

How Canadian Adult Education Professors Perceive Neuroscience Research in Relation to
Educational Practices

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Abstract

Numerous studies and recent publications have focused on the understandings of brain function as it relates to teaching and learning within the area of adult education. The purpose of this research study was to understand how adult education professors from post-secondary universities across Canada perceive neuroscience research related to educational practices. This research study utilized the internet as a tool to conduct qualitative e-mail interviews with 22 Canadian adult education professors. The interview consisted of 9 structured open-ended survey questions and 1 follow-up question. The results of this study gave insight into how aware adult education professors in Canada are of neuroscience research and education. The results of this study also report on whether adult education professors in Canada are currently enhancing their educational practices with neuroscience research evidence, whether they believed neuroscience research could enhance educational practices, and if given the opportunity to talk with a neuroscientist what their topic of interest would be. It is my hope that this research exploration will contribute to the dialogue between neuroscientists and educators and be beneficial to their merging community.

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Chapter 1: Introduction

The purpose of this research study was to understand how adult education professors from post-secondary universities across Canada perceive neuroscience research related to educational practices. Very few studies (e.g., Pickering & Howard-Jones, 2007; Zambo & Zambo, 2011; Hook & Farah, 2012; Serpati & Loughan, 2012) have been conducted focusing on uncovering the viewpoints and beliefs of educators about the use in education of recent neuroscience research evidence on how the brain learns. The participants in these above mentioned studies were educators who were mainly professional grade school teachers. At the time of conducting this present research study, no studies could be found that focused on uncovering the viewpoints and beliefs of post-secondary professors about the use in education of recent neuroscience research evidence on how the brain learns. Therefore, no studies were found that conducted research on adult education professors' perceptions of neuroscience research for education. Findings from the few studies mentioned above (e.g., Pickering & Howard-Jones, 2007; Zambo & Zambo, 2011; Hook & Farah, 2012; Serpati & Loughan, 2012) indicated that some educators (i.e., grade school teachers) placed value on neuroscientific findings. Many grade school teachers were confused about the educational value of neuroscience, some bought into the non-scientific brain-based learning materials, and some did not believe neuroscience research findings on how the brain learns had any value for the discipline of education. The results of these studies mentioned above also indicated that many grade school teachers were not well aware of the neuroscience research findings on how the brain learns.

Early dialogue between neuroscientists and educators began in the late 1990's where neuroscientists began an active role in suggesting education could benefit from an awareness of

brain research (Howard-Jones, 2010). Notable efforts of this early dialogue were made by Sarah-Jayne Blakemore and her colleague Uta Frith in the United Kingdom (Howard-Jones, 2010), and the supranational project ‘Learning Sciences and Brain Research’ launched by The Organisation for Economic Co-operation and Development’s (OECD) Centre for Educational Research and Innovation (CERI) (Howard-Jones, 2010). These early collaborative initiatives sparked many seminar series involving educators, psychologists, neuroscientists and policy makers. In parallel to these seminar series a few studies (i.e., Howard-Jones et al., 2007; Pickering & Howard-Jones, 2007) were being conducted to understand educators’ perceptions of the brain in education in the United Kingdom (Howard-Jones, 2010). Pickering and Howard-Jones (2007) argue that an important component about the interactions between neuroscientists and educators is to understand the perspectives of these seminar participants, and to ensure that educators’ perspectives contribute to the dialogue between the merging fields of neuroscience and education as it develops.

Numerous studies and recent publications have focused on the understandings of brain function as it relates to teaching and learning. Many of these studies and publications, as Johnson and Taylor (2006) posit are “in the pursuit of effective teaching and learning” (p.1) as it relates to the area of adult education. Neuroscience research on plasticity, memory and learning, sleep and learning, and emotion and learning is providing evidence for the value of neuroscience research for the field of adult education and educational practices. One interesting remark from Pickering and Howard-Jones (2007) study was that “a picture emerged in which educators feel that knowledge of the brain is important in making decisions about how they teach” (p.110). However, the idea that findings from neuroscience research on how the brain learns could enhance educational practices has been highly debated over the years. Hook and Farah (2012)

comment that neuroeducation, a term often used to name the collaborative efforts between neuroscience and education, has been a controversial field since the beginning. However, efforts to merge the two disciplinary fields have flourished and continue to do so. Even though there is growing neuroscience research evidence on how the brain learns, many educators (i.e., grade school teachers) are unaware of these significant findings and how they can inform educational practice (Howard-Jones, 2010).

1.1 Background

I first started my post-secondary studies in September 1993 and I currently hold a Bachelor of Fine Arts (majoring in painting and drawing) from the University of Calgary and a Bachelor of Environmental Design (Architecture) from Dalhousie University. I am currently enrolled in the Master of Arts in Education in Lifelong Learning Program at Mount Saint Vincent University. This present thesis research paper is a final requirement of the Master of Arts in Education in Lifelong Learning Program. Over the years as a post-secondary student, I have taken a wide range of courses (e.g., courses in painting, drawing, photography, sculpture, architectural design and drafting, art and architecture history, mathematics, anthropology, archeology, philosophy, geology, English, and education). These courses were held in different educational learning spaces (e.g., art studio spaces, computer labs, photography dark rooms, lectures theatres, classrooms, drafting studios, exhibition spaces, wood shops, and architectural sites) and taught through a diversity of educational teaching practices some good some bad.

When my oldest daughter started University in September 2009, having done fairly well in high school, she starting coming home frustrated commenting on how she did not ‘get’ what her professors were teaching. First, as a parent I felt bad for her circumstance and wished the

professor taught in such a manner that she could ‘get it’; but then second, having been a post-secondary student for just over 16 years, I did not ‘get’ some of my courses either. As a student you are not always aware of what makes a good professor. You just know that at the end of the course you ‘got it’. I have often reflected back to my first undergraduate experience with two professors teaching the same calculus course I wanted to take. Having done very well in calculus in high school, I did not think I would have any problems in a first year university calculus course. When I attempted my first calculus course, I was surprised that I had difficulties understanding what the professor was teaching. I realized that I was not the only student that was having problems. Some students dropped out, and eventually I withdrew from the course as well. A year later, I registered in the same calculus course with a different professor and I had no problems understanding the course material.

Both calculus professors presented the same course material designed to meet similar course objectives. However, there was a difference in how they presented the material. In the first calculus course, the educational practices used were ineffective in helping me learn the material as compared to the educational practices used in the second calculus course. I do not explicitly remember the educational practices each professor used. However, I do remember that in the first calculus course my professor wrote out on the chalkboard the entire proof for each theorem he introduced (which he asked us to copy down) along with a lot of historical information about the mathematician behind the proof. He rarely wrote out examples of how to apply the theorem(s) during class time. Alternately, the second professor would give a short easy to understand explanation of the theorem(s) which was then followed by many examples of how to apply it, and he gave us class time to practice applying them ourselves. I am mindful of the active role an adult student must play to progress their own learning, but my personal experience

with the calculus course I took provides evidence for the application of effective educational practices. It also indicated that effective educational practices were not universal in the same field, suggesting the importance for adult educators to collaborate and discuss effective educational practices (possibly alongside students).

When my eldest daughter complained about her university courses, I remembered my earlier university experience and began wondering about effective educational practices. Her complaints came at the same time I was learning about adult educational learning theories and practices in my current degree program. I started taking a more analytical approach to what I was learning and how I was learning. I began to wonder about why there were so many theories of adult learning accompanied by numerous educational practices, why some educational practices were referred to as best practices, and which adult learning theories and educational practices were truly effective in enhancing learning. My second eldest daughter started university in 2011 and had similar experiences of not ‘getting it’ as my first daughter. Her complaints came at the initial stages of my thesis research on effective educational practices, and I became increasingly interested in searching out what were considered effective educational practices. I came across a surprising amount of information on ‘brain-learning’ and effective educational practices. However, a voice of caution was expressed from the more scholarly studies I came across that warned about the commercialized non-scientific brain-based educational practices claiming to be based on scientific evidence (i.e., neuromyths). From the literature I read, there were cautionary views towards the merging fields of neuroscience and education, and many concerns were expressed regarding the potential claims about enhancing learning and educational practices with neuroscience research.

One of the concerns that has arisen from the commercialization of non-scientific brain-based teaching methods claiming to be based on scientific evidence is how such misleading information has shaped the “perceptions and views of educators about neuroscience and its potential role in education” (Howard-Jones, 2010, p.20). One of the interesting insights argued by Zambo and Zambo (2011) about educators’ views and beliefs about education is that these beliefs and views influence how they teach. Therefore, educators’ views and beliefs about education affect what they consider to be good educational practices. If the readily available information on neuroscience research is trumped as misleading or of little value for education, it is easy to understand how neuroscience research on how the brain learns could have an unfavourable standing in the field of education. Zambo and Zambo (2011) inform us that educators’ beliefs about teaching and learning come from their personal experience, experience and knowledge gained as students themselves, and experience gained from formal knowledge including teacher training events. It would be very interesting, I believe, to gain insight into how post-secondary professors in the field of education (i.e., adult education professors), who have a functional knowledge of educational practices by the nature of their field, view neuroscience research on how the brain learns. This current research paper attempts to understand how adult education professors perceive neuroscience research in informing educational practices.

1.2 Research Questions

This current research paper attempts to answer the research question: how do adult education professors perceive neuroscience research in informing educational practices? The purpose of this research study was to understand how professors in the field of education from post-secondary universities across Canada perceive neuroscience research in relation to educational practices. All professors who participated in this research study had an interest in

adult education and are referenced throughout this research paper as adult education professors. This participant demographic was targeted purposively taking into consideration that post-secondary professors in the field of education would have a functional knowledge of educational practices by the nature of their field. This present research study utilized the internet as a tool to conduct qualitative e-mail interviews with 22 Canadian adult education professors. The e-mail interview consisted of 9 structured open-ended survey questions and 1 follow-up question. These open-ended survey questions were designed to examine how adult education professors perceive neuroscience research in relation to educational practices.

1.3 Educational Neuroscience

As Howard-Jones (2010) points out, “the ‘big idea’ of including the brain in educational thinking and practice has been around a long time” (p. x). The information and knowledge about the brain we have today, according to Wilson (2011), is an amassment of research and study from the past 200 years. With the technological advancements of brain imaging technologies, the study of how the brain learns became increasingly popular and efforts to connect brain research with education first came to sight in the early 1990’s (Wilson, 2011). Over the last two decades, according to Battro, Fischer, and Léna (2008), scholars in the disciplinary fields of education and neuroscience have started to collaborate with one another and considerable advances have been made. During this time, numerous studies have been conducted focusing on the ‘brain-basis’ for learning (Kelly, 2011). According to Hruby (2012), efforts to bridge these two disciplinary fields have progressed from a “mere hope to noteworthy scholarly sophistication” (p.1). With the increasing understanding of brain functions, studies continued to flourish and in particular studies about the neural bases for mathematics and reading (Kelly, 2011). As Kelly (2011)

posits, one of the many goals of these types of studies is to improve educational teaching methods/practices and the quality of educational material.

The terms neuroeducation, educational neuroscience, and mind, brain, and education have been used to name this collaborative effort (Battro et al., 2008). Another term often used is cognitive neuroscience, a designation favoured by Howard-Jones (Schrag, 2011). From a generalized perspective, these collaborative efforts are at the intersections between cognitive science, behavioural science, neuroscience, and the biological basis of learning with educational science, educational policy, instructional design, and educational practices. However, according to Battro et al. (2008), neuroeducation is the effort that “emphasizes the educational focus of the transdisciplinary connection” (p.3); educational neuroscience is the effort “on neuroscience to which education connects” (p.3); and mind, brain, and education “encompasses both these focuses and others that bring together cognitive science, biology, and education” (p.3). In further defining educational neuroscience, Hruby (2012) offers that educational neuroscience draws “implications from the findings and theories of the neuroscience for application in educational research, theory, and practice” (p.2). For the purpose of this present research paper, I will be using the term educational neuroscience when referring to the collaborative efforts between the disciplinary fields of neuroscience and education.

Alongside the educational neuroscience advancements over the last two decades, numerous conferences, symposiums, conventions, and likewise initiatives around the world have been organized and held focusing on brain research, learning, and education. As a recent Canadian example, the Royal Society of Canada, the Canadian Institute for Advanced Research, and the Israel Academy of Sciences and Humanities organized and held a symposium this past June (2013) at Western University in London, Ontario, entitled *The Canada-Israel Symposium*

on Brain Plasticity, Learning, and Education. An increasing number of publications (e.g., books, journal articles, research papers) can be found whose content focuses on neuroscience and education with many publications appearing in adult education literature. Even more recently, interdisciplinary educational neuroscience programs are being established at many post-secondary institutions worldwide. A few examples of Canadian and United States universities with programs and/or academic research inquiries in educational neuroscience are:

1. University of Lethbridge Master of Education (General) study theme in Inclusive Education and Neuroscience.
2. John Hopkins University School of Education Mind, Brain, and Teaching Graduate Education Certificate.
3. Harvard University Graduate School of Education Mind, Brain, and Education Program.
4. Neuroscience and Education Program at Teachers College Columbia University.
5. The Doctor of Philosophy Program in Educational Neuroscience at Gallaudet University.
6. The academic research inquiry of Educational Neuroscience at Peabody College and Vanderbilt University.

These newly created post-secondary programs offer areas of study at the intersections between cognitive science, neuroscience, and education.

1.4 Context Introduction

Many authors of neuroscience and educational content (e.g., Howard-Jones, 2010; Battro, et al., 2008; Zull, 2002, 2011; Johnson & Taylor, 2006; Immordino-Yang, 2011; Wilson, 2011)

have expressed the importance of ‘bridging’ the gap between neuroscience research about how the brain learns and the discipline of education. These authors (e.g., Howard-Jones, 2010; Battro et al., 2008; Zull, 2011; Johnson & Taylor, 2006; Immordino-Yang, 2011; Wilson, 2011) suggest that neuroscience research can inform educational practices and educational observation can provide insights and direction for neuroscience research. Over the last two decades, according to Battro et al. (2008), scholars in these two disciplines have started to collaborate with one another under a new disciplinary field often termed neuroeducation. With technological advancements, research on the brain has broadened our understanding on how the brain learns. According to Johnson and Taylor (2006), most adult educators

rely on observation and experience, anecdotal evidence, and philosophical orientation to inform practice. Additional though sometimes conflicting guidance has been available from psychological theories and sociological analysis, which attempts to describe what learning is and how it takes place. Now, however, with the advent of brain imaging we can actually watch the neurophysiology of learning unfold. Not only can we trace the pathways of the brain involved in various learning tasks, but we can also infer which learning environments are most likely to be effective (p.1).

According to Zull (2002), brain imaging research has been able to identify which region(s) of the brain are active during specific learning tasks (e.g., learning a new word). Even more specific, research on the brain has shown that when learning takes place changes to the brain’s structure occurs. This structural change within the brain is known as plasticity (i.e., neuroplasticity). Howard-Jones (2010) states that “the brain’s continuing plasticity suggests it is well designed for lifelong learning and adaptation to new situations and experiences, and there is clear evidence that such adaptation can bring significant changes even in its structure” (p.6). A

well cited research study providing evidence for structural change in the aging human brain is the work done by Boyke, Driemeyer, Gaser, Buchel, and May (2008). Their work uses brain imaging techniques to measure the structural change(s) in the brains of volunteers who learned to juggle. Building upon a previous longitudinal research study (i.e., Draganski, Gaser, Busch, Schuierer, Bogdahn, & May, 2004) with healthy young adult participants (n=22, mean age=22), Boyke et al. (2008) conducted research with healthy senior citizens (n=69, mean age=60) to determine if the aging brain could exhibit structural neuroplasticity as had occurred in the previous study.

In each study, the homogeneous group of participants were divided into two groups (e.g., training and control) matched for gender and age and both groups were inexperienced at juggling at the time of the first brain imaging scan. The training group were given 3 months to learn three-ball juggling, and at that point a second brain imaging scan was taken. A third brain imaging scan was taken of the training group after a 3 month rest period after the second scan. As a result of the data collected, Boyke et al. (2008) findings showed that the “cohort of 60-year-old volunteers showed the same plasticity in the same areas as the brains of our previous cohort of 20-year-old volunteers” (p.7033). In addition to their findings, Boyke et al. (2008) found that there was a significant increase in gray matter in the hippocampus in the training group. The human hippocampus, according to Boyke et al. (2008), is one of the brain structures

known for its life-long neurogenesis (i.e., the ability to generate neurons derived from local stem cells)... Physical activity and an enriched environment (i.e., more opportunity for social interaction, physical activity, and learning) have been shown to improve the rate of adult neurogenesis and maintenance of these new neurons (p.7033).

The brain's continuing plasticity is exciting news for adult educators and their endeavor to lifelong learning.

Previous to the neuroscience research evidence for plasticity the brain was thought to be static in nature. According to Boyke et al. (2008),

until quite recently, it was generally assumed that the capability of the human brain to modify its structural pattern to fit new environmental demands is restricted to the early stages of development, i.e., not beyond a specific critical period; any subsequent structural adaptations were limited to local synaptic changes. Later, based on lesion models, researchers examined the functional reorganization of cortical maps in various areas in adult brains and provided evidence that neural systems are modifiable networks, and these processes are not limited to the early phases of development (p.7031).

Thus, the neuroscience research evidence of the brain's continuing plasticity is a very significant finding for adult educators and lifelong learning. Another area of neuroscience research and learning looks at the effects of sleep on learning. Howard-Jones (2010) mentions that neuroscience research provides evidence showing that sleep is an important process which helps process and consolidate information that has been encoded in the brain. This sleep process, according to Howard-Jones (2010), helps us remember what we learnt yesterday, helps to prepare us to learn more, and that sufficient sleep is essential for the brain to learn.

Another interesting area of neuroscience research is the area of emotion and learning. In exploring this area, Wolfe (2006) makes an argument for how adult educators can use emotion to positively aid learning. Wolfe (2006) explains that at the basic understanding of neural learning is the process of storage (memory) of incoming sensory information into neural networks. Wolfe (2006) goes on to explain that the brain, when bombarded with different kinds of sensory input

(e.g., sights, sounds, smells, tastes, tactile information), immediately filters this incoming input and only stores (memory) information that is relevant. Therefore, Wolfe (2006) argues that the brain “‘forgets’, or does not store, information it does not find useful or important” (p.36). Thus, the brain does not pay attention to nor encodes the sensory data that is irrelevant to its existing neural networks (Wolfe, 2006). Emotion, Wolfe (2006) argues, is one of the factors that “‘determines whether or not the brain initially pays attention to and retains information” (p.39). Wolfe (2006) further explains how the release of adrenaline during an emotional situation enhances the memory of that situation. Adrenaline, Wolfe (2006) continues is also released during mild emotional and positive situations, and that “‘classroom activities designed to engage students’ emotional and motivational interest are also quite likely to lead to more vivid memories of whatever grabs their attention. The more intense the arousal, however, the stronger the imprint” (p.39). Understanding the power of emotion, according to Wolfe (2006), adult educators can “‘affect learning and retention positively” (p.39).

Another area dealing with emotion and learning is fear. Perry (2006) acknowledges that the acquisition of new cognitive information and the process of retrieving stored information “‘is essential for effective functioning within our current educational system” (p.21). Perry (2006) goes on to explain how traumatic (childhood) experiences (e.g., maltreatment, shame, and humiliation) can have an effect on the adult learner. Perry (2006) outlines how the response to threat progresses along what he calls ‘the arousal continuum’ and the further an individual goes along this continuum the

less capable he or she will be of learning or retrieving cognitive content; in essence, fear destroys the capacity to learn... The person’s internal state shifts with the level of perceived threat; as it increases, vigilance may proceed along the arousal continuum to

terror. This is characterized by a graded increase in sympathetic nervous system activity, which in turn causes increased heart rate, blood pressure, and respiration, a release of glucose stored in muscle, and increased muscle tone. Changes in the central nervous system cause hypervigilance; the person tunes out all noncritical information. These actions prepare the individual to flight with or run away from the potential threat. The total-body mobilization of the fight-or-flight response is highly adaptive and involves many coordinated and integrated neurophysiological responses across multiple brain areas (p.23).

Perry (2006) posits that fear changes thinking, feeling, and behaviour.

As an example, according to Perry (2006), a traumatized person in a state of alarm (e.g., a person thinking about an earlier trauma) is less capable of “concentrating, more anxious, and more attentive to non-verbal cues such as tone of voice, body posture, and facial expressions – and may, in fact, misinterpret such cues because of anxiety-induced hypervigilance” (p.24). The long-term effect of trauma on an adult learner, Perry (2006) furthers, is that often these individuals are in a low-level state of fear. Perry (2006) compares this low-level state of fear to test anxiety, in that many if not all learning experiences for these individuals evokes an emotion of anxiety resulting in the learner being in a consistent low-level state of anxiety. This anxiety (fear or alarm response) inhibits learning, and as a result the learner places learning limitations upon themselves (Perry, 2006). Understanding how fear and past trauma can change the thinking, feeling, and behaviour of a learner, Perry (2006) argues, will help adult educators to liberate the limitations learners place on themselves because of fear. Emotion is a double-edged sword, Wolfe (2006) argues, as it has the ability to enhance learning or impede it. It is important for adult educators to understand the ‘biological underpinning of emotions’ so they can

effectively promote healthy learning (Wolfe, 2006). Advances in cognitive, affective and social neuroscience, according to Immordino-Yang (2011), have the “potential to revolutionize educational theories about learning” (p.35).

With recent advancements in neuroimaging in the last two decades, neuroscience researchers are providing evidence for the biology of learning. Learning, Zull (2002) argues, is about biology and biology can help inform educational practice. Neurons, according to Wolfe (2006) “are the basic functional unit of the brain and control learning. These billions of cells encode, store, and retrieve information – as well as control all other aspects of human behaviour” (p.35). Zull (2002) explains that educators usually view the learner as an individual who requires their help to learn. However, Zull (2002) reminds us that “actual learning takes place down there in the brain and body of the learner” (p.xiii). Learning is change, Zull (2006) argues, and many sensory experiments (i.e., learning how to juggle) have shown that “increased signaling by cortical neurons generates the growth of more branches, which increases the density of cellular material and enhances their ability to connect with other neurons – to form more synapses” (p.5). However, as Zull (2011) states, change in the brain’s structure as a result from learning is not always an increase or growth sometimes it is a reduction in neuron firing. In motor learning, Zull (2011) states, “the actual use of neurons becomes focused, efficient, and less complex as skills increase” (p.39). Learning is two-sided, Zull (2011) argues, and one needs both the complexity offered by sensory learning and the efficiency offered by motor learning. With this insight, Zull (2002) argues that understanding learning as a biological process can help enrich educational practices.

The merging fields of neuroscience and education, Battro et al. (2008) argue will produce more accurate knowledge about mind, brain, and education and new understandings will emerge

changing the way we teach and learn in the near future. Taylor (2006) argues that connecting neuroscience research on the brain and education will ensure meaningful learning. Howard-Jones (2010) posits that there are many areas of neuroscience research that can inform educational practice, and this includes the evidence about the brain's continuing plasticity. Along with the evidence for brain plasticity and the insights about emotion and learning, neuroscience research has also provided important findings related to memory and learning and sleep and learning. According to Howard-Jones (2010), neuroscience research has provided important insights about learning strategies where individuals who utilized multiple learning strategies showed improved memory performance. Neuroscience research on how sleep influences education, according to Cardinali (2008), concludes that "sleep deprivation significantly impairs memory and the acquisition of many skills, and disturbs emotional and cognitive performance as well" (p.110). According to Wolfe (2006), emotion plays a significant role in learning and "educators can use the power of emotion to affect learning and retention positively" (p.39). However, according to Howard-Jones (2010), there is clear evidence that most of the educators interviewed in one of his studies knew very little about neuroscience research about how the brain learns.

With all the neuroscience research evidence on how the brain learns, it is surprising that many educators are not well aware of the important contributions neuroscience research affords education. For example, at a recent 2005-2006 Economic and Social Research Council - Teaching and Learning Research Programme (ESRC-TLRP) seminar series "Collaborative Frameworks in Neuroscience and Education" in the United Kingdom, which brought together educators, neuroscientists, and psychologists, according to Howard-Jones (2010), many seminar audience attendees experienced 'first contact' in collaborating in the field of neuroscience and education. Another example, at the second annual Aspen Brain Forum Symposium entitled

“Cognitive Neuroscience of Learning: Implications for Education” in Aspen, Colorado held September 22 – 24, 2011, only two educators acknowledged that they had previous training in cognitive science and half the conference audience were educators (McGowan, 2011). These examples establish that educators at that time were not well aware of the significance of neuroscience research on how the brain learns for education. This establishment along with findings from other research studies (i.e., Pickering & Howard-Jones, 2007; Howard-Jones, 2010), affirms that there is a current general lack of awareness amongst educators of the significance of neuroscience research for education.

1.5 Current Lack of Awareness

There are many factors that should be considered when trying to determine why there is currently a general lack of awareness amongst educators of the significance of neuroscience research for education. One factor is that there is not a common language between neuroscientists and educators and that there may be a lack of scientific understanding amongst educators (Pickering & Howard-Jones, 2007). This disparity of language often results in ineffective communication between neuroscientists and educators. In citing one of their participants, Pickering and Howard-Jones (2007) offer the following, “the neuroscientists... some of them have got a fantastic wealth of knowledge, but it’s difficult for them to translate that knowledge into a hallmark that is comprehensible to the teachers” (p.112). Another factor is the circulating exposure of the non-scientific ‘brain-based’ ideas (i.e., neuromyths) within the education community. Neuromyths, according to Howard-Jones (2010), “have had a major influence on shaping the perceptions and views of educators about neuroscience and its potential role in education” (p.20), and as a result “educators have been exposed to a set of concepts about

the brain that differ from those established in science” (p.37). Along with circulating neuromyths promoting unsound concepts about the brain, there are misconceptions about the brain that are held amongst educators and the general public (Howard-Jones, 2010).

In citing a survey study conducted in 2002 with insights about misconceptions of the brain, Howard-Jones (2010) reports that

30 per cent of graduates did not know learning was related to neuronal connectivity, and almost a quarter did not know it corresponded to modifications in the brain at all. Several other predominant misconceptions about learning and the brain were also revealed by this survey. These included the belief, held by almost half (48 per cent) of graduates, that we use only 10 per cent of our brain at any one time (we use the entire brain), the belief of most graduates (53 per cent) that mental practice does not improve performance (it does) and the conviction held by 41 per cent that memory is stored in the brain like a computer (when, in fact, it is distributed) (p.39).

Howard-Jones (2010) acknowledges that educators continue to receive training after graduation (i.e., teacher training), however, Howard-Jones (2010) reports that often this training promotes information about non-scientific ‘brain-based’ (i.e., neuromyths) learning programs. With the misconceptions that exist about the brain, the contradictory ideas about the mind-brain relationship, and the often promoted non-scientific ‘brain-based’ learning material, Howard-Jones (2010) argues that “it can be expected that teachers’ ideas about the brain diverge from conventional scientific thinking” (p.39).

According to his own research, Howard-Jones (2010) comments that most of his participants (i.e., teachers) “made it clear they knew little about the brain and, indeed, it is unusual to hear educators offering their opinions about it. On the other hand, as those in the

profession know, almost everyone has an opinion about education” (p.53). One potential contributing factor for the varying opinions educator’s offer about education in the education community is the existence of numerous highly developed and scrutinized theories of learning. Merriam, Caffarella, and Baumgar (2007) argue that “there is no single theory that explains all of human learning” (p.83), and educators may ‘wrestle’ with the many ideas presented in these theories of learning to inform practice. Several studies (e.g., Kember & Kwan, 2000; Norton, Richardson, Hartley, Newstead & Mayes, 2005; Northcote, 2009) have been conducted acknowledging that “teachers’ practical approaches to teaching and their teaching intentions were directly influenced by their conceptions of teaching” (Northcote, 2009, p.70). Zambo and Zambo (2011) inform us that educators’ beliefs about teaching and learning come from their personal experience, experience and knowledge gained as students themselves, and experience gained from formal knowledge including teacher training events. Therefore, educators’ opinions and beliefs about teaching and learning affect what they consider to be good educational practices.

With the strong evidence that educators’ conceptions of good teaching directly influence their educational practices (Kember & Kwan, 2000; Norton et al., 2005; Northcote, 2009), one can argue that, educators’ conceptions about teaching (i.e., beliefs about teaching) is also linked to the general lack of awareness amongst educators of the value of neuroscience for education. In discussing how higher education lecturers’ concepts of teaching are not easily influenced by educational and/or other factors (e.g., institutional influences, curriculum design, student presage factors team teaching, heavy teaching loads, intensive procedures for monitoring and reviewing teaching), Kember and Kwan (2000) argue that “this observation suggests that approaches to teaching are strongly influenced by the lecturer’s conception of teaching” (p.489) and concluded

that “fundamental changes to the quality of teaching and learning are unlikely to happen without changes to lecturers’ conception of teaching” (469) (or changes to their beliefs). Taking into consideration Zambo and Zambo’s (2011) remarks about where educators’ educational beliefs stem from (e.g., teacher education, teacher training events), the misconceptions and misinformed concepts of the brain often presented to teachers (Howard-Jones, 2010), and the fact that educators’ educational beliefs are not easily influenced (Kember & Kwan, 2000), a picture emerges that supports the argument that educators’ conceptions about teaching can be linked to the general lack of awareness of the value of neuroscience in education amongst educators.

Chapter 2: Literature Review

Prior to the 1970's, according to Merriam et al. (2007), "adult educators relied primarily on psychological understandings of learning in general to inform their practice" (p.83). With the many scholarly publications on adult learning that surfaced around the early 1970's, attention then turned to research and theory building to describe learning which then informed practice (Merriam et al., 2007). These early publications attempted to differentiate between how adults learned and how children learned. According to Merriam et al. (2007), "attempts at codifying differences between adults and children as a set of principles, a model, or even a theory of adult learning have been, and continue to be, pursued by adult educators" (p.83). Merriam et al. (2007) also acknowledged that "just as there is no single theory that explains all of human learning, there is no single theory of adult learning" (p.83). When one explores these theories and/or models of learning, one realizes that the objectives of these theories and/or models were very similar; to establish an understanding of learning which could then inform practice to enhance learning (whether it be the learning of a child or the learning of an adult). Over the years these theories and/or models of adult learning (e.g., Knowles's Andragogy, multiple intelligence, transformational learning, experiential learning, behaviorism, constructivism) were reflected upon and critiques were advanced towards their underpinnings. These theories and/or models are still discussed in educational programs, still being critiqued, often built upon (e.g., revised, and/or adapted), and still inform educational practice within the education community.

The belief that neuroscience research can inform educational practices has been slowly creeping into adult education literature and seemingly greater interest has surfaced over the past few years. Numerous authors (e.g., Johnson & Taylor, 2006; Battro et al., 2008; Howard-Jones, 2010; Zull, 2002, 2011; Immordino-Yang, 2011; Wilson, 2011) have expressed the significance

of neuroscience research on how the brain learns for the education community. With the major advances in cognitive, affective, and social neuroscience with respect to learning, Immordino-Yang (2011) argues for the reconciliation of established educational learning theories with current neuroscience research on how the brain learns. Immordino-Yang (2011) argues for the importance of theory building, and that for

education to truly benefit from these neuroscientific findings in a durable, deep way, for the full implications to become apparent, educators must examine closely the theory on which good practice is built, to reconcile the new and exciting evidence with established models and philosophies (p.102).

As any educator in the field of education can probably attest to, there is an amazing amount of published literature on learning theories and educational practices (e.g., research studies, books, journal articles, pamphlets, websites, and the like) and numerous differing scholarly opinions and critiques of what learning is, how learning takes place, and what constitutes as good educational practices.

With the expanse of knowledge existing about learning theories and educational practices to date, and the scope at which learning theories and/or models have been rigorously scrutinized over the years, it is surprising that a wide array of learning theories still inform educational practices today (as is evident from the responses to question one of this research study). Even more surprising, is that this wide array of learning theories is informing educational practices in courses in the same field of study (e.g., the field of education). With the numerous learning theories educators are aware of and/or have been taught about, it may be challenging for an educator to determine what ‘ways of thinking’ should inform educational practices. According to Merriam et al. (2007), “we may wrestle with ideas presented in various theories and reflect later

on how powerful being exposed to different ways of thinking has been” (p.347). Theories, according to Kelly (2011),

are never abandoned easily, of course, but the disambiguation of claims at the hypothesis testing level using cognitive neuroscience data is likely to place upward pressure on theories, which are too often contingent descriptions of learning with little specification of mechanism or grounding in the larger set of findings in science (p.20).

So how does an adult educator determine which learning theories and/or models are worth pursuing and what educational practices are likely to be effective? An interesting argument found within scholarly educational literature is that educators’ educational beliefs strongly influence their educational practices.

2.1 Educational Beliefs

Most educators, according to Zambo and Zambo (2011) enter into the teaching profession because they believe they will make a difference in their student’s lives. Zambo and Zambo (2011) argue that educators’ educational beliefs have a powerful influence in their teaching practice and an influence on what they consider to be effective educational practices. According to Zambo and Zambo (2011), educators’ “beliefs are important because they influence their interactions with students, the expectations they set, the instructional decisions they make, and the lenses they use to interpret classroom events” (p.26). According to Northcote (2009), there is a strong link between educational beliefs and educational practices and this relationship is often referred to as the ‘belief-practice’ relationship. Northcote’s (2009) study investigated the educational beliefs of 5 university teachers (i.e., adult educators) and nearly 100 students, and most of the adult educators in Northcote’s (2009) study taught teacher education courses. In

citing findings from other studies about the strength of the belief-practice relationship, Northcote (2009) points out that educators' "beliefs inform their use of specific instructional strategies that, in turn, impact on the quality of student learning... [and that their] practical approaches to teaching and their teaching intentions were directly influenced by their conceptions of teaching" (p.70). Therefore, adult educators' views and beliefs about education affect what they consider to be good educational practices.

In examining the relationship between higher education lecturers' (i.e., adult educators) approaching to teaching and their conceptions of good teaching, Kember and Kwan (2000) interviewed qualitatively 17 adult educators from 3 university departments. With the well established link between conceptions of learning and approaches to study and learning, Kember and Kwan's (2000) research looks for parallel constructs for teaching in response to the following question: Can conceptions of teaching be identified and do they influence the approach to teaching which is adopted? In rehearsing the evidence for the established link between conceptions of learning and approaches to study and learning, Kember and Kwan (2000) state that "the study approaches adopted by students are a function of the student's predisposition, the form of the teaching and the nature of the teaching and learning environment, or the curriculum in the broader sense" (p.470). Kember and Kwan (2000) further remark that approaches to learning are influenced by the teaching and learning environment. Thus, it is pertinent for adult educators to understand the significance of effective educational practices. As part of their study, Kember and Kwan (2000) characterized approaches to teaching and determined that there were two broad approaches to teaching (i.e., content-centred, learning-centred), and these approaches were each further characterized by a one-dimensional motivation component and a five-

dimensional strategy component (i.e., instruction, focus, assessment, accommodation for student characteristics, source of experience/knowledge).

After defining approaches to teaching, Kember and Kwan (2000) further examined their research data to determine if there was a relationship between adult educators' conceptions of good teaching and teaching approaches. In defining conceptions of teaching, Kember and Kwan (2000) cite a definition given by Pratt:

conceptions are specific meanings attached to phenomena which then mediate our response to situations involving those phenomena. We form conceptions of virtually every aspect of our perceived world, and in so doing, use those abstract representations to delimit something from, and relate it to, other aspects of our world. In effect, we view the world through the lenses of our conceptions, interpreting and acting in accordance with our understanding of the world (p.483).

Two major categories of conceptions of teaching were identified in their study (i.e., teaching as transmission of knowledge, teaching as learning facilitation). Each category could then be further divided into 2 sub-categories. The sub-categories for teaching as transmission of knowledge, according to Kember and Kwan (2000), were 'teaching as passing information' and 'teaching as making it easier for students to understand'. The sub-categories for teaching as learning facilitation were 'teaching as meeting students' learning needs' and 'teaching as facilitating students to become independent learners'.

As a result of their study, according to Kember and Kwan (2000), there was a high level of correlation between lecturers' conceptions of good teaching and his/her approaches to teaching (i.e., 88.9 % of adult educators with the conception of teaching as teaching as the transmission of knowledge had a content-centred approach to teaching, and 87.5% of adult

educators with the conception of teaching as teaching as learning facilitation had a learning-centred approach to teaching). Based on their research, Kember and Kwan (2000) stated that there was little evidence that lecturers shifted their teaching approaches because of educational factors. In exploring the educational factors (e.g., institutional influences, curriculum design, and student presage factors) that may influence/modify teaching approaches, Kember and Kwan (2000) noted that “lecturers will normally adopt the approach which is consistent with their deep seated beliefs about teaching” (p.487). Other factors (e.g., team teaching, heavy teaching loads, intensive procedures for monitoring and reviewing teaching), according to Kember and Kwan (2000), “will impinge upon the teaching approach rather than the conceptions of teaching” (p.487). Kember and Kwan (2000) argue that “this observation suggests that approaches to teaching are strongly influenced by the lecturers’ conception of teaching” (p.489) and conclude that “fundamental changes to the quality of teaching and learning are unlikely to happen without changes to lecturers’ conception of teaching” (p.469).

In wanting to investigate adult educator’s beliefs and intentions about teaching in higher education, Norton et al. (2005) distributed a questionnaire measuring 9 different aspects of educator’s beliefs and intentions concerning teaching in higher education. This quantitative questionnaire was distributed to the teaching faculty at 4 higher education institutions in the United Kingdom yielding in 638 participants (i.e., 638 adult educators). On the onset of their study, Norton et al. (2005) remarked, even when educators “are teaching similar courses, different teachers teach in different ways, and this may affect their students’ satisfaction, motivation and attainment” (p.357). The aim of their study was to investigate the variations in teaching practices (i.e., educational practices) and the possibility that these variations were based on adult educators’ beliefs and/or intentions about teaching in higher education. Norton et al.

(2005) were “particularly interested in investigating whether [adult educators’] beliefs and intentions were influenced by their institution, their academic discipline, their amount of teaching experience and their exposure to formal training in teaching in higher education” (p.543) under two broad orientations to teaching (i.e., learning facilitation – teaching as bringing about conceptual change and intellectual development in the student, knowledge transmission – teaching as imparting information).

According to Norton et al. (2005), contextual variables (i.e., adult educators’ institution, academic discipline, teaching experience, gender) had a greater effect on adult educators’ teaching intentions than their teaching beliefs, reporting that “staff at different institutions have similar beliefs about teaching that were biased towards learning facilitation rather than knowledge transmission, but that their institutions vary in how much they constrain their staff when putting those beliefs into practice” (p.552), concluding that adult educators’ “intentions represent a compromise between their conceptions of teaching and their academic and social context” (p.564). Another interesting insight from the research of Norton et al. (2005) is that their results did not support the claim that adult educators’ “conceptions of teaching develop with increasing teaching experience,” concluding that “there has been little or no change in the beliefs or conceptions held by teachers who have begun teaching in higher education over the last 40 years” (p.557), concluding that “genuine development will come about only by addressing teachers’ underlying conceptions of teaching and learning” (p.561). However, Norton et al. (2005) found evidence that changes were made to adult educators’ intentions of teaching with experience. This is an important insight for the emerging new disciplinary field of educational neuroscience, as it may be difficult to enhance current ‘conceptions of teaching’ with new knowledge based on neuroscience research findings on how the brain learns.

2.2 Educational Neuroscience Debate

The recent developing collaborative effort between neuroscience and education has created a lot of excitement, confusion, and cautionary attitudes. A growing number of published scholarly works (e.g., Howard-Jones, 2010; Perkins, 2009; Wilson, 2011; Hruby, 2012; Tommerdahl, 2010; Goswami, 2004; Purdy & Morrison, 2009; Schrag, 2011; Kelly, 2011; Ansari, Coch, & De Smedt, 2011; Zull, 2011) have discussed important considerations around the educational neuroscience debate. These authors (e.g., Howard-Jones, 2010; Perkins, 2009; Wilson, 2011; Hruby, 2012; Tommerdahl, 2010; Goswami, 2004; Purdy & Morrison, 2009; Schrag, 2011; Kelly, 2011; Ansari et al., 2011; Zull, 2011) critically voice their concerns in and/or interests about the potential, if any, practical implications of neuroscience research for education. The educational neuroscience debate is centered, sometimes warmly heated (Howard-Jones, 2010), around whether neuroscience research on how the brain learns should be considered/included alongside educational thinking and practice, and to what potential can neuroscience enhance educational practice. According to Tommerdahl (2010), there are varying academic opinions regarding the relationship between the neurosciences and education. In the efforts to bring together the two disciplinary fields of neuroscience and education two main views are held amongst educators and neuroscientists. The first, as Schrag (2011) points out, is that the marriage between these two disciplines will be natural and very fruitful; and second, is that the forging relationship is unnatural and likely unprofitable.

Varying views are also found among grade school teachers. These views can be found within the findings from the few studies (e.g., Pickering & Howard-Jones, 2007; Zambo & Zambo, 2011; Hook & Farah, 2012; Serpati & Loughan, 2012) conducted aiming to understand the beliefs and perceptions teachers have of neuroscience research. As mentioned previously,

these findings indicated that some educators (i.e., grade school teachers) placed value on neuroscientific findings, some were confused about the educational value of neuroscience, some bought into the non-scientific brain-based learning materials, some did not believe neuroscience research findings on how the brain learns had any value for the discipline of education, and many were not well aware of the neuroscience research findings on how the brain learns. Along with these varying views are voices that claim that, as of yet, neuroscience research has not made any significant progress toward direct application to educational practices (Hruby, 2012; Schrag, 2011; Ansari et al., 2011). In discussing whether neuroscience matters for education in a review essay, Schrag (2011) assesses the efforts made by neuroscientists for education and some philosophers' efforts on neuroscience found in two recent anthologies. Schrag (2011) grants that there is a lot of fascinating information provided from neuroscience, but often this information is missing practical application of "how what has been learned through brain imaging leads or might lead to enhanced educational interventions" (p.225).

As argued by Ansari et al. (2011), the expectation of the ideal relationship between laboratory research results and classroom application (i.e., laboratory results can directly and easily be applied to educational thinking and practices) is currently unrealistic. Moreover, Ansari et al. (2011) argue, that this unrealistic expectation threatens "to erode efforts to forge useful connections between education and neuroscience" (p.39). In quoting John Bruer, Schrag (2011) brings up one argument that "whatever evidence we have for or against the efficacy of ... educational approaches can be found in any current textbook on educational psychology" (p.227). With this in mind, the view of education on neuroscience information, Schrag (2011) posits, may not be as "critical as some who are infatuated with the new technology of brain imaging believe" (p.232). Furthermore, in referencing the work of Howard-Jones who

acknowledges that there is a differing of the understandings of learning between neuroscientists and educators, Schrag (2011) suggests that this difference could make neuroscience irrelevant to educators. Even though Schrag (2011) has expressed some concerns with linking neuroscience research and educational thinking and practice, Schrag (2011) does not disregard the potential use of neuroscience to enhance education.

One fear that people may potential harbour about educational neuroscience, according to Tommerdahl (2010), “may be the impression that the brain sciences are declaring hegemony over a process that should be more holistic, encompassing the whole human instead of reducing the act of learning to change in a collection of neurons” (p.99). Tommerdahl (2010) agrees that it may not be easy for neuroscience findings to have direct application to educational practices, but argues that with the collaborative efforts of different types of knowledge (i.e., neurosciences, cognitive neurosciences, psychological mechanisms, educational theory, classroom) neuroscience findings can enhance educational practices. However, there is neuroscience research that has been used as the basis for improving and enhancing educational practices. As an example, Tommerdahl (2010) points out that the neurosciences have provided information in some areas (i.e., reading – the reading and writing program entitled ‘Collections for Young Scholars’) onto which effective educational practices were based, critically examined, tested at the classroom level, and found to be very effective and more successful. Current neuroscience research on the brain is providing evidence for the biology of learning and relevant research in areas that have an impact on learning (i.e., plasticity, memory and learning, sleep and learning, and emotion and learning).

Along with rehearsing and/or expressing the concerns about the merging relationship between neuroscience and education several authors (e.g., Tommerdahl 2010; Kelly, 2011;

Wilson, 2011; Schrag, 2011; Hruby, 2012) offer a basis for establishing an effective educational neuroscience. Hruby (2012) argues that there are three requirements that should be addressed in order to justify an educational neuroscience: intellectual coherence; mutually informing and respected scholarly expertise; ethical commitment to the moral implications and obligations shared within educational research. Tommerdahl (2010) proposes a model of five levels of different types of knowledge that must each contribute to the formation of new teaching practices: neuroscience, cognitive neurosciences, psychological mechanism, educational theory and testing, and classroom application. Kelly (2011) posits that “we are beginning to see...the basis for a revolution in theorizing about learning that designs and refines its measures, guides its hypotheses, informs its analyses and grounds its conclusions using data from cognitive neuroscience studies” (p.20). In parallel to these scholarly articles offering a basis for establishing an effective educational neuroscience are the newly formed post-secondary educational programs (e.g., Harvard University Graduate School of Education Mind, Brain, and Education Program). Granted that there should be (and there is beginning to be) a well defined and established basis for the merging relationship of neuroscience and education, educators should not lightly overlook the current and future potential for neuroscience research to enhance educational practices.

2.3 Neuromyths

Another concern about establishing an effective educational neuroscience is the existence of numerous, often commercialized, ‘brain-based’ techniques claiming to be based on neuroscience research when there is little or no evidence to support these claims (Pickering & Howard-Jones, 2007; Purdy & Morrison, 2009; Howard-Jones, 2010; Ansari et al., 2011; Hruby,

2012). As a premature response of the collaborative efforts between neuroscience and education, many ‘brain-based’ learning materials claiming to be based on neuroscience research have “gained widespread currency in schools and which, not being subject to rigorous scrutiny, often represent little more than neuromyths” (Purdy & Morrison, 2009, p.99). Neuromyths, as pointed out by Howard-Jones (2010), “are misconceptions generated by a misunderstanding, a misreading or a misquoting of facts scientifically established (by brain research) to make a case for use of brain research, in education and other contexts” (p.20). Purdy and Morrison (2009) and Hruby (2012) elicit a warning voice of caution about the easy acceptance of neuromyths into many educational school systems and argue for a very strict regulating presence to guard against the proliferation of neuromyths. With the proliferation of neuromyths and the outpouring of scholarly literature critical of unfounded claims about the brain and learning, it is easy to understand the growing confusion about the relevance of neuroscience for education.

In the research study of Pickering and Howard-Jones (2007), one of their participants offered the following insight about being misguided by non-scientific ‘brain-based’ techniques:

There isn’t one person here who doesn’t know about visual learners, auditory learners, brain gym, and it’s because I guess it’s something easy to understand, and I don’t mean that in a patronising way. It’s the sort of thing that you can grab onto and you can run with – but – we’ve been a bit misguided about that sort of thing haven’t we – not having the time to verify it for ourselves – we have no choice (p.111).

According to Howard-Jones (2010), “many educational projects have pursued improvement through tailoring programmes to meet individual learning styles but, as yet, there is no convincing evidence that any benefit arises” (p.24). In citing research findings from other studies about learning styles (i.e., visual, auditory, kinaesthetic), Howard-Jones (2010) reports that these

studies “failed to find convincing evidence that matching instruction to meet individual’s sensory strengths was any more effective than designing content-appropriate forms of education and instruction” (p. 24), and that these studies concluded that “educators’ attempts to focus on learning styles were ‘wasted effort’” (p.24).

As instructors in a college of education, Zambo and Zambo (2011) observed that many of their graduate students (i.e., practicing grade school teachers) were coming to class excited about ‘brain-based’ strategies that they were using in their field placement classrooms. From their observations, Zambo and Zambo (2011) noted that their

students were willing to try any idea if it was linked to neuroscience. Our students never considered that these strategies might be a waste of valuable classroom time...Our students were buying into the claims being made by the manufacturers...As teacher educators, we felt this surge of information was important because it stemmed from neuroscience, but as we discussed the brain in our classes and heard conversations like those mentioned earlier we began to see how reliable facts were being twisted with unwarranted claims. Even though our students were learning reliable information from their textbooks, they continued to believe in brain-based strategies and products without questioning, and as teacher educators we knew this could have consequences. We knew our students’ beliefs would influence their perceptions of children, how they learn, and how they should be taught (pp.25-26).

This observation, Zambo and Zambo (2011) argue, provided convincing evidence “that without direction education students’ beliefs could go astray and their students could be affected” (p.26). With this important insight from Zambo and Zambo’s (2011) research study, adult education

professors should be very aware of the concerns around neuroscience research on how the brain learns.

2.4 Educators' Perceptions of Neuroscience

This present research study draws on the findings of the few research studies (e.g., Pickering & Howard-Jones, 2007; Zambo & Zambo, 2011; Hook & Farah, 2012; Serpati & Loughan, 2012) that investigated educators' perceptions of neuroscience research for education. Educators in these studies were grade school teachers, educational psychologists, and other educational professionals. As adult education professors are educators, this present research study draws on and discusses the significance of the implications of educators' perceptions about neuroscience research in informing their education practices. In wanting to know more about how educators (i.e., grade school teachers, educational psychologists, other educational professionals) in the United Kingdom viewed the role of neuroscience in education, Pickering and Howard-Jones (2007) conducted research using a large-scale questionnaire study (n=189) followed by in-depth interviews with United Kingdom teachers (n=11). In their questionnaire study, Pickering and Howard-Jones (2007) also obtained responses from 40 international educational professionals that were visitors to an online discussion forum on the Organisation for Economic Co-operation and Development (OECD) website. The questionnaire was distributed to educators who had either attended a conference(s) that held discussions on neuroscience in education or were visitors to the OECD website. Pickering and Howard-Jones (2007) concluded that many educators were enthusiastic about bringing together neuroscience research and education; however, a number of challenges were identified (i.e., establishing and communicating ideas and initiatives between neuroscientists and educators).

Serpati and Loughan (2012) expanded the application of Pickering and Howard-Jones's (2007) study with 221 certified teachers in the United States. The results from the online Likert-response survey Serpati and Loughan (2012) administered were similar to the findings of Pickering and Howard-Jones's (2007) study with one exception. Serpati and Loughan (2012) noted that a large number of their participants reported "that a dialogue between educators and neuroscientist is not or less important" (p.175). This exception Serpati and Loughan (2012) believe resulted because of the belief that one can acquire information about neuroscience on one's own. According to Zambo and Zambo (2011), information about neuroscience and education is readily available to educators. Zambo and Zambo (2011) also wanted to uncover the beliefs teachers held about neuroscience and education, and conducted research with 62 southwestern United States teachers who were practicing teachers enrolled in a master level child development or educational psychology course. Zambo and Zambo (2011) administered an electronic version of the *Opinion of Neuroscience for Educators Questionnaire*, which asked the participants to answer the following essay question: What do you think about neuroscience and education? Zambo and Zambo (2011) reported that 57% of the teachers in their study believed that neuroscience had value for education, 24 % were believers with reservations, and 19 % were nonbelievers. According to Zambo and Zambo (2011) the beliefs teachers hold influences "the curriculum they provide, how they teach, and what their students learn" (p.36).

Hook and Farah (2012) conducted semi-structured interviews with 13 educators who were repeat attendees of the *Learning & the Brain* conferences. These conferences featured symposia and lectures by neuroscientists and neuroeducation specialists. The main focus of Hook and Farah's (2012) study was to

characterize educator's view of the role of neuroscience in education, specially to determine whether educators are in fact confused about the educational relevance of neuroscience and to learn whether and how knowledge of neuroscience enhances their work beyond the possibility of new methods for teaching (pp.1-2).

Hook and Farah (2012) acknowledge that their sample was biased towards educators who were interested in neuroscience, but argue that their research was aimed at understanding educators' attraction to neuroscience. The results of Hook and Farah's (2012) study indicated that educators are attracted to neuroscience research out of curiosity and that information on how the brain learns was intellectually stimulating for them. According to Hook and Farah (2012), almost all the educators interviewed "reported that learning about neuroscience research affirmed their beliefs about what makes good educational practice. Being able to relate their practices to a larger scientific picture of the brain gave them a sense of greater confidence in themselves" (p.6).

Teachers' views and beliefs about education, as stated by Zambo and Zambo (2011), "influence their interactions with students" (p.26), "the curriculum they provide, how they teach, and what their students learn" (p.36). Zambo and Zambo (2011) inform us that teachers' beliefs about teaching and learning come from their personal experience, experience and knowledge gained as students themselves, and experience gained from formal knowledge including teacher training events. Therefore, teachers' views and beliefs affect what they consider to be good educational practices. From their research, Hook and Farah (2012) argue that "a greater understanding of educators' motivations for learning about neuroscience, their understanding of what neuroscience means, and what it has to contribute to teaching practice can only serve to strengthen the relationship between neuroscientists and educators" (p.10). Understanding how adult education professors perceive neuroscience research in informing educational practices will

benefit the emerging field of educational neuroscience. According to Hook and Farah (2012) “educators’ motivations, beliefs, and pedagogical practices have a critical role to play in improving future work in, and discussion about, neuroeducation” (p.3). Conducting research with adult education professors who actively teach about effective teaching practices and methods will help to strengthen the dialogue between neuroscientists and educators.

2.5 Implications of the Literature Review: Purpose and Rationale

Battro et al. (2008) argue that new understandings will emerge with neuroscience research on the brain changing the way we will approach teaching and learning in the near future. With the insights about sensory and motor learning, Zull (2002) argues that understanding learning as a biological process can help enrich educational practices. Enriching educational practices would significantly be advantageous to enhancing learning, and isn’t that what educating is all about? More recently, many educational neuroscience experts argue that neuroscience research is ready to be extended to educational practices (Hook & Farah, 2012). In quoting Blakemore and Frith, Hook and Farah (2012) mentions that “there is a vast amount [of] brain research of direct relevance to educational practice” (p.2). Hook and Farah (2012) continue citing Blakemore and Frith, mentioning that they argue that the lack of ‘successful educational application of neuroscience’ is a result of the challenges of interdisciplinary interaction and communication. According to Hook and Farah (2012), “improving dialogue between the two disciplines will enrich research and practice in the field of neuroeducation, ultimately helping to build a better science of learning and the brain” (p.10). This research study is a response to help improve the dialogue between neuroscientists and educators. The findings from this research study report on aspects about how post-secondary professors in the field of education in Canada,

with interest in adult education (i.e., adult education professors), perceive neuroscience research in informing educational practices.

Neuroscience research on the brain is providing evidence for the biology of learning and relevant research in areas that have an impact on learning (i.e., plasticity, memory and learning, sleep and learning, and emotion and learning). With the new technological advancements, according to Battro et al. (2008), scientists and educators are getting closer to being able to “observe the effects of educational interventions on brain processing” (p.4) and this has caused a lot of excitement in the new merging field of educational neuroscience. However, in many instances there is clear evidence that many educators are not well aware of the significance of neuroscience research and learning. For example, at a recent 2005-2006 Economic and Social Research Council - Teaching and Learning Research Programme (ESRC-TLRP) seminar series “Collaborative Frameworks in Neuroscience and Education” in the United Kingdom, which brought together educators, neuroscientists, and psychologists, according to Howard-Jones (2010), many seminar audience attendees experienced ‘first contact’ in collaborating in the field of neuroscience and education. Another example, at the second annual Aspen Brain Forum Symposium entitled “Cognitive Neuroscience of Learning: Implications for Education” in Aspen, Colorado held September 22 – 24, 2011, only two educators acknowledged that they had previous training in cognitive science and half the conference audience were educators (McGowan, 2011).

The lack of neuroscience research awareness among educators is commonly mentioned throughout the literature. Results of this present research study also indicated that there was a lack of awareness of neuroscience research amongst adult education professors in Canada. In wanting to consider why there may be a lack of neuroscience research awareness among adult

education professors, several areas within the literature are taken into consideration. These considerations are; the differing of language between neuroscience research and educational research, the lack of scientific understanding among adult education professors, the proliferation and easy acceptance of neuromyths into educational practices, misconceptions about the brain in the education community and in the general public, the existence of numerous theories of learning, and that educators educational beliefs strongly influence their approaches to teaching. This research study also considers that the dissemination of neuroscience research into the educational community may not be currently proficient. This research study makes use of the importance of these considerations in answering this studies research focus. This studies research focus is to understand how adult education professors in Canada perceive neuroscience research in relation to educational practices. The implications of these considerations are discussed in Chapter 6: Discussion of Findings and in Chapter 7: Conclusions and Implications of this research paper.

Chapter 3: Methodology

In wanting to determine how adult education professors perceive neuroscience research in informing educational practices, a qualitative research approach is appropriate. Qualitative research methods are especially effective in obtaining the participants perspectives in their given situation, and “provide[s] complex textual descriptions... about the ‘human’ side of an issue” (Mack, Woodsong, MacQueen, Guest, & Namey, 2005, p.1). Qualitative research allows the researcher to ask open-ended questions and participants are allowed to answer them in their own words (Mack et al., 2005). Enhancing and improving educational practices for the benefit of productive learning is relevant to the education discipline. With technological advancements in the area of brain imaging, new knowledge and understandings of how the brain learns is being produced. Since educators’ views and beliefs influence how they teach (Zambo & Zambo, 2011), understanding how adult education professors perceive neuroscience research on how the brain learns would give insight into whether or not neuroscience research is informing their educational practices. Therefore, a qualitative research methodology will aid in understanding the perspectives and beliefs adult education professors place on current neuroscience research findings on how the brain learns in informing educational practices.

3.1 Recruitment of Participants

For the purpose of this study, all participants were post-secondary professors in the field of education employed at a Canadian University. All professors had an interest in adult education (e.g., Lifelong Learning, post-secondary education, study of adult teaching) and/or whose courses they taught were preparing their students for instructional roles to teach adult students (e.g., instructors of Continuing Education programs, universities, community colleges, technical

and vocational education, adult learning centres). Thus, all participants were post-secondary adult education professors. For this present research, a small sample size ($n=22$) of post-secondary adult education professors were selected through purposive sampling. In wanting to gain insight about how adult education professors perceive neuroscience research on how the brain learns in informing educational practices, this participant demographic was targeted purposively taking into consideration that post-secondary professors in the field of education would have a functional knowledge of educational practices by the nature of their field.

Participant recruitment was addressed through obtaining the appropriate written permissions and consents, and all adult education professors were informed of the purpose of the study prior to giving their consent to become a participant. Adult education professors were recruited through an e-mail invitation that was sent to their affiliated university e-mail addresses inviting them to participate in the purposed research. In considering that there were only a few studies (e.g., Pickering & Howard-Jones, 2007; Zambo & Zambo, 2011; Hook & Farah, 2012; Serpati & Loughan, 2012) that could be found at the time of conducting this present research study that focused on how educators (i.e., grade school teachers) perceived neuroscience research for education, it would be very interesting to know how those who teach about educational teaching practices and methods (i.e., post-secondary adult education professors) perceive neuroscience research in informing educational practices.

Several research tools were used for the purpose of this research study. All research tools were designed and created by the researcher and can be found in the appendix of this research paper as follows: Appendix 1 – Flyer, Appendix 2 – Invitation Letter, Appendix 3 – Informed Consent, and Appendix 4 – Research Questions. The invitation flyer (i.e., Appendix 1 – Flyer) which was created for this research study was not used. An e-mail invitation letter (i.e.,

Appendix 2 – Invitation Letter) was afterwards created and was approved by the University Research Ethics Board at Mount Saint Vincent University. This e-mail invitation letter was the only method used to recruit participants. Participants (i.e., adult education professors) of this current research study were recruited with this e-mail invitation inviting them to participate in the purposed research. Information from this invitation letter was pasted into the text body of the inviting e-mail, and/or sent as an attachment with the e-mail invitation. Interested respondents were then forwarded the informed consent form (i.e., Appendix 3 – Informed Consent) via e-mail as a signable Portable Document Format (PDF) and were asked to sign the PDF and return the signed informed consent form to the researcher via e-mail. Most adult education professors found this method of receiving and sending of the informed consent form to be straightforward.

3.2 Measure: Internet as a Tool to Conduct Research

In recent years, researchers have been exploring the internet as a tool for conducting qualitative interviews, and have found that conducting interviews in this way has been very effective. According to Meho (2006) the benefits of qualitative e-mail interviews are many, and even though there are disadvantages, the quality of data collected compares to traditional methods (i.e., face-to-face). In citing studies that collected and compared the quality of data obtained from face-to-face interviews and online e-mail interviews, Meho (2006) states that “these studies found that participants interviewed via e-mail remained more focused on the interview questions and provided more reflectively dense accounts than their face-to-face counterparts” (p.1291). According to Meho (2006), other advantages of conducting online e-mail interviews are: the ability to reach a geographically disperse sample of people, it decreases the cost and time of transcribing, and the ability to conduct research with more than one participant

at a time irrespective of their geographical location. Online interviewing eliminates some problems associated with face-to-face interviews “such as the interviewer/interviewee effects that might result from visual or nonverbal cues or status difference between the two (e.g., race, gender, age, voice, tones, dress, shyness, gestures, disabilities)” (Meho, 2006, p.1289). Online e-mail interviewing also allows the participants to have a sense of anonymity and to take their time in answering the questions in a comfortable environment such as their home (Meho, 2006).

Some of the main disadvantages to online qualitative e-mail interviews are that it limits the participants to those who have internet access, prevents the ability to ask immediate additional probing question with insights gained from immediate verbal responses, and there are no cues that can be observed from non-verbal and verbal jesters that can be observed during face-to-face interviews (Meho, 2006). However, as mentioned above, the data collected from online qualitative e-mail interviews is comparable to face-to-face interviews. The internet was used as a tool to conduct this research including all material that was sent to and received from all participants (e.g., e-mail invitations, informed consent forms, signed informed consent forms, research questions and responses, and follow-up question and responses). A separate password protected Mount Saint Vincent University e-mail address was established and used only for the purpose of this research. However, all sending and receiving of the e-mail invitations and consent forms were mainly from the personal password protected Mount Saint Vincent University e-mail address of the researcher. Of the 22 participants, 2 submitted their responses to the personal e-mail address of the researcher. There were 9 structured open-ended survey questions and 1 follow-up question that were delivered to the participants via e-mail. A qualitative data analysis software program (i.e., MAXQDA 11) was used to analyze the data

collected from this qualitative research study. This research method was used because of its innate ability to reach a targeted demographic population across Canada.

3.3 Instrument Design: Survey Questions

For the purpose of this research study, the structured open-ended survey questions were delivered to the participants of this research study via an e-mail interview. Prior to conducting the structured e-mail interview with the research participants, an interview schedule was constructed to give thought to the open-ended survey questions wording and sequence. According to Meho (2006), e-mail interview questions are to be more self-explanatory with clear indications as to the type of response required, as compared to traditional face-to-face interview questions. To eliminate the possibility of the participant misinterpreting the questions, Meho (2006) suggests giving the respondent the opportunity to ask for clarification before answering the interview question. The open-ended structured survey questions were formulated to address how participants perceive current neuroscientific research on how the brain learns in informing their educational practice(s). When designing and creating the open-ended survey questions for the purpose of this research, the researcher considered the following areas of relevance: awareness questions - neuroscience Literacy, perceptions and beliefs of the value of neuroscience research for education questions, touch point questions, future research interest questions, and follow-up questions. Table 1 below is a categorization of the open-ended survey questions under these areas of relevance.

Table 1. Categorization of Open-ended Survey Questions

Awareness Questions - Neuroscience Literacy

1. How would you define/explain the process of learning that takes place within the learner? Is your definition/explanation supported by an educational learning theory? If so, which one?
2. If a student in your course had impaired memory function, how would you provide support for their learning? What educational practices, if any, would you include in your course to enhance this student's learning?
3. It is said that “neurons that fire together wire together” and form stronger connections and stronger neuronal networks. Do you think learning is related to neuronal connectivity? If so, why? If not, why?

Perceptions and Beliefs of the Value of Neuroscience Research for Education Questions

4. Have you ever heard of or come across information about research on the brain and learning? What was it and where did you hear it or come across it? Did you think that the information you came across was useful for the field of education, for educational practices? Why or why not?
5. Have you ever changed your educational practices to reflect current research on how the brain learns? If so, what did you change and why? Did you find this change effective? What was the brain research you based your change on (e.g., memory and learning)?
6. How aware are you of the current neuroscience research on plasticity, memory and learning, sleep and learning, and emotion and learning? Do you think neuroscience research in these areas can help enhance educational practices?

Touch Point Questions

7. Has this research study stimulated your interest in neuroscience research on how the brain learns in informing educational practices? Did you look up any information on neuroscience research because of this study? If so, what type of information did you look up and where did you find it (e.g., internet search)?

Future Research Interest Questions

8. If there is one area about neuroscience research on how the brain learns that you would want to know more about what would it be and why?
9. If you had the opportunity to talk face-to-face with a neuroscientist who does research on how the brain learns what would you want to talk about and why?

Follow-up Question

1. Do you have any comments about the chosen delivery method for the structured e-mail interview questions? Would you participate in future research with this type of delivery method?
-

The first question sent to the adult education professors that participated in this research study asked them to define the process of learning that takes place within the learner, and if their definition was supported by an educational learning theory. This question was asked with two purposes in mind. First, it is a question that the adult education professors would have a working knowledge about, and secondly, it offers insight into adult education professors' current educational beliefs. Questions 2 through to 6 were designed to gain an understanding and insight into adult education professors' awareness and perceptions of neuroscience research on how the brain learns in informing educational practice(s). Question 7 was designed with the intention to learn if an interest in neuroscience research was stimulated by asking adult education professors about neuroscience research while the study was being conducted. Questions 8 and 9 were asked with the intention to potentially offer future researchers in educational neuroscience an insight into what areas of neuroscience adult education professors would want to know more, and potentially where future research in educational neuroscience could head towards. The follow-up question was designed to solicit comments about the delivery method (i.e., qualitative structured e-mail interview) of this research study. This follow-up question was asked to gain insights into a delivery method (i.e., e-mail interview) that is not typical of qualitative research.

3.4 Analysis Procedures

With e-mail interviewing, data collection is done by receiving textual responses from the survey questions from the participants. Participants were notified about the delivery method of this research study on the informed consent form. As outlined on the informed consent form, participants were asked to take part in answering approximately 8 to 10 questions delivered via e-mail over a two week period, and were notified that the questions were general enough to be answered from memory with the option of skipping any question they did not feel comfortable answering. It was the initial intention of the researcher to send out one question at a time and to receive the response back before the next question was sent. However, the first participant I sent the first question to asked for the remainder of the questions to be sent all at once. From the comments I received from this participant's response to the follow-up question, the option of sending all questions at once was suggested. Thus, from that time forward, all participants were informed about the option of receiving all research questions at once alongside the choice of the regular interview research schedule. Of the 22 participants, 5 asked to have all the questions sent to them at once, and an additional 5 were sent all the questions at once at the discretion of the researcher. This was due to the nature of these participants prolonged continued interest in the research study well past the initial sending of the first question.

As data collection went forward, and at the discretion of the researcher, question 4 and 5 were sent together in one e-mail as well as questions 7 through to 9 to those participants who followed the regular interview schedule. This decision was made due to the questions having similar questioning attributes. There were 21 participants whose responses were received as textual responses via e-mail. One of these participants submitted their textual responses in French. Although I have basic French, I enlisted a translation service to assist me with the

translation of these responses into English. One participant submitted all their responses in one approximate 15 minute YouTube video which was then transcribed by the researcher and entered as text into the qualitative data analysis software program (i.e., MAXQDA 11). Even though the delivery method of the open-ended structured survey research questions varied amongst the participants, there was no differing of responses as to their length or quality (i.e., you could not differentiate the collected responses from a participant who submitted all responses at once from that of the collected responses from a participant who submitted them separately). The professional qualitative data analysis software MAXQDA 11 was used to analyze the data collected from all 22 participants (i.e., adult education professors).

Each participant was assigned a research identification number from 1 to 22 and all personal identifying information was deleted from all data. This was done to protect the privacy of the participants. A separate profile document was created for each participant listing all their responses and biographical information. Thus, 22 participant profile documents were created and were referenced by their identification number (e.g., participant 1, participant 2, participant 3, ...participant 22). A master response document was then created where all participant responses were compiled together so that each of the research questions had 22 responses listed underneath. All 22 participant profile documents and the master response document were uploaded to the MAXQDA 11 software. Only the master response document was used for analysis (coding into themes) and the participant profile documents were used as a reference to create a spreadsheet for the analysis of their biographical information. All participants were asked for their biographical information before being asked the research questions. The follow-up question was delivered after all research questions were answered and only to those participants who consented to follow-up questions. All research data documents/files are stored

in a file on a password protected external USB storage device which is kept in a locked safety box in the possession of the researcher.

The data collected for this present research study was intended to understand how professors in the field of education, with interest in adult education (i.e., adult education professors), from post-secondary universities across Canada perceived neuroscience research in informing educational practices. Nine structured open-ended survey questions were delivered via e-mail to all adult education professors, and 1 open-ended follow-up question was delivered via e-mail to those adult education professors who consented to follow-up questions. For the purpose of this study, each question was separately examined for emerging themes before looking for convergent or divergent themes (i.e., superordinate themes) across the sample size. In reading and re-reading the responses, according to Smith and Osborn (2008) and Guldberg and Mackness (2009), a researcher gathers perceptions from the text into themes. The themes, according to Guldberg and Mackness (2009), represent recurring thoughts, ideas, and feelings that emerge throughout the individual responses. The analysis for each research question was handled independently; such that each question along with its corresponding 22 responses were read and coded for themes by the researcher with the aim in developing a sound understanding of the responses for each question.

Chapter 4: Demographic Statistics

The demographic statistics gathered for this research study included the following information with respect to the participants: the number of invitation e-mails sent to prospective participants and responses received, the number of representative universities, the highest level of education completed, years of teaching experience with adults, age, and gender. Of the 73 invitation e-mails that were sent out to post-secondary professors in the field of education (i.e., adult education professors) employed at a Canadian University inviting them to participate in this research study only 29 responded back. Of the 29 respondees, 23 were interested in participating in this research study. However, 1 interested respondee was given a letter of thanks as they were outside the research demographic. The remaining 22 interested adult education professors gave their consent to volunteer and participate in this research study. The adult education professors that participated in this research study were from 14 different Canadian universities, 9 were male and 13 were female.

Most adult education professors (n=20) listed Ph.D. as their highest level of education completed, and the other 2 adult education professors listed Ed.D. and Masters of Adult Education at Ph.D. thesis defence stage. The average combined age of all adult education professors was 55 years (rounded to the nearest year) ranging from 33 to 85 years in age. The average number of years of teaching experience at a post-secondary level of all the adult education professors was 16.68 years ranging from 5 to 36 years. The average years teaching experience with adult students other than at a post-secondary level of all the adult education professors was 6.45 years ranging from 0 to 35 years. Figure 1 below is a representation of the demographic statistics of this research study.

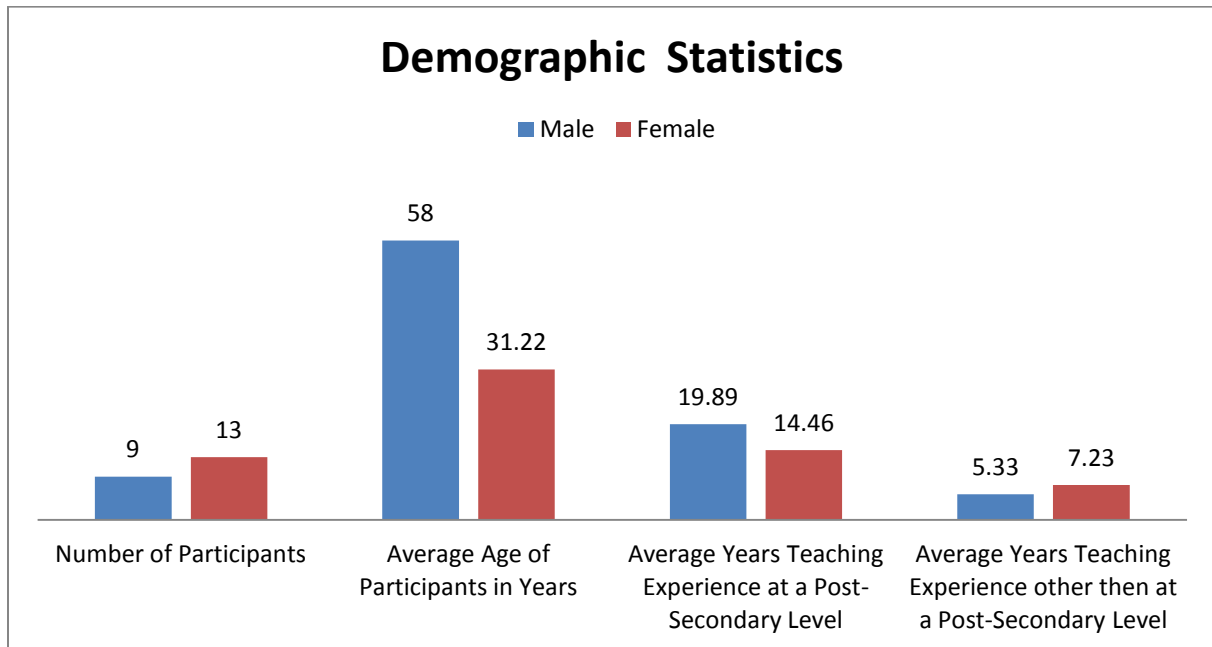


Figure 1. Demographic Statistics

Chapter 5: Summary of the Findings of the Survey Questions

The analysis of the data collected from the responses to the open-ended survey questions are mainly represented by the emerging themes from the participants' (i.e., adult education professors) responses. These themes gave insights about the perspectives adult education professors have of neuroscience research in relation to educational practices. In each question summary, these themes are discussed and coded to determine the adult education professors' perceptions of each research questions. These themes are supported with evidence from the responses given from the adult education professors. Themes were coded by examining 'indicating' phrases within the responses of the adult education professors for each question. For example, an educational theory of learning in question one was coded by examining phrases that indicated that the adult education professor was using that educational learning theory to inform their practice. These indicating phrases often started with 'I draw from', 'I favour', 'I work mainly from', 'my fundamental approach', and 'my work is a blend of several theories'. However, divergent themes across questions and/or interesting remarks were highlighted and will be mentioned in the discussion.

The follow-up question of this research study was delivered only to those participants who gave their consent to follow-up questions on the signed informed consent form. Participants were given the option of skipping any question(s) they did not feel comfortable answering and no adult education professor used this option. However, 1 adult education professor did not submit responses to questions 2, 5, 7. Efforts were made to solicit responses to these questions; however no further responses were submitted to the researcher. Each adult education professor was assigned a number and their corresponding e-mail responses the same number to ensure confidentiality and protect their privacy. The results of this research study represent the

perspectives of 22 post-secondary adult education professors in the field of education in Canada of neuroscience research on how the brain learns in informing educational practices, and therefore, may not be a representative perspective of all adult education professors in Canada or elsewhere in the world. Nor should it be assumed that the perspectives represented in this research study can be generalized to represent the perspectives of professors in different disciplines in post-secondary education in Canada or elsewhere in the world.

5.1 Question One

How would you define/explain the process of learning that takes place within the learner? Is your definition/explanation supported by an educational learning theory? If so, which one?

Most adult education professors (n=14 or 64%) defined learning as some kind of process (e.g., a cognitive process, a process of gaining a new skill or knowledge, a process of collective (group) learning, and/or a process of constructivist thought). Other adult education professors (n=2 or 9%) described learning as complex and multidimensional and several other (n=6 or 27%) adult education professors had unique definitions of learning. In examining the differing of the meaning of learning with perspectives from education and neuroscience, Howard-Jones (2010) argues that “educational ideas about learning are diverse and eclectic in their origins” (p.83). Educational definitions of learning, Howard-Jones (2010) furthers “are the product of a variety of different processes and forces, including those arising from theoretical educational and psychological traditions, and other culturally transmitted ideas from within and beyond the teaching profession” (p.83). The responses provided from the 22 adult education professors in defining learning provide evidence that adult education professors’ definitions of learning are ‘diverse, eclectic and a product of a variety of different processes and forces’. These responses

further substantiate the educational perspective of learning as mentioned by Howard-Jones (2010) above. Thus, including all 22 definitions of learning would be helpful in visualising the perspectives post-secondary adult education professors in the field of education in Canada have about learning.

Some adult education professors' definition of learning can be listed under several processes of learning listed above, however, for the purpose of this research study each adult education professors' definition will only be listed once under the main theme of their definition. The second part of this question – Is your definition/explanation supported by an educational learning theory? If so, which one? – will be discussed after reviewing the definitions of learning offered by all the adult education professors.

Learning as a process:

“I believe people learn through a process of dissonance and disequilibrium which is resolved by re-ordering or expanding their notion of ‘truth.’ Typically, this expansion is one in which the learner moves from simpler dualistic explanations to those that are more complex and context-driven.”

“I believe that learning is a process that takes place ‘within’ the learner and within supportive, safe, and challenging learning spaces. In this process, learners seek to make meaning of an experience (an event, some content, an interaction with ...) by connecting this experience with something that has relevance to/for them. I believe that learning is a non-linear process that involves reflection, engagement in, and interaction with. In light of diverse individual learning needs/abilities and

socio-cultural contexts/influences and power differentials, learning may or may not occur due to certain supports, challenges, tensions, and/or other barriers.”

“I cannot define or even explain the process of learning that takes place within the learner. The process is really a broad set of processes, and so I feel it is impossible to explain how each learning event takes place.”

“For me learning involves multiple processes and processings - some consciously and mindfully while some non-consciously seek what we already know - occurring in our brain-mind complexity within our physical body that facilitate and develop responses to stimuli in our senses, images, feelings and activities being experienced in a social context.”

“I believe that learning is a complex process that involves external stimuli, internal brain processes (including reflection) and social dimensions (experience and interaction with others).”

Learning as a cognitive process:

“I think about learning as a physiological event/process in which cognition, affect, and physiological investment in externalities (people, text, music, etc.) are permitted to make meaningful change in the individual’s knowledge/experience. Because I understand learning as an embodied experience I expect, like the hokey pokey, individuals to get engaged in the process.”

“I explain the learning process using a wheel that describes the movement through cognitive dissonance to cognitive assonance. When I’m explaining this process to

adult learners, I usually describe the process of moving from unconscious incompetence to conscious incompetence to conscious competence to unconscious competence (and so on through the stages).”

Learning as a process of gaining a new skill or knowledge:

“Learning is the process of gaining a new skill (learning to drive a car) or knowledge (knowing the chemical composition of water). That new skill or knowledge is attained if the learner can represent it in her own words, actions, creations.”

“In my experience Learning occurs when the learner is challenged to comprehend information that is new, interesting and of relevance. Hence, the onus is upon the teacher to present material that meets those criteria.”

“To me, the most important learning process that can take place within a learner is learning how to incorporate new knowledge. And that is a process and the process of learning requires that the learner is open enough to have their pre-existing notions and understandings, and even convictions, challenged by new information. I do believe, having said this, that the process of learning is different for each, individual learner. To be honest, as I’ve said, I believe that the process of learning that takes place within each learner is individual and is entirely dependent on how open the learner is to new ideas.”

Learning as a process of collective (group) learning:

“This is an interesting question and it makes me realize that I do not ‘separate’ people as individuals, but rather, place my emphasis on the collective learning process, and the potential that has. I realize there are psychological approaches and theories in adult education – such as Mezirow’s and Knowles’ (both Americans) - ideas around self-directed and transformative learning, but I am more interested in the way in which the group learns, and reinforces and challenges itself. But if I were to think about individual learning, I would place it in a feminist framework, where the learning inside is a sense of empowerment, of agency, a realization one is not alone as a woman, that the problems she faces are not her own fault. Here agency, is the most powerful. Coming to see herself as a valuable and key player.”

Learning as a process of constructivist thought:

“My work is a blend of several adult learning theories. I work mainly from the constructivist frames of andragogy (Knowles), the theory that students are self motivated and can be assisted in the learning transformation process. I see the learning that takes place as a stirring of knowledge and growth in the individual, one that occur in groups or by oneself... I see the learning as happening through andragogy.”

“I understand learning in complexity science terms, which accords with constructivist thought but extends it to both smaller scale living systems such as the immune system and larger scale living systems such as teams and ecosystems.

At all these levels, one can see processes of self-organized adaptation. The individual reorganizes his or her schema or webs of belief in relation to experience. Similarly, a team might organize its ways of working together and its knowledge is enacted in its products, e.g. patient care collaborative research papers.”

“Drawing on the cognitive and constructivist theories, I understand learning by linking prior knowledge and experience of the learner with new knowledge and experiences to which it is exposed. The result of this process, if it is perceived as meaningful and relevant by the learner, will result in the construction of new schemes, concepts and perspectives.”

Learning is complex and multidimensional:

“Learning is a complex and multifaceted phenomenon. It includes emotional, cognitive, spiritual and physical dimensions including biological or neurological functions and, most importantly, it occurs in *relationship or interaction* with persons and objects outside of the learner including the social structures in which we live, not simply ‘within’ the learner.”

“I see learning as multidimensional or holistic, involving intellect/cognition, emotions, senses and -- for some people – spirituality.”

Other definitions of learning:

“I’m assuming by this question that you are referring to how the brain works with learning? (you may want to refine that question). If we are talking about learning

biologically and through the nervous system, then what I would say [is] the brain receives sensory information, from the external environment, it makes sense of the impulses internally, it transmits from impulses between neuron's and then impulses are transmitted to muscles. But also involved in learning is the mind, cognition and intelligence. If you were talking about learning in general, I would probably talk about cycles of learning, learning styles, emotions, relationships, the context and the environment as well as way bodies learn. Therefore it's really difficult to separate the body, brain and mind and learning."

"My understanding of how they learn is derived almost entirely from my teaching experience. Students learn best when they are interested, engaged, and disciplined. They respond positively to professors who are accessible and supportive."

"I favour a psychoanalytically-based theory of learning: 1. knowledge is not a substance but a structural dynamic..., is not contained by any individual but... is essentially, irreducibly dialogic, 2. learning proceeds 'not through linear progression but through breakthroughs, leaps, discontinuities, regressions, and deferred action,' 3. learning is not 'a simple one-way road from ignorance to knowledge' (Felman, *Jacques Lacan and the Adventure of Insight*, 1987)."

"Generally the theory is dialectical materialism, and this really focuses learning on understanding how meaning is negotiated in creating structures which people then participate in historically."

"I am interested in, and impressed by, 'chunk' based models regarding analysis and learning, and find them appealing on a common-sense level. I would be a lot

warmer towards Mezirow's work on transformative learning if it were not so over-blown. I think that he describes a possible way of learning, but the tendency to universalise his ideas is really unhelpful and likely inaccurate. And hyper-rationalist. But nonetheless, there is something to the idea of schema."

"I teach a variety of modules for... students and interns – I do something there that your science can help. I try to create a dilemma in their minds about how they see themselves as (to be) development professionals (world saviors)! This sometimes is an emotional experience for them too. But they do remember it and they always e-mail me from afar about this exercise."

There were many different educational learning theories that were mentioned in the responses of the adult education professors in support of their definition(s) of learning. There were 22 different educational learning theories (e.g., Kolb's Experiential Learning, Transformational Learning, Social Learning Theory, Constructivist Theory, Connectivist Theory, Cognitive Theory, and Self-directed Learning) that were mentioned. An educational theory of learning was coded by examining phrases that indicated that the participant was using the educational learning theory to inform practice. These indicating phrases often started with 'I draw from', 'I favour', 'I work mainly from', 'my fundamental approach', and 'my work is a blend of several theories'. Therefore, not all educational learning theories that were mentioned were coded. Of the 22 adult education professors, 3 (13.6%) adult education professors did not mention a learning theory, and 8 (42%) of the 19 adult education professors who mentioned a learning theory stated that several theories informed their practice. In support of their indicated learning definition, adult education professors often mentioned the names of learning theorists.

“My idea of learning is obviously full of complexities and approaches, shaped by a number of learning theories which I have explored over time: for example, behaviorism, constructionism, pedagogy, andragogy, self-directed learning, control theory and social learning theory; and influenced by Dewey, Piaget, Cagne, Knowles, Verner, Gardner, Vygotsky, Granott, Lave, Kegan, and Birren. My conception of learning in post-secondary education reflects the necessity of diversity, flexibility and challenge - essential for meaning-making (Kegan) and individual development (Birren) in the acquisition of knowledge, skills and social behaviors” (Participant 5).

It was very interesting to visually see the numerous theories of learning that was informing the educational practices amongst post-secondary adult education professors in Canada as shown below in Figure 2. From the responses to this question, there were 21 theories of learning that were mentioned. Only 19 of the 22 adult education professors mentioned a learning theory in their response, and almost half (n=8 or 42%) of the 19 adult education professors mentioned that several theories informed their practice. These results suggest that adult education professor’ definitions of learning along with the accompanying supportive theories may be rooted in individual preference(s) and/or beliefs/conceptions of learning.

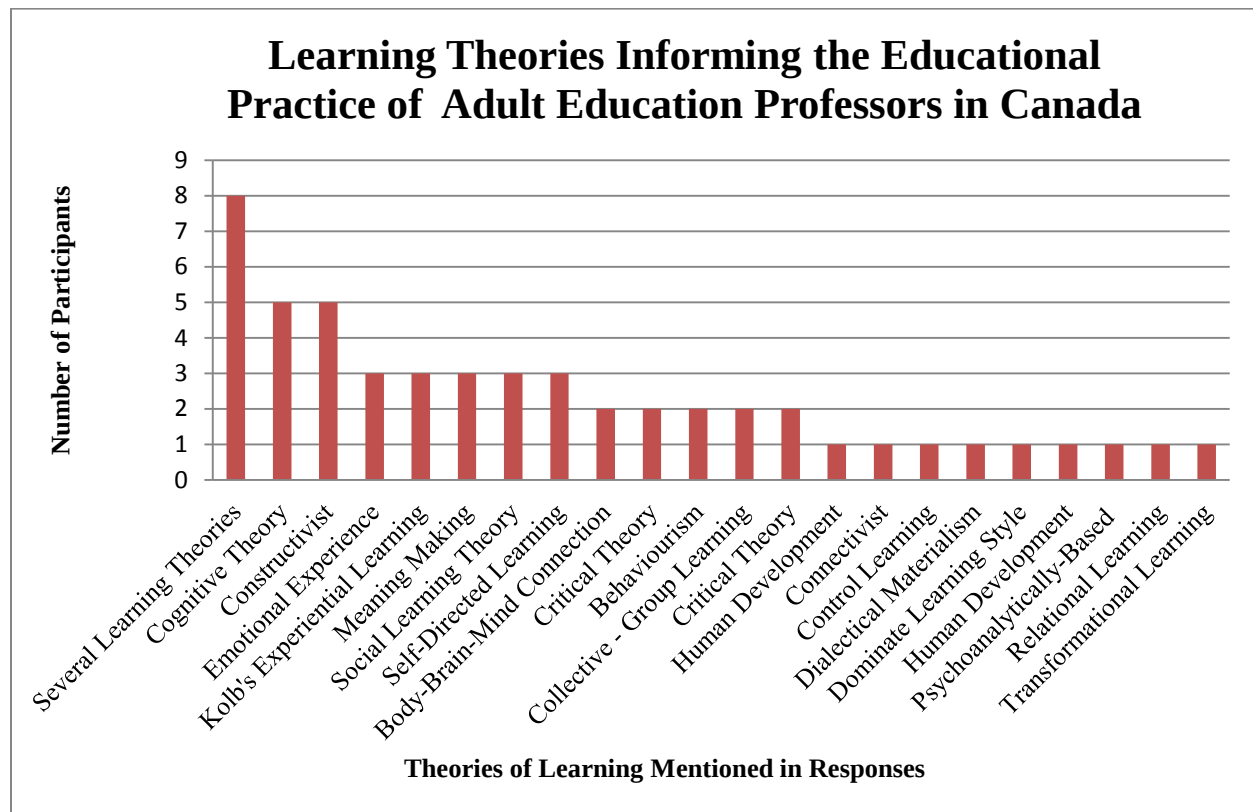


Figure 2. Learning Theories Informing the Educational Practice of Adult Education Professors in Canada.

5.2 Question Two

If a student in your course had impaired memory function, how would you provide support for their learning? What educational practices, if any, would you include in your course to enhance this student's learning?

There were five basic responses to this question in providing support for a student with impaired memory function and these are: recommendations from the university's learning resource centre, non-memory based assessments, course assessment accommodations, learning scaffolds, and no answer. More than half (n=12 or 55%) of the adult education professors indicated that they would seek help and/or recommend that the student seeks help from the

university's learning resource centre. Eight of these adult education professors that indicated that they would seek help and/or recommend that the student seeks help from the university learning resource centre also indicated that they would incorporate other educational practices such as non-memory based assessments, course assessment accommodations, and learning scaffolds. Seven (32%) of the 22 adult education professors only indicated that they would incorporate other educational practices (i.e., non-memory based assessments, course assessment accommodations, learning scaffolds). Three (13%) adult education professors did not have an answer as to what they would do if a student in their course had impaired memory function.

Recommendations from the university's learning resource centre:

“If a student disclosed this accessibility need to me, I would encourage them to meet with the learning strategist in the Accessibility Services office on campus. I would ask to be brought into the conversation once the strategist and student had identified the supports and practices that would best enhance the student's learning. I would then make every effort to include those supports and practices for the student” (Participant 15).

One participant offered this interesting insight about students registering with the university learning resource centre.

“But I will say too, you know if you're kind of looking at the experiences of teaching and learning within universities, a lot of times I'm not allowed to know if the student has registered with the center for disabilities. You know if there's an impaired memory function it would go to the center, the center would then contact

me and say ‘we have assessed their reasons for requiring extra time on a quiz or something’” (Participant 17).

Recommendations from the university’s learning resource centre and incorporate other educational practices:

“I would rely on our Disability Resource Centre for advice and that advice would be based, I assume, on an analysis of the kind of impairment and its severity. In general, I would do my best to provide digitally-available materials (readings, presentations, etc) so that the student could review at their own pace and in conditions conducive to retention. I would also use visuals as much as possible under the assumption that graphic materials that supplement verbal material might aid the student. My assignments are typically analytical essays and papers done on the student’s own time, so I would not be putting the student in a situation with test-taking time pressures” (Participant 4).

“The courses that I teach are not memory-based. In other words, students are always able to consult texts or notes, during class or for assignments. I would imagine that developing a good and thorough note-taking process would be very helpful, and I would work with the student as much as possible to develop a workable process. For additional ideas, I would consult with teaching and learning experts and/or the folks who manage accessibility supports on campus, and would encourage the student to do the same” (Participant 10).

“Our ‘access’ office usually takes care of such accommodations. But if I had to deal with this issue, I would probably provide or encourage the use of various kinds of scaffolds, such as concept maps, recording devices, power points and so

on. I consider these things and even our computers and day planners to be part of our ‘external memory’, since a lot of the things we do rely on ‘memory’ that is outside of our bodies. I, for instance, could never organize myself without my day planner. I guess that the theory that influences me here is Vygotskian social constructivist thought” (Participant 13).

No answer:

“I have no answer for this question as this has not occurred in my professional career or post-secondary activities” (Participant 5).

“This situation has never occurred to this day, so I have nothing planned for this purpose. Since the seat of learning is situated in the memory, such a student would have great difficulty in processing information (working memory) and/or to encode it (long term memory). I think the support or the re-education he would need greatly surpasses my current skills.” **Translated from:** “Cette situation ne s’est jamais produite à ce jour, je n’ai donc rien prévu à cet effet. Puisque le siège de l’apprentissage se situe dans la mémoire, un tel étudiant serait en grande difficulté pour traiter l’information (mémoire de travail) et/ou pour l’encoder (mémoire à long terme). Je pense que le soutien ou la rééducation dont il aurait besoin dépasse largement mes compétences actuelles” (Participant 14).

5.3 Question Three

It is said that “neurons that fire together wire together” and form stronger connections and stronger neuronal networks. Do you think learning is related to neuronal connectivity? If so, why? If not, why?

There were 3 dominate themes that emerged from the responses to this question: not well aware of neuronal connectivity (n=18 or 82%), yes learning is related to neuronal connectivity but learning is not limited to neuronal connectivity (n=2 or 9%), and yes learning is related to neuronal connectivity (n=2 or 9%). One sub-category emerged under the theme ‘not well aware of neuronal connectivity’ which was that even though adult education professors were ‘not well aware of neuronal connectivity they believed that neuronal connectivity is possible but that learning was not limited to neuronal connectivity’. Of the 18 adult education professors that were not well aware of neuronal connectivity, 10 (56%) made statements that suggested that learning could be related to neuronal connectivity. These 10 adult education professors were hesitant to fully believe that learning was connected to neuronal connectivity and suggested that learning is not limited to neuronal connectivity. Only 4 (18%) of the 22 adult education professors indicated/believed that learning is related to neuronal connectivity, however, 2 of these 4 adult education professors mentioned that learning is not limited to neuronal connectivity.

Not well aware of neuronal connectivity:

“I regret to say that lack of knowledge prevents me from answering Question 3. Anything I said would be irrelevant as I do not understand the topic” (Participant 6).

“I suppose so -- this is so far outside my area of knowledge that I can't comment beyond assuming that how well connected pathways are help us process information” (Participant 10).

“In terms of the hard neuroscience, the idea of linking neurons makes sense, though I’m not up enough on the details to provide a really insightful comment. I

suspect that we still have a long way to go in understanding the deep function of neural networks before we are able to relate physical structures to psychic processes definitively” (Participant 12).

“I know very little about neurons, beyond distantly remembered Biology 100. I have no idea if learning is related to neuronal connectivity” (Participant 21).

Sub-category: Not well aware of neuronal connectivity but believed that neuronal connectivity is possible and learning was not limited to neuronal connectivity:

“I really do not know much about it. I do believe there is a neurological basis for learning but I am not well informed about it” (Participant 1).

“I think yes, the learning process is linked to neuronal activity, but I can not say more about it.” **Translated from:** “Je pense qu’effectivement, le processus d’apprentissage est lié à l’activité neuronale, mais je saurais en dire plus à ce sujet” (Participant 14).

“Based on my decades-old training in physiology, this seems like a reasonable claim, so I would agree that learning is related to neuronal connectivity, but that neuronal connectivity is only one factor [the relative impact on learning I can’t speculate about] in learning. I am unsure whether learning reinforces or produces neuronal connectivity or neuronal connectivity explains learning...or accounts for the observable manifestations of learning” (Participant 4).

“I am sure that learning has a relationship to neurons because that’s how our brain works. However, I don’t believe this could be the whole story. Learning is far too complex to attribute it solely to neurological functions” (Participant 9).

“A friend of mine is a neurologist, stroke specialist, and has often mentioned how frighteningly little we know of the brain. That said, I think it makes total sense for the reason identified above that neuronal connectivity enhances learning. I don’t understand all of the images that researchers show of different brain hemispheres lighting up under different conditions as evidence of sociobiology claims but it seems plausible that increased brain activity is minimally correlated (and perhaps causing) learning to occur” (Participant 15).

Yes, learning is related to neuronal connectivity but learning is not limited to neuronal connectivity:

“Of course learning is related to neural conductivity. That is part of what reorganizes itself adaptively in learning. But human learning is not limited to the self organization that occurs in the brain. Our entire body reorganizes itself adaptively in relation to experience. A smaller scale, our immune system reorganizes its connections in relation to experience. On a larger scale, are social groups reorganize themselves as result of experience. All of these dynamic connections are involved in learning. I get irritated when people assert that learning is ‘all about’ just one level, such as neurons or social practices. All these levels are always involved in learning” (Participant 13).

Yes, learning is related to neuronal connectivity:

“I do have a science background – not much a believer in science as the remedy but a believer that science can explain. Yes I do agree in this statement. It says when two neurons, or populations of neurons, fire together the connection between them becomes stronger (very much like when two persons communicate

with each other); this is the basis of our learning and memory. The opposite is true too. When one neuron fires but the other one stays silence the connection between them becomes weaker (again very much like humans) and this is the basis of our forgetting. In our practice of education we need to create experiences to ignite the firing!!!” (Participant 2).

5.4 Question Four

Have you ever heard of or come across information about research on the brain and learning? What was it and where did you hear it or come across it? Did you think that the information you came across was useful for the field of education, for educational practices? Why or why not?

Sixteen (73%) adult education professors reported that they had come across information about research on the brain and learning, and 6 (27%) adult education professors reported that they did not come across information about research on the brain and learning. Of the 16 adult education professors that came across information on the brain and learning 4 mentioned that they found the information to be useful, 6 found the information not useful, 3 found the information to be useful and also not useful, and 3 did not comment to whether it was useful or not. Therefore, a total of 7 adult education professors found the information they came across as useful. Of these 7 adult education professors, 4 mentioned that the information they came across could be useful for education, 1 mentioned that the information they came across could be useful for educational practices, and 2 adult education professors did not make reference as to whether the information they came across could be useful for education or educational practices. The adult education professors that came across information about research on the brain mentioned that they came across the information from the following resources; conferences, books

(including adult education textbooks used for their course), websites, and popular science publications (i.e., books, magazines).

Adult education professors that did not come across information about research on the brain:

“I have not come across any literature in this area, but I do work in a department with educational psychologists who believe all learning is about the brain, and that society has little influence or bearing” (Participant 7).

Adult education professors that came across information about research on the brain and found it useful:

“I think it is very important to think about how the brain processes information, especially when preparing learning activities for adult learners, and those student with learning disabilities, brain injuries, and other brain-connected exceptionalities. I may think the student is unmotivated and not interested, but I may not be presenting the information in such a way that the brain can process” (Participant 3).

“As mentioned earlier, I’ve read a book about brain plasticity, which was very enlightening (the title escapes me now). I think the information is useful because it adds a neurological component to the social component of learning” (Participant 16).

“I use a chapter in my adult learning class from Dorothy MacKeracher’s Understanding Adult Learning in my graduate class that is an overview on the research on the brain and learning. This term I have a number of physicians in my class and they thought that the chapter did a great job describing how the brain

works physically for learning. I clearly think it's an important area and spend a week talking about the brain and body in learning in my graduate class"

(Participant 18).

Adult education professors that came across information about research on the brain and did not find it useful:

"Occasionally there is a conference session or other brief encounter with information on brain research and its implications for adult learning. I haven't seen much in adult education research journals about this, so it may be that it hasn't yet grabbed the interest of many adult education scholars. There is brief reference to brain research in the chapter on Adult Learning in the most recent Handbook of Adult and Continuing Education (Jossey-Bass, 2010), but not much detail is presented and there is no discussion of direct educational implications. So I would say that, so far, the information on brain research is intriguing, but not especially useful because its educational implications are not yet clear"

(Participant 4).

"Yes, I've read quite a bit about the brain and learning, but I find a lot of it ingenious and simplistic. I'm encouraged that psychologists have finally acknowledged the brain's plasticity, but I remain disappointed with the efforts of neurologists to reduce human experience to changes in brain chemistry. There's more to consciousness and learning than electronic impulses, increased blood flow, and changes in chemical composition. At best these kinds of studies reveal correlations, not causes" (Participant 8)

“Yes, I have come across information in popular science publications, both books and magazines. However, it is often not much use for shaping my practice as an educator. This seems to be for one of two reasons. Either it is really, really observational and somewhat banal (kids learn better when they are motivated, here’s a picture of a motivated brain) or it’s really not too useful for practice (here’s a brain of a good reader, here’s the brain of a struggling reader). As I’ve commented before, this field seems quite immature at the present time” (Participant 12).

“I have frequently heard of research on the brain and learning. I last heard about such research at the most recent STLHE and ISSOTL conferences. The information was very interesting to me, but inconclusive – as in, I could not make a direct connection between research on how learning takes place in the brain and learning strategies in a classroom” (Participant 21).

5.5 Question Five

Have you ever changed your educational practices to reflect current research on how the brain learns? If so, what did you change and why? Did you find this change effective? What was the brain research you based your change on (e.g., memory and learning)?

Of the 22 adult education professors, 20 (91%) responded that they had not made any changes to their educational practices based on neuroscientific research on how the brain learns, and 2 (9%) responded that they had made changes to their educational practices based on research on how the brain learns. However, 1 adult education professor that did not make changes to their educational practice to reflect research on the brain mentioned that literature on the brain they had come across may be indirectly influencing their educational practice. Two

other adult education professors that did not make changes to their educational practice mentioned that the neuroscientific information they had come across affirmed their current educational practices. Of the 2 adult education professors that responded that they had made changes to their educational practices based on research on how the brain learns, only 1 made explicit reference to changing their educational practices based on brain research and the other only made reference to changing their educational practice based on scholarship. However, both adult education professors indicated that the changes that they made to their educational practice were effective.

Did not change their educational practices based on research on how the brain learns:

“No, I have not changed my practices. I do try to use good teaching practices, try to increase critical thinking, raise essential and critical questions but none of these is in response to brain science” (Participant 1).

“No, not really. No research I’ve seen to date challenges what I consider as good practices, such as multi-modality and variety in information generation and problem-centred learning” (Participant 12).

Did not change their educational practices, but research on how the brain learns has had an indirect influence on their educational practice:

“No. Although the literature that does influence me – Piaget didn’t constructivism, Vygotsky and sociocultural theory and complexity science – often does have links to research on the brain. I suppose then that it’s influence on my educational practices is indirect” (Participant 13).

Did not change their educational practices, but research on how the brain learns has affirmed their current educational practice:

“The information I received affirmed my teaching practice with adult learners. It did, however, provide me with a theoretical context within/through which to better understand what I was doing in my practice and why I was doing it. It also provided me a language to discuss some of my teaching and facilitation strategies” (Participant 11).

Yes, changes to their educational teaching practice were made, but no mention that changes were based on actual research on the brain:

“I have always changed my practice based on scholarship. A good theory goes a long way. Its important to read broadly to make sure that it is sound research that one is depending on. My undergraduate program was in the social sciences and required the reading of primary research and its critique both from methodological and content perspectives. Most teachers in my experience at the Masters level are distanced from theory and mainly teach from their own model of teaching/learning...its difficult to have them think about how to deal with change because it means re-thinking their own practice. Some of my change works with some people and some doesn't. My new strategies are successful mainly for graduate students because of the level of experience they have compared to bachelor of education students who have no experience teaching, are learning pedagogical strategies but have little integration of their teaching content knowledge so they don't really have a facility yet to use it flexibly...I think they need a 4th year to consolidate their knowledge base...even though they are adults they are not yet practiced enough with their knowledge base to be able to

procedurally change and adapt it across contexts as students need....its not something that can just be explained....but teachers who come back for an advanced credential do have the content and affective and cognitive flexibility to be able to manipulated the practice and adapt it based on new knowledge” (Participant 20).

Yes, changes to their educational teaching practice were made based on brain research:

“Absolutely (see response to Question 4). For example, I have recorded podcasts of lessons so the student can review it over and over, provided speaker notes or PowerPoint to students in advance, changed the format of activities, offered choice to complete outcomes, etc. I believe the change was effective because the students could focus on the important stuff. These ideas came from readings about learning and how the brain works for students with learning disabilities” (Participant 3).

5.6 Question Six

How aware are you of the current neuroscience research on plasticity, memory and learning, sleep and learning, and emotion and learning? Do you think neuroscience research in these areas can help enhance educational practices?

Of the 22 adult education professors, 13 (59%) were not well aware of the current neuroscience research on plasticity, memory and learning, sleep and learning, and emotion and learning. The remaining 9 (41%) adult education professors responded that they had some awareness of the current neuroscience research on plasticity, memory and learning, sleep and learning, and emotion and learning. Four of the 13 adult education professors who were not well aware of the current neuroscience research mentioned that neuroscience research could enhance educational practices. Five of the 9 adult education professors that had some awareness of the

current neuroscience research thought that neuroscience research could enhance educational practices. Therefore, a total of 9 (41%) adult education professors believed that research in the areas of plasticity, memory and learning, sleep and learning, and emotion and learning could help enhance educational practice.

Not well aware of current neuroscience research and did not mention whether neuroscience research could enhance educational practices:

“I am aware that there is such research. As a previous social worker in a pediatric rehab hospital, I know that the brain can relearn and redevelop much more than was originally thought after traumatic brain injury. I know that there are neurological processes at play in memory, emotions and sleep. But I don’t know any of the science directly and I don’t know any that looks at the relationship of neuroscience and social factors. This would be very valuable for me. And a necessary element for me to find it useful in educational practices” (Participant 9).

“Horribly unaware. Like so many academics, I rarely read outside of my field. Unless the neuroscientists have partnered with education faculty to write for education journals, I fear I have likely not come across this cutting edge and likely very relevant scholarship. My hunch is that there is much to be learned but it needs to be translated in a way that someone in the social sciences will read. Here’s the perfect opportunity for interdisciplinary scholarship with huge potential benefit; my fear is that it is likely not going to be done” (Participant 15).

Not well aware of current neuroscience research but mentioned that they thought neuroscience research could enhance educational practices:

“I am not aware of this current neuroscience research and would like to learn more. From the little I do know, I believe that research in these areas would help and enhance educational practices” (Participant 11).

“I am not aware of recent research in this area. I do think that if teachers and adult educators were taught these processes, they could improve their educational practices in order to further promote the learning of their students or learners.”

Translated from: “Je ne suis pas au courant des recherches récentes dans ce domaine. Je pense qu’effectivement, si les professeurs et formateurs d’adultes étaient instruits de ces processus, ils pourraient améliorer leurs pratiques éducatives de façon à favoriser davantage l’apprentissage de leurs étudiants ou apprenants” (Participant 14).

“I do think that research in this area could be immensely helpful in understanding learning at any level. But this is not my field or my focus. So, as a result, I am not aware of current neuroscience research in any of these areas. But speaking as an individual, and not an ‘expert’ in the field, I will say that I do appreciate the benefits of sleep on learning and the potential pitfalls that negative emotions can have on learning, at least anecdotally” (Participant 19).

Some awareness of current neuroscience research but did not know if it could enhance educational practices:

“I am aware of the current research on plasticity, memory and learning and emotion and learning, as popular media reports. I am not aware of the research,

and I have only heard brief mentions of this research in conference sessions. I do not know if neuroscience research can enhance educational practices” (Participant 21).

Some awareness of current neuroscience research and thought it could enhance educational practices:

“Fairly aware. I think there is potential for it to be helpful, but I don't know what new information it provides. If it continues to show the neurological processes inherent in a specific task etc. that's not terribly useful-- as an educator I have to work with gross process, and dissection of students is discouraged. For example there was a story this weekend that gamblers experience almost as bit a hit of pleasure from almost winning as they do from winning. If I were working with problem gamblers I might find it interesting, but it really reinforces an observation rather than provides a new perspective (Participant 12).

5.7 Question Seven

Has this research study stimulated your interest in neuroscience research on how the brain learns in informing educational practices? Did you look up any information on neuroscience research because of this study? If so, what type of information did you look up and where did you find it (e.g., internet search)?

Thirteen (59%) adult education professors mentioned that this research study had stimulated their interest in neuroscience research on how the brain learns in informing educational practices. The remaining 9 (41%) mentioned that this research study did not stimulate their interest in neuroscience research on how the brain learns. Of the 13 adult education professors that interest in neuroscience was stimulated, only 5 looked up information

about neuroscience research on how the brain learns because of this study. These 5 adult education professors searched for information about how the brain learns by chatting with colleagues who had knowledge regarding neuroscience, in Google Scholar, and looking to see what information was provided in adult education textbooks. Interestingly, 2 adult education professors mentioned that they would be interested in looking for appropriate textbooks on neuroscience and education for their courses for next year. Several other participants mentioned that even though this study had stimulated their interest in neuroscience research on how the brain learns they would be unlikely to come across neuroscience information unless it was in an avenue that was particular to their discipline (e.g., published academic journals and other published scholarly literature, adult learning textbooks, and adult education handbooks). Therefore, these avenues should be considered in the dissemination of educational neuroscience research and findings.

Research study had stimulated their interest in neuroscience research on how the brain learns in informing educational practices:

“I can honestly say that it stirred my curiosity up again. I wonder just how much curriculum designers know and incorporate about brain-based research. I looked up a former colleague who teaches principles of learning in terms of the brain”
(Participant 3).

“Yes, I would say that this study occurring closely in time to the comment by a fellow social scientist (see my answer Q4) has stimulated my interest. I have not looked up any information yet but I would do so when I am preparing my course on adult learning and development for next year. I would be focused on finding literature by adult educators or other social scientists who are using this research

within a sociological framework. I don't feel qualified to sift through the neuroscientific literature myself directly" (Participant 9).

"I will probably not do any more research than currently. The main thing the study has done is make me think about the assumptions behind it. For example, the very traditional understanding of learning implied in the first question and relationships of power between different sorts of disciplines (Participant 13).

"This research study has stimulated my interest in how the brain influences student's learning, memory, attention, etc. I would be very interested in modifying my educational practices in light of neuroscience research findings. That said, unless this research is published in journals that I would come across in my normal academic reading or is translated in a popular media outlet, I can't imagine that I will come across it (Participant 15).

"I have to say that my interest is stimulated alright as I looked for a text to use next term in my class on learning in educational contexts. I am interested in students owning their own learning which means they need to know something about the way the operate" (Participant 20).

Research study did not stimulate their interest in neuroscience research on how the brain learns in informing educational practices:

"I didn't look for any information because of the study, and don't think that the study stimulated my interest in the topic. I would pay attention to relevant stories that I heard in the media -- I listen to CBC radio a lot, and from time to time, on a number of shows, there are relevant stories covered. Sometimes, I might look for

additional information on my own if a story struck me as interesting” (Participant 10).

“I have to say no to all questions. Not because I don’t think that this area is not important or relevant. To be honest, I really don’t have any interest in researching this area. Its just not my thing, but I can appreciate that it might be someone else’s thing. I believe it is relevant, for sure. But I also believe that this kind of research has informed adult education, at least in how adult education was conceived in the mid last century, for far too long and I worry that focusing too much on brain functioning and cognition will take us away from other areas that are equally important such as context, diversity, and social factors” (Participant 19).

5.8 Question Eight

If there is one area about neuroscience research on how the brain learns that you would want to know more about, what would it be and why?

There were many areas of neuroscience research that were of interest to adult education professors. However, only 14 adult education professors mentioned area(s) of interest and the other 8 adult education professors expressed no interest in wanting to know more about neuroscience research on how the brain learns. The areas of neuroscience research that are of interest to the 14 adult education professors are represented below in Figure 3.

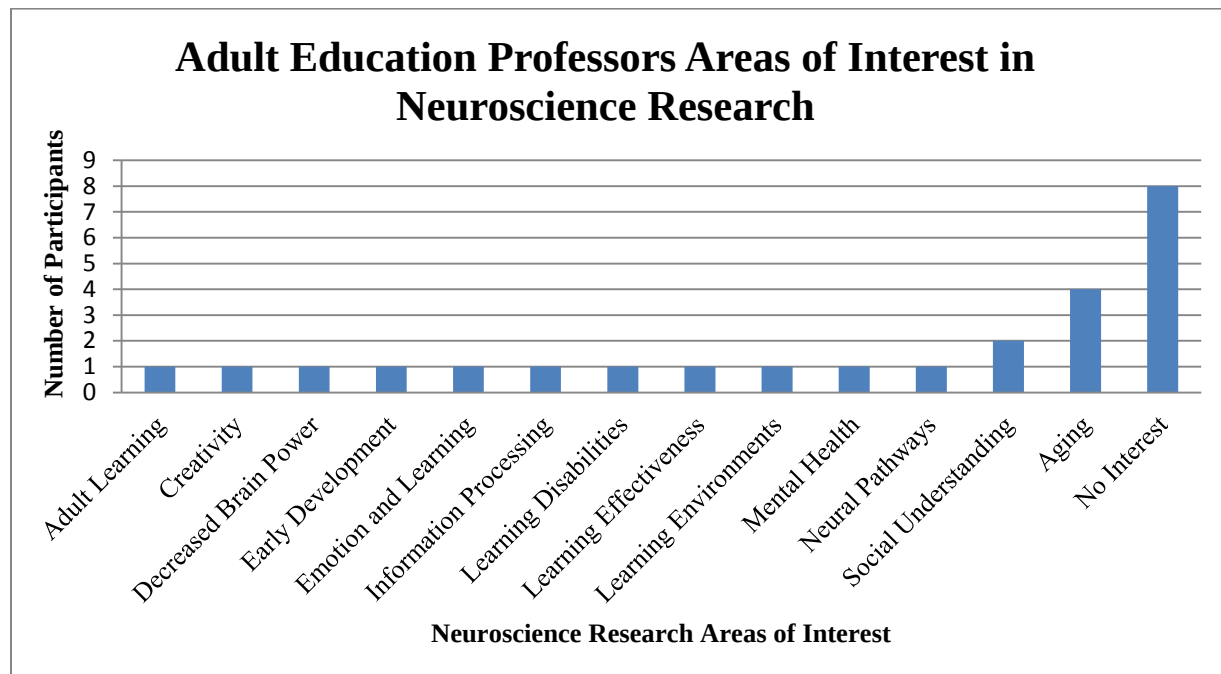


Figure 3. Adult Education Professors Areas of Interest in Neuroscience Research

Aging and learning:

“I am interested in decreased brain power, for instance my own declining ability in mathematical functions. I used to be a whiz and now I have issues with it. I would like to know more about decline. I assume it has something to do with the fact that I do not have to use it much anymore. Yet, I also am aware the numeracy is as important as literacy, and I never want to be a stereotypic female who says: I can’t do math” (Participant 1).

“I am curious about the brain and learning disabilities, especially for older adults. I wonder about the neural pathway development and wonder what impacts age and LDs have on learning new tasks” (Participant 3).

“The effects of aging on physical and cognitive structures. In the hope that it might be possible to understand and react to these better” (Participant 12).

Emotion and learning:

“I am interested to know more about the role of emotions in learning – some scientific understanding of improving learning through provoking emotions. What happens in brain when emotions get involved. In my practice and in adult ed research there is a discussion on the importance of emotions as well as other ways of learning (e.g., embodied learning)” (Participant 2).

Other areas of interest:

“Whatever area of research that is most relevant to adult learning and the practice of adult education. Since it is not clear to me which areas of neuroscience are likely most relevant, it make take some “interpretation” from neuroscientists to help clarify this” (Participant 4).

“Neuroscience tells us how the brain functions and the necessary parts and elements involved and how things change, but what about creativity, imagination, and insight” (Participant 5).

“Yes, how much neuroscience research acknowledges its ecological connection to learning processes at other levels, such as whole person and social groups and contexts. Some psychologists, such as Merlin Donald, acknowledge how much neurology is interwoven with culture and socialization. I’m curious to know how many neurologists believe this. Again, it is important to note that I’m not discounting the importance of neurological research. I’m just trying to see it

within a larger context” (Participant 13).

“I would like to know more about the relative educational advantages of standardized testing vs. more individualized forms of learning (essay writing etc.). I would also like to know more about the impact of technology and the wide use of social media on learning effectiveness” (Participant 22).

5.9 Question Nine

If you had the opportunity to talk face-to-face with a neuroscientist who does research on how the brain learns what would you want to talk about and why?

The same 14 adult education professors that expressed interest in knowing more about an area of neuroscience research in question eight had interest in talking with a neuroscientist. However, as question nine had similar questioning attributes to question eight, 9 of the 14 adult education professors responded to question nine with reference to their responses from question eight (i.e., ‘see question 8’) and did not offer any additional interest in neuroscience research. The remaining 5 adult education professors either gave additional areas of interest or expressed no added interest. Interestingly, 7 of the 8 adult education professors that had expressed no interest in wanting to know more about an area of neuroscience research on how the brain learns in question eight expressed interest in talking to a neuroscientist. Four of these 7 adult education professors gave areas of conversational interest (i.e., social aspects of learning, what have neuroscientist discovered about the brain and learning, why is neuroscience research important). Thus, there were additional areas of interest from all the responses to question nine which can be added to Figure 3 above from question eight. These additional areas of interest were: stress and

learning, social aspects of learning, mind-brain-concept, and why is neuroscience important for learning.

Additional areas of neuroscience interest:

“I’d love to hear just how electrical impulses are translated into a learning component. The whole concept of thought, memory, and creativity is fascinating when I think about it in terms of synaptic nodes and neural transmitters. Where will we be in 20, 50, 100 years in understanding the brain and actually using more than what we do now” (Participant 3).

“Let’s talk about who/what manages the brain-mind parts (Society of the Mind) to maximize capacity and ‘how to effectively use’ resources and select parts. How does the eco-social-context influence the who/what? Rather obscure but a useful dialogue for me as an educator” (Participant 5).

“I would want the person to start the conversation by focus of his/her research/expertise, and why it’s important” (Participant 10).

“I would say it would be about stress and learning” (Participant 17).

“I would want to hear about their research and ask how it dovetails with the social aspects of learning” (Participant 16).

“I don’t know if I would be interested so much in talking to one...particular one...beside...do we talk about ‘how the brain learns’ or how the brain assimilates learning....we speak in metaphors....how do we get at the phenomenon....we still need a discourse to talk about this....I don’t find the

students in my classes have much of a vocabulary for embodied knowledges....I am interested in how development conserves particular patterns that get rediscovered and then rearticulated over and over again in different contexts...frames and reframed, like in the work of someone like **Benoit Mandelbrot** and fractal theory” (Participant 20).

“I would enjoy speaking with a neuroscientist about what he or she thinks has been discovered about the brain and effective learning, but I have no avenue into that conversation beyond what I hear in popular media, which does no service to the field. Right Brain Left Brain, for example, is I understand ‘nonsense’ to a neuroscientist. Similarly, neurolinguistic programming. What I hear in popular media cannot be relied upon” (Participant 21).

5.10 Follow-up Question

Do you have any comments about the chosen delivery method for the structured e-mail interview questions? Would you participate in future research with this type of delivery method?

This question was only sent to those adult education professors that consented to follow-up questions on their informed consent form and 6 adult education professors did not give their consent. Of the remaining 16 adult education professors that gave their consent for follow-up questions, 4 did not submit an answer and 9 mentioned that they liked and/or would prefer this chosen delivery method (i.e., structured e-mail interview). The responses of 2 adult education were only comments (e.g., advice) on the delivery method, and 1 adult education professor had no comment about the chosen delivery method but mentioned that they would participate in

future research via an e-mail interview. A total of 5 adult education professors mentioned that they would participant in future research via e-mail interviewing.

“I wonder if you should have screened people first. I was not conversant in neuroscience so I struggled to answer the questions. I do not think you will get much useful data from me. I think that it is asking a lot of people to have them fill out your questionnaire every day or a few days. You could make it easy by sending it all at once” (Participant 1).

“I liked the e-mail delivery method. I could respond to a question in 5 minutes when I had five minutes. I imagine it must be frustrating for the researcher though to have to send reminders to tardy respondents. It’s also nice, though to get the responses via e-mail so you don’t have to do transcription. Well played!!” (Participant 3).

“Yes I kind of liked the delivery method. It allowed me to respond in my own time and it was always in my inbox until I did! I liked your gentle reminders. They were very important. I also liked that you were clear that we didn't need to look up anything in order to answer the questions. Just work from our own experience and perceptions in the moment. That way, I was more likely to actually get them done!” (Participant 9).

“I have never experienced this type of interview approach before and found that it worked very well” (Participant 11).

“I found the divided questions a bit less engaging than working through the whole thing at once, with time clearly set aside to complete it. I think I’d prefer this format” (Participant 12).

“I think you saved some time in having respondents type their answers in that now you don’t have to transcribe interviews” (Participant 15).

“E-mail is a good venue for the questions. Just be careful that your questions are not too repetitive. I have no problem participating in research via e-mail.

Although sometimes it’s hard to keep track when I get buried in e-mails. It’s easy to let the e-mail fall down in my inbox” (Participant 18).

“I’ve done e-mail interviews myself. I would participate in future research using this delivery method” (Participant 19).

Chapter 6: Discussion of the Findings

As previously stated, this present research study surveyed the perceptions post-secondary professors in the field of education (i.e., adult education professors) in Canada have of neuroscience research in relation to educational practices. This present research study also provided further insights to the previous research studies (e.g., Pickering & Howard-Jones, 2007; Zambo & Zambo, 2011; Hook & Farah, 2012; Serpati & Loughan, 2012) discussing educators' (i.e., grade school teachers) viewpoints and beliefs on how brain research contributes to education. As mentioned previously, very few studies at the time of conducting this research study had focused on finding out how educators (i.e., grade school teachers) perceive neuroscience research for education, and none could be found that were conducted on how post-secondary professors in the field of education (i.e., adult education professors) perceive neuroscience research for education. Findings from the few studies found (e.g., Pickering & Howard-Jones, 2007; Zambo & Zambo, 2011; Hook & Farah, 2012; Serpati & Loughan, 2012) indicated that some educators (i.e., grade school teachers) placed value on neuroscientific findings and some grade school teachers were confused about the educational value of neuroscience. Findings from these above mentioned studies also indicated that some grade school teachers bought into the non-scientific brain-based learning materials, some did not believe neuroscience research findings on how the brain learns had any value for the discipline of education, and many were not well aware of the neuroscience research findings on how the brain learns.

The results of this research study, in a comparative way, confirmed findings from these studies (e.g., Pickering & Howard-Jones, 2007; Zambo & Zambo, 2011; Hook & Farah, 2012; Serpati & Loughan, 2012) that there is a general lack of awareness of the significance of

neuroscience research amongst adult education professors and that some adult education professors placed value on neuroscience research for education. Many adult education professors did not know whether or not neuroscience research could enhance educational practices, and some did not believe neuroscience research findings on how the brain learns had any value for the discipline of education. However, one finding that was not confirmed from the findings from these previous research studies (e.g., Pickering & Howard-Jones, 2007; Zambo & Zambo, 2011; Hook & Farah, 2012; Serpati & Loughan, 2012) was that adult education professors did not buy into the non-scientific brain-based learning materials (i.e., neuromyths) as did some educators (i.e., grade school teachers). Neuromyths, as pointed out by Howard-Jones (2010), “are misconceptions generated by a misunderstanding, a misreading or a misquoting of facts scientifically established (by brain research) to make a case for use of brain research, in education and other contexts” (p.20).

Interestingly, several adult education professors were aware that misconceptions currently exist about how the brain learns.

“As a side-note, there tends to be some confusion about brain plasticity in general understanding, and I’ve read some people say that we can’t rewire neurons after the age of five. This is complete nonsense, of course, and a great example of bad scientific understanding” (Participant 12).

“Right Brain Left Brain, for example, is I understand ‘nonsense’ to a neuroscientist. Similarly, neurolinguistic programming. What I hear in popular media cannot be relied upon” (Participant 21).

These adult education professors acknowledged that reliable sound scientific understanding of how the brain learns is not well disseminated in general understanding and that they could not

rely on ‘popular media’ for sound dissemination of neuroscience research on how the brain learns. In regards to disseminating neuroscience research on how the brain learns an adult education professor offered this following insight:

“Like so many academics, I rarely read outside of my field. Unless the neuroscientists have partnered with education faculty to write for education journals, I fear I have likely not come across this cutting edge and likely very relevant scholarship” (Participant 15).

For neuroscience research to have an impact in the adult education community, dissemination needs to be through an avenue that adult education professors are likely to cross (e.g., adult education textbooks and/or handbooks, academic education journals, curriculum design materials, conferences, and seminars).

Another concern regarding dissemination expressed among several adult education professors regarding neuroscience research on how the brain learns was that they felt unqualified to explore such literature.

“Although I enjoy reading about how the brain works and how learning happens, but I lack the necessary knowledge on the cutting edge scientific research” (Participant 2).

“I don’t feel qualified to sift through the neuroscientific literature myself directly” (Participant 9).

Not only did several adult education professors feel unqualified to ‘sift’ through neuroscience research on how the brain learns, many expressed that the language of this research was not in a language that they could easily relate to.

“I would want it to be in a language that was accessible, as some of the articles I looked up seemed to assume that one already had a basic understanding”

(Participant 11).

“I am always interested in research that may help students learn more effectively.

My experience, however, is that the reported research is specific in language to those in the field that I can find little of use. The sessions I have attended have left me with little information, because we seem to be speaking two different languages” (Participant 21).

Thus, dissemination of neuroscience research on how the brain learns into the field of education needs to be expressed in a language that is understood by the education community.

Even though many adult education professors (n=16 or 73%) came across information on how the brain learns, only 7 adult education professors thought that the information they came across was useful for education. Many adult education professors mentioned that information on neuroscience research was ‘peripheral to their scholarship’.

“I have not had clear information on it. I saw a special issue of Adult Learning on it but did not read it through. So, I guess I know very little about it. I am more interested in sociology than biology/psychology” (Participant 1).

“Frankly, I’ve not paid much attention to current brain research because it seems pretty far removed from day to day educational practice” (Participant 4).

“I’m not a fan of neuroscience” (Participant 8).

“It is very peripheral to my own scholarship and, beyond the introductory survey courses that I teach, is not information that I tend to return to often” (Participant 10).

“I’m sure I have come across research on the brain and learning. The problem is, I don’t have a clear memory of what it is that I’ve read or where I read it. I don’t think it was clear to me how this research could be applied in educational settings. Seems like a perfect example of relevant research that fails to have been mobilized for applicable audiences” (Participant 15).

With neuroscience research being ‘peripheral’ to the scholarship of many adult education professors, it may not be surprising that only 2 (9%) adult education professors mentioned that they made changes to their educational practice with neuroscience research on how the brain learns.

In examining the differing of the meaning of learning from the perspectives of education and neuroscience, Howard-Jones (2010) argues that “educational ideas about learning are diverse and eclectic in their origins” (p.83). Educational definitions of learning, Howard-Jones (2010) furthers “are the product of a variety of different processes and forces, including those arising from theoretical educational and psychological traditions, and other culturally transmitted ideas from within and beyond the teaching profession” (p.83). The results of this research study support this claim made by Howard-Jones (2010). The first question of this research study asked adult education professors to define learning and indicate if their definition of learning was supported by an educational learning theory. Most adult education professors (n=14) defined learning as some kind of process (e.g., a cognitive process, a process of gaining a new skill or knowledge, a process of collective (group) learning, and/or a process of constructivist thought), 2

described learning as complex and multidimensional, and 6 had unique definitions of learning. There were 22 different educational learning theories (e.g., Kolb's experiential learning, transformational learning, social learning theory, constructivist theory, connectivist theory, cognitive theory, and self-directed learning) that were mentioned, and 3 adult education professors did not mention a learning theory. Several adult education professors (n=8 or 42 %) who mentioned a learning theory stated that several educational learning theories informed their practice.

From the results of this research study, adult education professors' educational definitions of learning are indeed 'diverse, eclectic and a product of a variety of different processes and forces'. This may suggest that adult education professors' educational definitions of learning may be rooted in individual preference(s) and/or individual beliefs/conceptions of learning, as there was not a unified definition/approach to learning and/or theory that informed the educational practice of post-secondary professors in the field of education in Canada. The lack of consensus within educational thinking, according to Howard-Jones (2010), "ensures that individual teachers' beliefs about learning play a critical role in their practice. Teacher's personal beliefs develop through an accrued professional understanding and do not usually require empirical validation" (p.83). The results of this research study that various educational learning theories are informing the educational practice of adult education professors in Canada may suggest that adult education professors may be 'wrestling' with the many ideas presented in theories of learning to inform practice. As previously mentioned, according to Merriam et al. (2007), "just as there is no single theory that explains all of human learning, there is no single theory of adult learning" (p.83), and educators may 'wrestle' with the many ideas presented in these theories of learning to inform practice.

The results of this research study suggest that adult education professors in Canada primarily understand learning in relation to educational learning theories. However, 1 adult education professor from this research study offered the following perspective regarding learning theories:

“Any theory of learning presupposes/assumes an understanding of 1. the world and what it comprises (ontology), and 2. knowledge and what it comprises (epistemology). Standard theories of learning assume knowledge is 1. something that ‘subjects’ (conscious beings) possess about ‘objects’ (non-conscious beings), 2. amassed incrementally, linearly, and cumulatively, and 3. can be differentiated into discrete units, studied in isolation, and then reconstituted. Typically, this produces a theory of learning wherein 1. an ‘object’ to be studied is broken down into discrete units of knowledge, 2. information about each of these units is ‘transmitted’ to the learner, 3. learners master everything about each unit of knowledge before the next is transmitted, and 4. learners are tested on their ability to reconstitute the ‘object’ based on the knowledge they retain. This model is highly problematic because most people do not learn in this manner” (Participant 8).

The results of this study indicated that the educational practices of adult education professors in Canada were informed by a diversity of learning definitions and numerous educational learning theories. Diverse educational practices can have an impact on student learning. Higher education educators, as stated by Norton et al. (2005), “even when they are teaching similar courses, different teachers teach in different ways, and this may affect their students’ satisfaction, motivation and attainment” (p.539). Thus, student learning can be affected

by educational teaching practices. Therefore, the use of effective educational teaching practices may enhance student learning. As mentioned previously, enriching educational practices would significantly be advantageous to enhancing learning, and isn't that what educating is all about? With the new neuroscience research on how the brain learns, Taylor (2006) argues that connecting neuroscience research on how the brain learns with education will ensure meaningful learning. These authors (e.g., Johnson & Taylor, 2006; Battro et al., 2008; Howard-Jones, 2010; Tommerdahl, 2010; Zull, 2011; Immordino-Yang, 2011; Wilson, 2011) suggest that neuroscience research can inform educational practices. Thus, enhancing educational practices with neuroscience research on how the brain learns will enhance student learning. Therefore, it would be beneficial for adult education professors to consider enhancing their definitions of learning with neuroscience research on how the brain learns.

From the results of this research study, adult education professors were not well aware of the current neuroscience research on learning (i.e., plasticity, memory and learning, sleep and learning, emotion and learning), were not well aware that learning was related to neuronal connectivity, and mentioned that neuroscience research was peripheral to their academic scholarship. Of the adult education professors (n=9 or 41%) that had some awareness of the current neuroscience research on the brain (i.e., plasticity, memory and learning, sleep and learning, emotion and learning) only 5 thought that this research could enhance educational practices. Thus, adult education professors may not perceive current neuroscience research as a significant contributor to enhance educational practices. This was indicated in the responses of several adult education professors who participated in this research study.

“I have frequently heard of research on the brain and learning. I last heard about such research at the most recent STLHE and ISSOTL conferences. The

information was very interesting to me, but inconclusive – as in, I could not make a direct connection between research on how learning takes place in the brain and learning strategies in a classroom” (Participant 21).

“So I would say that, so far, the information on brain research is intriguing, but not especially useful because its educational implications are not yet clear” (Participant 4).

Two adult education professors that participated in this research study offer differing perspectives regarding neuroscience research and adult education.

“Often conversations in adult education programs are not fueled by any scientific theory and people just share what they feel about things. I do not appreciate that. There is some sort of anti-science movement in critical/emancipatory adult education. I believe there is a science that can explain learning – but also I do understand that we have a lot of experiential ways to promote learning for which we have seen the results/consequences of learning through changes in people’s attitude and behavior – for this we do not necessarily need to know how does the brain process it and what happens in our brains that produce the learning outcome. BUT I believe this science in future could help us better understand the process of learning; then integrating such knowledge to our practice could be useful (or harmful – depending on the intention!!!).

If we know the science behind the different ways of knowing (e.g., emotional) then we can, in a more informed way, integrate that in our teaching. By that I mean an informed and deliberative process of walking the students

through an emotional journey could have some positive learning outcomes”
(Participant 2).

“Because we differ on the fundamentals of what constitutes the world (ontology) and what comprises knowledge/learning (epistemology), I find I have little interest in what neuroscience has to say. Scans of brains that reveal different levels of activity in different spheres are interesting, but only at a superficial level. There are many examples of people who think and learn without significant portions of their brain, so why the obsession with identifying certain process with certain portions of the brain? Moreover, the brain’s acknowledge plasticity is another reason why ‘mapping’ learning onto neural networks, the brain, chemical changes makes no sense” (Participant 8).

The results of this research study provided evidence that there is a general lack of awareness of the relevance of neuroscience research on how the brain learns for education amongst adult education professors in Canada. This result may suggest that neuroscience research on how the brain learns may not be in ‘alignment’ with adult education professors’ conceptions of good teaching (i.e., educational beliefs). Zambo and Zambo argue (2011) that educators’ core beliefs are “resistant to change, and are self-perpetrating. Teachers see what they believe, and they believe what they see when it aligns with their beliefs and this applies to instruction” (p.26). Northcote (2009) points out that educators’ “beliefs inform their use of specific instructional strategies that, in turn, impact on the quality of student learning... [and that their] practical approaches to teaching and their teaching intentions were directly influenced by their conceptions of teaching” (p.70). Therefore, educators’ opinions and beliefs about teaching and learning affect what they consider to be good educational practices. With the strong evidence

that adult educators' educational beliefs directly influence their educational practices (Kember & Kwan, 2000; Norton et al. 2005; Northcote, 2009, Zambo & Zambo, 2011), and that these educational beliefs are not easily influenced by educational and/or other factors (Kember & Kwan, 2000; Zambo & Zambo, 2011), it may be difficult to enhance adult education professors' 'conceptions of teaching' with new knowledge based on neuroscience research findings on how the brain learns.

Chapter 7: Conclusions and Implications

As discussed previously, the recent developing collaborative effort between the fields of neuroscience and education has created a lot of excitement, confusion, and cautionary attitudes. Results from this research study suggest that even though adult education professors may have concerns (e.g., research language, lack of scientific understanding, dissemination methods) with linking neuroscience to education many believed (n=9) that neuroscience research on how the brain learns could enhance educational practices.

“Yes, neuroscience research in the areas you suggest can/will enhance educational practices as the appropriate connections are made. However, there seems to be a ‘lag’ and a ‘gap’ in applying what neuroscience is finding (exploring and documenting) in body-brain studies and potential applications to educational/teaching practices, and the methods for evaluating educational practice including learning processes and outcomes. Wlodkowski’s book bridges a great deal of the gap, and there are other education resources and studies no doubt. But the lag - gap is also a social-policy issue” (Participant 5).

Tommerdahl (2010) agrees that it may not be easy for neuroscience findings to have direct application to educational practices, but argues for the importance of collaborative efforts to help enhance education practices with neuroscience research. Several adult education professors from this research study also recognized that collaborative efforts are needed.

“That will mean someone or some group (hopefully a keen educator or group of educators also steeped in neuroscience research) will take up the task” (Participant 4).

“Here’s the perfect opportunity for interdisciplinary scholarship with huge potential benefit” (Participant 15).

As previously discussed, the results of this research study bolster and extend the findings of other research studies (e.g., Pickering & Howard-Jones, 2007; Zambo & Zambo, 2011; Hook & Farah, 2012; Serpati & Loughan, 2012) whose focus was on understanding the perceptions educators have about neuroscience research for education. The findings of the research studies mentioned above should be of particular interest to adult education professors, as the participants in these research studies (i.e., primarily grade school teachers) often represent a large percentage of their student population in the post-secondary courses they teach. One finding that emerged from these studies mentioned above was that many educators (i.e., grade school teachers) were buying into non-scientific brain-based learning material (i.e., neuromyths). The results of this research study indicated that adult education professors were not buying into non-scientific brain-based learning material. It would appear that grade school teachers have become soft targets to those who manufacture/commercialize non-scientific brain-based learning materials, and this has some practical implications for adult education professors regarding the academic education their students receive.

As instructors in a college of education, Zambo and Zambo (2011) observed that many of their students (i.e., practicing grade school teachers) were coming to class excited about ‘brain-based’ strategies that they were using in their field placement classrooms. From their observations, Zambo and Zambo (2011) noted that their students

were willing to try any idea if it was linked to neuroscience...[and they] never considered that these strategies might be a waste of valuable classroom time...Even though our students were learning reliable information from their textbooks, they continued to

believe in brain-based strategies and products without questioning, and as teacher educators we knew this could have consequences. We knew our students' beliefs would influence their perceptions of children, how they learn, and how they should be taught (pp.25-26).

This observation, Zambo and Zambo (2011) argue, provides convincing evidence “that without direction education students' beliefs could go astray and their students could be affected” (p.26). Hook and Farah (2012) posit that educators' (i.e., grade school teachers) susceptible vulnerability to neuromyths may be due to the lack of scientific training needed to critically examine these non-scientific brain-based learning materials.

Several interesting comments regarding teaching/training education students were offered by one of the adult education professors that participated in this present research study.

“In the last 12 years I have taught mainly post graduate students who have already mastered their own learning to a great extent. More challenging are the teacher candidates who want to be taught the way they think they should be teaching...and not be treated as adults who need to adapt their teaching to their student's developmental level. Most satisfying are upgrading college instructors across disciplines...

Most teachers in my experience at the Masters level are distanced from theory and mainly teach from their own model of teaching/learning...its difficult to have them think about how to deal with change because it means re-thinking their own practice...

Education has developed such a middle range discourse that I find it problematic to move students into empirical research of most sorts. They don't seem to

understand the basis of empirical research and don't trust it. I see it as a discourse problem and a praxis problem...if it doesn't match their experience its hard to move adults...because that is where they are....so part of it is an adult learning problem...

Even though they are adults they are not yet practiced enough with their knowledge base to be able to procedurally change and adapt it across contexts as students need....its not something that can just be explained....but teachers who come back for an advanced credential do have the content and affective and cognitive flexibility to be able to manipulate the practice and adapt it based on new knowledge” (Participant 20).

The above comments made by Participant 20 provide support for the observation made by Zambo and Zambo (2011) that education students need proper training and direction.

In the experience of this adult education professor (i.e., Participant 20), most education students at the Master level “are distanced from theory and mainly teach from their own model of teaching/learning...its difficult to have them think about how to deal with change because it means re-thinking their own practice...if it doesn't match their experience its hard to move adults” (Participant 20). This insight supports the claim that educational practices are strongly influenced by educational beliefs and that these (core) beliefs are ‘resistant to change’ (Zambo & Zambo, 2011). This adult education professor (i.e., Participant 20) also found it “problematic to move students into empirical research of most sorts. They don't seem to understand the basis of empirical research and don't trust it” (Participant 20). Could it be because empirical research is not generally included in the basic training education students receive? Could it be because adult education professors also do not trust empirical research, as indicated by the comments of

several adult education professors from this research study (i.e., “I’m not a fan of neuroscience”, Participant 8), and therefore, do not include empirical research in their courses they teach? This insight provides convincing evidence that education students need ‘direction’ and ‘proper training’ in their academic education to build a solid educational foundation (Zambo & Zambo, 2011; Hook & Farah, 2012).

As mentioned previously, findings from the studies (e.g., Pickering & Howard-Jones, 2007; Zambo & Zambo, 2011; Hook & Farah, 2012; Serpati & Loughan, 2012) that many educators were unaware of the significance of neuroscience for education (Pickering & Howard-Jones, 2007), that educators (i.e., grade school teachers) are susceptible to neuromyths (Hook & Farah, 2012), “that without direction education students’ beliefs could go astray and their students could be affected” (Zambo & Zambo, 2011, p.26), and that neuroscience research can enhance educational practices (Taylor, 2006), one can conclude that it is important to include the area of educational neuroscience in the education of future educators. Ansari et al. (2011) argue “that it is crucial for training in aspects of cognitive neuroscience to become a fundamental part of teacher education” (p.400). The comments made above by Participant 20 provide evidence that those education students who receive extra training “do have the content and affective and cognitive flexibility to be able to manipulate the practice and adapt it based on new knowledge” (Participant 20). Thus, it is important for educators in the field of education (i.e., adult education professors) to be well informed about educational neuroscience and to include educational material about educational neuroscience in the courses they teach.

According to Hook and Farah (2012), neuroscience research is ready to be extended to educational practices, and many authors (e.g., 2006; Immordino-Yang, Battro et al., 2008; Howard-Jones, 2010; Tommerdahl, 2010; Zull, 2011; Johnson & Taylor, 2011; Wilson, 2011)

suggest that neuroscience research can inform educational practices. Kelly (2011) posits that “we are beginning to see...the basis for a revolution in theorizing about learning that designs and refines its measures, guides its hypotheses, informs its analyses and grounds its conclusions using data from cognitive neuroscience studies” (p.20). In quoting Blakemore and Frith, Hook and Farah (2012) mention that “there is a vast amount [of] brain research of direct relevance to educational practice” (p.2). Hook and Farah (2012) continue citing Blakemore and Frith, mentioning that they argue that the lack of ‘successful educational application of neuroscience’ is a result of the challenges of interdisciplinary interaction and communication. To overcome these challenges, according to Hook and Farah (2012), “improving dialogue between the two disciplines will enrich research and practice in the field of neuroeducation, ultimately helping to build a better science of learning and the brain” (p.10). The comments made by several adult education professors from this research study aid to the petition to improve the dialogue between neuroscience and education. Therefore, continued collaborative efforts between neuroscience and education will bring about effective educational practices to enhance learning.

7.1 Future Research

An important concern often expressed in regards to future collaborative efforts between neuroscience and education is the voiced concerns around scientific language and understanding. According to Pickering and Howard-Jones (2007) there may not be a common language between neuroscientists and educators and there may be a lack of scientific understanding amongst educators. This claim made by Pickering and Howard-Jones (2007) is supported by the results of this research study. There were several participants (i.e., adult education professors) that mentioned that their lack of scientific language/understanding was a barrier to them when they came across information on neuroscience research on how the brain learns.

“I would want it to be in a language that was accessible, as some of the articles I looked up seemed to assume that one already had a basic understanding”

(Participant 11).

“In current neuroscience materials the phrase ‘the mind’ is used often - what is the mind?” (Participant 5).

From the remarks of the adult education professors that participated in this present research study, future research in educational neuroscience should be in a suitable language for anticipated audiences. Furthermore, future authors of neuroscience research for the education community should not automatically assume that their anticipated audiences have a basic scientific understanding of neuroscience research on how the brain learns.

As previously mentioned, Purdy and Morrison (2009) and Hruby (2012) elicit a warning voice of caution about the easy acceptance of neuromyths into many educational school systems and argue for a very strict regulating presence to guard against the proliferation of neuromyths. Neuromyths, according to Howard-Jones (2010), “have had a major influence on shaping the perceptions and views of educators about neuroscience and its potential role in education” (p.20), and as a result “educators have been exposed to a set of concepts about the brain that differ from those established in science” (p.37). Along with circulating neuromyths promoting unsound concepts about the brain are the misconceptions about the brain that are held amongst educators and the general public (Howard-Jones, 2010).

“As a side-note, there tends to be some confusion about brain plasticity in general understanding, and I've read some people say that we can't rewire neurons after the age of five. This is complete nonsense, of course, and a great example of bad scientific understanding” (Participant 12).

With the misconceptions that exist about the brain, the contradictory ideas about the mind-brain relationship, and the often promoted non-scientific ‘brain-based’ learning material, Howard-Jones (2010) argues that “it can be expected that teachers’ ideas about the brain diverge from conventional scientific thinking” (p.39). Thus, it would be very beneficial to the education community if research in this area (i.e., misconceptions about the brain, neuromyths) was well documented and disseminated amongst educators and the general public.

Many authors (Hruby, 2012; Schrag, 2011; Ansari et al., 2011) have voiced the claim that, as of yet, neuroscience research has not made any significant progress toward direct application to educational practices. Many adult education professors that participated in this research study have also expressed that the ‘educational implications’ of neuroscience research on how the brain learns for education is not well understood.

“So I would say that, so far, the information on brain research is intriguing, but not especially useful because its educational implications are not yet clear”

(Participant 4).

However, Tommerdahl (2010) points out that the neurosciences have provided information in some areas (i.e., reading – the reading and writing program entitled ‘Collections for Young Scholars’) onto which effective educational practices were based, critically examined, tested at the classroom level, and found to be very effective and more successful. Thus, future educational neuroscience research could look at the implications of neuroscience research on how the brain learns for education and progress toward its direct application to educational practices. One way to approach this type of future research is through theory building, where one would critically examine and possibly build upon existing educational learning theories with the new and current neuroscience research on how the brain learns (Immordino-Yang, 2011).

With the major advances in cognitive, affective, and social neuroscience with respect to learning, Immordino-Yang (2011) argues for the reconciliation of established educational learning theories with current neuroscience research on how the brain learns. Immordino-Yang (2011) argues for the importance of theory building, and that for

education to truly benefit from these neuroscientific findings in a durable, deep way, for the full implications to become apparent, educators must examine closely the theory on which good practice is built, to reconcile the new and exciting evidence with established models and philosophies (p.102).

One adult education professors from this research study expressed the following regarding new theories of learning.

“In order for a ‘new’ learning theory to gain adherents among educators, it must point to or lead to better/more effective decisions about pedagogical practices within diverse learner communities...

That will mean someone or some group (hopefully a keen educator or group of educators also steeped in neuroscience research) will take up the task” (Participant 4).

Researchers may find that some educational learning theories can be further enhanced with neuroscience research leading to more effective educational practices, while some educational theories and practices may need to be dispelled and/or abandoned.

Future researchers in educational neuroscience may want to explore research in the areas of neuroscience interest that was expressed among the adult education professors that participated in this research study. These areas of neuroscience interest are documented in Chapter 5 of this research paper in sections 5.8 Question Eight and 5.9 Question Nine. Adult

education professors had interest in adult learning, aging and learning, creativity and learning, decreased brain power, early development, emotion and learning, information processing, learning disabilities, learning effectiveness, learning environments, mental health, neural pathways, social understanding, stress and learning, social aspects of learning, mind-brain-concept, and why is neuroscience important for learning. Several adult education professors expressed interest in having neuroscience information on how the brain learns to be made available for their students.

“I would want neuroscience research that is accessible for students, until then I use a book that provides an overview with a few articles to supplement”
(Participant 18).

“I have to say that my interest is stimulated alright as I looked for a text to use next term in my class on learning in educational contexts” (Participant 20).

Thus, authors of educational neuroscience could tailor their research on how the brain learns for the use of education students.

Educational neuroscience researchers who have an interest in improving and advancing educational practice in adult education with neuroscience research on how the brain learns should be mindful of their chosen dissemination methods.

“We have learned from decades of experience that research findings...regardless of how compelling...only become part of professional knowledge if they are communicated/mobilized in a form that can be understood and acted upon by practitioners” (Participant 4).

“I would be very interested in modifying my educational practices in light of neuroscience research findings. That said, unless this research is published in journals that I would come across in my normal academic reading or is translated in a popular media outlet, I can’t imagine that I will come across it” (Participant 15).

For future neuroscience research on how the brain learns to have an impact in the adult education community, dissemination needs to be through an avenue that adult education professors are likely to cross (e.g., adult education textbooks and/or handbooks, academic education journals, curriculum design materials, conferences, and seminars).

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Appendices

Appendix 1 – Flyer

A Research Study about Neuroscience and Post-Secondary Education

What the study is about: The purpose of this study is to understand how adult educators perceive neuroscience research in informing educational practices.

Participant recruitment: All participants will be professors in the field of Education from post-secondary universities across Canada.

What we will ask you to do: If you agree to be a part of this study, you will take part in answering approximately 8-10 short-answer questions that will be delivered via e-mail over a two week period. The questions are general enough that you will be able to answer from memory, without needing to refer to any materials. Follow up questions may be asked.

Risks and benefits: We do not anticipate any risk for your participation in this study. We hope that what we learn in the study will help us to benefit future communication between neuroscientists and educators.

Taking part is voluntary: Taking part in this study is completely voluntary. If you decide to take part, you have the right to withdraw up to six months after answering the questions. If you decide to withdraw, the data collected from you up to the time you withdraw will be destroyed at your request.

Your participation is appreciated!

To take part in this research study contact Elizabeth Jong at elizabeth.jong@msvu.ca

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Appendix 2 – Invitation Letter



*Faculty of Education
Graduate Programs*

Date 2013

Research title: Neuroscience and Post-Secondary Education: How Do Adult Educators Perceive Neuroscience Research in Informing Educational Practices?

My name is Elizabeth Jong. I am a thesis candidate in the Education Faculty at Mount Saint Vincent University in Halifax, Nova Scotia, Canada. I am conducting research as part of the requirements of my degree in Master of Arts in Education (Lifelong Learning), and I would like to invite you to participate.

I am investigating how post-secondary professors in the field of Education – who have an interest in adult education (e.g., Lifelong Learning, post-secondary education, the study of adult education) – perceive neuroscience research in informing educational practices.

If you agree to be a part of this study, you will take part in answering approximately 8-10 short-answer questions that will be delivered via e-mail over a two week period. The questions are general enough that you will be able to answer from memory, without needing to refer to any materials. You have the right to skip any questions that you do not feel comfortable answering.

Taking part in this study is completely voluntary. If you decide to withdraw, all collected data from you will be destroyed at your request. We do not anticipate any risk for your participation in this study. We hope that what we learn in the study will help us to benefit future communication between neuroscientists and educators.

This research project has met the ethical standards of the University Research Ethics Board at Mount Saint Vincent University. If you have questions about how this study is being conducted and wish to speak with someone not involved in the study, you may contact the Chair of the University Research Ethics Board (UREB) c/o MSVU Research Office, at 457-6350 or via e-mail at research@msvu.ca.

Thank you for your consideration. Please send your invitation reply to Elizabeth Jong at elizabeth.jong@msvu.ca.

With kind regards,

Student Researcher at Mount Saint Vincent University
Elizabeth Jong

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Appendix 3 – Informed Consent



*Faculty of Education
Graduate Programs*

Research title: Neuroscience and Post-Secondary Education: How Do Adult Educators Perceive Neuroscience Research in Informing Educational Practices?

What the study is about: The purpose of this study is to understand how post-secondary professors in the field of Education perceive neuroscience research in informing educational practices.

Participant recruitment: Participants will be selected through purposive sampling. All participants will be post-secondary professors in the field of Education from post-secondary institutions across Canada.

What we will ask you to do: If you agree to be a part of this study, you will take part in answering approximately 8-10 short-answer questions that will be delivered via e-mail over a two week period. The questions are general enough that you will be able to answer from memory, without needing to refer to any materials. You have the right to skip any questions that you do not feel comfortable answering. Follow up questions may be asked.

Risks and benefits: We do not anticipate any risk for your participation in this study. We hope that what we learn in the study will help us to benefit future communication between neuroscientists and educators.

Taking part is voluntary: Taking part in this study is completely voluntary. If you decide to take part, you have the right to withdraw up to six months after you answer the questions. If you decide to withdraw, all collected data from you will be destroyed at your request.

Your answers will be confidential: The records of this study will be kept private. In any reports about the study we will not include any information that could be used to identify you. Research records will be kept in a password protected file on a password protected hard drive in a locked safety box in the possession of the researcher. Only the researcher will have access to the data records.

Future use of data collected: After the data analysis of this research is complete, the researcher will retain the right to use the data collected from this research study for future research projects up to 10

years. All identifying information will be removed from the data collected and pseudonyms will be used in their place. After the study is complete, the data will be stored in a password protected file on a password protected hard drive in a locked safety box for a period of 10 years. After the 10 year period all participant data collected for this study will be permanently deleted and destroyed.

You will be informed of the research outcomes: The results of this study will be sent to you in a summative report. The final thesis paper will be made available to you upon request.

Dissemination: Details of the research outcomes will be made available to other interested audiences (e.g., other researchers, academics, journals, etc.) and a summative report of the research outcomes will be tailored to those audiences.

This research project has met the ethical standards of the University Research Ethics Board at Mount Saint Vincent University. If you have questions about how this study is being conducted and wish to speak with someone not involved in the study, you may contact the Chair of the University Research Ethics Board (UREB) c/o MSVU Research Office, at 457-6350 or via e-mail at research@msvu.ca.

Informed Consent:

☐ Please check if you consent to follow up questions.

Print name: _____

Signature: _____

Date: _____

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Appendix 4 – Research Questions

Thesis research title: **Neuroscience Research and Post-Secondary Education: How Do Adult Educators Perceive Neuroscience Research in Informing Educational Practices?**

Elizabeth M. L. Jong
MAEd (Lifelong Learning)
Thesis Candidate
elizabeth.jong@msvu.ca

Structured Interview Questions

Awareness Questions - Neuroscience Literacy

1. How would you define/explain the process of learning that takes place within the learner? Is your definition/explanation supported by an educational learning theory? If so, which one?
2. If a student in your course had impaired memory function, how would you provide support for their learning? What educational practices, if any, would you include in your course to enhance this student's learning?
3. It is said that “neurons that fire together wire together” and form stronger connections and stronger neuronal networks. Do you think learning is related to neuronal connectivity? If so, why? If not, why?

Perceptions and Beliefs of the Value of Neuroscience Research for Education Questions

4. Have you ever heard of or come across information about research on the brain and learning? What was it and where did you hear it or come across it? Did you think that the information you came across was useful for the field education, for educational practices? Why or why not?
5. Have you ever changed your educational practices to reflect current research on how the brain learns? If so, what did you change and why? Did you find this change effective? What was the brain research you based your change on (e.g., memory and learning)?
6. How aware are you of the current neuroscience research on plasticity, memory and learning, sleep and learning, and emotion and learning? Do you think neuroscience research in these areas can help enhance educational practices?

Touch Point Questions

7. Has this research study stimulated your interest in neuroscience research on how the brain learns in informing educational practices? Did you look up any information on neuroscience research because of this study? If so, what type of information did you look up and where did

you find it (e.g., internet search)?

Future Research Interest Questions

8. If there is one area about neuroscience research on how the brain learns that you would want to know more about what would it be and why?

9. If you had the opportunity to talk face-to-face with a neuroscientist who does research on how the brain learns what would you want to talk about and why?

Appendix 5 – Summative Report for Participants

How Canadian Adult Education Professors Perceive Neuroscience Research in Relation to
Educational Practices

Elizabeth M. L. Jong

Master of Arts in Education (Lifelong Learning)

Mount Saint Vincent University

Summative Report

May 2014

Abstract

Numerous studies and recent publications have focused on the understandings of brain function as it relates to teaching and learning within the area of adult education. The purpose of this research study was to understand how adult education professors from post-secondary universities across Canada perceive neuroscience research related to educational practices. This research study utilized the internet as a tool to conduct qualitative e-mail interviews with 22 Canadian adult education professors. The interview consisted of 9 structured open-ended survey questions and 1 follow-up question. The results of this study gave insight into how aware adult education professors in Canada are of neuroscience research and education. The results of this study also report on whether adult education professors in Canada are currently enhancing their educational practices with neuroscience research evidence, whether they believed neuroscience research could enhance educational practices, and if given the opportunity to talk with a neuroscientist what their topic of interest would be. It is my hope that this research exploration will contribute to the dialogue between neuroscientists and educators and be beneficial to their merging community.

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1. Executive Summary

The purpose of this research study was to understand how adult education professors from post-secondary universities across Canada perceive neuroscience research related to educational practices. Very few studies (e.g., Pickering & Howard-Jones, 2007; Zambo & Zambo, 2011; Hook & Farah, 2012; Serpati & Loughan, 2012) have been conducted focusing on uncovering the viewpoints and beliefs of educators (i.e., grade school teachers) about the use in education of recent neuroscience research evidence on how the brain learns. Findings from these few studies found (e.g., Pickering & Howard-Jones, 2007; Zambo & Zambo, 2011; Hook & Farah, 2012; Serpati & Loughan, 2012) indicated that some educators (i.e., grade school teachers) placed value on neuroscientific findings and some grade school teachers were confused about the educational value of neuroscience. Findings from these above mentioned studies also indicated that some grade school teachers bought into the non-scientific brain-based learning materials, some did not believe neuroscience research findings on how the brain learns had any value for the discipline of education, and many were not well aware of the neuroscience research findings on how the brain learns. However, neuroscience research on plasticity, memory and learning, sleep and learning, and emotion and learning is providing evidence for the value of neuroscience research for the field of education and educational practices.

Many authors of neuroscience and educational content (e.g., Goswami, 2004; Johnson & Taylor, 2006; Battro, Fischer, & Léna, 2008; Howard-Jones, 2010; Tommerdahl, 2010; Zull, 2002, 2011; Immordino-Yang, 2011) believe that neuroscientific research on how the brain learns can benefit the field of education and enhance educational practices. Early collaborative efforts between neuroscientists and educators began in the late 1990's where neuroscientists began an active role in suggesting education could benefit from an awareness of brain research

(Howard-Jones, 2010). These early collaborative initiatives sparked many seminar series involving educators, psychologists, neuroscientists and policy makers. In parallel to these seminar series, a few studies (i.e., Howard-Jones et al., 2007; Pickering & Howard-Jones, 2007) were being conducted to understand educators' perceptions of the brain in education in the United Kingdom (Howard-Jones, 2010). Pickering and Howard-Jones (2007) argue that an important component about the interactions between neuroscientists and educators is to understand the perspectives of these seminar participants. In this present research paper, educators refer to professional teachers (i.e., grade school teachers, post-secondary professors, or adult educators). This present research exploration offers an insightful contribution to the dialogue about educators' perceptions about neuroscience research and education.

1.1 Context Introduction

Numerous studies and recent publications have focused on the understandings of brain function as it relates to teaching and learning. Many of these studies and publications, as Johnson and Taylor (2006) posit are “in the pursuit of effective teaching and learning” (p.1) as it relates to the area of adult education. Most adult educators, according to Johnson and Taylor (2006), rely on observation and experience, anecdotal evidence, and philosophical orientation to inform practice. Additional though sometimes conflicting guidance has been available from psychological theories and sociological analysis, which attempts to describe what learning is and how it takes place. Now, however, with the advent of brain imaging we can actually watch the neurophysiology of learning unfold. Not only can we trace the pathways of the brain involved in various learning tasks, but we can also infer which learning environments are most likely to be effective (p.1).

With technological advancements, research on the brain has broadened our understanding on how the brain learns. According to Zull (2002), brain imaging research has been able to identify which region(s) of the brain are active during specific learning tasks (e.g., learning a new word). Even more specific, research on the brain has shown that when learning takes place changes to the brain's structure occurs. This structural change within the brain is known as plasticity. Howard-Jones (2010) states that "the brain's continuing plasticity suggests it is well designed for lifelong learning and adaptation to new situations and experiences, and there is clear evidence that such adaptation can bring significant changes even in its structure" (p.6).

The brain's continuing plasticity is exciting news for adult education professors and their endeavor to lifelong learning. Plasticity, according to Pascual-Leone, Freitas, Oberman, Horvath, Halko, Eldaief et al. (2011), is an intrinsic property of the human brain that is "essential to the establishment and maintenance of brain circuitry" (p.303). Previous to the neuroscience research evidence for plasticity the brain was thought to be static in nature. According to Boyke, Driemeyer, Gaser, Buchel, and May (2008),

until quite recently, it was generally assumed that the capability of the human brain to modify its structural pattern to fit new environmental demands is restricted to the early stages of development, i.e., not beyond a specific critical period; any subsequent structural adaptations were limited to local synaptic changes. Later, based on lesion models, researchers examined the functional reorganization of cortical maps in various areas in adult brains and provided evidence that neural systems are modifiable networks, and these processes are not limited to the early phases of development (p.7031).

According to the research of Boyke et al. (2008), "the human brain, even in older age, maintains its capacity to change its structure according to learning or exercise demands" (p.7033). Thus,

the neuroscience research evidence of the brain's continuing plasticity is a very significant finding for adult education and lifelong learning.

The merging fields of neuroscience and education, Battro et al. (2008) argue, will produce more accurate knowledge about mind, brain, and education, and new understandings will emerge to change the way we teach and learn in the near future. Taylor (2006) argues that connecting neuroscience research on the brain and education will ensure meaningful learning. Howard-Jones (2010) posits that there are many areas of neuroscience research that can inform educational practice, and this includes the evidence about the brain's continuing plasticity. Along with the evidence for brain plasticity, neuroscience research has also provided important insights and findings related to memory and learning, sleep and learning, and emotion and learning. According to Howard-Jones (2010), neuroscience research has provided important insights about learning strategies where individuals who utilized multiple learning strategies showed improved memory performance. Neuroscience research provides evidence that sleep has an influence on learning. According to Cardinali (2008), "sleep deprivation significantly impairs memory and the acquisition of many skills, and disturbs emotional and cognitive performance as well" (p.110). According to Wolfe (2006), emotion plays a significant role in learning and "educators can use the power of emotion to affect learning and retention positively" (p.39). However, according to Howard-Jones (2010), there is clear evidence that most of the educators (i.e., grade school teachers) interviewed in one of his studies knew very little about neuroscience research on how the brain learns.

With all the neuroscience research evidence on how the brain learns, it is surprising that many educators were not well aware of the important contributions neuroscience research affords education. Very few studies (e.g., Pickering & Howard-Jones, 2007; Zambo & Zambo, 2011;

Hook & Farah, 2012; Serpati & Loughan, 2012) have been conducted focusing on uncovering the viewpoints and beliefs of educators (i.e., grade school teachers) about the use in education of recent neuroscience research evidence on how the brain learns. According to Hook and Farah (2012) some educators were confused about the educational relevance of neuroscience, and little research, previous to their study, had been conducted considering “teachers’ own opinions on the ways neuroscience can contribute to educational practices” (p.9). Educators in these studies (e.g., Pickering & Howard-Jones, 2007; Zambo & Zambo, 2011; Hook & Farah, 2012; Serpati & Loughan, 2012) were mainly teachers who taught children in grade school. Furthermore, educators in these studies (i.e., Pickering & Howard-Jones, 2007; Zambo & Zambo, 2011; Hook & Farah, 2012) had attended a conference and/or a course where educational neuroscience topics were discussed. In furthering the discussion about educators’ viewpoints and beliefs on how brain research contributes to education, it would be beneficial to understand the current perspectives and opinions that adult education professors have about neuroscience research and education. It would also be interesting to learn if adult education professors are implementing neuroscience research findings on how the brain learns into their educational practices. This present research paper aims to explore these issues.

1.2 Educational Neuroscience

As Howard-Jones (2010) points out, “the ‘big idea’ of including the brain in educational thinking and practice has been around a long time” (p. x). However, over the last two decades, according to Battro et al. (2008), scholars in the disciplinary fields of education and neuroscience have started to collaborate with one another and considerable advances have been made. The terms neuroeducation, educational neuroscience, and mind, brain, and education have been used

to name this collaborative effort (Battro et al., 2008). Another term often used is cognitive neuroscience, a designation favoured by Howard-Jones (Schrag, 2011). From a generalized perspective, these collaborative efforts are at the intersections between cognitive science, behavioural science, neuroscience, and the biological basis of learning with educational science, educational policy, instructional design, and educational practices. However, according to Battro et al. (2008), neuroeducation is the effort that “emphasizes the educational focus of the transdisciplinary connection” (p.3); educational neuroscience is the effort “on neuroscience to which education connects” (p.3); and mind, brain, and education “encompasses both these focuses and others that bring together cognitive science, biology, and education” (p.3). For the purpose of this present research paper, I will use the term educational neuroscience when referring to the collaborative efforts between the disciplinary fields of neuroscience and education.

1.3 Educational Neuroscience Debate

The recent developing collaborative effort between neuroscience and education has created a lot of excitement, confusion, and cautionary attitudes. A growing number of published scholarly works (e.g., Goswami, 2004; Perkins, 2009; Purdy & Morrison, 2009; Howard-Jones, 2010; Tommerdahl, 2010; Wilson, 2011; Schrag, 2011; Kelly, 2011; Ansari, Coch, & De Smedt, 2011; Zull, 2011; Hruby, 2012) have discussed important considerations around the educational neuroscience debate. This debate is centered, sometimes warmly heated (Howard-Jones, 2010), around whether neuroscience research on how the brain learns should be considered/included alongside educational thinking and practice, and to what potential can neuroscience research enhance educational practice. According to Tommerdahl (2010), there are varying academic

opinions regarding this emerging relationship between neuroscience and education. Varying views are also found among educators (i.e., grade school teachers). The findings from the few studies (e.g., Pickering & Howard-Jones, 2007; Zambo & Zambo, 2011; Hook & Farah, 2012; Serpati & Loughan, 2012) conducted aiming to understand the beliefs and perceptions educators (i.e., grade school teachers) have of neuroscience research, as mentioned previously, indicated that some educators place value on neuroscientific findings and that some were confused about the educational value of neuroscience. Some educators (i.e., grade school teachers) in these above mentioned studies bought into the non-scientific brain-based learning materials, some did not believe neuroscience research findings on how the brain learns had any value for the discipline of education, and many were not well aware of the neuroscience research findings on how the brain learns.

In the efforts to bring together the two disciplinary fields of neuroscience and education, two main views are held amongst educators and neuroscientists. The first, as Schrag (2011) points out, is that the marriage between these two disciplines will be natural and very fruitful; and second, is that the forging relationship is unnatural and likely unprofitable. With a cautionary perspective, Hraby (2012) mentions that “research on the nervous system is not on instruction, assessment, classroom management, or curriculum; generating coherent application from one for the other would not be a simple matter” (p.9). Along with the growing cautionary voices are other voices that claim that neuroscience research on how the brain learns has not made any significant progress toward direct application to educational practices (Hraby, 2012; Schrag, 2011; Ansari et al., 2011). Schrag (2011) grants that there is a lot of fascinating information provided from neuroscience, but often this information is missing practical application of “how what has been learned through brain imaging leads or might lead to

enhanced educational interventions” (p.225). As argued by Ansari et al. (2011), the expectation of the ideal relationship between laboratory research results and classroom application (i.e., laboratory results can directly and easily be applied to educational thinking and practices) is currently unrealistic.

As a premature response of this collaborative effort, many ‘brain-based’ learning materials claiming to be based on neuroscience research have “gained widespread currency in schools and which, not being subject to rigorous scrutiny, often represent little more than neuromyths” (Purdy & Morrison, 2009, p.99). Neuromyths, as pointed out by Howard-Jones (2010), “are misconceptions generated by a misunderstanding, a misreading or a misquoting of facts scientifically established (by brain research) to make a case for use of brain research, in education and other contexts” (p.20). Purdy and Morrison (2009) and Hruby (2012) elicit a warning voice of caution about the easy acceptance of neuromyths into many educational school systems and argue for a very strict regulating presence to guard against the proliferation of neuromyths. With the proliferation of neuromyths and the outpouring of scholarly literature establishing that fact, it is easy to understand the growing confusion about the relevance of neuroscience for education. Tommerdahl (2010) agrees that it may not be easy for neuroscience findings to have direct application to educational practices, but argues that with the collaborative efforts of different types of knowledge (i.e., neurosciences, cognitive neurosciences, psychological mechanisms, educational theory, classroom) neuroscience findings can enhance educational practices. As an example, Tommerdahl (2010) points out that the neurosciences have provided information in some areas (i.e., reading – the reading and writing program entitled ‘Collections for Young Scholars’) onto which effective educational practices were based,

critically examined, tested at the classroom level, and found to be very effective and more successful.

Along with rehearsing and/or expressing the concerns about the merging relationship between neuroscience and education, several authors (e.g., Howard-Jones, 2010; Tommerdahl, 2010; Kelly, 2011; Wilson, 2011; Schrag, 2011; Hruby, 2012) offer a basis for establishing an effective educational neuroscience and/or discussions on the future of neuroscience and education. Hruby (2012) argues that there are three requirements (i.e., intellectual coherence, mutually informing and respected scholarly expertise, ethical commitment to the moral implications and obligations shared within educational research) that should be addressed in order to justify an educational neuroscience. Tommerdahl (2010) proposes a model of five levels (i.e., neurosciences, cognitive neurosciences, psychological mechanisms, educational theory, classroom) of different types of knowledge that must each contribute to the formation of new educational practices. Kelly (2011) posits that “we are beginning to see...the basis for a revolution in theorizing about learning that designs and refines its measures, guides its hypotheses, informs its analyses and grounds its conclusions using data from cognitive neuroscience studies” (p.20). In parallel to these scholarly articles offering a basis for establishing an effective educational neuroscience are the newly formed post-secondary educational programs (e.g., Harvard University Graduate School of Education Mind, Brain, and Education Program). Granted that there should be (and there is beginning to be) a well defined and established basis for the merging relationship of neuroscience and education, adult educators should not lightly overlook the current and future potential for neuroscience research to enhance educational practices.

1.4 Educational Beliefs

Most educators, according to Zambo and Zambo (2011) enter into the teaching profession because they believe they will make a difference in their student's lives. Zambo and Zambo (2011) argue that educators' educational beliefs have a powerful influence in their teaching practice and an influence on what they consider to be effective educational practices. According to Zambo and Zambo (2011), educators' "beliefs are important because they influence their interactions with students, the expectations they set, the instructional decisions they make, and the lenses they use to interpret classroom events" (p.26). Northcote (2009) points out that educators' "beliefs inform their use of specific instructional strategies that, in turn, impact on the quality of student learning... [and that their] practical approaches to teaching and their teaching intentions were directly influenced by their conceptions of teaching" (p.70). In defining conceptions of teaching, Kember and Kwan (2000) cite a definition given by Pratt:

conceptions are specific meanings attached to phenomena which then mediate our response to situations involving those phenomena. We form conceptions of virtually every aspect of our perceived world, and in so doing, use those abstract representations to delimit something from, and relate it to, other aspects of our world. In effect, we view the world through the lenses of our conceptions, interpreting and acting in accordance with our understanding of the world (p.483).

As a result of their study conducted with 638 higher education lecturers (i.e., adult educators) from 4 higher educational institutions in the United Kingdom, according to Kember and Kwan (2000), there was a high level of correlation between lecturers' conceptions of good teaching (i.e., educational beliefs) and his/her approaches to teaching (i.e., educational practices). Based on their research, Kember and Kwan (2000) stated that there was little evidence that

lecturers shifted their teaching approaches because of educational factors. In exploring some educational factors (e.g., institutional influences, curriculum design, and student presage factors) that may influence/modify teaching approaches, Kember and Kwan (2000) noted that “lecturers will normally adopt the approach which is consistent with their deep seated beliefs about teaching” (p.487). Other factors (e.g., team teaching, heavy teaching loads, intensive procedures for monitoring and reviewing teaching), according to Kember and Kwan (2000), “will impinge upon the teaching approach rather than the conceptions of teaching” (p.487). Kember and Kwan (2000) argue that “this observation suggests that approaches to teaching are strongly influenced by the lecturers’ conception of teaching” (p.489) and concluded that “fundamental changes to the quality of teaching and learning are unlikely to happen without changes to lecturers’ conception of teaching” (p.469). This is an important insight for the emerging new disciplinary field of educational neuroscience, as it may be difficult to enhance current ‘conceptions of teaching’ with new knowledge based on neuroscience research findings on how the brain learns.

1.5 Purpose of the Study

Battro et al. (2008) argue that new understandings will emerge with neuroscience research on the brain changing the way we will approach teaching and learning in the near future. With the insights about sensory and motor learning, Zull (2002) argues that understanding learning as a biological process can help enrich educational practices. Enriching educational practices would significantly be advantageous to enhancing learning, and isn’t that what educating is all about? More recently, many educational neuroscience experts argue that neuroscience research is ready to be extended to educational practices (Hook & Farah, 2012). In quoting Blakemore and Frith, Hook and Farah (2012) mention that “there is a vast amount [of] brain research of direct relevance to educational practice” (p.2). Hook and Farah (2012) continue

citing Blakemore and Frith, mentioning that they argue that the lack of ‘successful educational application of neuroscience’ is a result of the challenges of interdisciplinary interaction and communication. According to Hook and Farah (2012), “improving dialogue between the two disciplines will enrich research and practice in the field of neuroeducation, ultimately helping to build a better science of learning and the brain” (p.10). This present research study is a response to help improve the dialogue between neuroscientists and educators. The findings from this research study report on aspects about how post-secondary professors in the field of education in Canada, with interest in adult education (i.e., adult education professors), perceive neuroscience research in informing educational practices.

Neuroscience research on the brain is providing evidence for the biology of learning and relevant research in areas that have an impact on learning (i.e., plasticity, memory and learning, sleep and learning, and emotion and learning). With the new technological advancements, according to Battro et al. (2008), scientists and educators are getting closer to being able to “observe the effects of educational interventions on brain processing” (p.4) and this has caused a lot of excitement in the new merging field of educational neuroscience. However, in many instances there is clear evidence that many educators are not well aware of the significance of neuroscience research and learning. For example, at a recent 2005-2006 Economic and Social Research Council - Teaching and Learning Research Programme (ESRC-TLRP) seminar series “Collaborative Frameworks in Neuroscience and Education” in the United Kingdom, which brought together educators, neuroscientists, and psychologists, according to Howard-Jones (2010), many seminar audience attendees experienced ‘first contact’ in collaborating in the field of neuroscience and education. Another example, at the second annual Aspen Brain Forum Symposium entitled “Cognitive Neuroscience of Learning: Implications for Education” in

Aspen, Colorado held September 22 – 24, 2011, only two educators acknowledged that they had previous training in cognitive science and half the conference audience were educators (McGowan, 2011).

The lack of awareness of neuroscience research among educators is commonly mentioned throughout the literature. Results of this present research study also indicated that there was a lack of awareness of neuroscience research amongst adult education professors in Canada. In wanting to consider why there may be a lack of neuroscience research awareness among adult education professors, several areas within the literature are taken into consideration. These considerations are: the differing of language between neuroscience research and educational research, the lack of scientific understanding among adult education professors, the proliferation and easy acceptance of neuromyths into educational practices, the misconceptions about the brain in the education community and in the general public, the existence of numerous theories of learning, and that educators' educational beliefs strongly influence their approaches to teaching. This present research study also considers that the dissemination of neuroscience research into the educational community may not be currently proficient. This present research study draws from the significant meanings of these considerations in answering this study's research focus. This study's research focus is to understand how adult education professors in Canada perceive neuroscience research in relation to educational practices. The implications of these considerations are discussed in sections 1.9 Discussion and 1.10 Conclusions of this research paper.

1.6 Methodology

In wanting to determine how adult education professors perceive neuroscience research in informing educational practices, a qualitative research approach is appropriate. Qualitative research methods are especially effective in obtaining the participants' perspectives in their given situation, and "provide[s] complex textual descriptions... about the 'human' side of an issue" (Mack, Woodson, MacQueen, Guest, & Namey, 2005, p.1). Qualitative research allows the researcher to ask open-ended questions and participants are allowed to answer them in their own words (Mack et al., 2005). Enhancing and improving educational practices for the benefit of productive learning is relevant to the education discipline. With technological advancements in the area of brain imaging, new knowledge and understandings of how the brain learns is being produced. Since educators' views and beliefs influence how they teach (Zambo & Zambo, 2011), understanding how adult education professors in Canada perceive neuroscience research on how the brain learns would give insight into whether or not neuroscience research is informing their educational practices. Therefore, a qualitative research methodology will aid in understanding the perspectives and beliefs adult education professors in Canada place on current neuroscience research findings on how the brain learns in informing educational practices.

Research Participants

For the purpose of this study, all participants were post-secondary professors in the field of education employed at a Canadian University with an interest in adult education (i.e., adult education professors). For this present research, a small sample size (n=22) of post-secondary adult education professors were selected through purposive sampling. In wanting to gain insights about how adult education professors perceive neuroscience research on how the brain learns in

informing educational practices, this participant demographic was targeted purposively taking into consideration that post-secondary professors in the field of education have a functional knowledge of educational practices by the nature of their field. Participant recruitment was addressed through obtaining the appropriate written permissions and consents, and all adult education professors were informed of the purpose of the study prior to giving their consent to become a participant. Adult education professors were recruited through an e-mail invitation that was sent to their affiliated university e-mail addresses inviting them to participate in the purposed research.

Measure: Internet as a Research Tool

In recent years, researchers have been exploring the internet as a tool for conducting qualitative interviews. These researchers have found that conducting interviews via the internet has been very effective, and that the data collected from online qualitative e-mail interviews was comparable to face-to-face interviews (Meho, 2006). The internet was used as a tool to conduct this research study including all materials (e.g., e-mail invitations, informed consent forms, signed informed consent forms, research questions and responses, follow-up question and responses) that was sent to and received from all participants (i.e., adult education professors). This research method was used because of its innate ability to reach a targeted demographic population across Canada. A separate password protected Mount Saint Vincent University e-mail address was established and used only for the purpose of this research study. However, all sending and receiving of the e-mail invitations and informed consent forms were mainly from the personal password protected Mount Saint Vincent University e-mail address of the researcher. Of all the 22 adult education professors that participated in this research study, 2 submitted their responses to the personal e-mail address of the researcher.

Data Collection

With e-mail interviewing, data collection is done by receiving textual responses from the interview questions from the participants. Participants were notified about the delivery method of this research study on the informed consent form. As outlined on the informed consent form, participants were asked to take part in answering approximately 8 to 10 questions delivered via e-mail over a two week period. Participants were notified that the questions were general enough to be answered from memory with the option of skipping any question they did not feel comfortable answering. It was the initial intention of the researcher to send out one question at a time and to receive the response back before the next question was sent. However, the first participant I sent the first question to asked for the remainder of the questions to be sent all at once. From the comments I received from this participant's response to the follow-up question, the option of sending all questions at once was suggested. Thus, from that time forward, all participants were informed about the option of receiving all research questions at once alongside the choice of the regular interview research schedule. Of the 22 participants, 5 asked to have all the questions sent to them at once, and an additional 5 were sent all the questions at once at the discretion of the researcher. This was due to the nature of these participants prolonged continued interest in the research study well past the initial sending of the first question.

As data collection went forward, and at the discretion of the researcher, question 4 and 5 were sent together in one e-mail as well as questions 7 through to 9 to those participants who followed the regular interview schedule. This decision was made due to the questions having similar questioning attributes. One of these participants submitted their textual responses in the French language. Although I have basic French, I enlisted a translation service to assist me with the translation of these responses into English. One participant submitted all their responses in

one approximate 15 minute YouTube video which was then transcribed by the researcher and entered as text into the qualitative data analysis software program MAXQDA 11. Adult education professors were given the option of skipping any question(s) they did not feel comfortable answering, and no adult education professor used this option. However, 1 adult education professor did not submit responses to questions 2, 5, 7. Efforts were made to solicit responses to these questions; however no further responses were submitted to the researcher. Even though the delivery method of the structured open-ended survey varied amongst the participants, there was no differing of responses as to their length or quality (i.e., you could not differentiate the collected responses from a participant who submitted all responses at once from that of the collected responses from a participant who submitted them separately). The professional qualitative data analysis software MAXQDA 11 was used to analyze the data collected from all 22 participants (i.e., adult education professors).

Each participant was assigned a research identification number from 1 to 22 and all personal identifying information was deleted from all data. This was done to protect the privacy of the participants. A separate profile document was created for each participant listing all their responses and biographical information. Thus, 22 participant profile documents were created and were referenced by their identification number (e.g., participant 1, participant 2, participant 3, ...participant 22). A master response document was then created where all participant responses were compiled together so that each of the research questions had 22 responses listed underneath. All 22 participant profile documents and the master response document were uploaded to the MAXQDA 11 software. Only the master response document was used for analysis (coding into themes) and the participant profile documents were used as a reference to create a spreadsheet for the analysis of their biographical information. All participants were

asked for their biographical information (i.e., age, gender, highest level of education completed, years of teaching experience) before being asked the research questions. The follow-up question was delivered after all research questions were answered and only to those participants who consented to follow-up questions. All research data documents/files are stored in a file on a password protected external USB storage device which is kept in a locked safety box in the possession of the researcher.

Data Analysis

The data collected for this present research study was intended to understand how professors in the field of education, with interest in adult education (i.e., adult education professors), from post-secondary universities across Canada perceive neuroscience research on how the brain learns in informing educational practices. Nine structured open-ended survey questions were delivered via e-mail to all adult education professors, and 1 open-ended follow-up question was delivered via e-mail to those adult education professors who consented to follow-up questions. In reading and re-reading the responses, according to Smith and Osborn (2008) and Guldberg and Mackness (2009), a researcher gathers perceptions from the text into themes. The themes, according to Guldberg and Mackness (2009), represent recurring thoughts, ideas, and feelings that emerge throughout the individual responses. For the purpose of this study, each question was separately examined for emerging themes before looking for convergent or divergent themes (i.e., superordinate themes) across the sample size. The analysis for each research question was handled independently; such that each question along with its corresponding 22 responses were read and coded for themes by the researcher with the aim in developing a sound understanding of the responses for each question. However, divergent themes across questions and/or interesting remarks were highlighted and will be discussed in

section 1.8 Highlights of the Findings of this research paper. The structured e-mail interview research questions are shown below in Table 1.

Table 1. Structured Open-ended Survey Questions

Topic	Questions
Biographical Questions	1. Age: 2. Gender: 3. Highest level of education completed: 4. Number of years teaching at a post-secondary level: 5. Do you have experience teaching adults other than at the post-secondary level? If yes, please state the number of years of teaching experience with adults other than at a post-secondary level.
Research Questions	1. How would you define/explain the process of learning that takes place within the learner? Is your definition/explanation supported by an educational learning theory? If so, which one? 2. If a student in your course had impaired memory function, how would you provide support for their learning? What educational practices, if any, would you include in your course to enhance this student's learning? 3. It is said that “neurons that fire together wire together” and form stronger connections and stronger neuronal networks. Do you think learning is related to neuronal connectivity? If so, why? If not, why? 4. Have you ever heard of or come across information about research on the brain and learning? What was it and where did you hear it or come across it? Did you think that the information you came across was useful for the field of education, for educational practices? Why or why not? 5. Have you ever changed your educational practices to reflect current research on how the brain learns? If so, what did you change and why? Did you find this change effective? What was the brain research you based your change on (e.g., memory and learning)? 6. How aware are you of the current neuroscience research on plasticity, memory and learning, sleep and learning, and emotion and learning? Do you think neuroscience research in these areas can help enhance educational practices?

7. Has this research study stimulated your interest in neuroscience research on how the brain learns in informing educational practices? Did you look up any information on neuroscience research because of this study? If so, what type of information did you look up and where did you find it (e.g., internet search)?

8. If there is one area about neuroscience research on how the brain learns that you would want to know more about what would it be and why?

9. If you had the opportunity to talk face-to-face with a neuroscientist who does research on how the brain learns what would you want to talk about and why?

**Follow-up
Question**

1. Do you have any comments about the chosen delivery method for the structured e-mail interview questions? Would you participate in future research with this type of delivery method?

1.7 Demographic Statistics

The demographic statistics gathered for this research study included the following information with respect to the participants: the number of invitation e-mails sent to prospective participants and responses received, the number of representative universities, the highest level of education completed, years of teaching experience with adults, age, and gender. Of the 73 invitation e-mails that were sent out to post-secondary professors in the field of education (i.e., adult education professors) employed at a Canadian University inviting them to participate in this research study only 29 responded back. Of the 29 respondees, 23 were interested in participating in this research study. However, 1 interested respondee was given a letter of thanks as they were outside the research demographic. The remaining 22 interested adult education professors gave their consent to volunteer and participant in this research study. The adult education professors that participated in this research study were from 14 different Canadian universities, 9 were male and 13 were female. Most adult education professors (n=20) listed Ph.D. as their highest level of education completed, and the other 2 adult education professors

listed Ed.D. and Masters of Adult Education at Ph.D. thesis defence stage. The average combined age of all adult education professors was 55 years (rounded to the nearest year) ranging from 33 to 85 years in age. The average number of years of teaching experience at a post-secondary level of all the adult education professors was 16.68 years ranging from 5 to 36 years. The average years teaching experience with adult students other than at a post-secondary level of all the adult education professors was 6.45 years ranging from 0 to 35 years.

1.8 Highlights of the Findings

Many insightful findings emerged from the analysis of the collected data of this research study. The summary of the results for each of the structured open-ended survey questions are mainly represented by the emerging themes from the participants' (i.e., adult education professors) responses. These themes gave insights about the perceptions adult education professors have of neuroscience research in relation to educational practices. Themes were coded by examining 'indicating' phrases within the responses of the adult education professors for each question. These indicating phrases often started with 'I draw from', 'I favour', 'I work mainly from', 'my fundamental approach', and 'my work is a blend of several theories'. The first question of this research study asked post-secondary adult education professors to define learning and indicate if their definition of learning was supported by an educational learning theory. Most adult education professors (n=14) defined learning as some kind of process (e.g., a cognitive process, a process of gaining a new skill or knowledge, a process of collective (group) learning, and/or a process of constructivist thought). Other adult education professors (n=2) described learning as complex and multidimensional and several adult education professors

(n=6) had unique definitions of learning. Thus, there was a diversity of definitions of learning amongst the adult education professors.

In support of these learning definitions, there were 22 different educational learning theories (e.g., Kolb's experiential learning, transformational learning, social learning theory, constructivist theory, connectivist theory, cognitive theory, and self-directed learning) that were mentioned. An educational theory of learning was coded by examining phrases that indicated that the participant was using the educational learning theory to inform their practice. These indicating phrases often started with 'I draw from', 'I favour', 'I work mainly from', 'my fundamental approach', and 'my work is a blend of several theories'. Therefore, not all educational learning theories that were mentioned were coded. From the responses to this question, there were 21 theories of learning that were mentioned. Only 19 of the 22 adult education professors mentioned a learning theory in their response, and almost half (n=8 or 42%) of the 19 adult education professors mentioned that several theories informed their practice. These results suggest that adult education professor' definitions of learning along with the accompanying supportive theories may be rooted in individual preference(s) and/or beliefs/conceptions of learning. It was very interesting to visually see the numerous theories of learning that was informing the educational practices amongst post-secondary adult education professors in Canada as shown below in Figure 1.

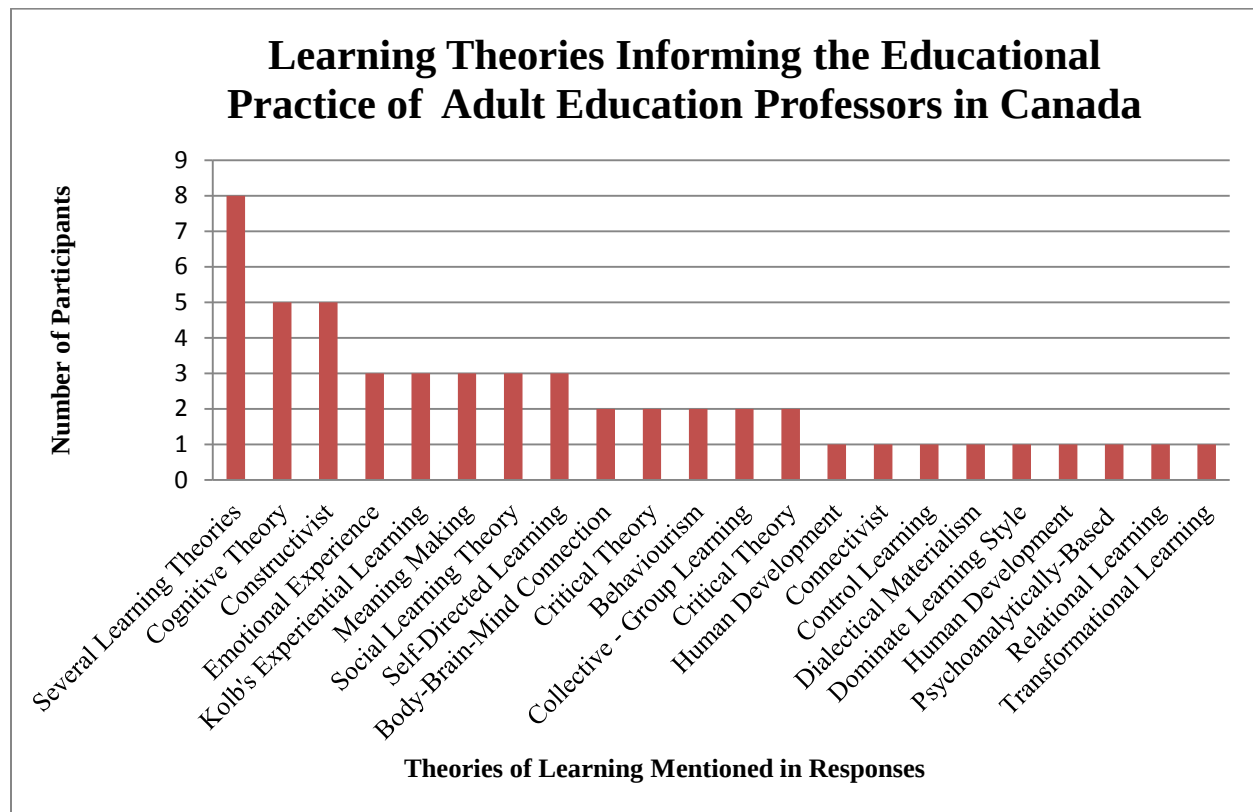


Figure 1. Learning Theories Informing the Educational Practice of Adult Education Professors in Canada.

In addition to their learning definition and supportive learning theory(ies), post-secondary adult education professors often mentioned the names of learning theorists.

“For me learning involves multiple processes and processings - some consciously and mindfully while some non-consciously seek what we already know - occurring in our brain-mind complexity within our physical body that facilitate and develop responses to stimuli in our senses, images, feelings and activities being experienced in a social context.

My idea of learning is obviously full of complexities and approaches, shaped by a number of learning theories which I have explored over

time: for example, behaviorism, constructionism, pedagogy, andragogy, self-directed learning, control theory and social learning theory; and influenced by Dewey, Piaget, Cagne, Knowles, Verner, Gardner, Vygotsky, Granott, Lave, Kegan, and Birren. My conception of learning in post-secondary education reflects the necessity of diversity, flexibility and challenge - essential for meaning-making (Kegan) and individual development (Birren) in the acquisition of knowledge, skills and social behaviors” (Participant 5).

Questions 2 through to 6 addressed the current awareness of neuroscience research on how the brain learns in informing educational practices amongst post-secondary adults education professors. When asked how they would support a student with impaired memory function, more than half of the adult education professors (n=12 or 55%) indicated that they would seek help and/or recommend that the student seeks help from the university’s learning resource centre. Several adult education professors (n=7) indicated that they would incorporate supportive educational practices to aid a student with impaired memory function (i.e., non-memory based assessments, course assessment accommodations, learning scaffolds), and 3 adult education professors did not have an answer as to what they would do if a student in their course had impaired memory function. Many of the professors (n=8) who indicated they would seek help from the university learning resource centre also indicated that they would incorporate supportive educational practices.

“I would rely on our Disability Resource Centre for advice and that advice would be based, I assume, on an analysis of the kind of impairment and its severity. In general, I would do my best to provide digitally-available materials (readings, presentations, etc) so that the student could review at their own pace and in

conditions conducive to retention. I would also use visuals as much as possible under the assumption that graphic materials that supplement verbal material might aid the student. My assignments are typically analytical essays and papers done on the student's own time, so I would not be putting the student in a situation with test-taking time pressures" (Participant 4).

There were 3 dominate themes that emerged from question 3 in regards to whether or not adult education professors thought learning was related to neuronal connectivity; not well aware of neuronal connectivity (n=18 or 82%), yes learning is related to neuronal connectivity but learning is not limited to neuronal connectivity (n=2 or 9%), and yes learning is related to neuronal connectivity (n=2 or 9%).

When asked if they had ever come across information on the brain and learning, 16 (73%) adult education professors reported that they had, and 6 (27%) reported that they had not. Of the 16 adult education professors that came across information on the brain and learning, 4 (25%) found the information to be useful, 6 (38%) found the information not useful, 3 (19%) found the information to be useful and also not useful, and 3 (19%) did not comment on whether it was useful or not. The adult education professors that came across information about research on the brain mentioned that they came across this information from conferences, in books (including adult education textbooks used for their course), on websites, and popular science publications (i.e., books, magazines). Adult education professors were asked if they had made any changes to their educational practices based on neuroscience research on how the brain learns. Of the 22 adult education professors, 20 (91%) responded that they had not made any changes to their educational practices based on neuroscientific research on how the brain learns, and 2 (9%) indicated that they had made changes to their educational practices. Of the 2 adult

education professors that responded that they had made changes to their educational practices based on research on how the brain learns, only 1 made explicit reference to changing their educational practice based on brain research reporting that the changes that were made were effective. The other one only made reference to making effective changes to their educational practice based on scholarship.

Post-secondary adult education professors were asked if they were aware of the current neuroscience research on how the brain learns and if they thought that neuroscience research could enhance educational practices. More than half of the adult education professors (n=13 or 59%) were not well aware of the current neuroscience research on plasticity, memory and learning, sleep and learning, and emotion and learning, and 9 (41%) responded that had some awareness of the current neuroscience research on plasticity, memory and learning, sleep and learning, and emotion and learning.

“Horribly unaware. Like so many academics, I rarely read outside of my field.

Unless the neuroscientists have partnered with education faculty to write for education journals, I fear I have likely not come across this cutting edge and likely very relevant scholarship. My hunch is that there is much to be learned, but it needs to be translated in a way that someone in the social sciences will read.

Here’s the perfect opportunity for interdisciplinary scholarship with huge potential benefit; my fear is that it is likely not going to be done” (Participant 15).

“I am not familiar with research on plasticity. In terms of the other research, my knowledge is more of broad understandings rather than specific details. Sleep is a necessary component to the learning process, based on the ‘down-time’ during REM sleep when ideas are processed and reinforced. Emotional readiness is a key

idea to consider – especially in term of attitude, anxiety, frustration – all impact the way the neural patterns flow. The ‘fight or flight’ instinct comes to mind” (Participant 3).

Only 9 (41%) adult education professors mentioned that they thought neuroscience research on how the brain learns could enhance educational practices.

Of the 22 adult education professors, 13 (59%) mentioned that this research study had stimulated their interest in neuroscience research on how the brain learns in informing educational practices, and the remaining 9 (41%) mentioned that this research study did not stimulate their interest in neuroscience research on how the brain learns. Of the 13 adult education professors whose interest in neuroscience was stimulated by this research study, only 5 looked up information about neuroscience research on how the brain learns. Adult education professors mentioned many areas of interest when asked what area(s) of neuroscience they would want to know more about or to discuss with a neuroscientist (e.g., stress and learning, social aspects of learning, mind-brain-concept, creativity and learning, emotion and learning, learning environments, information processing, aging and learning, learning and disabilities, neural pathways, why is neuroscience important to adult education, etc).

“I am interested to know more about the role of emotions in learning – some scientific understanding of improving learning through provoking emotions. What happens in brain when emotions get involved. In my practice and in adult ed research there is a discussion on the importance of emotions as well as other ways of learning (e.g., embodied learning)” (Participant 2).

Participants also mentioned that the area(s) of neuroscience research they were interested in should be in a language that was understandable to them.

“I would want it to be in a language that was accessible, as some of the articles I looked up seemed to assume that one already had a basic understanding”

(Participant 11).

“I would be very irritated if it were an ‘one-way’ conversation in which he or she simply told me what learning was about, and I was expected simply to ‘apply it’ in classrooms” (Participant 13).

Of all the adult education professors (n=12) that submitted a response to the follow-up question in regards to participating in this research study via e-mail, 9 (75%) mentioned that they liked and/or would prefer this chosen delivery method (i.e., e-mail interview), and 5 adult education professors mentioned that they would participate in future research via an e-mail interview.

“Yes I kind of liked the delivery method. It allowed me to respond in my own time and it was always in my inbox until I did! I liked your gentle reminders. They were very important. I also liked that you were clear that we didn't need to look up anything in order to answer the questions. Just work from our own experience and perceptions in the moment. That way, I was more likely to actually get them done!” (Participant 9).

1.9 Discussion

This present research study surveyed adult education professors’ (i.e., post-secondary professors in the field of education in Canada) perceptions of neuroscience research on how the brain learns in informing educational practice. This present research study also provides further insights to the previous research studies (e.g., Pickering & Howard-Jones, 2007; Zambo &

Zambo, 2011; Hook & Farah, 2012; Serpati & Loughan, 2012) discussing educators' (i.e., grade school teachers) viewpoints and beliefs on how brain research contributes to education. As mentioned previously, very few studies at the time of conducting this research study had focused on finding out how educators (i.e., grade school teachers) perceive neuroscience research for education, and none could be found that were conducted on how post-secondary professors in the field of adult education perceive neuroscience research. Findings from the few studies found (e.g., Pickering & Howard-Jones, 2007; Zambo & Zambo, 2011; Hook & Farah, 2012; Serpati & Loughan, 2012) indicated that some educators (i.e., grade school teachers) placed value on neuroscientific findings. That some grade school teachers were confused about the educational value of neuroscience, some bought into the non-scientific brain-based learning materials, some did not believe neuroscience research findings on how the brain learns had any value for the discipline of education, and many were not well aware of the neuroscience research findings on how the brain learns.

The results of this research study, in a comparative way, confirmed findings from these studies (e.g., Pickering & Howard-Jones, 2007; Zambo & Zambo, 2011; Hook & Farah, 2012; Serpati & Loughan, 2012) that there is a general lack of awareness of the significance of neuroscience research amongst adult education professors. That few adult education professors place value on neuroscience research for education, that many did not know whether or not neuroscience research could enhance educational practices, and some did not believe neuroscience research findings on how the brain learns had any value for the discipline of education. However, one finding that was not confirmed from the findings from these previous research studies (e.g., Pickering & Howard-Jones, 2007; Zambo & Zambo, 2011; Hook & Farah, 2012; Serpati & Loughan, 2012) was that adult education professors did not buy into the non-

scientific brain-based learning materials (i.e., neuromyths) as did some educators (i.e., grade school teachers). Neuromyths, as pointed out by Howard-Jones (2010), “are misconceptions generated by a misunderstanding, a misreading or a misquoting of facts scientifically established (by brain research) to make a case for use of brain research, in education and other contexts” (p.20). Although, several adult education professors were aware that misconception existed about how the brain learns.

“Right Brain Left Brain, for example, is I understand ‘nonsense’ to a neuroscientist. Similarly, neurolinguistic programming. What I hear in popular media cannot be relied upon” (Participant 21).

Even though many adult education professors (n=16 or 73%) came across information on how the brain learns, only 7 adult education professors thought that the information they came across was useful for education. Several adult education professors mentioned that information on neuroscience research is ‘peripheral to their scholarship’.

“I have not had clear information on it. I saw a special issue of Adult Learning on it but did not read it through. So, I guess I know very little about it. I am more interested in sociology than biology/psychology” (Participant 1).

“Frankly, I’ve not paid much attention to current brain research because it seems pretty far removed from day to day educational practice” (Participant 4).

“I’m not a fan of neuroscience” (Participant 8).

“It is very peripheral to my own scholarship and, beyond the introductory survey courses that I teach, is not information that I tend to return to often” (Participant 10).

“I’m sure I have come across research on the brain and learning. The problem is, I don’t have a clear memory of what it is that I’ve read or where I read it. I don’t think it was clear to me how this research could be applied in educational settings. Seems like a perfect example of relevant research that fails to have been mobilized for applicable audiences” (Participant 15).

Only 2 (9%) adult education professors made mention that they enhanced their educational practice with neuroscience research on how the brain learns.

In examining the differing of the meaning of learning from the perspectives of education and neuroscience, Howard-Jones (2010) argues that “educational ideas about learning are diverse and eclectic in their origins” (p.83). Educational definitions of learning, Howard-Jones (2010) furthers “are the product of a variety of different processes and forces, including those arising from theoretical educational and psychological traditions, and other culturally transmitted ideas from within and beyond the teaching profession” (p.83). The results of this research study support this claim made by Howard-Jones (2010). The first question of this research study asked adult education professors to define learning and indicate if their definition of learning was supported by an educational learning theory. Most adult education professors (n=14) defined learning as some kind of process (e.g., a cognitive process, a process of gaining a new skill or knowledge, a process of collective (group) learning, and/or a process of constructivist thought), 2 described learning as complex and multidimensional, and 6 had unique definitions of learning. There were 22 different educational learning theories (e.g., Kolb's experiential learning, transformational learning, social learning theory, constructivist theory, connectivist theory, cognitive theory, and self-directed learning) that were mentioned, and 3 adult education professors did not mention a learning theory. Several adult education professors (n=8 or 42 %)

who mentioned a learning theory stated that several educational learning theories informed their practice. The results of this research study suggest that adult education professors in Canada primarily understand learning in relation to educational learning theories.

From the results of this research study, adult education professors' educational definitions of learning are indeed 'diverse, eclectic and a product of a variety of different processes and forces'. This result suggests that adult education professors' educational definitions of learning may be rooted in individual preference(s) and/or individual beliefs/conceptions of learning, as there was not a unified definition/approach to learning and/or theory that informed the educational practice of post-secondary professors in the field of education in Canada. The lack of consensus within educational thinking, according to Howard-Jones (2010), "ensures that individual teachers' beliefs about learning play a critical role in their practice. Teacher's personal beliefs develop through an accrued professional understanding and do not usually require empirical validation" (p.83). With the strong evidence that adult educators' educational beliefs directly influence their educational practices (Kember & Kwan, 2000; Norton, Richardson, Hartley, Newstead, & Mayes, 2005; Northcote, 2009, Zambo & Zambo, 2011), and that these educational beliefs are not easily influenced by educational and/or other factors (Kember & Kwan, 2000; Zambo & Zambo, 2011), it may be difficult to enhance adult education professors' 'conceptions of teaching' with new knowledge based on neuroscience research findings on how the brain learns.

The result of this research study indicated that there is a general lack of awareness amongst adult education professors of neuroscience research on how the brain learns. This general lack of awareness suggests that neuroscience research on how the brain learns may not be in 'alignment' with adult education professors' conceptions of good teaching (i.e., educational

beliefs). Zambo and Zambo argue (2011) that educators' core beliefs are "resistant to change, and are self-perpetrating. Teachers see what they believe, and they believe what they see when it aligns with their beliefs and this applies to instruction" (p.26). Of the adult education professors (n=9 or 41%) that had some awareness of the current neuroscience research on the brain (i.e., plasticity, memory and learning, sleep and learning, emotion and learning) only 5 thought that this research could enhance educational practices. Therefore, adult education professors may not perceive neuroscience research as a significant contributor to enhance educational practices. This was indicated in the responses of several adult education professors who participated in this research study.

"I have frequently heard of research on the brain and learning. I last heard about such research at the most recent STLHE and ISSOTL conferences. The information was very interesting to me, but inconclusive – as in, I could not make a direct connection between research on how learning takes place in the brain and learning strategies in a classroom" (Participant 21).

"So I would say that, so far, the information on brain research is intriguing, but not especially useful because its educational implications are not yet clear" (Participant 4).

1.10 Conclusions

The results of this study indicated that the educational practices of adult education professors in Canada were informed by a diversity of learning definitions and numerous educational learning theories. Diverse educational practices can have an impact on student learning. Higher education educators, as stated by Norton et al. (2005), "even when they are

teaching similar courses, different teachers teach in different ways, and this may affect their students' satisfaction, motivation and attainment" (p.539). Thus, student learning is affected by educational teaching practices. Therefore, effective educational teaching practices can enhance student learning. As mentioned previously, enriching educational practices would significantly be advantageous to enhancing learning, and isn't that what educating is all about? With the new neuroscience research on how the brain learns, Taylor (2006) argues that connecting neuroscience research on how the brain learns with education will ensure meaningful learning. From the results of this research study, those who teach about educational practices (i.e., adult education professors) were not very aware of the current neuroscience research on learning (i.e., plasticity, memory and learning, sleep and learning, emotion and learning) and were not well aware that learning was related to neuronal connectivity. Many adult education professors mentioned that neuroscience research was peripheral to their academic scholarship and several were not interested in further seeking out neuroscience information on learning.

There is strong evidence that adult educators' educational beliefs directly influence their educational practices (Kember & Kwan, 2000; Norton et al., 2005; Northcote, 2009, Zambo & Zambo, 2011), and that these educational beliefs are not easily influenced by educational and/or other factors (Kember & Kwan, 2000; Zambo & Zambo, 2011). The results of this study indicated that there is general lack of awareness of neuroscience research amongst adult education professors, that many were not interested in further seeking out neuroscience information on learning, is very suggestive that neuroscience research on how the brain learns may not be in 'alignment' with adult education professors conceptions of teaching. From the results of this research study, adult education professors' educational definitions of learning are indeed 'diverse, eclectic and a product of a variety of different processes and forces'. According

to Merriam, Caffarella, and Baumgar (2007), “just as there is no single theory that explains all of human learning, there is no single theory of adult learning” (p.83), and educators may ‘wrestle’ with the many ideas presented in these theories of learning to inform practice. The results of this research study provide evidence that adult education professors may be ‘wrestling’ with the many ideas presented in theories of learning to inform practice, as there was not a unified approach and/or theory that informed the educational practice of post-secondary professors in the field of education.

As discussed previously, the recent developing collaborative effort between the fields of neuroscience and education has created a lot of excitement, confusion, and cautionary attitudes. Results from this research study suggest that even though adult education professors may have concerns with linking neuroscience to education many believed (n=9) that neuroscience research on how the brain learns could enhance educational practices.

“Yes, neuroscience research in the areas you suggest can/will enhance educational practices as the appropriate connections are made. However, there seems to be a ‘lag’ and a ‘gap’ in applying what neuroscience is finding (exploring and documenting) in body-brain studies and potential applications to educational/teaching practices, and the methods for evaluating educational practice including learning processes and outcomes. Wlodkowski’s book bridges a great deal of the gap, and there are other education resources and studies no doubt. But the lag - gap is also a social-policy issue” (Participant 5).

Tommerdahl (2010) agrees that it may not be easy for neuroscience findings to have direct application to educational practices, but argues that with the collaborative efforts of different types of knowledge (i.e., neurosciences, cognitive neurosciences, psychological mechanisms,

educational theory, classroom) neuroscience findings can enhance educational practices (i.e., reading – the reading and writing program entitled ‘Collections for Young Scholars’).

According to Hook and Farah (2012), neuroscience research is ready to be extended to educational practices. In quoting Blakemore and Frith, Hook and Farah (2012) mention that “there is a vast amount [of] brain research of direct relevance to educational practice” (p.2). Hook and Farah (2012) continue citing Blakemore and Frith, mentioning that they argue that the lack of ‘successful educational application of neuroscience’ is a result of the challenges of interdisciplinary interaction and communication. To overcome these challenges, according to Hook and Farah (2012), “improving dialogue between the two disciplines will enrich research and practice in the field of neuroeducation, ultimately helping to build a better science of learning and the brain” (p.10). Therefore, continued collaborative efforts between neuroscience and education will bring about effective educational practices to enhance learning. In enhancing educational practices with neuroscience research, future research could look into critically examining and testing evidence from neuroscience research on how the brain learns at the classroom level. One way to approach this type of future research is through theory building, where one would critically examine and possibly build upon existing educational learning theories with the new and current neuroscience research on how the brain learns (Immordino-Yang, 2011). Researchers may find that some educational learning theories can be further enhanced with neuroscience research leading to more effective educational practices, while some educational theories and practices may need to be dispelled. Dissemination of future research should be in a suitable language for intended audiences and in avenues that intended audiences are likely to cross (i.e., educational academic journals).

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