COGNITIVE TRAINING IN THE RURAL ELDERLY:
A RANDOMIZED TRIAL TO EVALUATE THE EFFICACY AND
ACCESSIBILITY OF A NEW APPROACH

by

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Abstract

Background: Cognitive training is an important determinant of successful aging but rural areas of Canada are uniquely deprived from accessing such speciality services. A need exists to examine the application of cognitive training through a rural lens.

Objectives: 1. To develop a novel collaborative approach to improving access to cognitive training in rural settings. 2. To evaluate the efficacy of a multicomponent cognitive training program for improving cognition in normal elderly persons.

Treatment Conditions: Experimental training (ET) consisted of three modules: (1) Executive Functioning, (2) Memory, and (3) Psychosocial Training. Active control (AC) consisted of word searches, reading short stories and answering multiple-choice questions.

Method: A multisite, randomized control, double-blind trial was conducted with 28 experimental participants (M_{age} = 70.68 \pm 8.89) and 28 active controls (M_{age} = 74.39 \pm 9.39). Treatments were self-administered 1 hour/5 days a week for 4 weeks. Pre-and post-training neuropsychological measures were utilized as determinants of program success.

Results: Compared to the AC group, the ET group displayed significant gains on targeted abilities, executive (p = .002) and memory (p < .001), but not psychosocial (p = .105) ability. Training-induced benefits were also observed for the ET group on untrained measures of global (BCRS, p = .002) and functional abilities (DAD, p < .001; FRS, p = .042). Performance improvements were more reliable for the ET than AC for executive (55.5% vs. 12.5%), memory (55% vs. 19.5%) and functional ability (41% vs. 7.5%). Participant recruitment and compliance rates were enhanced by the involvement of a physician.

Conclusion: Results support the efficacy of multicomponent cognitive training in reliably improving targeted and functional abilities. Physicians are critical players to the delivery of regimented cognitive training for older adults both in terms of recruitment and compliance.
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Introduction: When Aging and Rurality Collide

Much has been made of the fact that Canada’s population is aging; demographic shifts are unprecedented and difficult to ignore. Age is the pre-eminent determinant of cognitive decline (Reichman, Fiocco & Rose, 2010). Nearly half of normal seniors express concern about declining cognitive abilities (Lowenthal et al., 1967). Such concerns are warranted as cognitive impairment often leads to disability (Cappaa et al., 2005), loss of independence (Sands, Yaffe, & Lui, 2002; Yaffe, Petersen, & Lindquist, 2006), reduced quality of life [World Health Organization (WHO, 1980)], and huge illness costs borne by the community (Andlin-Sobocki, Jönsson, & Olesen, 2005). A concerted effort by public health authorities is required to contend with cognitive decline and its diverse consequences (Yi-jung, Yang, Lan, & Chen, 2008).

The aging population and the consequent need for specialized cognitive care is remarkably challenging for rural communities (Morgan, Crossley, Kirk, D’Arcy, & Stewart, 2009). Attempts to intervene have been made using pharmacological forms of therapy (e.g., cholinesterase inhibitors), but while these approaches offer symptomatic management in severe cases, there is opposition to their use among the general population (Naismith et al., 2009; Tricco et al., 2013). Additionally, research suggests that older adults are increasingly opting for non-pharmacological forms of therapy to address psychological and cognitive difficulties (Fernandez & Goldberg, 2009; Reichman et al., 2010). Innovative behavioural approaches such as cognitive training may be the best way to promote cognitive vitality (Anekwe, 2013), but rural areas of Canada are uniquely deprived from accessing such speciality services (Romanow, 2002). Governments [Canadian Collaborative Mental Health Initiative (CCMHI, 2006)], health researchers (Forbes et al., 2006; Mitura, 2003), and practitioners (Morgan et al., 2009) continue to identify a significant need to examine these applications through a rural lens.
Section 1. Theory Based Approach: Identifying the Scope and Themes of Cognitive Aging

This paper begins with a general description of the concepts related to cognitive intervention. I review several theoretical positions that differ with respect to the shaping of treatment protocols. I then locate our position on each theoretical topic, and how this thinking led to the approach to cognitive training.

Remediation: Distinguishing Cognitive ‘Training’ from ‘Stimulation’ & ‘Rehabilitation’

Cognitive remediation is the umbrella term that refers generally to behavioural interventions aimed at ameliorating cognitive decline (Acevedo & Loewenstein, 2007; Medalia & Richardson, 2005). The literature uses many terms to describe cognitive remediation techniques, such as “cognitive training”, “cognitive rehabilitation”, and “cognitive stimulation”, all of which differ in their approach (Belleville, 2008). Applying these terms interchangeably tends to obscure some important differences in concept and application (Clare & Woods, 2004).

Cognitive training involves repetitive practice on tasks known to reflect specific cognitive abilities (Belleville, 2008; Liberati, Raffone, & Belardinelli, 2012). This approach is restorative in nature and aims to reverse wear and tear to optimal performance levels (Sitzer, Twamley, & Jeste, 2006). It is evident that cognitive training does not correspond to non-specific “brain jogging” but rather relies on theoretically valid techniques that consider the pattern of impaired and intact capacities (Belleville, 2008). Both animal (Churchill, Galvez, Colcombe, Swain & Greenough, 2002) and human (Wilson, Scherr, & Schneider, 2003) studies have provided evidence that engaging in mentally challenging activities improves the functioning of the neural system and prevents future cognitive decline from occurring.

Cognitive rehabilitation is typically applied to individuals with brain damage (McLellan, 1991). This approach is compensatory in nature (Sitzer et al., 2006) and teaches explicit strategies that are used to adapt to weaknesses (Naveh-Benjamin, Brav, & Levy, 2007; O'Hara,
Both internal (e.g., visualizing or paraphrasing information during learning) and external techniques (e.g., using calendars or environmental cues) are encouraged. Cognitive rehabilitation is specific insofar as it targets a specific functional or social task (WHO, 1980). Unlike cognitive training, it emphasizes improving a task at hand than restoring the core cognitive process (Wilson, 1997). Although improvements are generally seen after strategy-based rehabilitation, performance gains typically do not generalize beyond the specific trained tasks (Fillit, Butler, & O’Connell, 2002), and it is not clear whether older adults continue to use learned strategies over time (Rebok, Carlson, & Langbaum, 2007).

Cognitive stimulation involves engagement in a range of group activities and forums aimed at general enhancement of cognitive and social functioning (Clare & Woods, 2004). In contrast to the strategic approach taken in cognitive training or even cognitive rehabilitation, cognitive stimulation is integrally reliant on general social interaction and non-specific enhancement of the status quo (Clare & Woods, 2004). The approach of cognitive stimulation does, however, overlap with cognitive training in that it targets core cognitive processes, rather than restoring an isolated task that was confiscated by an illness (i.e., cognitive rehabilitation).

**Multifactorial versus Unifactorial Training Approach**

In contrast with unifactorial programs wherein a specific cognitive process is trained, a multifactorial approach comprises modules in several cognitive and noncognitive domains. Researchers interested in the multifactorial approach to cognitive training have recognized the importance of incorporating factors such as emotional states (depression and anxiety levels) and belief structures (self-efficacy beliefs) into their training program. The rationale of this approach is that broader (multifactorial) treatment can demonstrate performance gains that are stronger, more durable, and generalizable to other tasks and situations than isolated (unifactorial) training (Herrmann, Weingartner, Searleman, & McEvoy, 1989; Stigsdotter, 1989). The superiority of
multifactorial training over unifactorial approaches is intuitive but remains empirically
inconclusive (Winocur et al., 2007).

**Uniform versus Unequal Decline**

One prevalent view in the field of cognitive psychology is that aging is related to global
brain deterioration that affects all cognitive areas at the same rate (Stuss et al., 2007). According
to this view, the effect of aging is linear progressive deterioration across domains, after age 25
(Park & Hedden, 2002; Verhaeghen & Salthouse, 1997). There is a body of evidence supporting
this linear effect of aging—in neuropsychology (Park & Hedden, 2002), in neurophysiology
(Picton, Stuss, Champagne, & Nelson, 1984), and in neuroanatomy (Colcombe et al., 2003;
Jernigan, 2001; Raz, 2000). If the changes are indeed related to global linear decline,
interventions would need to be designed to target the full range of affected cognitive processes;
an approach that would heavily support a general stimulation program. An alternate view is that
different abilities decline at different rates (Kennedy & Raz, 2009; Rabbitt, Lowe, & Shilling,
2001; Rypma, Prabhakaran, Desmond, & Gabrieli, 2001). There is a rich history of studies that
associate normal aging with decline in selective processes while others remain preserved (Chan,
Shum, & Toulopoulou, 2008). If the changes are indeed related to specific, non-linear decline,
this might lead to the assumption that interventions could be successful only if they are directed
to the process most vulnerable to aging.

**The Approach**

**Cognitive Training**

The current project falls under the rubric of cognitive training, rather than stimulation or
rehabilitation. My inclination for this approach is based on numerous studies demonstrating the
mediating effect of cognitive training in averting age-associated cognitive decline. Moreover,
there is evidence that training-induced benefits can be maintained for a considerable period of
time beyond training (Stigsdotter & Backman, 1993) and are associated with reduced risk of Alzheimer’s disease (Wilson, Mendes, & Barnes, 2002). Also, because the focus of cognitive rehabilitation is on activities of daily living, it seems amiss to provide this kind of intervention in healthy adults, who by definition, are not impaired in these activities. Likewise, because cognitive stimulation traditionally requires the gathering of individuals for discussion, it is poorly suited for our rural and northern context. Consistent with the goals and principles of cognitive training, the focus of our protocol was to improve or at least arrest cognitive decline in normal older adults.

**Multifactorial**

The protocol emphasizes the appropriateness of a multifactorial approach that, in addition to emphasizing cognitive processes, takes into account the importance of optimal emotional function for the realization of full cognitive potential (Prigatano, 1999; Stuss et al., 2007). Multifactorial approaches are successful because they permit the flexibility needed to treat the considerable variability that characterizes normal aging (Winocur et al., 2007). Accordingly, the benefits of these approaches tend to be diverse in nature, improving behaviour (Stigsdotter & Backman, 1993), social (Fryer & Fralish, 1998; Moore & Plovnick, 1998) and vocational domains (Cicerone, 2005; Malec, 1996). Conversely, research relating unifactorial cognitive training to these benefits is less consistent and compelling (Gordon et al., 2006); a finding that cautions against assuming the practical value of such approaches (Dawson & Chapman, 1995; Lezak & O’Brien, 1990).

For the current project, I have identified emotional (i.e., depression and anxiety) components in addition to cognitive training. The rationale for choosing emotion is based on two lines of reasoning. First, emotional processes are age-sensitive (Salthouse, 1991): Compared to young adults, older adults are more susceptible to anxiety and hold on to more negative, self-
defeating attitudes (Lachman, 1990). This increased susceptibility among older adults may be attributable to greater degrees of concern over forgetfulness (Smith et al., 2009). Another reason for choosing anxiety is because of its direct impact on learning and cognitive performance (Eysenck, 1998). The importance of addressing emotions is reflected in a body of work showing that cognitive training programs that address negative emotions improve cognitive functioning to a greater extent than programs addressing only cognitive skills (Belleville, 2008; Oswald, Gunzelmann, Rupprecht, & Hagen, 2006). Meta-analysis of 33 studies of similar size and scope to the current project allows us to anticipate moderate effects (average ES = .07) (Verhaeghen, Marcoen & Goossens, 1992).

Non-uniform Decline

This intervention grew out of a non-linear theoretical model that recognizes fluid intelligence as being particularly vulnerable to decline (Ryan, Sattler & Lopez, 2000). Fluid intelligence is the ability to analyze and solve novel problems, independent of acquired knowledge (Miller, Myers, Prinzi, & Mittenberg, 2009). Dysfunction in fluid intelligence is intimately associated with normal aging and may supersede other personal characteristics (e.g., age and education) in accounting for age-related cognitive deficits (Salthouse, 1996). Fluid intelligence has been associated with important cognitive operations such as episodic memory (Levitt, Fugelsang, & Crossley, 2006), working memory (Baudouin, Vanneste, & Isingrini, 2004; Schatz, Kramer, Ablin, & Mattay, 2000), learning (Backman, Jones, Berger, Laukka, & Small, 2004; Edwards et al., 2005), and reasoning abilities and verbal fluency (Bryan, Luszcz, & Crawford, 1997; Lindenberger, Mayr, & Kliegl, 1993). In other words, fluid intelligence may be a common factor underlying several different cognitive domains. This leads to the prediction that training fluid intelligence will exert a positive influence on widespread outcomes (e.g., Tsai, Yang, Lan, & Chen, 2008). Both cross-sectional (Levine, 2000; Stuss et al., 2007) and
longitudinal studies (Ball et al., 2002; Buiza, 2007) suggest that fluid intelligence is amenable to training and worth pursuing.

Section 2. Place-Based Approach: Identifying the Scope and Themes of Rural Psychology

Rural psychology is a distinct sub-field of psychology as it focuses on unique people and contexts, and features distinct models of practice and service delivery (Forbes, Morgan, & Janzen, 2006; Hardy, Rizkalla, & Rollings, 2012). A clear understanding of the nuances of rurality is critical to applying effective and appropriate research methodology. In the section to follow, I elaborate further on specific topics of rural psychology that have instrumentally shaped the direction of this project. These topics include: definitions of rural, demographic features of rural communities, and alternative service delivery models. Many of these topics expose a rural-urban gradient with rural and northern populations at a heightened risk for psychological and cognitive difficulties (Luchsinger, Reitz, Tang, Manly, & Mayeux, 2007; Reed et al., 2004)

Defining Rural Psychology

The technical definition of “rural” uses indexes such as population density and degree of metropolitan influence (e.g., Bollman & Clemenson, 2008; Du Plessis, Beshiri, Bollman, & Clemenson, 2001). For example, using population density as the criterion, Census Rural Areas (CRA) identifies an area as being ‘rural’ if the population is less than 1,000 and the density below 400 persons per square kilometre. Alternatively, Metropolitan Influence Zones (MIZ) uses metropolitan influence as the criterion and defines rural according to the proportion of people that must commute to a larger centre for work. A more encompassing definition of rural is used by the Organisation for Economic Co-operation and Development (OECD), which distinguishes between “predominantly rural regions” (50% of the population living rurally) and “rural communities” (population densities of less than 150 persons per square kilometre). Statistics Canada has extended this definition to also describe rural metro-adjacent, rural non-metro-
adjacent, and rural northern communities. Under this framework, the term ‘rural northern’ is used to refer to Nunavut, northern territories, and areas that are north of provincially-defined lines of parallel (Bollman & Clemenson, 2008). Rural northern can more elaborately be described as isolated (no year-round road) or remote (over 350 km) from the nearest year-round road (Public Health Agency of Canada, 2009). Whilst there is no standard way to define rural, there seems to be a common understanding among rural-dwellers of what it means to “live rural”: low population, long distance to large metropolitan areas, and unmet healthcare needs (Harowski, Turner, Levine, Schank, & Leichter, 2006). While these characteristics appear restrictive, it is important to recognize that rural areas also possess inherent strengths that make them uniquely able to address community needs. To name a few: tight social networks, rich history, success in collaborative efforts in crisis situations, and a high quality of self-sufficiency (Phillips & McLeroy, 2004). Identifying and drawing on these strengths can lead to reduction of the stigma of the “rural deficit”.

**Demographic Features of Rural Communities**

Canadian demographic trends show that the proportion of seniors is expected to grow 12% by 2031. While the aging phenomenon is occurring across Canada, aging rates are most striking in rural and remote regions of Canada (Statistics Canada, 2006). Over the years, rural Canada has typically experienced net losses of younger cohorts (aged 24 and younger) and net gains of older cohorts (aged 25 to 69) (Rothwell, 2002). As it stands, approximately 20% of Canada’s population lives in rural areas with these numbers on the rise (Barbopoulos & Clark, 2006; Canadian Institute for Health Information, 2006). For example, in the province of British Columbia (B.C.), seniors currently make up 16% of the population, with these figures projected to rise to 24% by 2031 (Statistics Canada, 2004). With the expanding aging population in
Northern B. C., the consequent increase in the prevalence of dementia poses a crisis that specifically challenges rural communities (Morgan et al., 2009).

**Rural Nuances and the Call for Alternative Models**

People living in rural areas are confronted with significant barriers that make it difficult to receive adequate health care. One of the major issues is a shrinking number of health care professionals and resources (CCMHI, 2006). Urban Canadians have much greater access to psychologists than rural Canadians. National data, in corroboration with provincially specific studies (e.g., McWilliams, Brown, Winder, Glasgow, & Weldrick, 2012), reveal that the ratio of psychologists to population is significantly higher in urban areas (9,619:1) than rural areas (2,195:1) (Bezanza, 1999). The scarcity of psychologists necessitates the burden of expenses incurred while traveling to obtain health care (Bedard, Koivuranta, & Stuckey, 2004; Gale, Loux, Shaw, & Hartley, 2010). For example, two-thirds of northern residents have to travel 100 kilometres to visit a physician (Ng, Wilkins, Pole, & Adam, 1997). If steps are not taken to remedy this problem, seniors will be forced to relocate in order to obtain healthcare (Rothwell, 2002). For all these reasons, The Ministerial Advisory Committee on Rural Health (2002) has identified seniors as a special-needs population.

Hinton, Franz, and Friend (2004) point out that the long-standing shortage of services has shifted the provision of aging care to primary care physicians. It is estimated that 60% of psychological care is delivered by primary care physicians (Geller, 1999; Harowski et al., 2006). These responsibilities are both burdensome and substandard (Large, 2000). A number of studies have raised concerns about primary physicians' confidence in treating patients with cognitive impairment. For example, Turner et al. (2004) found that general practitioners in rural regions are insecure in their diagnosis and management of aging and dementia. Their hesitation extends to basic assessments of mental status (Camicioli et al., 2000) or talking with patients about their
cognitive difficulty (Iliffe & Wilcock, 2005). Because of these concerns and the protracted nature of cognitive issues, there is a need to accelerate access to psychological services, with an emphasis on supporting general practitioners in rural communities (Church, Cornish, Callanan, & Bathune, 2008; Iliffe & Wilcock, 2005; Romanow, 2002)

**Collaborative models.**

It is anticipated that the establishment of collaborative networks effectively provides services in ways that improve the cognitive health of rural communities (CCMHI, 2006). Despite increasing calls for interprofessional collaboration in rural regions (Romanow, 2003), controlled trials addressing the most appropriate models for collaboration are ‘sparse to non-existent’ (CCHMI, 2006). However, collaborative care efforts have seen growing support in the empirical literature and public policy (Elterman, 2011). For example, recent initiatives in B. C. that have psychologists as part of integrated health teams point towards enhanced management of chronic conditions, reliable behavioural changes of patients, more timely interventions, and reduced demands on the health care system (College of Psychologists of British Columbia, 2011; Hunsley & Lee, 2003; Romanow & Marchildon, 2004).

For psychologists to facilitate effective collaborative relationships, it must first be understood that integrative service delivery must be formulated with a place-specific lens (Humphreys et al., 2002; Markey, Halseth, & Manson, 2009). For example, given that primary care providers are the de facto providers of psychological services in rural communities, Kainz (2002) argued that it is up to psychologists to adjust to the culture of primary care and use their position to integrate behavioural interventions into clinical practice.

There are successful examples of collaborative models that rural researchers can draw from (Hardy et al., 2013). Large (2000), for example, champions for the improved utilisation of students to supplement available professional services. The Rural and Remote Memory Clinic
(RRMC) is another successful integrative program that was made possible within a rural framework (Linzmayer, 2003). The RRMC provides one-stop interprofessional services that include clinical psychologists in the provision of dementia care (Crossley, Morgan, Lanting, Bello-Haas, & Kirk, 2008; Morgan et al., 2009). This integrated model of care has bridged sectors at various levels of government, and, by facilitating timely integration of knowledge, has improved day-to-day levels of practice. Consistent with these examples, it is my view that streamlining co-ordination of services between primary care providers, psychologists, paraprofessionals, and technology will lead to an effective integrative response to rural healthcare needs.

Section 3: The Future of Cognitive Training in Rural Psychology

The current project represents an integrative approach in that it pulls disparate strategies together to create a comprehensive program. I simultaneously build on previous methodologies while trying to address some their limitations. The telehealth and self-help approach described below is expected to apply practically to problems facing older adults in rural regions of Canada.

Telehealth

Psychologists practising in rural Canada may circumvent delivery barriers by using alternative methods of service delivery (CCMHI, 2006; Schopp, Demiris, & Glueckauf, 2006). Telehealth is one such alternative method that makes it possible to administer cognitive services from a distance (Poon, Hui, Dai, Kwok, & Woo, 2005; Rossi, 2006). The use of technology to provide services such as consultation, intervention and assessment has critical implications for the effectiveness of the rural healthcare system (Farrell & McKinnon, 2003; Romanow, 2002). Though data relating the application of telerehabilitation to cognitive aging is still in its infancy, this new paradigm is an expanding area of research (Brennan, Georgeadis, & Baron, 2002; Caltagirone & Zannino, 2008). For example, Beebe (2001) reports the value of telephone help-
lines on extending community tenure in unstable outpatients. This application has clear links to current Canadian health policies to decrease geriatric hospitalizations and encourage individuals to maintain their independence at home (Farrell, Blank, Koch, Munjas, & Clement, 1999). Foundational work in this area has demonstrated good psychometric equivalency between telehealth and in-person auditory assessments for elderly patients in rural areas (Brennan et al., 2002; Loh, 2004; McEachern, Kirk, Morgan, Crossley, & Henry, 2008). The adequacy of telerehabilitation is corroborated by studies showing that active ingredients (e.g., therapeutic alliance) are not lost to this method (Lingley-Pottie & McGrath, 2006), and remote care is acceptable by today’s cohort of elderly adults (Morgan et al., 2009; Poon et al., 2005).

That being said, when developing programs for older adults, the degree of technological sophistication must be carefully considered. A recent body of research suggests that highly sophisticated technology should be avoided for older generations (Glueckauf et al., 2005; Rotondi et al., 2005). Older adults frequently experience frustration and feelings of low efficacy when confronting technologically-based systems (Czaja et al., 2006). The issue is compounded by the fact that internet connectivity and usage vary greatly across geographic locations. The difference between urban and rural access to internet connectivity has been coined the ‘digital divide’ (Wade & Wolfe, 2005). The challenges posed by the digital divide and its relevance to the provision of healthcare was articulated in a recent service plan reported by the Northern Health Authority (2010). Consistent with this, Glueckauf et al. (2005) suggest that online, computer-based interventions are less acceptable for seniors in rural and remote regions. The authors themselves opted to use the relatively low-tech approach of telephones with their elderly rural-dwelling participants. Their decision underscores the trade-off between the advantages of emerging technologies and the offsetting issues of usability and acceptability with particular populations (Glueckauf et al., 2005).
Self-Help Training

There is a general understanding that rural health problems are unlikely to be adequately addressed by mainstream programs but must be designed within a rural lens (Humphreys, Hegney, Lipscombe, Gregory, & Chater, 2002). In the context of cognitive training, for example, geographical constraints prohibit the use of traditional cognitive training platforms, as these platforms typically involve participants meeting in a group-designated setting (Rebok et al., 2007). In this context, there is an increased need for alternatives to formal group-based cognitive intervention (Faucounau, Wu, Boulay, DeRotrou, & Rigaud, 2010). There are a number of strategies that can be used to work with the community to meet rural needs. The general consensus is that providing supportive house-based, self-administered programs can offer flexible training platforms that are more easily accessible and culturally appropriate for the rural public (CCMHI, 2006). The idea of self-help programmes is to allow patients to supervise themselves on a prescribed plan of treatment, thereby synergistically alleviating high practice demands experienced by physicians. Rural Canadians may be especially receptive to self-help treatments because they inherently promote privacy and other cultural concerns (Hardy et al., 2013). Self-administered treatment may be a valuable non-invasive treatment option and a step towards fostering autonomy and encouraging patients to actively participate in their own health care (Acevedo & Loewenstein, 2007). Prior research has demonstrated that these kinds of resources are well regarded within the professional community (Adams & Pitre, 2000; Norcross et al., 2003) and that physicians are willing to routinely recommend these resources to their patients (Farrand, 2005; Norcross et al., 2003). Canadian adults match this enthusiasm and are open to consulting self-help resources for health-related issues (Church et al., 2008). For patients who opt for a more hands-on approach, supportive coaching by a paraprofessional may also
accompany self-help programs to boost program desirability (Rogers, Oliver, Bower, & Lovel, 2004).

Home-based therapy is not a second-class treatment option. Relevant to the goal of cognitive training, outcomes produced from self-administered programs are both effective and durable. In terms of efficacy, intervention research has demonstrated that home-based, self-guided practice with cognitive materials results in improved cognitive performance (Schutz, 2007) and, in many cases, those in self-guided conditions do as well as those in instructor-guided training groups (Braga, Da Paz & Ylvisaker, 2005; Kotler-Cope & Camp, 1990; Lachman, Weaver, Bandura, Elliott, & Lewkowicz, 1992). Speaking to longevity, Blackburn et al. (1988) found that self-guided treatment effects were more durable than instructor-guided effects. Rodin, Cashman, and Desiderato (1987) concluded that more durable effects are products of self-guided interventions because they more effectively impact one’s feelings of control. Likewise, participants are more likely to stay engaged throughout training because they witness the direct relationship between improvement and their own efforts (Hill, Backman, & Stigsdotter-Neely, 2000).

Section 4: Literature Review: Cognitive Training in Normal Aging

There is a considerable tradition of cognition-focused intervention with elderly (Clare & Woods, 2004; Floyd & Scogin, 1997; Verhaeghen et al., 1992). For normal older adults, these interventions typically focus on training in cognitive skills to enhance current function, with the primary goal of averting future cognitive decline (Acevedo & Loewenstein, 2007). Interest in the application of cognitive training (CT) in the elderly has resulted in retrospective (Friedland, Fritsch, & Smyth, 2000; Kondo, 1994) and prospective (Wilson, Bennett, & Bienias, 2002; Wilson et al., 2002) investigations, both of which suggest positive impact (Fratiglioni, Paillard-Borg, & Winblad, 2004; Mowszowski, Batchelor, & Naismith, 2010). Randomized controlled
studies are relatively sizable and also corroborate the therapeutic benefits of cognitive training in elderly populations (Faucounau et al., 2010; Valenzuela & Sachdev, 2009). Moreover, there is a body of literature documenting that cognitive benefits can be maintained for a considerable period of time beyond training, thereby staving off cognitive decline and subsequent dementia (Belleville, 2008; Oswald et al., 2006). A summation of the literature suggests sustained improvements for as long as five years in normal adults (Willis et al., 2006) and at least one year for pre-clinical (i.e., mildly impaired) populations (Rozzini et al., 2007).

Though evidence for the efficacy of CT in healthy and pre-clinical populations is promising, definitive conclusions are limited by vast differences in methodological rigor, study design, and nature of each CT program. Differences pertain to factors such as group versus self-based treatment, home versus clinic-based training, and computer versus paper-based approaches. Other differences pertain to program duration and intensity, whether the content is multifactorial or unifactorial, and assessment methodology. Differences in the design of CT programs may be understandable insofar as they follow differing theoretical approaches; however, they add to the complexity of synthesizing findings from a heterogeneous field. Such differences have been noted in many recent review papers (Belleville, 2008; Medalia & Richardson, 2005; Sitzer et al., 2006). The single consensus of opinion, however, is that well-designed randomized controlled studies of multicomponent cognitive interventions are greatly needed to foster progress in this field (Acevedo & Loewenstein, 2007; Niemeier & Taylor, 2005).

Given the potential for CT to induce long-lasting improvement in older adults, an overview of the state of the literature is timely. As there is little homogeneity, I chose to synthesise the key findings of high quality studies (i.e., rigorous Randomized Control Trials, RCTs), highlighting themes that emerged and lessons learned in studies’ procedures and results.
RCTs are recognized to be the best and most definitive way of demonstrating that an intervention is effective because they permit maximum control over the manipulation of interest (Kazdin, 2003). A total of 11 high quality studies are reviewed below.

The SIMA trial investigated the effectiveness and durability of distinct cognitive interventions on improving cognitive and functional abilities in normal community-dwelling older adults (Oswald et al., 2006). The controlled trial involved 390 participants who received 30 hours of training in one of five conditions: competence training, memory training, psychomotor training, combined psychomotor and competence training, combined memory and psychomotor training, or no treatment control. After 36 weeks of training, significant improvements followed each training program in the cognitive domain in which they received training, with benefits persisting even 5 years post-treatment. Benefits did not, however, generalize to real-world activities. The only participants who demonstrated generalized gains were those who received combined psychomotor and memory training. It appears as though training of any kind is better than no training, but above and beyond this, the evidence suggests that multifaceted training produces more robust gains.

The ACTIVE trial was similar to the SIMA trial in that it examined the effectiveness and durability of distinct cognitive interventions (memory training, reasoning training, speed of processing training) in improving the performance of normal elderly persons on basic measures of cognition and on measures of daily functional activities (Ball et al., 2002). This RCT included 2,802 community-dwelling older adults who received 60 hours of training in their respective domain over a 6 week time period. Cognitive and functional measures were administered after the intervention and at 2- and 5-year follow-ups. As in the SIMA trial, results indicated that compared with the no-contact control group, participants in all intervention groups showed cognitive (but not functional) improvement in their respective trained domains after the
intervention and at follow-ups (Willis et al., 2006). Again it is apparent that training of any kind is better than no training. Additional insight was gained in the speed of processing group who showed the most reliable cognitive improvement, and were the only participants who showed improvements in real-world measures. In this regard, it seems that functional improvement is a likely response to training processing speed, presumably because this component underlies most cognitive systems (Acevedo & Loewenstein, 2007).

The researchers of the IMPACT study distinctively singled out sensory systems as the most important components underlying cognition (Smith et al., 2009). Accordingly, the study randomly assigned 487 normal older adults to either CT targeting speed of auditory information processing or to an active control group. This self-administered training program delivered 40 hours of treatment over eight weeks. Follow-up testing revealed significant improvement in the intervention group on both trained and untrained cognitive measures, presumably reflecting generalization of treatment. Furthermore, the large effect sizes accompanying training are all the more impressive given the incorporation of an active control group in lieu of no-contact or placebo used in previous trials.

Other studies have reported generalizability of processing speed training to everyday activities. Specifically, a RCT conducted by Edwards and colleagues (2002) compared the functional performance of a no-contact control group to a group of individuals who completed 10 hours of processing speed training. Compared to controls, older adults who completed the training significantly improved on trained cognitive and functional outcome measures. A more recent study (Edwards, Wadley, & Vance, 2005) looking to extend their investigation did so by raising the bar of the control group to active conditions and by selecting a sample of older adults who at baseline demonstrated processing speed difficulties. Results of this new RCT replicated
their earlier findings in that participants trained in processing speed outperformed participants in both social and computer-based active control conditions.

In an effort to synthesize several key components of cognitive training, a RCT conducted by Mahncke and coworkers (2006) addressed the issues of treatment longevity and generalizability, enhanced benefits of multifactorial training involving processing speed, incorporation of active controls, and the feasibility of self-administered treatment. The study randomly assigned 155 community-dwelling older adults to an intervention that emphasized processing speed versus an educational active control condition or a no-contact control group. Participants self-administered 40 hours of treatment over 8 weeks. After the intervention, only participants in the treatment group demonstrated cognitive and functional gains. Performance improvements generalized to untrained tasks and were still present at 3 months after treatment.

Using a slightly different design methodology, Stuss and colleagues (2007) employed a longitudinal randomized crossover design to evaluate the impact of a 12 week multicomponent intervention program consisting of memory, executive functioning, and psychosocial skills. Fortynine participants were randomized into two groups, each receiving the same treatment and control procedures, differentiated only by the order of condition that they received first (treatment or control). The added value of this methodology to the discussion on cognitive training pertains to the patterns of results that emerge over an extended period of time during treatment and control conditions: stable cognitive and function gains were achieved during treatment phase and was maintained to a lesser degree when treatment was withdrawn.

Belleville and colleagues (2006) showed that it is appropriate to include two populations with different degrees of impairment in a single program and to expect that both will improve. The researchers developed a multifactorial intervention programme delivered to persons with mild cognitive impairment (MCI) \( (n = 14) \) and persons with normal cognitive aging \( (n = 9) \).
Following 16 hours of training delivered over 8 weeks, treated participants showed significant cognitive improvement compared to controls (Belleville et al., 2006). Apart from demonstrating the appropriateness of cognitive training in populations differing on cognitive functioning, there were two other significant aspects of this design that merit elaboration. First, by including both MCI and normal participants, it was possible to assess the magnitude of the intervention effect in normal as compared to those with cognitive decline. The effect sizes for participants with MCI were in the range of those commonly reported in normal healthy older adults, indicating compatible therapeutic benefits for both populations. Second, a measure of clinical significance was possible by evaluating whether the intervention actually normalized performance of MCI participants at the end of treatment. The evidence provided (comparing treated MCI and pre-treatment controls) was informative insofar as it suggested treatment’s potential to change the diagnostic status of adults with MCI to be closer to that of normal adults.

There are several lines of work that show the enduring benefits of multicomponent cognitive training. The groundwork began in a ‘proof of principle’ study that was designed to illustrate the existence of maintained improvements for MCI following computer-based CT. Günther et al. (2003) treated 19 individuals with a multicomponent programme carried out for 14 weeks. The efficacy of the intervention was evaluated using a broad cognitive battery (assessing attention, reaction time, memory, and language) at pre-training, immediately after training, and at 5 month follow-up. Significant and long-term improvements were observed at both time points, indicating that the effects of the programme were relatively long-lived (Günther, Schäfer, Holzner, & Kemmler, 2003).

In a more rigorous trial, Buiza et al. (2007) employed a RCT to investigate the benefits of multicomponent cognitive intervention in 238 cognitively normal elderly over a period of 2 years. The research was designed to compare two multicomponent cognitive training programs
differing on whether the program included psychosocial content (e.g., anxiety, relaxation) or not. The intervention provided 180 hours of training and each participant received six evaluations, an initial assessment followed by another every 6 months. Compared to no-treatment control, both groups receiving cognitive treatment showed immediate and long-term improvements in a variety of cognitive domains. To begin with, then, this study corroborates the findings of previous studies addressing the superiority and stability of multifactorial cognitive treatment. Above and beyond stability, however, results showed that participants receiving added treatment in psychosocial components had a trajectory of scores that continued to rise, while the other multifactorial group remained flat. What this suggests is that although multifactorial treatments are generally beneficial, the learning potential may be at enhanced levels in programs that focus on psychosocial factors in addition to cognition.

Rozzini et al. (2007) designed a one year longitudinal study intended to assess the external validity of cognitive training on a more representative sample of older adults on cholinesterase inhibitor (ChEI). Fifty-nine adults with MCI were randomized into three conditions, each building on the previous one: one group was not treated \((n = 22)\), one group was treated with ChEI \((n = 22)\), one group was treated with ChEI plus 60 hours of cognitive training \((n = 22)\). A neuropsychological battery was administered pre-treatment, 3 months post-treatment, and one year follow-up. The results demonstrated that only those receiving cognitive training improved in memory and reasoning, and that the improvements were maintained at one-year follow-up. Besides illustrating treatment durability on a broader sample base, this project makes a case that cognitive interventions are promising both as a single management strategy (Belleville, 2008), and when combined with pharmacological treatment (Rozzini et al., 2007; Talassi et al., 2007).
Summary: Lessons and Key Considerations from the Literature

The literature provides a solid knowledge base for future research in cognitive aging. Significant contributions are evident in the development of theory-driven and empirically supported techniques for cognitive training. If we broadly look across these seminal studies, we see a sharing of certain design principles that produced positive results, namely: multifactorial programs and intensive practice focused on age vulnerable decline (i.e., fluid intelligence). Training programs that follow this format appear to produce robust and long-lasting benefits on both trained (proximal) and untrained (distal) measures. At the same time, methodological and conceptual lessons can be drawn from the literature to better design interventions that maximize therapeutic impact. Specifically, to maximize the ability to draw reliable conclusions regarding the effects of my training protocol, special attention was paid to the use of appropriate control groups (internal validity), generalizability of training findings (external validity), and manipulation checks of treatment protocol (construct validity).

Section 5: The Current Research

Place-Based Overview

Whilst the program draws heavily from modern thinking about cognitive training, it is set apart from predecessors by its place-based infrastructure. I distinctly examine the role of collaborative models in producing place-appropriate cognitive interventions. Two unique features of this program make it possible for rural elderly to overcome service delivery barriers: opportunity for multiple routes of study entry and treatment that could be delivered at a distance. Therefore, my approach addresses issues of service accessibility in addition to treatment efficacy, and representing optimal goodness of fit between my framework and the needs of the target population.
Treatment Design Overview

This was a multi-community, randomized controlled, double-blind trial. This study was designed to compare two conditions, experimental intervention (EI) and active control (AC), on cognitive outcome measures. The inclusion of a yoked active control allowed me to eliminate threats to internal validity while enhancing construct validity. Manipulation checks were implemented to endure the fidelity of the treatment protocol. All directly involved stakeholders (i.e., principal investigator, participants, physicians) were blind to group membership to equalize placebo effects. Assignment of persons to these conditions was completed at random; a strategy done to minimize the likelihood of selection bias and maximize the likelihood of group equivalency at baseline. Pre-treatment and post-treatment neuropsychological assessments served as program outcomes and allowed me to objectively compare the magnitude of improvement on trained and untrained measures between the EI and AC program. Overall, the study was designed to evaluate the efficacy of this experimental treatment; attributing group differences to treatment modules and not to extraneous factors.

Objectives

1. To develop a novel collaborative approach to improving access to cognitive training that is appropriate for rural settings.

2. To evaluate the efficacy of a novel cognitive training program for improving cognition in rural elderly persons.

Hypotheses

1. Collaborative networks between researchers and primary health care providers can be used to improve access to cognitive training for rural elderly.

A) Recruitment success: Recruitment success rates will be highest with collaborative methods compared to other recruitment routes.
B) Program Compliance: Participants recruited through collaborative method will use the program significantly more than participants recruited through other routes.

2. Cognitive training (IV) will significantly improve cognitive functioning (DV).
   A) Change Score: At pre-intervention, there will be no differences between the groups on outcome measures. At post-intervention there will be group differences on change scores favouring the experimental group.
   B) Reliable Change: A larger percentage of participants in the experimental group will show reliable changes on outcome measures than in the active control group.

Method

Stages of Program Development

In the development of this program, the emphasis on rurality was captured in the selection of research methods that would overcome capacity and service delivery barriers. The strategy was to adopt various elements of Community Based Research (CBR), thereby positioning the research in a sustainable footing for the future. For example, in the early stages of the research, a preparatory phase preceding the implementation of the program was used to foster community engagement and heighten prospects for supporting the upcoming work. Six months lead time was used for introductions and informal discussions about aging and research interests. These interactions provided a catalyst for the exchange of ideas and set a foundation for a series of three local presentations and one radio interview that explored various aspects of aging concerns. In this phase I learned that community partners were basing their decision to participate on amount of time and clinical restructuring required. In response, a mutual agreement to restrict community involvement to just patient recruitment was successful at creating fluidity and openness towards the research process. A total of 6 physicians, 2 community representatives, and 2 geriatric service providers formed the collaborative team for
active engagement in this project. Several others showed support in a more hands-off way by agreeing to post fliers in their shops or supply research materials free of charge. This resulted in broad recruitment from medical clinics, pharmacies, senior centers and community organizations.

The next phase of the research process was more formal in nature and involved front-end negotiation about the research protocol, stakeholder roles, and expectations about the potential outcomes. A great deal of effort went towards formalizing a clearly outlined plan to deal with the ebbs and flows of the rural workforce. Take, for example, the method of referral correspondence between the researcher and the community members. Some offices were comfortable faxing referral forms, whereas others requested face-to-face pick-ups during weekends or off-clinic hours. Another matter that needed explicit planning was research ethics and deciding how to deal with unexpected or averse events. Pre-determining the mechanism for information sharing and how to deal with an unexpected detection of cognitive impairment facilitated quick decision-making and adaptation.

The final phase before launching the program was the development of the training modules. Over the course of four months, a total of 500 evidence-based exercises were created specifically for this program. Activities included pattern reasoning/completion to train executive functioning, word list pairing/retention to train memory, and psychoeducation/journaling to train psychosocial functioning. This formative stage was a multilayered endeavour that also necessitated a community-based approach. Colleagues, research assistants, and community members were involved in piloting the exercises contained within the program. Their feedback was used to adjust the activities, improve the layout and readability of instructions, and create a manual and answer key that would be subsequently used by coaches.
Analytic Strategy

To measure the efficacy of the training program, after screening testing, there were two major assessment sessions: pre-training and post-training.

Pre-training: I compared baseline performance between the two groups using analysis of variance (ANOVA) to test for possible differences on each of the measures. This assessment indicated whether the two groups were equivalent before training. Because participants were assigned to the two groups using a stratified randomization procedure, I predicted that there would be no differences between the groups on any of the measures at baseline.

Post-training: The subsequent assessment provided a test of the effects of training of the EI relative to the AC. I investigated differential change between the two groups on each measure using mixed model effect (MIXED). I predicted a training effect in the EI relative to the AC.

The major capabilities that differentiate MIXED from general linear models are that MIXED handles correlated data, unequal variances, and uneven spacing of repeated measurements (For review, see McCulloch & Searle, 2000; Verbeke & Molenberghs, 2000). MIXED present a clear advantage over other methods because it increases the precision of analyzing complex original data by estimating fixed and random effects in one model.

Hypothesis tests were set at a-level of 5%. Because the control condition decreased the expected difference between groups (decreased effect size), the design was inherently conservative and adjustments for multiple comparisons were not made for the purpose of conserving power and avoiding Type II error. Accordingly, however, appropriate caution was taken in interpreting the results, and, where informative, results of reliable change are provided to further index of the effect of training on performance. When setting alpha at .05 coupled with a moderate effect size ($d = .6$, outlined by meta-analysis), a power analysis suggests that a sample size of N = 50 is needed to yield power of .70 (Cohen, 1988).
Participants

Participants were recruited across 6 field sites from November 2012 to July 2013. The recruitment goal was to select healthy seniors living in numerous rural communities of Northern British Columbia. Participants were enrolled if they were 60 years of age or older and free of diagnosed neurological or psychiatric illness history (including stroke or traumatic brain injury). Persons were excluded from participation if they were taking cognitive stabilizers (e.g., acetylcholinesterase inhibitor), if they did not perform within 1.5 SD of normative data at baseline assessment, or if they became nonadherent to the training regimen [completing ≤ 14/20 sessions (70%)]. Oral assent was obtained for a telephone screening and participants’ responses determined their eligibility for inclusion in the study. Eligible participants were required to submit written informed consent by mail. Individuals who failed the screening interview were informed that they were not suitable for the study and were encouraged to talk to a physician.

Procedure

Participants were referred to the program either by a family physician or through self-referral. Participants were assigned an identification number and randomly assigned to an age-stratified treatment group. A random EI and AC sequence was generated within each stratum and sent to sites before study commencement. Physicians dispensed EI and AC training kits on site and faxed concealed referral forms to the research team. Persons who directly contacted the research team (i.e., self-referral) were mailed a training package through the same concealed randomization process. The method of study entry was recorded for analysis of recruitment success and compliance. An unblinded training coach followed up all referrals for secondary screening and to obtain consent. Participants self-administered treatment for 1 hour/day, 5 days/week over 4 weeks. To track the effects of training, repeated testing on standard neuropsychological outcomes was obtained by telephone by a trained psychometrist (the blind
principal investigator) at pre-and post-intervention (within one week of treatment conclusion).

To ensure protocol fidelity, participants were monitored by phone and were required to submit completed homework by mail.

Training Coaches

In recognition of the importance of personalizing the treatment process (Stuss et al., 2007) and maintaining stakeholders’ blindness with respect to group assignment, participants received telephone supportive sessions with a paraprofessional coach, an approach that has become popular in compliance schemes (Frude, 2004; Worrall & Yiu, 2000). The coaches called weekly and used standardized scripts to discuss progress, monitor training compliance, and document qualitative exchanges.

Training Programs

Experimental Intervention (EI). A synthesis of several evidence-based activities was used to formulate the EI toolkit (see Appendix for example). The multicomponent program was designed to improve cognitive abilities in ways that would be expressed in a broad range of cognitive and functional domains. The paper-based program consisted of three distinct modules developed specifically for this trial: (1) Executive Functioning, which is designed to enhance reasoning processes; (2) Memory, where participants exercise retaining and recovering visual and verbal information; (3) Psychosocial Training, where the emphasis is on education and enhancing well-being in “real-life” situations. These three modules and their content were selected because they showed the most promise in efficacy studies and had been related to cognitive and functional activities.

Active Control (AC). AC participants received an active-placebo and were yoked to intervention group in terms of number of sessions, duration of treatment, and test administration. This condition has no known benefit and consists of word searches, reading short stories, and
answering multiple-choice questions. Activities of this nature are consistent with common physician recommendations for active lifestyles (Smith et al., 2009) and are among the most popular form of self-help resources (Church et al., 2008), both factors that contribute to the condition's face validity.

**Measures**

**Compliance.** This post-treatment measure was operationalized as a composite of 5 items, each item measuring the degree to which a participant availed themselves of the program: pre-assessment (out of 1), post-assessment (out of 1), hours spent in training (≤ 14 hours = terminated, 15-17 hours = 1; 18-20 hours = 2), number of weeks completed (≤ 2 weeks = terminated, 3 weeks = 1; 4 weeks = 2), and amount of training exercises attempted (out of 2).

**Satisfaction.** A post-treatment questionnaire was used to assess participants' comfort levels towards different attributes of the program. The questionnaire, rated on a five-point Likert scale (1 = strong disagreement and 5 = strong agreement), consisted of 4 statements pertaining to the following program components: telephone assessment, paper-based activities, self-directed training, and home-based setting. When rating each component, participants were asked to consider the alternative method of delivery (i.e., face-to-face assessment, computer-based, therapist-directed, clinic-based setting). The sum across all questions served as an index of the participants' overall satisfaction with the program.

**Test Battery Measures**

The assessment battery was comprehensive in relation to the domains addressed in the training. A trained psychometrist, suitably experienced for this study, performed the assessment. Primary outcomes measures were selected to examine the efficacy of treatment in the domains addressed in the training: executive functioning, memory, and psychosocial attributes. Secondary outcome measures in more distal cognitive and functional domains enabled me to measure
generalized benefits to processes that were not specifically addressed in training: attention, language, global cognition, and activities of daily living. The use of multiple tests allowed me to make use of composite measures for primary outcomes of interest. Each composite was the average of 2 test scores, equally weighted, and was designed to represent a reliable measure of performance for each domain as a whole, rather than performance on a specific test. The use of tests that could have similarity with training tasks was avoided in order to reduce the possibility that post-intervention scores represented rote practice effects rather than veridical improvement (Ylvisaker, Hanks, & Johnson-Greene, 2002). Selected tests were qualified by the need to be orally administered while still being sensitive to age-related cognitive decline and relevant to domains of interest.

**Executive domain.**

**Animal Naming Test.** Animal Naming (Barr & Brandt, 1996) is a common executive category fluency test, chosen because of its large standardization samples (Crossley, D'Arcy, & Rawson, 1997; Kozora & Cullum, 1995; Selnes et al., 1991), its high reliability (test re-test ICC = .90) (Abwender, Swan, & Bowerman, 2001), and its prior use in examining executive functioning. The participant is required to list as many animals as possible in one minute and the score is the number of correct responses.

**Letter-Number Sequence.** This auditory subtest of the third edition Wechsler Adult Intelligence Scale (Wechsler, 1987) captures the processing speed component of the executive functions (Raymond, Chan, Toulopoulou, & Chen, 2008; Spreen & Strauss, 1998). Psychometrically, it possesses test–retest reliability ($r = 0.9$, internal consistency ($\alpha = 0.9$) (Spreen & Strauss, 1998) and high validity coefficient ($r = .82$) (Sattler & Ryan, 2009). The examiner presents a series of alternating numbers and letters. The examinee is required to respond by recalling the numbers in ascending order and the letters in alphabetical order.
Memory domain.

*Hopkins Verbal Learning Test (HVLT).* This is a popular verbal memory task (Brandt & Benedict, 2001) that includes three learning trials and a 20 minute delayed recall condition. It possesses reliability ($r = .50$) that is comparable to test-retest correlations reported for other tests of verbal memory (e.g., California Verbal Learning Test) (Rasmusson, Bylsma, & Brandt, 1995). The sum of items recalled across the three learning trials provides the total acquisition score and represents short-term verbal memory. The number of items recalled upon delay represents long-term memory integrity.

*Logical Memory.* Logical Memory is part of the fourth edition of the Wechsler Memory Scale (Wechsler, 1987) and involves immediate and delayed recall following the examiner reading two short stories aloud. Among healthy elderly, this test demonstrates good reliability (test-retest $r = 0.81$) (Mitrushina & Satz, 1991) and validity [e.g., construct: $r = .93$ with CVLT (Randolf, 1994)]. It also benefits from large-scale standardization and norms (Spreen & Strauss, 1998). Furthermore, Logical Memory has been shown to be sensitive to the effects of aging and is not susceptible to practice effects (Lezak, 1995). Points are earned for each correctly repeated story “unit”.

Attention domain.

*Digit Span Forward & Backward.* This subtest of the third edition Wechsler Adult Intelligence Scale (Weschler, 1987) is used to measure attention and short term working memory (Lezak, 1995). Both tests possess strong reliability (test-retest $r = .89$) and widespread validity (Kaufman, McLean, & Reynolds, 1991). It consists of seven pairs of random number sequences that the examiner reads aloud. The examinee is required to repeat the numbers in the same order presented (Digit Forward) or to repeat the numbers in reverse order (Digit Backward).
Language domain.

**Controlled Oral Word Association Test (COWAT).** This instrument was designed to measure language fluency wherein examinees name as many words as possible from a given category or phoneme. (Benton & Hamsher, 1987). It was chosen because of its sensitivity to language impairment (Troyer, Moscovitch, & Wonocur, 1997) and because it benefits from a very large standardization sample of elderly adults (Ivnik, Malec, Smith, Tangalos, & Petersen, 1996). The instrument possesses near perfect reliability \( r_{ic} = .9 \) (Ross, 2003); coefficient alpha = .83, test-retest \( r = .74 \) (Ruff, Light, & Parker, 1996)], and its validity is well established (construct, predictive and discriminant) (Lezak, 1995; Spreen & Strauss, 1998). The score is the total number of words produced across the three letters presented.

**Similarities.** This subtest of the third edition of the Wechsler Adult Intelligence Scale (Wechsler, 1987) is widely used to assess verbal concept formation and abstract reasoning. It benefits from large standardization samples and comprehensive normative data (The Psychological Corporation, 1997). Psychometrically, it possesses high reliability (ICC = .9, and coefficient alpha = .87) and validity (convergent \( r = .8 \)) (Spreen & Strauss, 1998). Examinees are presented two concepts and required to abstractly perceive their common elements and bring them under a single concept. The WAIS standard scoring system was used.

Emotional symptomatology domain.

**Geriatric Depression Scale (GDS).** A widely accepted test of depression (Brink et al., 1982) commonly used in the elderly research population (Lezak, 1995). Psychometric properties among elderly populations show strong reliability (test-retest \( r = .93 \)) (Kasniak & Allender, 1985) and concurrent validity (BDI correlated with the GDS, \( r = .79 \)) (Gatewood-Colwell, 1989). The score is the number of items endorsed in the pathological direction.
**Beck Anxiety Index (BAI).** This index is used to assess anxiety symptomatology among older adults (Beck & Steer, 1990). The BAI possesses high internal consistency (Cronbach's alpha = .94) and test-retest reliability (r = .67). When compared to other anxiety and depression scales, the BAI shows strong convergent and discriminant validity (Fydrick, Dowdall, & Chambless, 1992) and construct validity (Kabacoff, Segal, Hersen, & Van Hasselt, 1997). The score is the number of items endorsed in the pathological direction.

**Functional domain.**

**Disability Assessment for Dementia (DAD).** This inventory measures both basic and instrumental activities of daily living in patients with cognitive impairment (Gelinas, Gauthier, McIntyre, & Gauthier, 1999). It demonstrates high internal consistency (Cronbach’s alpha = .96) and reliability (test-retest ICC = .96; inter-rater ICC = .95) (Gelinas, Gauthier, McIntyre, & Gauthier, 1999).

**Functional Rating Scale (FRS).** This instrument was chosen for its large standardization samples and because it was specifically developed for assessing the functional capacity of older people living at home (Feldman, Schulzer, Wang & Tuokko, 1994). It possesses high reliability (R_{ICC}= 0.7) (Hawes, Morris, Phillips, Fries, & Nonemaker, 1995) and concurrent validity with gold measure standards (r= 0.74 for Barthel; r = 0.81 Lawton index) (Landi et al., 2000).

**Global domain.**

**Mini Mental State Examination (MMSE).** The 30-point test is a popular general cognitive screening examination (Folstein, Folstein, & McHugh, 1975). It is known for quantitatively assessing the severity of cognitive impairment (Tombaugh & McIntyre, 1992). Internal consistency is strong (inter-rater IIC = .90) (Molloy & Standish, 1997). This test can be auditory administered (Newkirk & Kim, 2004) and examines a broad range of ability including: orientation, word recall, working memory, and repetition.
Brief Cognitive Rating Scale (BCRS). This structured interview provides both an estimate of global cognitive status and qualitative characteristics observed within the confines on the interview (Reisenberg & Ferris, 1988). Commonality among the indexes is near perfect (r = 97) (Reisberg, Ferris, & Borenstein, 1987). The rating scale characterizes the degree of impairment, from normal to very severe, on five global axes (concentration, short term/long term memory, orientation, and self-care).

Statistical Analysis

Hypothesis 1.

A collaborative approach leads to improved access to cognitive training.

A) Recruitment success. Nonparametric statistics assessed differences in recruitment success rates (proportion agree out of total invited) between each method of study entry.

B) Program compliance. Analysis of variance (ANOVA) was used to compare program compliance between treatment groups (experimental vs. control) and between referral source (physician vs. self).

C) Satisfaction. Nonparametric statistics assessed the proportion of participants who agreed (or strongly agreed) they were satisfied with the program overall and with individual program components (i.e., telephone-assessment, self-directed, paper-based, home-based). Independent-samples t-test was used to compare overall satisfaction between treatment groups (experimental vs. control).

Hypothesis 2.

The experimental cognitive training program improves cognition in normal elderly persons.
A) Change scores. Change scores for each outcome compared groups using linear mixed effects models (Ball et al., 2002; Oswald et al., 2006; Smith et al., 2009). Each model included Group (experimental, control) and Time (pre, post) as fixed factors and Referral Source (physician, other) as a random factor. The interaction term, Group X Time, was chosen to represent the net effect of cognitive training on outcome measure change. A significant Group X Time interaction (in conjunction with the predicted direction of group means) would indicate that training benefits were greater in the experimental group than in the active control group. Hypothesis tests were set at alpha-level of 5%. To allow direct comparison of different outcomes, effect sizes (i.e., difference in means divided by intra-subject SD) are reported alongside significance tests. Following the definition of Cohen (1988) effect sizes are interpreted as: small, $d = .10$; medium, $d = .25$; large, $d = .40$.

B) Reliable change index. To further characterize the results, the clinical importance of treatment effects was examined using reliable change score analysis. A participant was classified as having improved reliably on a particular measure if their reliable change index (RCI) exceeded 1.96 (formula for RCI outlined by Jacobson & Traux, 1991). The percentages of participants in each group who showed reliable change are reported.

Results

Participants

Of 70 individuals assessed for eligibility, 60 (85.71%) were eligible, 4 (5.71%) were ineligible, and 6 (8.56%) declined participation (Figure 1). Of the 60 randomized, two individuals withdrew from the study voluntarily and two were dropped by the investigator due to training nonadherence [completing ≤ 14/20 sessions (70%)]. None of these withdrawals were due to an inability to understand or self-administer the EI or AC programs. The EI and AC non-completion groups were not demographically different from each other (attrition rates: EI = 2 vs.
AC = 2; MMSE, $p = .869$; age, $p = .407$; education $p = .138$) and they were not different from those who completed the programme (MMSE, $p = 0.149$; age, $p = .636$; education, $p = .478$). The sample had a total of 56 participants.

The geographic distribution of participants is shown in Figure 2. This map, created using CID (Community Information Database, see [http://www.cid-bdc.ca/home](http://www.cid-bdc.ca/home)) software, plots urban-rural topology and the location of persons using census subdivisions. Using the OECD definition described above, of the 56 persons enrolled, 41 were from rural areas (either metro or non-metro adjacent) and 15 from rural northern communities. On average, our research office was 57.54 km away from rural residents and 490.67 km away from northern residents.

**Recruitment Rates**

Physicians invited a total of 32 individuals to participate in the research, 29 (91%) of whom accepted. The remaining 24 individuals were enrolled via self-referral. Although it is difficult to ascertain the total number of "invitations" sent out through other means, a general picture can be derived by the degree of advertisement and public exposure: 1 hour local radio time, 100 distributed brochures, and three community-based talks presented by the PI.

**Compliance**

Results of the ANOVA showed that compliance was not significantly different between the EI ($M = 7.25 \pm 0.80$) and AC ($M = 7.11 \pm 0.79$) groups ($F(1, 52) = 3.24, MSE = 0.55, p = 0.078$). Conversely, compliance was significantly greater for physicians ($M = 7.46 \pm 0.76$) than self ($M = 6.93 \pm 0.74$) referral sources ($F(1, 52) = 9.80, MSE = 0.55, p = .003$).

**Satisfaction**

80.4% of participants agreed (or strongly agreed) they were comfortable with the training program. Results of the $t$-test showed no significant difference between treatment ($M = 4.02 \pm 0.36$) and control ($M = 4.13 \pm 0.33$) groups on satisfaction scores [$t(54) = 1.26, p = .804$]. The
rates of highly satisfied participants (agree or strongly agree) for each program component were as follows: telephone-assessment (50.0%), self-directed (78.6%), paper-based (91.0%), home-based (92.8%).

**Pre-Training**

Pre-training means and standard deviations for demographic and overall cognitive function are presented in Table 1. The baseline characteristics served both as a comparison between groups and as a measure of compatibility with published normative data. The EI and AC groups were comparable in virtually every aspect. There were no differences in demographic or cognitive function. Group equivalency at baseline is an important prerequisite for interpreting any group differences at post-intervention. Moreover, both groups performed within 1.5 SD from the mean score of the published normative data.

Fifty-six participants completed treatment and were included in the analysis. For each measure, the net effect of training is expressed as change scores and presented in Table 2, along with significance and effect size (Cohen d). The results presented in Table 2 pertain to the group (EI vs AC)-by-time interactions. For significant effects, the interaction indicates that training benefits were greater in the EI group than in the AC group.

**Post-Training**

Training produced significant effects on the directly trained composite measures, memory \(F(1, 54) = 14.79, \text{MSE} = 1.68, p < .001, d = 0.56\) and executive functioning \(F(1, 54) = 29.43, \text{MSE} = 0.67, p < .001, d = 0.47\), indicating greater gains in the EI group. Improvement in the memory composite between EI and AC was 2.48 versus 0.48 score units, respectively, yielding a large effect size. Performance on the executive composite improved by 1.56 versus 0.11 score units, yielding a large effect size. Conversely, there was no impact of training on the emotional symptomatology composite \(F(1,54) = 2.34, \text{MSE} = 0.32, p = .105, d = 0.20\). On
untrained performance, there were significant effects favouring the ET group for functional
ability \( F(1,54) = 16.70, MSE = 0.14, p < .001, d = 0.57 \). Conversely, no significant differences
were observed for attention \( F(1,54) = 2.06, MSE = 1.08, p = 0.157, d = 0.35 \) or language
\( F(1,54) = 1.43, MSE = 4.32, p = 0.237, d = 0.28 \). Other untrained measures of global cognition
had mixed results, with significant effects for some measures \( BCRS, F(1,54) = 10.33, MSE = 0.14, p = .002, d = .12 \) but not others \( MMSE, F(1,54) = 0.650, MSE = 0.22, p = .424, d = .06 \).
For a few tests of interest, Figure 3 shows group trends in the mean scores for animal naming,
letter-number-sequence, logical memory delay, and disability assessment of dementia.

**Reliable Change**

Consistent with the results from the primary analysis, the results demonstrated that a
larger percentage of participants in the EI group reliably improved on each outcome measure
compared to the AC group (Table 3).

**Discussion**

This dissertation reports the outcome of a RCT that evaluated a new multicomponent
cognitive training (CT) program made broadly available to a sample of normal rural elderly. The
program, 4 weeks long and self-administered, provided comprehensive training in three distinct
but integrated modules—Executive Functioning, Memory, and Psychosocial Function. The
lessons learned regarding the potential application of these results are discussed here.

Overall, this study demonstrated that cognitive interventions helped normal older adults
to perform better on multiple measures of the specific cognitive ability for which they were
trained. Significant improvement favouring the EI group on memory and executive functioning
confirms the study hypothesis and the large effect sizes obtained are consistent with those
reported in other training programs (e.g., Ball et al., 2002; Smith et al., 2009). Measures related
to emotional symptomatology were the only exception to the pattern of results; effects hovered
around medium but did not reach statistically significant levels. It is important to note, however, that this sample was emotionally well-adjusted at enrolment and remained so over the course of the month. Moreover, performance improvements generalized to untrained measures of global and functional abilities, implying that training benefits are robustly achievable across systems. These 'spill over' gains may be particularly potent for systems containing an executive-based component. For example, further examination of the DAD (which measures functional ability) revealed that significant findings were primarily attributable to improvements in the Initiation sub-section of this measure, which accounted for 65% of the variance. Initiation- an executive-based measure subserved by the superior frontal lobe (Stuss et al., 2005)- was presumably strengthened by the executive training module, at levels sufficient to yield improvements for the DAD as a whole. A related issue arises as to whether the training-induced benefits are the result of the program as a whole, secondary to one of the modules, or due to some dynamic interplay between the modules. Although the program was designed to be integrative, it is possible that not all the modules contributed equally to the end result. If it turns out that modules are disproportionately contributing to the end result, it would be worthwhile to dismantle the protocol to include just the underlying salubrious factors.

Following an evidence-based framework, the training modules focused on age-associated cognitive deficiencies that exhibit predictable rates of deterioration. Thus, it is reasonable to speculate that training programs producing effect sizes that are comparable with the amount of decline expected longitudinally could reverse age-related decline. Specifically, normal persons ages 67-74 are expected to decline 0.22 SD in executive functioning or 0.25 SD in memory over a 7-year interval (Schaie, 1996; Small, Dixon, Hultsch, Hertzog, 1999; Zelinski & Burnright, 1997). The attained executive training effects (0.47 SD) and memory training effects (0.56 SD) were nearly double the amount of expected decline; potentially acting as a disease preventative
tool by building cognitive reserve (Valenzuela, 2008). Cognitive reserve refers to the cognitive flexibility that is associated with increased efficiency and/or capacity of existing neural pathways. One theoretical perspective is that high cognitive reserve modulates the impact of normal brain changes on cognitive performance (Reichman et al., 2010). As a consequence, persons with high reserve can enjoy long asymptomatic periods throughout the aging process because a high threshold of pathological burden must be crossed before these changes appear in any clinical manner (Miller et al., 2009). The effect sizes seen in this research adds to a body of evidence that points to the potential benefits of CT on cognitive vitality and, by association, neural plasticity across the lifespan (Churchill, Galvez, Colcombe, Swain, Greenough, 2010; Valenzuela et al., 2003). However, longitudinal research is needed to determine the risk reduction rates of cognitive training on pathological aging.

Clinical Implications

This treatment research evaluated the effects of the intervention by showing statistically significant changes from pre-to-posttreatment. While these statistically significant findings indicate that group differences were likely not chance occurrences, they do not reflect the clinical applicability of treatment response from person to person. To improve on standard statistical comparisons, reliability indices were used to make decisions about the practical importance of the statistical effects. Reliability indices provided information regarding the proportion of participants in each condition who reliably benefited from the treatment. The study established that a high percentage of trained participants achieved reliable improvement on executive (56%), memory (55%) and functional (41%) ability. In contrast, we can expect only 13%, 22% and 8% of control participants to reliably improve in executive, memory and functional ability, respectively. When combining these findings with the large effect sizes attained, there is good reason to believe that the two conditions give rise to clinical outcomes and are palpably different.
While the present study illustrates the potential for self-directed CT to address the cognitive needs of individuals with limited access to health care, results do not negate the influence of physicians in the treatment process. As indicated by improved compliance rates, physicians were critical players in the delivery of regimented treatment. Likewise, although equal amounts of people were enrolled through the two routes of study entry (physician versus self), physicians were exponentially more efficient in obtaining “buy-in”. The superiority of “hit” rates by physicians is understandable given the highly regarded nature of their relationship with the community. These findings support previous recommendations (Ylvisaker, Hanks, Johnson-Greene, 2002) for self-directed CT to be ordered by physicians; as a single management strategy or as an arm within traditional strategies.

**Critical Features of the Research Design**

This study was designed to allow us to attribute EI performance benefits to our specific training approach. The main design features and the lessons informing future trials are discussed.

**Internal Validity**

In the rehabilitation literature, there are several reports of improved cognitive abilities following training (e.g., Ball et al., 2002; Belleville, 2008; Buiza et al., 2007; Stuss et al., 2007). However, because of methodological and design limitations, it is often difficult to attribute benefits squarely to the treatment effect (internal validity) (Levine & Downey-Lamb, 2004). A major limitation of the literature under consideration is the range of conditions included as control. For example, some studies included a control group with un-equal pre-treatment characteristics (Ciprinani, Bianchetti, & Trabucchi, 2006), which compromised the interpretation of results. Other studies used a no-contact group, which, at best, informed us that treatment of some kind is better than nothing. Thus, whilst these findings are encouraging in suggesting the efficacy of CT, many seeming confounds may contribute to, or be responsible for, therapeutic
change (Kazdin, 2003). Such methodological variability suggests that tighter methodologically controlled trials are warranted (Mowszowski et al., 2010). The use of an active control set a high standard for measuring success, but in-turn allowed me to make quite specific claims about the effects of treatment. By matching groups on potentially confounding factors (e.g., contact with staff, time spent being cognitively active), there was greater likelihood that the unique properties of the intervention were responsible for post-treatment group differences.

**External Validity**

The primary concern in training research is not an improvement on an outcome measure per se, but rather change in the latent construct the measure is said to represent. Therefore, while a participant may improve on a measure, there is no guarantee that this performance will be linked to real life functional improvement or quality of life (Halligan & Derick, 2005). The degree to which beneficial effects of the intervention can be demonstrated beyond the training tasks themselves is referred to as generality (Ben-Yishay & Prigatano, 1990; Wilson, 1997). Impressive as the findings from the literature are, the challenge to generalize training gains beyond a specific training task has notoriously plagued cognitive intervention research (Ball et al., 2002; Stigsdotter & Backman, 1993; Winocour et al., 2007).

Verhaeghen (2000) has discussed the kind of evidence that would be necessary to argue that generalization has occurred. Among the points made, a strong emphasis was placed on the importance of demonstrating the everyday ‘practicality’ of results. Functional measures figured prominently in our selection of secondary outcome measures both because they are key in the definition of dementia and because these improvements provide meaningful endings (Belleville, 2008; Niemeier & Taylor, 2005). Few studies have incorporated functional performance as part of study outcome measurement, and those that do often fail to find any improvements. For example, the ACTIVE study (Ball et al., 2002) reported inconclusive findings on the impact of
training on activities of daily living (ADLs): initially, no benefits to ADLs were observed, but at five-year follow-up, an effect was seen in one of the three training group (Willis et al., 2006).

The program benefited from a number of elements that were implemented to increase generalization. In all likelihood, the emphasis of training in executive function (Edwards et al., 2002) dovetailed with variable and graded difficulty levels, led to improved functional status in our participants (Belleville et al., 2006). This design feature facilitates generalization by providing multiple opportunities for learning, and in doing so, averts superficially acclimated improvement (Gardener, Strayer, Woltz, & Hill, 2000).

**Construct Validity**

When research is well designed, it is common to mistakenly attribute post-treatment improvements to treatment effectiveness without separate measures of treatment fidelity (Hart, 2009). Treatment fidelity involves qualitative and/or quantitative checks to ensure that the treatment has been implemented as designed. Elderly compliance is a very real concern in cognitive training research. Verhaeghen and Marcoen (1996) found that older adults are 25% more susceptible to treatment noncompliance than younger adults and more likely to incorrectly apply a treatment technique by mixing it with old habits. A work group in the National Institute of Health Behaviour Change Consortium has developed comprehensive recommendations for methodologies to assess treatment fidelity that are relevant to RCT (Spillane et al., 2007). In following these recommendations, I believe in the faithful rendition of each treatment condition, and thus in the interpretation of trial outcomes.

Special attention was paid to include constructs such as treatment receipt (understanding) and treatment enactment (behaviour). First, written instructions were provided and regularly reviewed by coaches to ensure that participants understood the training protocol and rationales. Participants also had open opportunity to directly contact the research team with questions at any
point throughout the training period. Second, participants were required to submit their completed activities, enabling us to monitor behavioural enactment.

Treatment integrity is not an all-or-none matter. Hence, it was necessary to define fidelity and the range of acceptable departures. Here, we defined inadequate treatment to be any instance in which the participant completed less than 14 of 20 sessions (i.e., completes less than 70% of program tasks). From the results we learned that compliance depended on the involvement of a physician and not to group assignment, consolidating the role that physicians will play in expediting effective training protocols. On a separate but related note, the equivalency in compliance rates between EI and AC treatment groups also spoke towards the integrity of participant blinding by suggesting that participants had impartial belief in the effectiveness of training.

Community Based Research (CBR)

This research program was initiated in an effort to improve the cognitive health of elderly persons living in rural and northern areas in British Columbia. When developing training programs for the north, it is important to consider how the rural context influences the selection of different methods. I focused on the development of a program that would speak towards what systemic process (e.g., referral) or program attributes (e.g., paper-based) make suitable vehicles for delivering cognitive training to rural communities. In the section to follow, I reflect on my CBR experience and share some pragmatic lessons about how to conduct cognitive training in a rural setting.

CBR is important in rural places because of its ability to ground the research parameters in a realistic understanding of local practice (Markey et al., 2009). Prior to study implementation, initial community consultations were undertaken with physicians in surrounding rural and northern communities. The purpose was to obtain feedback on plans for the program and to
heighten prospects for community buy-in as recruitment sites. There was strong support for the proposed research by rural and northern providers, who reported a growing demographic shift in their practices and the need for more supportive resources. It was during these visits that the principal investigator identified feasibility issues related to the study design’s control procedure.

The initial plan was to conduct a randomized trial that used multivariate analysis to compare the outcomes of two conditions, cognitive training versus an inactive placebo control. However, I was led to modify the control design as physicians expressed discomfort in referring (already disadvantaged) patients to a no-treatment condition. The design was subsequently modified to compare cognitive training to an active-control. This incorporation of an active control meant the real possibility of performance improvements in the control group. It was for this reason that change score analysis, another design modification, was the most appropriate method of analysis. Despite a high criterion for measuring success (i.e., a possible masking effect by the AC condition), differences remained statistically significant, attesting to the durability of the EI training effect. It is important to be aware that northern communities are increasingly basing their decision to engage in research on the rights to negotiate outcome deliverables (Markey, 2009). The lesson we wish to convey is that integrated knowledge translation is critical for identifying potential pitfalls and facilitating the implementation of experimental trials into existing clinical operations. The process requires flexibility, patience, and the ability to cope with uncertainty, while still maintaining research structure and positive relations with community members.

Throughout the course of the program, participants offered personal thoughts on their comfort levels with different attributes of the program. These discourses generated qualitative data, that when combined with quantitative analysis, becomes complimentary and enables us to arrive at a more comprehensive understanding of the research question (Brewer & Hunter, 2006).
Triangulating data sources to study concepts such as cognitive aging is particularly valuable for
the development of rural psychology and should be an emphasis of future studies.

A main theme emerging from weekly exchanges was that the majority of older adults
were satisfied with distance training as they felt that this mode of care offered convenience in
terms of time and travel cost as compared with existing programs offered in memory clinics.
Indeed, one-way travel saved by self-directed training was approximately 57.54 km for rural
participants and 490.67 km for northern participants. Furthermore, almost all participants
preferred paper-based activities, revealing extant generational differences in technological
comfort. However, despite high acceptability with distance training, many people would have
preferred face-to-face administration of cognitive testing.

**Limitations**

Overall, the results of this trial add to a growing body of work showing the causal
influence of cognitive training on cognitive functioning in older adults. At the same time, we are
aware of limitations to the trial, and of the need to qualify our results. In the section to follow, we
summarize the main limitations and offer some pragmatic lessons for improving the protocol.

Although this study produced robust positive effects, sample size may have contributed
to the observed null-findings for primary outcomes in emotional symptomatology. On the basis
of the obtained small-moderate effect size, significant differences may be found with \( n = 100 \).
Power analysis suggests that such a study would have an 80% chance of detecting significant
findings in symptomatology. It is important to emphasize that despite the modest sample size,
the effect sizes obtained were still comparable to those obtained in much larger studies (e.g.,
ACTIVE trial, \( N = 2832 \)), attesting to the efficacy of the cognitive program.

On the grounds of the preliminary nature of this trial, the protocol did not include follow-
up measurements to better understand the long-term effects of treatment. The promising findings
Evidence-based interventions, appropriate assessment, and clinical experience were critical elements for the success of this program. The PI of this project possesses these skills and, for the purpose of a dissertation, assumed the role of designing the research and conducting outcome assessment. A principal disadvantage to following this approach is that it does not allow me to unequivocally rule out the possibility that observed benefits were not the results of tester bias. However, the inclusion of coaches was a strategy employed to minimize contact with the PI and protect against bias. I therefore consider tester bias to be an unlikely explanation of the observed findings.

**Closing Remarks**

Interventions aimed at addressing the impact of aging are irrefutably worth pursuing (Naismith et al., 2009). In this paper I have described the operation and evaluation of a fresh approach to healthy aging aimed at improving access to cognitive services for individuals living in rural and northern communities. The experimental design allowed me to conclude that our cognitive intervention was superior to control at targeting a range of cognitive and functional domains. In explaining the tremendous application of these findings, cognitive training may act as an early preventive tool for healthy older adults, potentially reducing the incidence of disease or halting the trajectory of pre-clinical stages. While it is clear that cognitive training can benefit older adults, utilization itself is achieved through collaborative efforts with primary care. When taking a few steps back in an attempt to view the overall picture that emerges when the project findings are combined, one image seems very clear – bred hybrids between teleheath, cognitive training and interdisciplinary collaboration produce significant benefits for rural elderly.
recipients. Elements of this project are the first of its kind and we trust that the information garnered will better prepare rural Canada for the impact of an aging population.
Table 1. Baseline Demographic, Neuropsychological and Normative Data Summary

<table>
<thead>
<tr>
<th>Measure</th>
<th>Experimental N=28</th>
<th>Control N=28</th>
<th>Non-completion N=4</th>
<th>Norms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean ± SD</td>
<td>70.68 ± 8.89</td>
<td>74.39 ± 9.39</td>
<td>74.75 ± 4.79</td>
<td>70±</td>
</tr>
<tr>
<td>Education, mean ± SD</td>
<td>13.29 ± 2.79</td>
<td>11.68 ± 2.61</td>
<td>10.75 ± 2.50</td>
<td>N/A</td>
</tr>
<tr>
<td>Male, n (%)</td>
<td>28.57%</td>
<td>21.48%</td>
<td>25.00%</td>
<td></td>
</tr>
<tr>
<td>Animal</td>
<td>14.07 ± 3.16</td>
<td>12.86 ± 3.37</td>
<td>16 ± 4</td>
<td></td>
</tr>
<tr>
<td>Letter-Number Sequence</td>
<td>7.29 ± 2.14</td>
<td>6.64 ± 2.60</td>
<td>8 ± 2.5</td>
<td></td>
</tr>
<tr>
<td>HVLT Immediate</td>
<td>19.43 ± 4.22</td>
<td>18.54 ± 5.26</td>
<td>10.5 ± 2</td>
<td></td>
</tr>
<tr>
<td>HVLT Delay</td>
<td>3.86 ± 2.72</td>
<td>3.71 ± 3.04</td>
<td>N/A</td>
<td>6.8 ± 3.2</td>
</tr>
<tr>
<td>Story Immediate</td>
<td>28.64 ± 7.96</td>
<td>30.21 ± 10.76</td>
<td>19.11 ± 6.74</td>
<td></td>
</tr>
<tr>
<td>Story Delay</td>
<td>13.18 ± 6.79</td>
<td>12.57 ± 5.98</td>
<td>15.33 ± 7.57</td>
<td></td>
</tr>
<tr>
<td>Digits Total, mean ± SD</td>
<td>14.47 ± 3.54</td>
<td>15.85 ± 4.49</td>
<td>15 ± 4.00</td>
<td></td>
</tr>
<tr>
<td>COWAT</td>
<td>30.18 ± 8.67</td>
<td>28.50 ± 8.94</td>
<td>34.8 ± 12.8</td>
<td></td>
</tr>
<tr>
<td>Similarities</td>
<td>15.11 ± 3.67</td>
<td>14.00 ± 4.00</td>
<td>20.0 ± 6.5</td>
<td></td>
</tr>
<tr>
<td>MMSE, mean ± SD</td>
<td>19.14/21 ± 1.41</td>
<td>18.50/21 ± 2.05</td>
<td>17/21± 0.82</td>
<td>28/30± 1.60</td>
</tr>
<tr>
<td>GDS, mean ± SD</td>
<td>3.50 ± 2.15</td>
<td>4.07 ± .09</td>
<td>3.20 ± 3.67</td>
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</tr>
<tr>
<td>BAI, mean ± SD</td>
<td>2.14 ± 2.10</td>
<td>2.00 ± 1.59</td>
<td>N/A</td>
<td>Normal range 0-9</td>
</tr>
</tbody>
</table>

Note. Norm Information: for MMSE, GDS, refer to Spreen & Strauss (1998); for Digit Span, Logical Memory, LN Sequence and Similarity, refer to Weshsler (1987); for Beck Anxiety Inventory, refer to Beck & Steer (1990), for Animal and COWAT refer to Tombaugh, Kozak & Rees (1999), for HVLT, refer to Hester, Kinsella & Ong (2004).
Table 2. Net Effect of Training on Primary and Secondary Outcome Measures

<table>
<thead>
<tr>
<th>Test</th>
<th>Experimental</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline M ±SD</td>
<td>Change Mean M ±SD</td>
</tr>
<tr>
<td></td>
<td>Experimental</td>
<td>Control</td>
</tr>
<tr>
<td></td>
<td>n = 28</td>
<td>n = 28</td>
</tr>
<tr>
<td></td>
<td>M ±SD</td>
<td>M ±SD</td>
</tr>
<tr>
<td>Executive Composite</td>
<td>10.68 ± 2.16</td>
<td>9.75 ± 2.55</td>
</tr>
<tr>
<td>Animal</td>
<td>14.07 ± 3.16</td>
<td>12.86 ± 3.37</td>
</tr>
<tr>
<td>Letter-Number Sequence</td>
<td>7.29 ± 2.14</td>
<td>6.64 ± 2.60</td>
</tr>
<tr>
<td>Short-term Memory Comp</td>
<td>24.04 ± 5.52</td>
<td>24.38 ± 7.44</td>
</tr>
<tr>
<td>HVLT Immediate</td>
<td>19.43 ± 4.22</td>
<td>18.54 ± 5.26</td>
</tr>
<tr>
<td>Logical Immediate</td>
<td>28.64 ± 7.96</td>
<td>30.21 ± 10.76</td>
</tr>
<tr>
<td>Memory Delay Comp</td>
<td>8.52 ± 4.31</td>
<td>8.14 ± 4.25</td>
</tr>
<tr>
<td>HVLT Delay</td>
<td>3.86 ± 2.72</td>
<td>3.71 ± 3.04</td>
</tr>
<tr>
<td>Logical Delay</td>
<td>13.18 ± 6.79</td>
<td>12.57 ± 5.98</td>
</tr>
<tr>
<td>Attention</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digit Forward</td>
<td>8.64 ± 1.68</td>
<td>9.36 ± 2.36</td>
</tr>
<tr>
<td>Digit Backward</td>
<td>5.82 ± 1.39</td>
<td>6.50 ± 2.13</td>
</tr>
<tr>
<td>Language</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COWAT</td>
<td>30.18 ± 8.67</td>
<td>28.50 ± 8.94</td>
</tr>
<tr>
<td>Similarities</td>
<td>15.11 ± 3.67</td>
<td>14.00 ± 4.00</td>
</tr>
<tr>
<td>Emotion Composite</td>
<td>2.82 ± 1.89</td>
<td>3.04 ± 1.69</td>
</tr>
<tr>
<td>GDS</td>
<td>3.50 ± 2.15</td>
<td>4.07 ± 0.99</td>
</tr>
<tr>
<td>Beck Anxiety</td>
<td>2.14 ± 2.10</td>
<td>2.00 ± 1.59</td>
</tr>
<tr>
<td>Functional Composite</td>
<td>35.63 ± 1.46</td>
<td>35.23 ± 1.88</td>
</tr>
<tr>
<td>DAD</td>
<td>34.07 ± 1.15</td>
<td>34.00 ± 1.19</td>
</tr>
<tr>
<td>FRS</td>
<td>37.18 ± 2.25</td>
<td>36.46 ± 3.13</td>
</tr>
<tr>
<td>Global Cognition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MMSE</td>
<td>19.14 ± 1.41</td>
<td>18.50 ± 2.05</td>
</tr>
<tr>
<td>BCRS</td>
<td>1.53 ± 0.49</td>
<td>1.74 ± 0.63</td>
</tr>
</tbody>
</table>
Table 3. Percent of Participants Showing Reliable Improvement

<table>
<thead>
<tr>
<th>Measure</th>
<th>Experimental</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$n = 28$</td>
<td>$n = 28$</td>
</tr>
<tr>
<td>Executive</td>
<td>55.5%</td>
<td>12.5%</td>
</tr>
<tr>
<td>Animal</td>
<td>46%</td>
<td>14%</td>
</tr>
<tr>
<td>Letter-Number Sequence</td>
<td>65%</td>
<td>11%</td>
</tr>
<tr>
<td>Short-term Memory</td>
<td>54.5%</td>
<td>21.5%</td>
</tr>
<tr>
<td>HVLT Immediate</td>
<td>63%</td>
<td>7%</td>
</tr>
<tr>
<td>Story Immediate</td>
<td>46%</td>
<td>36%</td>
</tr>
<tr>
<td>Memory Delay</td>
<td>55%</td>
<td>19.5%</td>
</tr>
<tr>
<td>HVLT Delay</td>
<td>46%</td>
<td>7%</td>
</tr>
<tr>
<td>Story Delay</td>
<td>64%</td>
<td>32%</td>
</tr>
<tr>
<td>Emotional</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDS</td>
<td>11%</td>
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<td>Functional</td>
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<td>DAD</td>
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<td>FRS</td>
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<td>BCRS</td>
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Figure 1. CONSORT-type figure illustrating the flow of participants through the trial.
Figure 2. Home Communities of Participants relative to Research Base in Prince George.
Results Comparing the Net Effect of Training Between Groups

A. Animal Naming.
   $p < .001, d = 0.21$

B. Letter-Number Sequence
   $p = .001, d = 0.41$

C. Logical Memory Delay
   $p = .01, d = .14$

D. Disability Assessment Dementia
   $p = .001, d = 0.22$

Figure 3. Pre-treatment and post-treatment means with 95% confidence intervals. For each outcome measure, the P-value and Cohen $d$ effect size estimate is from the training group (experimental training (ET) vs. active control (AC)) X-time interaction.
What is the Missing Piece?

Identify the pattern in the picture. From the options provided below, circle the missing piece that completes the pattern.

The Bottom Line

Can you fill each square in the bottom line with the correct number?

Next to each number is a symbol that tells you something important about that number.

This information will help you solve the bottom line.

Keep in mind that each number appears only once in the bottom line.

Bottom Line
References


Canadian Collaborative Mental Health Initiative. (2006). Establishing collaborative initiatives between mental health and primary care services for rural and isolated populations. A companion to the CCMHI planning and implementation toolkit for health care providers and planners. Mississauga, ON.


Cappaa, S. F., Benkeb, T., Clarkec, S., Rossid, B., Stemmere, B., & Van Heugtenf, C. M. (2005). European national neurological societies (EFNS) guidelines on cognitive rehabilitation:


Friedland, R., Fritsch, T., & Smyth, K. (2001). Patients with Alzheimers disease have reduced activities in midlife compared with healthy control-group members. Proceedings of the National Academy of Sciences, 98(6), 3440-3445. doi:10.1073/pnas.061002998


http://dx.doi.org/10.1016/S0887-6185(96)00033-3


session presented at the 73rd Annual Convention of the Canadian Psychological Association. Halifax, N.S.


Sattler, J., & Ryan, J. (2009). Assessment with the WAIS. La Mesa, CA: Jerome M. Sattler Publisher.


