Natural Sciences and Engineering Research Council of Canada
Conseil de recherches en sciences naturelles et en génie du Canada

FORM 101
Application for a Grant
PART I

Institutional Identifier	
System-ID (for NSERC use only)	155702325
Date	2011/10/23

Family name of applicant	Given name	Initial(s) of all given names	Personal identification no. (PIN)
McGrenere	Joanna	JL	**Valid** 166692

Institution that will administer the grant	Language of application	Time (in hours per month) to be devoted to the proposed research / activity
British Columbia	[X] English [ ] French	24

Type of grant applied for	For Strategic Projects, indicate the Target Area and the Research Topic; for Strategic Networks indicate the Target Area.
Discovery Grants - Individual	

Title of proposal
The Design of Information Computing Technology for Older Adults

Provide a maximum of 10 key words that describe this proposal. Use commas to separate them.
human-computer interaction, older users, age-related differences, graphical user interfaces, input mechanisms and interactions, mobile devices, desktop computing, iterative prototyping, user studies, quantitative/qualitative evaluation

Research subject code(s)		Area of application code(s)	
Primary	Secondary	Primary	Secondary
2700	2710	802	801

CERTIFICATION/REQUIREMENTS

If this proposal involves any of the following, check the box(es) and submit the protocol to the university or college's certification committee.

Research involving : Humans [X] Human pluripotent stem cells [ ] Animals [ ] Biohazards [ ]

Does any phase of the research described in this proposal a) take place outside an office or laboratory, or b) involve an undertaking as described in Part 1 of Appendix B?

[ ] NO [X] If YES to either question a) or b) – Appendices A and B must be completed

TOTAL AMOUNT REQUESTED FROM NSERC

Year 1	Year 2	Year 3	Year 4	Year 5
96,550	96,550	96,550	96,550	96,550

SIGNATURES (Refer to instructions "What do signatures mean?")

It is agreed that the general conditions governing grants as outlined in the NSERC *Program Guide for Professors* apply to any grant made pursuant to this application and are hereby accepted by the applicant and the applicant's employing institution.

Applicant

Head of department

Dean of faculty

President of institution (or representative)

Applicant's department, institution, tel. and fax nos., and e-mail
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The information collected on this form and appendices will be stored in the Personal Information Bank for the appropriate program.
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Version française disponible
Canada

Personal identification no. (PIN)	Family name of applicant
Valid 166692	McGrenere

SUMMARY OF PROPOSAL FOR PUBLIC RELEASE (Use plain language.)
This plain language summary will be available to the public if your proposal is funded. Although it is not mandatory, you may choose to include your business telephone number and/or your e-mail address to facilitate contact with the public and the media about your research.

Business telephone no. (optional): (604) 827-5201
E-mail address (optional): joanna@cs.ubc.ca

My long-term objective is to help establish the field of elder-computer interaction: putting older users (65+) at the center of interactive technology design, rather than being an afterthought, which is most often the case now. The research program is to design interactive information and communication technologies (ICT) for emerging and current platforms such as smartphones, tablets, and desktop computers in accordance with the unique sensory, perceptual, cognitive, and motor abilities of older adults, as well as their preferences, computing expertise, and contexts of use. Elder-computer interaction is investigated within three parallel yet complementary threads. The first seeks to understand the nature of interruptions and multi-tasking experienced by ICT users, and how ICT designs should accommodate those interruptions. A specific focus is to understand how these needs change across the lifespan. The second thread examines the unique ICT learning needs and preferences of older adults to design novel, age-appropriate mobile and desktop interfaces. The third thread assesses and builds upon strengths and limitations of different input methods and their respective interaction techniques, including touch, for older users.

The research methodology includes iterative prototype design and development, formal lab experiments, and qualitative field evaluation. Investigations include participants across the lifespan, from young adult to age 65+, in order to identify age effects. The overarching design approach emphasizes personalization: designs that adapt or evolve as a user ages based on changing abilities, preferences, and contexts of use. The research program will produce novel interfaces and interaction techniques, design guidelines for existing and future platforms, and fundamental new knowledge about human interaction capabilities. All of the proposed research falls within Computer Science in the area of Human-Computer Interaction (HCI) and aligns with Universal Usability and User-Sensitive Inclusive Design.

Other Language Version of Summary (optional).

Personal identification no. (PIN)	Family name of applicant
Valid 166692	McGrenere

Before completing this section, **read the instructions** and consult the *Use of Grant Funds* section of the NSERC Program Guide for Professors concerning the eligibility of expenditures for the direct costs of research and the regulations governing the use of grant funds.

TOTAL PROPOSED EXPENDITURES (Include cash expenditures only)

	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**
1) Salaries and benefits					
a) Students	47,500	47,500	47,500	47,500	47,500
b) Postdoctoral fellows	25,000	25,000	25,000	25,000	25,000
c) Technical/professional assistants	2,000	2,000	2,000	2,000	2,000
d)	0	0	0	0	0
2) Equipment or facility					
a) Purchase or rental	6,000	6,000	6,000	6,000	6,000
b) Operation and maintenance costs	0	0	0	0	0
c) User fees	2,000	2,000	2,000	2,000	2,000
3) Materials and supplies	0	0	0	0	0
4) Travel					
a) Conferences	7,000	7,000	7,000	7,000	7,000
b) Field work	2,000	2,000	2,000	2,000	2,000
c) Collaboration/consultation	1,000	1,000	1,000	1,000	1,000
5) Dissemination costs					
a) Publication costs	1,000	1,000	1,000	1,000	1,000
b)	0	0	0	0	0
6) Other (specify)					
a) home Internet connection	550	550	550	550	550
b) software & subject fees	2,500	2,500	2,500	2,500	2,500
TOTAL PROPOSED EXPENDITURES	96,550	96,550	96,550	96,550	96,550
Total cash contribution from industry (if applicable)					
Total cash contribution from university (if applicable)					
Total cash contribution from other sources (if applicable)	0	0	0	0	0
TOTAL AMOUNT REQUESTED FROM NSERC (transfer to page 1)	96,550	96,550	96,550	96,550	96,550

Form 101 – Detailed Budget Justification

1) Salaries and benefits

a) **Students ($47,500/yr).** I am budgeting for 50% of: three PhD students ($19,000/yr), two MSc students ($16,500/yr), and one undergraduate student ($5,000/yr). I expect that approximately half of the graduate students will be on scholarship or will be supported from other sources, and similarly that half of my undergrad students will have USRAs or other awards, which is why I use an overall rate of 50%. In the past, I have been very successful at attracting scholarship students. Consistent with that, PhD student Matthew Brehmer, who will be working on research questions 1.a and 1.b, has just been awarded an NSERC PGSD3. I have been similarly successful at attracting USRA students; $5,000 is needed to supplement the funds NSERC provides.

b) **Postdoc ($25,000/yr).** The research program requires a highly-trained individual in field methods. Given the size of my supervision load, I no longer have the capacity to provide the necessary off site training to my students. Dr. Charlotte Tang will fulfill this role for at least one more year.

c) **Lab assistant ($2,000/yr).** The Imager lab requires a part-time lab assistant who maintains and manages software licenses and hardware, printing issues, helps to schedule and manage participants for our user studies, and generally keeps the lab running smoothly. The salary is shared by 10 faculty members. This is my portion based on the number of students I have working in the Imager Computer Graphics, Visualization, and Human-Computer Interaction Laboratory.

2) Equipment of facility

a) **Purchase or rental ($6,000/yr).** This budget allows for the purchase and upgrades of PCs, mobile devices, and other hardware for the research needs of the graduate and undergraduate students working under my supervision. This includes two PCs (often laptops with external display and peripherals) (2 x $1500), mobile devices such as phones and tablets (4 x $500), and miscellaneous hardware such as large (non-mobile) touch displays ($1000).

c) **User fees ($2000/yr).** Our department has followed NSERC guidelines in the institution of user fees for such shared department facilities as file servers and networking. The current rate is 2% of the grant total, but will vary somewhat each year.

4) Travel

a) **Conferences ($7,000/yr).** This amount covers one conference for the applicant per year, estimated at $2,500 per conference, and one conference for each of five graduate students and one postdoc per year, estimated at $750 per conference. The usual cost for a student/postdoc is about $1500 per conference. I have budgeted half of that because when a student is presenting a paper, there are a number of mechanisms at UBC to supplement the student's conference travel. The main conferences that we will be attending include ACM CHI, ACM ASSETS, ACM UIST, ACM CSCW, and Graphics Interface

b) **Field work ($2,000/yr).** My research includes field studies that often involve a lot of local travel as well as fees to pay the participants for their involvement.

c) **Collaboration/consultation ($1000/yr).** This is for travel of the applicant or my students/postdocs to other research groups (for example, University of Toronto) for joint research projects, or for hosting of collaborators at UBC.

5) Dissemination costs

a) **Publication costs ($1,000/yr).** This is required to pay for the costs associated with journal publications that have page charges.

6) Other

a) **Home high-speed Internet connection ($550/yr).** This enables the principal investigator to work from home.

b) **Software and subject fees ($2,500/yr).** A number of software licenses need to be purchased, which include statistical analysis software, software development environments, and user interface prototyping software (approximately $1,000/yr). We also require funds to pay subjects in our laboratory experiments (approximately $1,500/yr).

Form 101 – Relationship to Other Research Support

I currently hold one grant. I have also applied for one grant.

1. NCE Program: GRaphics, Animation, and New meDia (GRAND) (*ongoing*)

This grant supports approximately 65 Network Investigators (of which I am one) and 70 Collaborating Network Investigators. It spreads a large amount of money ($4.6M/yr) thinly across many researchers. My allocation of direct funds this year is $37,000, and I expect to receive approximately the same amount for future years. I am a member of two subprojects within GRAND: (1) Personalized User Interfaces in Real World Contexts (PERUI), and (2) Accessibility of New Media for Disabled, Elderly and Vulnerable Individuals (INCLUDE). I am submitting a proposal in November of this year for a third project titled: (3) Children's Digital Culture (DIGIKIDS). All GRAND Network Investigators are nominally expected to participate in three subprojects, hence my proposal this fall. I've been told explicitly that it is highly unlikely that there will be any increase in funding, even if the proposal is accepted. The great majority of GRAND researchers are on 3 subprojects for which they are receiving $37,000 this year. Assuming I will be no different, each of my three subprojects will receive approximately $12.3K in funding starting in 2012. My research on the PERUI project relates to my personalization research that has no direct relationship with the proposed research program, nor any budget overlap. My research on the soon-to-be proposed DIGIKIDS subproject relates to my research with children, which has no direct relationship with the proposed research program, nor any budget overlap. My research on the INCLUDE project is conceptually related, but there is minimal budget overlap, as the funds I receive from GRAND only cover about half of the total cost to support one graduate student. In the past, for example, I have used GRAND funds to support small amounts of Matt Brehmer during his MSc and former PhD student Rock Leung, who was the lead student on much of the recent research progress I report in Thread Two of the proposal. The combination of the GRAND funding for INCLUDE with an increased Discovery grant is absolutely required to strengthen and expand on my current activities investigating ICT for older users.

As noted in the Impact section of the proposal, some of my work which was jointly funded under INCLUDE and an NSERC Engage grant, was selected recently by GRAND to receive $7,000 to support the first stages of commercialization. The project is a home screen replacement interface for older users designed to reduce the complexity of the home screen on a smartphone. This was work done by PhD student Rock Leung. Those funds have been awarded to the Canadian startup company that we collaborated with on the Engage grant, ikamobile.

2. CIHR, Institute of Aging, Operating Grant: Exploring and Validating the Contributions of C-TOC (Cognitive Testing On Computer) Use in Clinical Assessment (*application under submission*)

This CIHR application is for a three year grant to cover the development and evaluation of a cognitive assessment test (for the detection of cognitive impairment or dementia) that older users will take independently from their own homes, using a web browser. It reflects a strong collaboration with researchers in the Department of Medicine at UBC, in which Dr. Claudia Jacova (Neurology) is the PI. I report on some of my recent progress on this project at the outset of Thread One. The proposed work and the CIHR application under submission are synergistic, with some conceptual overlap, but there is no budget overlap.

In terms of allocation to my research program, the budget for the CIHR application includes coverage for one graduate student (~$23,000 for each of years 1, 2, and 3, to be applied initially to MSc student Shathel Haddad) and one half of a postdoc (~$25,000 for each of years 2 and 3, to be applied to half of postdoc Charlotte Tang), with the other half being requested in my Discovery Grant proposal. There are also funds to hire a programmer at the outset of the grant ($10,000 for year 1). To summarize, approximately $33,000 for year 1 and $48,000 for each of years 2 and 3 will support my research, assuming the funding is awarded.

The two grant proposals are synergistic in that they are both seeking to design ICT for older users, and thus the findings from the respective research programs will be able to leverage one another. The key difference is that all the work being done under CIHR funding is strictly being applied to C-TOC (Cognitive Testing On Computer). Thread One of the proposed Discovery Grant program seeks to generalize the findings to date, by testing our findings about the impact of interruptions in everyday ICT applications, and to evolve our understanding of interruptions and multitasking experienced by older adults. There is little overlap between Threads Two and Three in the Discover proposal and the CIHR grant application.

Please see the attached file, under “Other Documents,” which provides supporting documentation:

- Summary page
- Budget pages

Form 101 – Research Proposal

My long-term objective is to help establish the field of elder-computer interaction: putting older users (65+) at the center of interactive technology design, rather than being an afterthought, which is most often the case now. It has been understood for some time that individual differences among users often play a substantial role in the usability of information and communication technologies (ICT) [7]. Yet, despite the well-documented changes in sensory, perceptual, cognitive, and motor abilities that occur in humans as we age [5, 26, C19], the field of Human-Computer Interaction (HCI) continues to largely focus on the mythical "average user'' who is a young-ish adult (~20-50 years old) and presumed to be reasonably adept with ICT. Our community has recognized the unique needs of children: "child-computer interaction" is now a well-established area within HCI with its own dedicated conference (ACM Interaction Design for Children). In sharp contrast, there is no analogous area of HCI, nor any HCI conference *dedicated* to the needs of older users, despite early and continual awareness in our community of the importance and uniqueness of older users [6, 9, 12, 21]. The Canadian population is aging and it is working longer [3, 8]; these trends directly point to an increase in ICT use by older adults, necessitating development of well understood elder-computer interaction design principles, interfaces, interaction techniques, and methodologies, as well as ICT that is deemed to be *useful* by older adults and worthy of their learning effort [12].

My on-going research program fills that need and will act as a catalyst to help establish the field of elder-computer interaction as a fully recognized sub-area within HCI. The program's focus is to design, build, and evaluate mobile and desktop ICT in accordance with the unique needs, preferences, and past experiences of older users (65+). This involves challenging problems that require more than five years. This proposal describes three parallel yet complementary threads of research that comprise the next stage of the research. The threads address (1) interruptions and multi-tasking, (2) learnability, and (3) input/interaction techniques.

A. Recent Progress

The proposed research builds and extends research that I have done with my graduate students and collaborators in recent years. I have been conducting research on healthy older users since 2005, and on older users with aphasia since 2002. In the last six years I have supervised 5 graduate students (2 PhD, 3 MSc) and published 10 journal (or journal-equivalent) papers in the area of ICT for older users. Sections 1.A and 1.B of my Form 100 summarize my general progress in these two areas. Specific aspects of recent progress are in Objectives and Methodology below, so they are discussed directly within the context of proposed research.

B. Objectives and Methodology

I have three research threads. This section describes each thread in turn, providing motivation for the area of research and a brief overview of my related recent progress, followed by the research questions to be addressed and the methods that will be used. User-centered design is the general methodology that spans all of my proposed research. This methodology is a cornerstone of HCI research. It espouses an early and continual focus on users, iterative prototyping at various levels of fidelity, and evaluation with real users. In my research, evaluation always relies on both quantitative experiments and qualitative field work. Experiments will include users across the lifespan (19+), because an overarching goal of this work is to identify age effects. Rigorous field work is often more time consuming than laboratory experiments, so the number of participants per field study is likely to be less than per experiment. We may also choose to exclusively focus on adults in the upper age ranges (50-64 and 65+) for some of the field work.

Thread One: Interruptions and multi-tasking

Interruptions and multi-tasking are common-place in both the workplace and in the home. A large body of HCI research has emerged on these topics [15]. For example, interruptions have been shown to be detrimental to ongoing tasks, incurring costs to productivity [22], causing an increase in errors [10], and generally resulting in frustration [1, C16]. To our knowledge, however, with the exception of our own recent work (described below), there has been no HCI research focusing on interruptions for older adults. While interruptions can be challenging for all users, they are particularly problematic for users with poor short term memory [4]. The objective of this proposed research thread is to better understand the nature of interruptions and multi-tasking experienced by ICT users, and how ICT should be designed to accommodate those interruptions, with a specific interest in how these change across the lifespan.

Our most recent work, with three papers now under submission, looks at the effects of interruptions in the context of a novel cognitive assessment test (for the detection of cognitive impairment or dementia), which older people will eventually take independently, in their homes, using a web browser [S3]. Our experimental work [S1] indicates that older adults can be disproportionately slower to resume tasks and can experience interruptions very differently than do younger users, and that the types of task (verbal working memory and spatial reasoning were tested) are impacted differently by interruptions. Our complementary field work [S2] assessed older users using a prototype of the cognitive test in their own homes while experiencing naturalistic interruptions. From that we developed a taxonomy of domestic interruptions that will inform the design of the test. For example, it may be best to intercept technological interruptions (e.g., email notifications) and delay them until a subtest is complete; whereas personal interruptions (e.g., physiological) may be best mitigated through reminders given at the outset of each subtest of the test duration and to take any breaks before starting. Many questions remain.

1.a. How do interruptions generally affect older users while performing ICT tasks? What is the relative importance of various situational factors? We seek to understand the generalizability, beyond cognitive testing, of our most recent results. Specifically, we will test the effect of varying levels and types of interruptions on performance and subjective satisfaction (including frustration) and we will assess how these change depending on situational factors such as type of task (in terms of sensory-perceptual-cognitive skills needed), environment (office vs. home setting), and age. Some types of tasks are likely to be more sensitive to interruptions, for example multi-step tasks that time out, which are common in e-commerce transactions (e.g., booking an airline flight, online banking). A series of laboratory studies will vary subsets of factors to clarify their respective effects, with complementary situated field evaluations.

1.b. Which design strategies best mitigate the effects of interruptions? What strategies support task resumption? How does the effectiveness of these strategies differ with respect to situational factors? Based on the outcomes of 1.a., we will explore the design space of mitigation strategies, implementing and evaluating different techniques. Potential techniques include system-initiated prompting to verify presence, and user-generated input to report an interruption. Challenges include timing prompts to not cause annoyance, and varying prompts depending on whether the system recognizes that the user is still close at hand (e.g., interacting with a different application) versus away from the computer but still within visual/auditory range. Machine-learning algorithms may be important for a solution. Resumption strategies may include short playback of recent interaction history [24] to promote recall of an interrupted task. A design challenge is minimizing interface complexity while still providing this support. As in 1.a., we will include situational factors beyond age, and systematically evaluate our design solutions for effectiveness.

Thread Two: Learnability and usability of mobile devices and desktop computers

Mobile computing devices, such as smart phones and tablets, are increasingly pervasive, computationally powerful, and feature rich. They offer benefits that may be especially valuable to older adults. For example, innovative memory aids may help older adults remember important information [14]. However, older adults have been shown to have difficulty learning to use mobile computing devices [19], which may explain in part the lower adoption rates among older adults [23]. The objective of this thread is to understand the unique ICT learning needs and preferences of older adults and to design novel solutions to meet those needs and preferences.

Our most recent work in this area investigated several complementary design approaches to meet this objective. For example, we have tried multi-layered interfaces [27], a scaffolding approach that tries to improve the initial learning of software application by reducing the functionality available. Our experiment showed that a reduced-functionality layer, compared to a full-functionality interface, helped older participants more than younger participants to perform initial basic task attempts in less time and they preferred it for learning to use the mobile application [J8]. As another example, we tried an approach that provides supportive scaffolding through the temporary addition of a larger display. This adds screen real estate so that older adults have access to learning materials that would otherwise be too large for the display on the mobile device they are trying to learn to use. We designed an augmented touch display system Help Kiosk based on a comprehensive survey (94 respondents) that we conducted to understand learning needs and preferences of older adults [20]. Many questions remain.

2.a. What are the learning needs and preferences of older adults? Our earlier survey was an appropriate first step to addressing this question, but survey methodologies have inherent limitations as do single-session observational studies [18]. Our next step is a multi-session field study where we provide approximately 10 older adults with smartphones which we ask them to learn to use over a period of several weeks. We will meet with each participant several times to assess learning strategies and resources adopted and their perceived effectiveness. Participants will keep a learning journal (as in [25]) and will be contacted by phone in between the face-to-face meetings to collect detailed learning information. A natural follow-on step will be to repeat the study but force a particular strategy on participants, one that was either shown to be especially effective in the first study, or one that may be a variant of those most used.

2.b. Can we design effective learning interfaces/systems to support those needs and preferences? First steps will be to refine and extend our preliminary Help Kiosk prototype. One important component of the system that has yet to be prototyped is the exploratory mode, which allows a user to try out mobile tasks on their phone and have the option to save their changes or return to the state that the device was in before entering the exploratory mode. This mode addresses concerns we've heard repeatedly from older adults that they might break the device or cause some unwanted change to settings or stored data. This mode presents a significant design and implementation challenge. In parallel to that work, we will advance our multi-layered research by looking at how to layer functions for more applications that are more complex than the contacts application we used in previous research [J8], and we will assess longitudinal learning and usability in the field. A particular focus will be how the different layers are used over time, similar to other work I have done in the past [J1]. Longer term, we seek to understand the extent to which these novel systems and interface designs can improve ICT adoption.

Thread Three: Input and interaction techniques

Motor ability declines with age [17] and impacts usability of mainstream input devices such as a mouse or a pen/stylus [C25]. The relatively recent popularization of touch interaction on mobile devices such as the iPhone and iPad may provide more usable input for older users, but there has been relatively little work addressing touch and gesture input for older users, despite a large and growing body of work on younger users [29]. One study showed that given the opportunity to define their own gestures, older users have significantly less agreement among themselves than do younger users [28], which may suggest that specific touch gestures will be less intuitive to older users. Other work has looked at the optimal size and spacing of buttons on a touchscreen for older users [16], but provides no comparison of what younger users need. The objective of this thread is to understand the strengths and limitations of different input methods and their respective interaction techniques, including touch, for older users.

Our recent work focused on pen-based target acquisition and identified three main sources of difficulty: missing-just-below, slipping, and drifting [C19]. We demonstrated empirically how these vary across task situation and age. Importantly, our work showed that including older adults as participants uncovers *general* pen-interaction problems: missing-just-below and drifting were evident in both younger and older users alike, but were much more apparent in the older users. Based on these findings, we developed seven new target acquisition techniques to improve pen-based interaction, specifically addressing the three difficulties identified and particularly targeting older adults [J5, C23, C25]. Many research questions still remain.

3.a. What are the strengths and limitations of touch based interaction for older adults? Can new touch techniques be developed that specifically accommodate older adults? Rather than take the approach (mentioned above) where users adopted their own gestures [28], we will extend our methodology used to understand pen errors [C23] to study touch interaction. More specifically, we will conduct a baseline study that explores the impact of age and motor ability on the performance of multiple tasks that span existing mainstream touch interaction gestures, including scrolling, typing, basic object selection, complex multi-object selection, resizing, and dragging. Given the findings in [28] for touch input and our findings for pen input [C23], we expect to observe that older adults will have varying difficulty with existing touch gestures, but the exact difficulties are unpredictable without conducting the baseline study. This will then open the opportunity for developing novel touch techniques that specifically target older users, much like we did for the pen. Formal evaluation of these new techniques will be a natural next step.

3.b. What is the relative effectiveness of touch, pen, and mouse-based input techniques? The distinction between desktop and mobile computing is no longer clear. It is increasingly the case that users have a choice of what platform to use, as well as which input device or combination of devices to use, both in work and in leisure contexts. In our own work, when we've presented findings that older users can struggle with the mouse and pen, we often get the question: won't touch input be easier for older adults? While it seems intuitive that touch may be comparatively better, it remains to be seen. For one thing, the different input mechanisms may result in highly different levels of fatigue, which could produce very different accuracy curves over time. We propose to investigate how the respective input mechanisms compare in terms of performance and satisfaction, and to what extent there is a dependency on age and situational factors. It will be particularly important here (and with research question 3.a as well) to collect longitudinal data in order to assess learning curves and performance changes that might be explained by fatigue.

Weaving the Three Threads Together

The three proposed threads are synergistic, beyond just their shared focus on older adults. They operate at different levels of interaction: from low-level input interactions (thread three) that typically last on the order of milliseconds or seconds to high-level interactions, such as those in exploratory mode (thread two) that last on the order of minutes or tens of minutes. The threads address challenges faced by older users related to different abilities: sensory-perceptual (thread one), motor (thread three), and cognitive (threads one and two). There is considerable overlap in the methodologies needed to address the research questions across all three threads, which means that the threads reinforce and build upon each other. The overarching design approach will be, where possible, personalization: designs that adapt or evolve as a user ages based on changing abilities, preferences, and contexts of use. I will be drawing on my significant background in personalized user interfaces (See my Form 100 Section 1c) in all stages of the research.

The three threads are not exhaustive of the HCI research needed to put older adults on par with younger users for ICT design. The threads have been chosen to map out a reasonable scope, both in depth and breadth of research, for the next five years, and to leverage work I have already done with older users. Other research threads might well complement the proposed research; for example, designs to support social interaction among isolated seniors. If time and resources permit, my students and I may also look at some of these in the five year funding period. It is more likely, however, that they will be part of the follow-on stages of my research program.

C. Literature Review

Related work is interspersed in context throughout this proposal, most notably at the outset of each research thread. For the reader who wishes to get up to speed quickly, I recommend the following subset of references: general older users and HCI [21], interruptions overview [15], older users learning mobile devices [20], and pen, mouse, and touch interaction [C19, 29].

D. Impact

The potential impact of the proposed research program is substantial. It is well known that the Canadian population is aging: The number of Canadians 65 years of age or older is expected to double between 2010 and 2036, and by 2051 one in four Canadians will be in this age bracket [3]. Both mandatory retirement and the trend towards early retirement are on the decline in Canada [8, 11]. Altogether this suggests that older people will be an increasing proportion of ICT users, and that their uses will be spanning both work and leisure. Even beyond work and leisure, ICT has the potential to help older adults remain more independent and maintain their quality of life as they experience declines in perceptual, motor, and cognitive abilities due to natural aging.

I am often asked if the challenges faced by older users with ICT simply reflect their lack of experience with computers and if this may be alleviated in future generations that are more technology literate. I acknowledge that younger adults who are more experienced with today's computers may be able to leverage this experience as older adults to learn new computer technology with greater ease than do today's older adults. However, research shows that as people age they become less likely to try new things [9], and more afraid of making errors [2]. I believe tomorrow's older adults will show similar personality changes and declines in function as do today's older adults, so the need for better interfaces for older users will endure.

My research with older adults has received GRAND NCE commercialization funding (see Relationship to Other Research). My collaboration with Nokia is a further indicator of industry recognition of the importance of the older user demographic. I plan to continue collaborating with leading equipment manufacturers to examine how new types of hardware can provide opportunities to support older users and users with various disabilities.

Form 101 – Training of HQP

Training HQP is one of my greatest strengths. It is a key source of pride in my research program. I have always assumed a large supervision load relative to others in my department. One highlight is that my first three PhD students have all landed tenure-track faculty positions. It is an impressive statistic given today's limited academic hiring climate. My Form 100 Section 5 provides more details on this and other HQP training in which I am engaged.

High quality, hands-on graduate supervision is extremely important to me. I spend considerable time with each of my grad students, including a one-hour weekly meeting with most of my students, and considerable additional time co-authoring papers, piloting studies, attending practice talks, and giving detailed reviews of their various documents (from scholarship applications to thesis chapters). I regularly discuss overall progress with each student (at least a couple of times of year) in order to mitigate students from taking longer than necessary or from dropping out prematurely. In addition to this one-on-one time, I hold an informal one-hour weekly lunch meeting with all of my students. In that meeting, all of us, including me, take a brief turn highlighting our past week's work and our work agenda for the coming week, including anticipated challenges. The goal for this meeting is to build community and research awareness amongst my own students (which can sometimes reach as many as 10, including undergraduates, at any given time, often working on a diverse set of topics), and to allow the students to learn from each other. I have an open style where students are encouraged to voice concerns about their degree program and my supervision. In addition, I have been the lead faculty instigator and initial organizer of a broader weekly HCI research group meeting (formerly IDRG, now MUX), which serves a similar purpose to my lunch meeting, but brings together all of the HCI faculty in the department and their respective students.

Training HQP is an integral part of my proposed research. Each of the three threads requires at least one individual; however, having sufficient funding for two individuals per thread will lead to more comprehensive findings. I have found that pairing students on related research projects has significant benefits in terms of their enjoyment of their research and the quality of work they are able to produce. MSc student Brehmer (lead author on the experimental work on interruptions) has just graduated and transitioned to the PhD program; he will continue the interruptions research, starting with research questions 1.a. and then moving to 1.b. Postdoc Tang, who brings deep qualitative methodological skills, will be staying with me at least one more year and will complement Brehmer's research by working on questions 1.a. and 1.b. but the field rather than in the laboratory. Dr. Tang will also support the second thread by leading the field investigation on learning methods. The additional students required to staff threads two and three are yet to be determined. Matching between HQP and research thread often happens in an opportunistic manner that accommodates the strengths and interests of individual graduate students. This has always worked well for me.

The skills that HQP develop vary somewhat depending on the particular thread and research questions addressed, but generally they will include: experimental design and statistical analysis, qualitative study design and data analysis, development of data collection instruments, such as questionnaires and interviews, preparing and amending protocols for the Behavioural Research Ethics Board, low- and medium-fidelity prototyping using state-of-the-art prototyping tools, learning to pilot and run a user study, including techniques to recruit and work with older adults (which differ from younger users), participatory design, and last but not least technical implementation skills specific to the system being developed, including for state-of-the-art touch displays and devices, and novel algorithms to support new interaction techniques.

Form 101 – References

[Please note: all references of the form [**Jnn]**, [**Cnn]**, and [**Lnn]** are found in my **Form 100**. Below are papers referenced as [**Snn]** and in the form **[nn]**.**]**

Manuscripts under submission (2 of 5 papers I submitted to CHI 2012, and 1 journal submission):

[S1] **Brehmer, M.**, McGrenere, J., **Tang, C.** and Jacova, C. Effects of Interruptions on Older Adults' Computerised Cognitive Testing Performance. Submitted to ACM CHI 2012 on Sept 23, 2011 (10 pages) http://anonypapers.wordpress.com/

[S2] **Tang, C.**, McGrenere, J., **Brehmer, M.** and Jacova, C. Domestic Interruptions: A Taxonomy and Resumption Strategies. Submitted to ACM CHI 2012 on Sept 23, 2011 (10 pages) http://anonypapers.wordpress.com/

[S3] Jacova, C., McGrenere, J., Lee, H., Wang, W., **Brehmer, M.**, **Tang, C.**, Feldman, S., Hayden, S., Beattie, B. and Hsiung, G. Cognitive Testing on Computer (C-TOC): Development of a new computer-based battery for office and home administration. Submitted on Sept 14, 2011 to *Alzheimer's and Dementia, the Journal of the Alzheimer's Association*. (36 pages)

Other references:

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Exploring and Validating the Contributions of C-TOC… (summary page, under submission)

Background and Preliminary Data. An unprecedented number of individuals in Canada's aging society will become vulnerable to the onset of cognitive impairment and dementia. By 2038, an estimated three million Canadians will have cognitive impairment or dementia. They will require clinical assessment and continued care. A large number of healthy individuals worried about their cognition will also seek diagnostic help. The demand for dementia diagnostic and care services could overwhelm Canadian health care resources. Innovation in cognitive testing is an urgent unmet need. Thus, it is critical to develop a cognitive testing method that accurately identifies early neurodegenerative disease, so that valuable resources can be allocated to the assessment of affected individuals. Our team of cognitive and computer scientists and behavioural neurologists have developed a novel tool, Cognitive Testing On Computer (C-TOC) to make this possible. C-TOC covers all cognitive domains assessed by neuropsychological testing (NPT), includes test paradigms that require productive skills, for example sentence generation, likely to be most sensitive to the earliest cognitive changes associated with dementia, has culturally fair test contents, and optimized human-computer interaction, with input from representatives of the tool's end users. C-TOC has currently been developed to version 4 (C-TOC.v4), which will be utilized for clinical validation (Study 1). C-TOC.v4 will be developed further to design an online version that can be taken from home (C-TOC.v5) (Study 2).

Hypotheses: We hypothesize that a novel computer-based test battery, C-TOC, can: 1) detect the presence and severity of cognitive impairment in individuals seeking evaluation for concerns about cognitive functioning; 2) differentiate between typical AD and other types of dementing disorders; 3) accurately detect cognitive impairment when taken online in the home environment.

General Aim: To establish C-TOC as a tool in the clinical assessment protocol for cognitive impairment and dementia; specifically, to determine its clinical validity, reliability and feasibility.

Specific Aims: 1) Test C-TOC's ability to detect cognitive functioning below what is normal for an individual's age; 2) Explore C-TOC's ability to discriminate between different etiologies underlying cognitive impairment; 3) Identify and mitigate potential C-TOC feasibility issues that may arise in online home-based testing.

Research Plan. We will conduct two parallel studies. **1) Clinical Validation Study:** In this cross-sectional study with a 1-month retest component, we will administer C-TOC.v4 and NPT to clinic-referred patients with a diagnosis of No Cognitive Impairment (NCI), Cognitive Impairment Not Dementia (CIND), and mild dementia including Alzheimer disease (AD), Frontotemporal dementia and its variants, Parkinson's/Lewy Body and Vascular dementia. We will examine the ability of C-TOC.v4 to differentiate between NCI, CIND and mild dementia, and between typical AD and other dementias. We will also assess C-TOC's ability to differentiate between other dementias. We will determine the test-retest reliability and practice effects for C-TOC subtests. **2) Home Testing Feasibility Study:** In this cross-sectional experimental study, we will investigate interruptions that may pose a significant threat to valid online test-taking from home. We will investigate their impact on C-TOC subtest performance in clinic patients with CIND and cognitively normal controls by administering C-TOC.v4 subtests with and without interruptions. We will determine conditions under which interruptions invalidate test performance. We will then test the effectiveness of specific user-interface features in preventing, detecting and mitigating the effects of interruptions. These findings will be crucial for the design of C-TOC.v5 for home-based online testing.

Relevance. This research could establish C-TOC as a valid, widely accessible screening tool for neurocognitive impairment, which can be taken in the clinic office, and potentially online from home. Additionally, it may validate the ability of C-TOC to identify the etiology underlying impairment, thereby helping direct patients to the most appropriate care pathways. C-TOC could become an integral part of the clinical cognitive assessment protocol in specialty clinics and in family physicians' offices. Thus, C-TOC has the potential to improve the diagnosis, management, and health care services of individuals affected by cognitive disorders, thereby reducing the associated burden on the Canadian health care system.

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Appl. # 258481

Application for Funding – Budget

Funding Opportunity

Operating Grant 2011-09-15

Nominated Principal Applicant/Candidate

Last Name	First Name	Institution
JACOVA	Claudia	University of British Columbia

Financial Assistance Required **Year** 1

Research Staff (excluding trainees)	No.	Salary	Benefits	CIHR	Other Funding Sources: Cash*	Other Funding Sources: In-Kind*	Total
Research Assistants	1.0	$46,500	$9,300	$55,800	$0	$0	$55,800
Technicians	0.0	$0	$0	$0	$0	$0	$0
Other personnel (as specified in Employment History)	0.0	$0	$0	$0	$0	$0	$0

Research Trainees	No.	Stipend	Benefits	CIHR	Other Funding Sources: Cash*	Other Funding Sources: In-Kind*	Total
Postdoctoral Fellows (post PHD, MD, etc.)	0.0	$0	$0	$0	$0	$0	$0
Graduate Students	1.0	$20,000	$3,000	$23,000	$0	$0	$23,000
Summer Students	1.0	$10,000	$0	$10,000	$0	$0	$10,000

Materials, Supplies and Services	CIHR	Other Funding Sources: Cash*	Other Funding Sources: In-Kind*	Total
Animals	$0	$0	$0	$0
Expendables	$7,308	$0	$0	$7,308
Services	$0	$0	$0	$0
Other (as specified in the Details of Financial Assistance Requested)	$3,350	$0	$0	$3,350

	CIHR	Other Funding Sources: Cash*	Other Funding Sources: In-Kind*	Total
Travel	$0	$0	$0	$0
Total Operating	$99,458	$0	$0	$99,458
Total Equipment	$0	$0	$0	$0
Total Request	$99,458	$0	$0	$99,458

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Appl. # 258481

Application for Funding – Budget

Funding Opportunity

Operating Grant 2011-09-15

Nominated Principal Applicant/Candidate

Last Name	First Name	Institution
JACOVA	Claudia	University of British Columbia

Financial Assistance Required **Year** 2

Research Staff (excluding trainees)	No.	Salary	Benefits	CIHR	Other Funding Sources: Cash*	Other Funding Sources: In-Kind*	Total
Research Assistants	1.0	$45,536	$11,380	$56,916	$0	$0	$56,916
Technicians	0.5	$18,600	$2,976	$21,576	$0	$0	$21,576
Other personnel (as specified in Employment History)	0.0	$0	$0	$0	$0	$0	$0

Research Trainees	No.	Stipend	Benefits	CIHR	Other Funding Sources: Cash*	Other Funding Sources: In-Kind*	Total
Postdoctoral Fellows (post PHD, MD, etc.)	1.0	$50,000	$4,000	$54,000	$0	$0	$54,000
Graduate Students	1.0	$20,260	$3,200	$23,460	$0	$0	$23,460
Summer Students	1.0	$2,500	$0	$2,500	$0	$0	$2,500

Materials, Supplies and Services	CIHR	Other Funding Sources: Cash*	Other Funding Sources: In-Kind*	Total
Animals	$0	$0	$0	$0
Expendables	$7,308	$0	$0	$7,308
Services	$0	$0	$0	$0
Other (as specified in the Details of Financial Assistance Requested)	$1,850	$0	$0	$1,850

	CIHR	Other Funding Sources: Cash*	Other Funding Sources: In-Kind*	Total
Travel	$0	$0	$0	$0
Total Operating	$167,610	$0	$0	$167,610
Total Equipment	$0	$0	$0	$0
Total Request	$167,610	$0	$0	$167,610

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Appl. # 258481

Application for Funding – Budget

Funding Opportunity

Operating Grant 2011-09-15

Nominated Principal Applicant/Candidate

Last Name	First Name	Institution
JACOVA	Claudia	University of British Columbia

Financial Assistance Required **Year** 3

Research Staff (excluding trainees)	No.	Salary	Benefits	CIHR	Other Funding Sources: Cash*	Other Funding Sources: In-Kind*	Total
Research Assistants	1.0	$46,454	$11,600	$58,054	$0	$0	$58,054
Technicians	1.0	$17,608	$4,400	$22,008	$0	$0	$22,008
Other personnel (as specified in Employment History)	0.0	$0	$0	$0	$0	$0	$0

Research Trainees	No.	Stipend	Benefits	CIHR	Other Funding Sources: Cash*	Other Funding Sources: In-Kind*	Total
Postdoctoral Fellows (post PHD, MD, etc.)	1.0	$50,000	$4,000	$54,000	$0	$0	$54,000
Graduate Students	1.0	$20,429	$3,500	$23,929	$0	$0	$23,929
Summer Students	1.0	$2,500	$0	$2,500	$0	$0	$2,500

Materials, Supplies and Services	CIHR	Other Funding Sources: Cash*	Other Funding Sources: In-Kind*	Total
Animals	$0	$0	$0	$0
Expendables	$7,808	$0	$0	$7,808
Services	$0	$0	$0	$0
Other (as specified in the Details of Financial Assistance Requested)	$3,350	$0	$0	$3,350

	CIHR	Other Funding Sources: Cash*	Other Funding Sources: In-Kind*	Total
Travel	$3,000	$0	$0	$3,000
Total Operating	$174,649	$0	$0	$174,649
Total Equipment	$0	$0	$0	$0
Total Request	$174,649	$0	$0	$174,649

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APPENDIX A (Form 101)
Environmental Impact

Complete this Appendix if you have checked the "YES" box under Certification/Requirements on page 1, Form 101. Include activities that will take place in Canada **and/or abroad.** This information will assist NSERC in determining whether a screening is required under the *Canadian Environmental Assessment Act* (see the "Requirements for Certain Types of Research" in the NSERC *Program Guide for Professors).*

Family name of applicant	Given name	Initial(s) of all given names	Personal identification no. (PIN)
McGrenere	Joanna	JL	**Valid** 166692

Name of applicant's organization
British Columbia

Title of proposal
The Design of Information Computing Technology for Older Adults

Name of other participating organizations (if applicable)
N/A

Name of Location (Please complete an additional copy of Appendix A for EACH location at which research will be undertaken.)
homes and offices of older users

1. Main characteristics of the location (i.e., physical description & coordinates)

These are locations where older users take part in their activities of everyday living.

Continue on page 3 of this Form (if necessary).

NOTE: There is a potential to generate several Appendices A. **Please ensure that all Appendix A pages are numbered consecutively in the space provided in the upper right corner of the form. IF YOU FORESEE THE NEED FOR MORE THAN 3 (THREE) APPENDICES A, PLEASE CONTACT NSERC'S ENVIRONMENTAL ASSESSMENT UNIT BY TELEPHONE AT (613) 992-3612 OR (613) 995-8079, OR BY E-MAIL AT enviro.assess@nserc-crsng.gc.ca.**

The information contained in this form will be used by NSERC to determine any potential environmental effects. (see the "Requirements for Certain Types of Research" in the NSERC *Program Guide for Professors).*

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Personal identification no. (PIN)	Family name of applicant
166692	McGrenere

APPENDIX A (Form 101) CONTINUED

2. Principal activity(ies) and activity component(s).

Observation and interviews while users interact with interactive computing technology.

Continue on page 3 of this Form (if necessary).

3. For each principal activity and activity component, list the environmental elements affected and provide a description of those effects.

There will be no environmental elements affected.

Continue on page 3 of this Form (if necessary).

4. Mitigation measures.

There are no mitigation measures needed.

Continue on page 3 of this Form (if necessary).

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APPENDIX A (Form 101) CONTINUED **ADDITIONAL INFORMATION**

Use this page to enter additional text from sections 1, 2, 3, and/or 4 (if necessary).

N/A

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APPENDIX B (Form 101)
Canadian Environmental Assessment Act
Pre-Screening Checklist

Complete this Appendix if you have checked the "YES" box under Certification/Requirements on page 1, Form 101. Include activities that will take place in Canada **and/or abroad.** This information will assist NSERC in determining whether a screening is required under the *Canadian Environmental Assessment Act* (see the "Requirements for Certain Types of Research" in the NSERC *Program Guide for Professors).*

Family name of applicant	Given name	Initial(s) of all given names	Personal identification no. (PIN)
McGrenere	Joanna	JL	**Valid** 166692

Name of applicant's organization: British Columbia

Applicants are responsible for verifying whether permits are required for any of the activities listed below. Please indicate yes (Y), no (N) or unknown (U) by checking the appropriate box for EACH of the listed activities.

Y	N	U	DESCRIPTION OF ACTIVITY
			Part 1. - Determination of Physical Work under the CEAA
	X		Does any phase of the proposal involve the **construction, operation, modification, decommissioning, abandonment or other activity** in relation to a built structure that has a fixed location and is not intended to be moved frequently?
			Part 2. - Determination of Assessable Activities under the CEAA
	X		Activity takes place in a National Park or National Nature Reserve in Canada
	X		Activity takes place on First Nation lands
	X		Activity takes place in the North (Yukon, Nunavut, or the Northwest Territories)
	X		Activity takes place in or within 30 metres of the right-of-way of a power line, a natural gas line, or a railway line
	X		Activity takes place in or adjacent to a water body, resulting in harmful alteration, disruption or destruction of fish habitat (including the removal or damaging of aquatic vegetation)
	X		Destruction of fish other than by fishing
	X		Sampling or prospecting for ores or minerals
	X		Disposal of a prescribed nuclear substance other than in a laboratory equipped for such disposal
	X		Deposit of a deleterious or other substance into the environment (in the earth, air, or water)
	X		Any kind of remediation of contaminated land
	X		Deposit of oil, oil wastes or any other substances harmful to migratory birds in waters or in areas frequented by migratory birds
	X		Killing or removal of migratory birds, their nests, eggs, or carcasses or other physical activities that may require a permit or other authorisation under the *Migratory Birds Regulations* or *Migratory Bird Sanctuary Regulations*
	X		The removal or damaging of vegetation and/or the carrying on of agricultural activities or the disturbance or removal of soil in a wildlife area that requires a permit under section 4 of the *Wildlife Area Regulations* under the *Canada Wildlife Act*
	X		Physical activities that are carried on in Canada and that are intended to threaten the continued existence of a biological population in an ecodistrict, either directly or through the alteration of its habitat
	X		Establishment or operation of a field camp in a single location that will be used for 200 person-days or more within a calendar year
	X		Seismic surveying involving more than 50 kg of chemical explosive in a single blast; or marine or freshwater seismic surveying, if during the survey the air pressure measured at a distance of one metre from the source would be greater than 275.79 kPa (40 lbs/sq in)

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Personal identification no. (PIN)	Family name of applicant
Valid 166692	McGrenere

APPENDIX B (Form 101) continued

Are any authorizations, permits, or licences required to undertake any activity for any phase of the proposal? If **yes**, list them below, along with the name of the issuing agency(ies). If **no**, please state "None required" and submit this page with the rest of your proposal.

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