HEARING ACCESSIBILITY, ASSISTIVE TECHNOLOGY, and ACOUSTIC DESIGN RESEARCH FACILITY

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1. INTRODUCTION

We aspire to establish the first research facility in the world dedicated to applying recent advances in computer virtual reality simulation and digital signal processing to the health issues of people with hearing problems using an ecological approach. Our plan is guided by the recent re-conceptualization of impairment, disability, and handicap by the World Health Organization (WHO, 1999), whereby a person with a health problem must be understood in terms of how they function in their physical and social context. In the new labs, our interdisciplinary team will study how listeners function in realistic activities in realistic contexts and we will build on this knowledge to derive new solutions to alleviate disabling and handicapping conditions for listeners. We will co-develop technologies, rehabilitative practices, and built-environment and social standards such that solutions are achieved in context. Highly qualified personnel will be trained in research related to careers in education, engineering, and health.

2. OBJECTIVE

The overall objective of our basic research is to understand how the interactions between listeners and the listening environment affect the performance of complex behaviours such as communication. The associated applied research concerns how behavioral, technological, and environmental solutions can be combined to optimize performance and improve health and quality of life. Performance and design standards will be developed for communications technology and the built environment. Rehabilitative, educational, and health promotion programs will be planned and evaluated.

3. INTERDISCIPLINARY TEAM

The proposed research can only be accomplished if a new interdisciplinary team of researchers can work together in a new infrastructure. We will need biological, behavioural and social scientists (Cynader, Gick, Jamieson, Kingstone, Pichora-Fuller, Schneider) to model the complexities of listeners and their relationships to their social and physical environment; we will need engineers and computer scientists (Fels, Hodgson, Laszlo, Pai) to prepare complex stimuli using digital signal processing methods and design new technologies and environments; and we will need applied scientists in health and education (Jamieson, Pichora-Fuller) to develop interventions that will enhance auditory performance and quality of life. The proposed infrastructure will draw on and integrate the disciplinary expertise of each core investigator. Links to other CFI-funded initiatives will enable useful exchanges between a broader network of basic and applied researchers.

The ten core investigators are based in six faculties (Applied Science, Arts, Education, Graduate Studies, Medicine, Science) and two universities. They are Kathy Pichora-Fuller (Project Leader, Audiologist and Psychologist, Institute for Hearing Accessibility Research[1]), Murray Hodgson (Physicist, School of Occupational & Environmental Hygiene; Dept of Mechanical Engineering), Janet Jamieson (Psychologist, Dept of Special Education and Educational & Counselling Psychology), Alan Kingstone (Psychologist, Dept of Psychology), Charles Laszlo (Biomedical Engineer, Dept of Electrical & Computer Engineering), and Dinesh Pai (Computer Scientist, Dept of Computer Sciences); liaison to other CFI-funded projects are Max Cynader (Neuroscientist, Brain Research Centre), Sidney Fels, (Electrical Engineer, Institute for Computer Information and Cognitive Systems), Bryan Gick (Linguist, Interdisciplinary Speech Research Lab), and Bruce Schneider (Psychologist, Centre for Research on Biological Communication Systems, UTM).

4. LABS

Six laboratories constitute the infrastructure.

4.1 Auditory Virtual Reality Lab

AVR simulations will involve computing three components to construct realistic auditory scenes: 1. filter properties for the listener's two ears (i.e., customized head-related transfer functions - HRTFs); 2. properties of the space (e.g. size of room and absorptive properties of the walls, ceiling, and floor); 3. acoustical signals associated with various sound sources (e.g. speech, music, background sounds such as air-conditioning noise, chairs scraping on a floor). When these components are computationally combined, and the resulting left- and right-ear soundfiles are played out over earphones, the listener sitting in our lab will experience sound as if listening to real sources in a real room. Thus, we will create the experience of listening to a lecture in a classroom, an announcement in the subway, or multiple talkers at a cocktail party, etc. We will design such

stimuli for use in perceptual and cognitive experiments and new engineering and clinical evaluation procedures, with our outcomes guiding the development of further AVR research, technology design, and behavioral interventions. The lab extends and applies more basic technologies to be developed at ICICS.

4.2 Anechoic Environment Lab

An anechoic chamber and control roomwill be used to measure sound without the contamination of reverberation. We will need this pure environment to obtain accurate measures of customized HRTFs, properties of auditory objects (e.g., contact sounds), performance characteristics of assistive listening technology, and performance of listeners. The lab provides an important control condition for both the virtual and physical simulation conditions.

4.3 Variable Acoustical Space Lab

Typical situations will be physically simulated to study of the effect of environmental factors (e.g., acoustics, lighting) on task-related behaviours, validate virtual simulations of real environments, and assess changes in behaviour resulting from specific environmental design modifications. A large space is required so that variable walls, floors, and ceilings can be added to alter room dimensions and the absorptive properties of the surfaces.

4.4 Perception and Cognition Lab

Two sound-attenuating booths for soundfield testing and control rooms are needed. Experiments will be conducted using computers to present multi-modal stimuli and record and score listener responses. Two additional work stations are needed for stimulus and experimental protocol preparation and programming, data analysis, manuscript preparation, on-line library access, etc.. Selected behavioural experiments may be adapted for brain imaging experiments to be conducted in facilities at the BRC.

4.5 Recording Studio

A sound-treated room with video- and audio-recording equipment and variable lighting will be used to obtain naturalistic samples of speech as either data or stimuli, with editing, sound analysis, and transcription facilities for subsequent manipulation of the raw recordings. Sophisticated analyses of these samples can be conducted in facilities at the ISRL.

4.6 Design Lab

This lab will be essential for us to design, construct, and test custom-built electronic and mechanical experimental equipment (e.g. response boxes, robotic interfaces) and prototype assistive technologies and listening devices. Electronics and computer equipment is required, including circuit modelling, design and layout software, tools for construction of circuits and devices.

5. LOCATION

The proposed facility will be located in the Rotary Hearing Centre (RHC) to be built as a self-contained wing of a new ambulatory care building planned for Vancouver Hospital in the heart of the city. The RHC will bring together a unique combination of resources and expertise that are now geographically dispersed: city-wide hospital and community hearing services (audiology and otolaryngology annual caseload of 25,000), UBC research and teaching, public education and consumer advocacy facilities. This city-centre location will greatly expand the number of research participants we can recruit from the city and provincial population. Co-location of our team with others engaged in clinical health research, teaching, and service delivery confers huge advantages in terms of networking with academic and professional colleagues and engaging the public, and especially hard-of-hearing consumers, in community-based research.

REFERENCES

WHO (World Health Organization). International Classification of Impairments, Disabilities, and Handicaps (ICIDH-2), Geneva : WHO, 1999.

FOOTNOTE

1. Effective September 1, 2002, Kathy Pichora-Fuller began an appointment in the Dept of Psychology at UTM; she retains an adjunct appointment at UBC.