaborate increasingly with neurologists and neuroanatomists under the banner of Behavioural Neuroscience.

Academic psychology departments and research institutes serve as training grounds for professional psychologists working in clinical and educational settings; they also function as home bases for carrying out the research underpinning such professional applications. Indeed, many psychologists working in professional fields see and classify themselves as 'scientist-practitioners,' emphasizing the close relations between the basic discipline and its areas of application.

### **Topics of Research in Present-Day Psychology**

Psychology is extremely broad, merging into sociology and anthropology at one end of its spectrum and into neuro-pharmacology and neuroanatomy at the other. Methods to study attitudes toward immigrants or moral development in children necessarily differ from those used to explore neuronal regeneration after stroke or areas of the brain involved in memory processes. Indeed, some universities have even organized "psychology as a life science" and "psychology as a social science" into separate departments. Such a separation is counterproductive in our view; individual differences in genetic inheritance and brain structure are obviously important for cognitive, developmental, and personality psychologists. Likewise the aspects of brain development concerned with language and with pattern perception depend heavily on cognitive and social interactions during the child's early years. Psychology as a discipline thus unifies the study of the individual, and serves to counter the tendency of researchers to focus on their own specific problem to the exclusion of its contextual surroundings or related problems.

The following examples illustrate the range of topics under investigation in Canadian departments of psychology today. These are mostly samples of "fundamental science" projects, although actual and potential applications are also indicated.

- \* **Neuroimaging of memory.** The recent development of functional neuroimaging methods, such as positron emission tomography (PET) and functional magnetic resonance imaging (fMRI), allows neuroscientists to study brain activities "online." The *functions* of the brain include such psychological constructs as attention, perception, memory, and language, and Canadian psychologists have been major players researching their neural correlates. An excellent example is Endel Tulving's discovery of different sites in the brain controlling memory encoding and retrieval, respectively.
- \* **The study of pain.** Canadian psychologists are among the world's foremost researchers of chronic and acute pain. Ronald Melzack was a co-author of the gate control theory of sensory-dependent pain, and his recent work includes an even broader theory of chronic pain -- the neuromatrix theory -- which links stress and pain and proposes that pain is

produced by the body-self neuromatrix in the brain. A complete theory of pain will necessarily involve personality and environmental factors, as well as factors tied to physiology and pathology.

- \* **Neuropsychology of memory, attention and language.** The influence of the late Donald Hebb still pervades Canadian psychology. The pioneering work of Hebb and his student Brenda Milner at McGill and the Montreal Neurological Institute led to theories of amnesia and attentional neglect. Single case studies, such as the celebrated HM investigated by Milner and others, laid the groundwork for understanding how the brain encodes, stores, and retrieves personal memories.
- \* **Brain plasticity.** Another of Hebb's major influences stemmed from his realisation that perceptual-motor experience can influence brain structure. His initial work showed that rats reared in enriched environments had superior perceptual-motor abilities in adulthood. This research, still carried on by Bryan Kolb at Lethbridge and others worldwide, has clear implications for understanding neural regeneration after traumatic brain injury.
- \* **Bilingualism.** Research on bilingualism is particularly appropriate in Canada, and Wallace Lambert -- another McGill-based pioneer -- studied this topic for some decades. His research revealed the cognitive, educational, and social advantages to being or becoming bilingual and his advocated 'immersion education' method has now become a system for second-language learning used widely throughout Canada, the U.S., and Europe.
- \* **Studies of animal learning.** Research on animal learning is of interest in its own right and also for clues to human learning. Bennett Galef has shown that rats learn from others in their colony to prefer certain foods and avoid poisoned bait, and Sara Shettleworth has investigated memory for cached food in birds. Some species of birds can hide hundreds of seeds and recover them months later--an interesting example of a highly evolved adaptive ability. "Bird brains" are demonstrably superior to human brains, in some respects at least!
- \* **Language and literacy.** Canadian researchers have contributed important insights into the body of evidence that shows the effects of social context and parental involvement in language development on the acquisition of literacy and the course of literacy in the early years. We know that talking to children, reading stories to them, and playing word games contribute to children's mastery of the literate form and their facility in using it. The unique contribution of Canadian researchers has been to study this development in children who speak different languages (English or French) or who are raised in bilingual families.
- \* **Psychopathy.** Psychopaths commit a disproportionate share of crime in society and have high rates of re-offending, so it is important both to detect this syndrome and understand the factors producing it. Robert Hare at UBC is researching this question; his Psychopathy Check List, developed over the years, is arguably the best psychological instrument for diagnosing and assessing this condition.
- \* **Studies of the family.** Canadian psychologists have contributed greatly to understanding the pressures on family structure and bringing up children. Classic research on children's social learning in children was first undertaken at the University of Waterloo. Today, there is excellent Canadian research on parenting styles, on how to discipline and interact with

the child, and on inculcating values and morals. Special focus has been placed on the form of parent-child interaction within 1- and 2-parent families, sexual identification of boys reared in fatherless homes, and child-rearing problems associated with maternal employment, day-care, and early childhood education. Closely related is extensive research on 'close relationships': intimate relationships across the lifespan, sibling relationships, as well as couple relations within marriage or cohabitation.

- \* **"Critical Thinking" and educational policy.** Education is more than transmitting knowledge; it is instilling in the individual the ability to analyze information, to evaluate arguments, and to make decisions. In educational jargon, these skills have come to be part of the goal called "critical thinking." Research in critical thinking has implications for educational policy in terms of decisions to develop standardized testing, focus curricula on basic skills, and restrict the range of optional subjects available. Because of the enormous impact of such decisions, they need to be informed by research that assesses long term outcomes from various educational alternatives, monitors progress as children acquire these skills, and evaluates the effects on children's intellectual development. Canadian psychologists have made important contributions to this area, although much work remains to be done.
- \* **Environmental psychology -- school and workplace conditions.** As the Canadian economy relies increasingly on knowledge-based and service workers, the prevention and amelioration of indoor environment problems becomes ever more pressing. Complaints about indoor air quality and "sick building syndrome" symptoms, and diagnoses of Multiple Chemical Sensitivity receive regular attention in the Canadian media. Environmental psychologists have shown that individual and organizational characteristics, both alone and in interaction with physical conditions, provide a critical guide to understanding these problems.
- \* **Health and well-being.** Many major health problems facing Canadians are ultimately attributable to problems with behaviour. For example, substance abuse disorders, compulsive gambling, and obesity have behavioural components that must be understood in order to develop better treatment and prevention strategies. Further, disorders traditionally considered purely physical in nature are increasingly understood as "biobehavioural" in nature. For example, poor exercise and diet, both with large behavioural components, are now recognised as significant factors in developing coronary heart disease. As understanding of complex relationships between behaviour and health increases, psychology will be recognized as having a large role to play in conceptualising physical health and illness.
- \* **Further areas of application.** Much psychological research is driven by the desire to create new fundamental knowledge. Some of that knowledge is directly applicable to important problems in Canadian society, however, and an increasing number of psychologists in hospitals, research institutes, and universities, are involved in such applied problems. Below we list a series of topics being studied by Canadian researchers with notes on their areas of application:

**Basic Research Area**

Mechanisms of visual perception  
 Computer simulations of intelligence  
 Cognitive neuroscience  
 Research on memory  
 Personality and environment  
 Learning in adulthood  
 Social/developmental psychology  
 Social attitudes  
 Social decision-making  
 Social/developmental  
 Social/Psychopharmacology  
 Measurement/Statistics

**Application**

Robotics; space travel  
 Pattern recognition: machine intelligence  
 Neurosurgery  
 Eyewitness testimony  
 Eating disorders; anorexia  
 Re-training; Rehabilitation  
 Effects of TV violence  
 Multiculturalism; discrimination  
 Jury selection; sentencing  
 Child abuse; elder abuse  
 Addictions and their treatment  
 Social and medical science at large

**Scientific Psychology in Canada**

The preceding examples give some flavour of what psychologists do in their research lives. Clearly, many topics under investigation involve other disciplines: studies of language involve phonologists and linguists, the study of child development involves educators and pediatricians, research into deviant behaviour involves sociologists and criminologists -- many more examples could be given. Similarly, many psychologists working in applied settings carry out research on problems affecting their specialty; the focus of the present report, however, is on fundamental research in the discipline. The central location of academic psychology among the life sciences, medical sciences, social and human sciences is underlined by the fact that psychology is perhaps the only discipline whose members apply routinely to all three Canadian granting agencies -- NSERC, SSHRC, and MRC. Being a discipline that spans the cognitive sciences, neurosciences, health sciences, social sciences, and human sciences, psychology is thus uniquely positioned to examine the full continuum of human behaviour and to generate systematic knowledge and information bearing on the health and well-being of Canadians and on Canada's ability to create sustainable employment and economic growth.

Most psychological researchers are employed by university psychology departments. Many other Canadian psychologists -- the majority, in fact -- work in hospitals, schools, and industrial settings, but their time is largely devoted to the practical issues of assessment, diagnosis, treatment, and training. Nonetheless, the "scientist-practitioner" model flourishes in this country, and a substantial proportion of psychologists working in educational and clinical settings are involved in basic research projects. Concurrently, the emphasis on real-life applications of research by various granting agencies has induced many university-based psychologists to tackle applied problems, which is a very healthy state of affairs. Relative to physics, chemistry and biology, psychological science is still in its initial stages of development. Thus, the continuous interplay of lab-based experimental work and society-based applications keeps lab research relevant and provides both a source of new ideas and a test bed for theories.

Educating and training students is a major concern of academic psychologists. As in other disciplines, it involves undergraduate teaching and supervision, mentoring graduate students, and collaborative research with postdoctoral fellows and other colleagues. Appropriate training for

psychologists requires a breadth and depth of knowledge achievable only through doctoral study. The needs of society and the interest of students in psychology are well demonstrated by the fact that there are many times more applicants for graduate study in psychology than we are able to accept, and that psychology programmes in Canada produce more doctoral degrees than almost any other discipline. Psychology can improve its leadership in interdisciplinary enterprises but only if its teaching programmes emphasize both basic training in psychological theory and methodology and bridge gaps with other disciplines (e.g., with the biomedical disciplines in psychobiology, with sociology and political science in social psychology, with management and technology programs in industrial-organisational psychology, with computer science, mathematics, and statistics in computational neuroscience, and with psychiatry in clinical and personality psychology). Our challenge is to build appropriate interdisciplinary training into the curriculum of psychology programmes, while still maintaining the strong, traditional basis of Psychology.

### **The Position and Influence of Canadian Psychology**

How does Canadian psychology rate as a research discipline, both relative to psychology in other countries and also to other scientific disciplines within Canada? In Table 1, we show some comparative publication and citation statistics (i.e., the frequency with which publications are cited and referred to by others) for the G7 countries and Australia. Statistics for the world are included for comparison. The statistics are based on publication and citation data in two five-year periods: 1981-1985 and 1988-1992 (inclusive). Consider first the impact factor of Canadian publications. For the period 1981-1985, Canada had the highest impact factor and was a clear international winner. The impact factor of Canadian publications was well above the world average and higher than all other comparison countries. The nearest competitor was the United States. For 1988-1992, the impact factor for the U.S. increased so as to match Canada. Impact factors for Canada and the U.S. were equal and both higher than any other G7 nation or Australia.

The strength of psychology within Canada relative to other disciplines was evaluated by computing the 'revealed comparative citation advantage' (RCCA) and the 'revealed comparative publication advantage' (RCPA) for the G7 countries and Australia (Table 1). The RCCA is a particular country's share of all the citations in a given field (in this case, the Canadian share of all citations in psychology) relative to that country's share of all citations in all fields (the Canadian share of all citations across all fields). This statistic reflects the impact of a given country's publications in a given field relative to the impact of publications in all fields in that country. We expect a value of 1.0 for a discipline that has an international impact factor comparable with that of the international impact factor of all other disciplines in that country. Values greater than 1.0 indicate that a particular discipline attracts more citations to its publications than other disciplines in that country.

As seen in Table 1, for both periods, the impact of Canadian psychology was very high compared to other disciplines in Canada (about twice as large a share of world citations as expected

Table 1. Comparative indices of research quality in Psychology\*

	Impact Factor		RCCA		RCPA	
	81-85	88-92	81-85	88-92	81-85	88-92
Canada	1.71	1.78	2.05	2.16	1.56	1.75
Australia	1.11	1.18	1.29	1.27	1.48	1.47
France	0.79	0.98	0.16	0.23	0.24	0.33
Germany	0.78	1.02	0.22	0.32	0.35	0.46
Italy	0.75	1.12	0.17	0.28	0.26	0.34
Japan	0.43	0.56	0.09	0.10	0.26	0.25
U.K.	0.92	1.40	0.74	0.74	1.12	0.78
U.S.A.	1.55	1.73	1.44	1.45	1.53	1.58
World	1.35	1.50				

Notes:

\* Source - ISI National Indicators Database

Impact Factor = average citations per published paper

RCCA = revealed comparative citation advantage (see text)

RCPA = revealed comparative citation advantage (see text)

based on other disciplines). RCCA statistics for other G7 countries and for Australia show that the relative strength of psychology within Canada is exceptionally high. It is not the case that psychology is relatively strong in every country. Only for Australia, Canada and U. S. was the RCCA greater than 1. For the remaining countries (excepting the U. K.), the relative strength of psychology is much lower than for other disciplines in those countries.

Table 1 also shows the revealed comparative publication advantage (RCPA) statistics for psychology for the G7 countries and Australia. This statistic reflects a country's share of all world publications in psychology relative to that country's share of all publications in all fields. For 1981-1985, psychology in Australia, Canada, and the U. S. had equivalent RCPA values and these values were clearly greater than 1. The proportion of world publications in psychology from researchers in these countries was about 1.5 times the proportion of world publications for all disciplines in those countries. For 1988-1992, the strength of psychology increased relative to other disciplines within Canada (to 1.75), making Canada the most outstanding country (among the G7 and Australia) in terms of the relative strength of psychology.

The impact factors in Table 1 show that Canadian psychology is very strong internationally (matched by only one other G7 country in only one of the two-sampled time periods). Furthermore, the RCCA results also suggest that the international impact of Canadian psychology is disproportionately strong relative to the impact of other disciplines within Canada. To appreciate the RCCA results, it is useful to compare the RCCA value for Canadian psychology with the RCCA values for all other categories in the Institute of Scientific Information's National Indicators Database. For 1981-1985, only four other disciplines (out of 78) had a higher RCCA value. For 1988-1992, only three other disciplines (out of 78) had a higher RCCA value. For 1988-1991, only five disciplines (out of 78) had higher RCCA values. Clearly, Canadian research in

psychology is outstanding, both in quality and quantity, as reflected in the statistics shown in Table 1.

The relative productivity of Canadian researchers in psychology is estimated in two ways in Table 2. Canadian psychologists publish more papers relative to the gross expenditure on research and development (GERD) in their country than psychologists in any of the other comparison countries. They also publish more papers relative to the total number of scientists and engineers in Canada than psychologists in any other comparison country. The productivity of Canadian researchers in psychology is outstanding. This high productivity level is not achieved at the cost of poor quality or low impact, as demonstrated from the results in Table 1.

Table 2. Scientific productivity (papers published) of researchers in psychology in G7 countries and Australia (1988-1992)

Country	No. papers	GERD(\$M)	Papers/\$M	S&E	Papers/S&E
Canada	6327	6353	1.00	60.8	104.1
Australia	2532	3131	0.81	38.6	65.6
France	1259	19478	0.06	115.1	10.9
Germany	2283	28199	0.08	170.0	13.4
Italy	693	9852	0.07	74.8	9.3
Japan	1300	52371	0.02	535.0	2.4
U.K.	5938	18111	0.33	130.0	45.7
U.S.A.	48376	136358	0.35	927.3	52.2

GERD = gross expenditure on research and development (\$M in 1988).

S&E = Number of Scientists and Engineers (1000's in 1988).

## Facilitation of Psychological Research

**Receiving, sharing, and disseminating information.** Psychological research is published in a very wide range of peer-reviewed journals, in edited collections of chapters, and in books and monographs. As in other disciplines, dramatic findings of wide interest are published in general journals such as *Science* and *Nature*, but the great bulk of research is published in specialty journals. Within Canada the Canadian Psychological Association (CPA) publishes two research-based journals -- the *Canadian Journal of Experimental Psychology* and the *Canadian Journal of Behavioural Science*. However, much of Canadian psychology is published in "international" (often U.S.-based) journals. Traditionally, journal articles by academic psychologists are single-authored or written with one or two students or colleagues. As psychologists have become more involved in neurosciences and medical sciences, the numbers of collaborators and co-authors have tended to increase. The discursive, descriptive style of 50 years ago has given way to densely written articles that typically describe a series of linked experiments. Thus, the usual publication mode in psychology, as with other features of the discipline, lies between the single-authored books of the humanities and the short, multi-authored reports of medical sciences.



In recent years there has been a disturbing trend towards underfunding libraries, leading to an inability of these institutions to maintain the broad cross-section of journals essential to many sub-disciplines of psychology. A partial solution to this problem may lie in the current revolution in electronic publishing in which research publications will be submitted, reviewed, published, and accessed on-line. To strengthen the dissemination and use of knowledge generated by Canadian psychologists, the Canadian Psychological Association has recently decided to join in the electronic revolution and will make its journals available through a new network that will become the largest source of psychological knowledge in the world. This millennial revolution notwithstanding, traditional libraries and reading rooms will still play the major role for the foreseeable future. Therefore, continued adequate funding for books and journals is a crucial ingredient of the discipline's continuing health.

**Space and equipment.** Psychology is a laboratory discipline. The specific needs of different researchers depend on the person's speciality, ranging from relatively unserviced small rooms and testing booths in the case of cognitive and perceptual researchers to elaborately serviced labs for psychopharmacologists and physiological psychologists. Social and developmental psychologists require large spaces for group testing and observation of parent-child interactions. One-way mirrors are often needed for observation purposes, and video-recording equipment is required for later scoring and analysis. "State of the art" computers are essential for the presentation of material to experimental participants, for recording responses, and for data analysis. Ethernet connections are also obligatory in virtually all cases.

Biobehavioural researchers have special needs, and their access to equipment funds must be on a par with other life scientists and medical researchers. Animal colonies are often involved in this type of research, with the consequent need for vivarium housing, cage washers, and so on. A sensible solution to meeting these expenses lies in establishing shared facilities--with zoologists, physiologists, and pharmacologists for example--and the concept of Centres and Institutes becomes relevant as a way of making the best use of specialised technologies. Neuroimaging presents similar problems and suggests similar solutions.

**Staffing and training.** Psychology, like other life sciences and social sciences, needs well-trained research assistants, who increasingly must be knowledgeable about computer programming, data analysis, and operating specialized equipment. It no longer suffices simply to employ bright undergraduates to test subjects. Assistants must be trained, usually after completing an undergraduate degree in psychology or a related discipline; and funds are necessary for this on-the-job training. One feature of U.S. funding that Canadian agencies might emulate is awarding training grants to groups of researchers in the same or neighbouring institutions to support the education and training of graduate students and postdoctoral fellows in a particular research speciality. They also play an important role in establishing research groups with a specific focus.

Twenty years ago, federal funding agencies recognized that there were very few university faculty openings for a period of time, and, with great foresight, created funds to provide salaries for this generation of young researchers (through the University Research Fellowship programmes). Hence, we did not lose the continuity, the energy, and intellectual contributions of this cohort. In the next 10 years, more than half of Canada's university faculty will retire. Canada will need to have a pool of highly qualified personnel as replacements. To help these efforts, Federal agencies have an important role in providing a high level of pre- and postdoctoral fellowship funding during this period. These young researchers will also need funds to establish and maintain international

contacts (e.g., for travel and sponsorships to international conferences) and to set up laboratories. Obviously, if we are to continue to provide this group of trainees with the up-to-date, world class training required for their success, their supervisors also will need to upgrade their own infrastructure and equipment, which has been seriously eroded by several years of budget cuts.

**Funding of psychological science.** Psychological research is not 'big science' for the most part, but still needs substantial funding for assistants, graduate students, post-docs, and computers. In addition, specialised equipment of various types is needed for social, developmental, and cognitive researchers. In the area of perception, the need for expensive equipment becomes greater--devices for producing auditory and visual stimuli of varying complexity and devices for recording and measuring participants' responses. Researchers in visual and auditory sciences also need to set up specialized labs to ensure the precision of such presentations and recordings. When the behavioural neurosciences are considered, techniques have changed markedly in the last ten years, and costs have escalated accordingly. These techniques are multi-disciplinary and include neurophysio-logical methods such as brain stimulation and the recording of neural activity; neuroanatomical procedures such as neurohistology, immunochemistry, neuroimaging, and electron microscopy; neurochemical analyses (e.g., high performance liquid chromatography, voltametry, neurodialysis); neurogenetics (e.g., use of gene knockout and transgenic animals); plus other molecular biological, biochemical, and neuropharmacological techniques. These molecular and genetic techniques are revolutionizing the study of brain function and having a major impact on research costs.

With regard to the various possible models of research funding, participants at the Aylmer Conference were unanimous in giving individual research grant programs the highest priority. Although experimental psychologists collaborate increasingly with each other and with researchers in neighbouring disciplines, there is a strong consensus that individual research grants provide the stable base on which university and institute-based scientists can set up their labs and provide facilities for their students and assistants. Such grant programs provide the necessary stability for planning an ongoing research program and for developing new lines of research. It is also the case that in most areas of psychology it is still perfectly possible to carry out first-rate research as an individual located in a relatively small or isolated university. In such situations an active lab serves to attract excellent undergraduates to the discipline and to provide them with basic training before going on perhaps to graduate school at a large centre.

Nonetheless, collaborative research is also increasing in Canadian Psychology and the discipline needs more help from administrators and policy-makers in the greater provision of facilities and programs to promote flexible collaboration among researchers. Canadian politicians have traditionally favoured establishing *Networks* of researchers, typically composed of academics with university positions. This model has the advantage of bringing together researchers from different parts of the country, fostering better communications and more efficient sharing of ideas and findings -- but in many cases the benefits may be political rather than scientific. Perhaps especially at the biological end of psychology, a great need exists for establishing more Centres and Institutes where researchers can focus on specific problems and collaborate on a daily basis. Some excellent existing examples of Canadian centres whose members have had a major international impact include the Montreal Neurological Institute and the Rotman Research Institute (in Toronto), whose primary focus is the neuropsychology and neuroscience of cognitive processes. Canadian researchers excel in several areas of visual psychophysics (e.g., colour, motion, persistence) and auditory perception and psychophysics. Two particularly important

research groups and centres are the McGill Vision Research Unit and the York University Centre for Vision Research. At these centres, research in visual psychophysics is combined with research in anatomy and physiology to achieve significant progress in understanding the human visual system. This model of research centres, located at a variety of appropriate locations across the country, could extend to other psychological themes including the study of learning disabilities, criminal behaviour, immigration, and aspects of child development.

Non-invasive brain imaging techniques (PET, MEG, functional MRI, etc.) provide enormous potential for understanding and treating cognitive, affective, and other biopsychological disorders, effecting functional recovery after brain injury, etc. Psychologists, with their strong quantitative expertise, excel in analysing complex, dynamic data. With their demonstrated success in analyzing behavioural/cognitive/affective processes and in creating theoretical models about how the brain works, they are uniquely positioned to exploit these new evolving and expensive technologies. Now is the time for interdisciplinary partnerships and, given the initial capital costs, operating costs, and rapid developments in technology, the most cost effective solution involves establishing and maintaining half a dozen interdisciplinary, regional centres.

A sound resource base is necessary to conduct basic research and also for applied research. Although some applied research by psychologists can be co-sponsored by industry and thereby take advantage of programmes such as MRC's strategic grants-industry program, relatively little psychological research generates immediately marketable goods. Instead, much of our applied research utility lies in the service sector (e.g., hospitals, correctional services, the organisation of industrial systems). Research in these areas is generally aimed at questions related to optimal treatment strategies of maximizing efficiency in some area of behavioural functioning (whether of patients, inmates, or company employees). Some research is co-funded by the "users" of those findings (e.g., the Correctional Services of Canada is actively involved in evaluating the effectiveness of treatment programs for sex offenders, a topic of high societal interest and importance to Canadians). Some of this work is not for immediate application, however, and requires a continuing health and applied psychology focus. In this regard, the funding available from agencies such as NHRDP is an important benefit, although these grants often have small budgets or come with specific mandates. Consequently, much innovative research that could be conducted in Canada is simply not being done. A review of the research potential in these domains clearly suggests a significant shortfall in the assets needed to optimize future research.

### **Advocacy and public policy**

If scientific psychology is to be more influential in Canada and receive adequate funding, facilities, and staffing from granting agencies and institutions, the first step is for Canadian psychologists to be better advocates for their own discipline. In our experience, the general public, and even university administrators, are often vague and only partially informed about the types of research psychologists carry out. The two broad stages of advocacy that must be accomplished are: (1) describing to others what psychologists do, and (2) laying out in some detail how scientific and applied psychology can address some major problems facing Canadian society.

In this enterprise, academic psychologists should not lose sight of the fact that their *primary* goal is to achieve greater understanding of mind, brain, and behaviour; i.e., pursuing excellent fundamental science. Even here, however, the general public should be made more aware that many practical problems are solved serendipitously as a by-product of basic research -- many of the major drugs used to treat schizophrenia, depression, and anxiety disorders were discovered in this

way. Another example in which 50 years of research findings were brought to bear on a difficult social problem is the phenomenon of “recovered memories.” This phenomenon reached virtually epidemic proportions in the 1980's and early 1990's. Memory researchers largely discounted the validity of the experiences related by clients (while not questioning the *sincerity* of their accounts or the reality of the physical and sexual abuse that was considered to cause the repression). In turn, the evidence from psychological studies was influential in producing skeptical media reports and in the abatement of the “epidemic.” Interestingly, the involvement of academic psychologists in this real-life problem has led to renewed interest in studies of memory illusions, their causes, and neural correlates.

Policy in the major professional fields of law, medicine, education, management, and engineering has been dictated largely by the professionals themselves, as indeed it should be. Nonetheless, policy and practice in all these fields should be determined by scientific evidence rather than by professional intuition; and psychology has much to contribute. For example, how valid is eyewitness testimony? How should “quality of life” be factored into medical decision-making, and how should it be measured? What are the *facts* in favour of phonics as opposed to whole-word reading? Does the keyword method really facilitate acquiring a second-language vocabulary? Does daycare have positive and/or negative effects on children's cognitive and emotional development? Can we develop sensitive behavioural indicators to detect Alzheimer's Disease in its early stages? How do *humans* (as opposed to computers) make economic decisions? Can we spot managerial talent by means of psychological tests? What is the optimal design for complex control panels? What is the best configuration of postal codes and telephone numbers to minimize human errors? Psychologists have investigated all of these issues with both theoretically-driven and applied research programs. Given the importance of the answers in societal (and purely economic) terms, psychologists must persuade policy-makers of the importance and value of the discipline and be given the facilities and funding to carry out the appropriate fundamental and applied research.

## Conclusions

The discipline of psychology, in all of its various manifestations, is thriving throughout Canada. When assessed recently against other scientific fields funded by NSERC, using rigorous objective criteria and a panel of distinguished international scientists, psychology was judged to be first in international stature. This achievement is all the more remarkable because funding for research in psychology in Canada is pitifully small, compared to the funds available to psychology in many of the other G-7 countries.

Canadian psychology embraces many areas of strength in university and hospital settings where researchers are working at the leading edge of the discipline at the international level. Such centres of excellence are to be found in every province, and together they serve as a resource for training and research that can address many of our society's most urgent social, developmental, educational, and medical problems. All that is lacking to optimize use of this tremendous national resource is adequate funding, commensurate to that provided by our major economic competitors to scientists in their countries.

There is a growing realization in the U. S. that human capital is our most valuable, yet least understood resource, one most worthy of increased financial support from funding agencies. It is also becoming clear that the research currently pursued by behavioural, social, and neural scientists

will have a more direct impact on our lives than almost any other branch of science. At present, funding for the social, behavioural and economic sciences by the National Science Foundation is more than US \$130 million and is scheduled for a further 15% increase to US \$150 million in the 1999 fiscal year. The situation is just as rosy in the National Institutes of Health whose budget for 1999 is projected to be US \$14.8 billion, with the National Institute for Drug Abuse alone receiving over US \$575 million. In the current fiscal climate, politicians in the U.S. Congress are promising to *double* the funds available for biomedical research.

The challenge for psychologists, in partnership with our fellow scientists throughout this country, is to communicate more effectively with both members of the public and politicians alike, so that we can convince them that funding scientific research is an investment and not simply an irretrievable expenditure. The time for passive reflection and self-congratulation is over. As psychologists we are well aware of the excellence and innovation that characterize our discipline, but now is the time to take a more active stand and to publicize our achievements and potential to affect real change for the benefit of all Canadians.