PHYSICAL LITERACY AND READING LITERACY: THE RELATIONSHIP BETWEEN FINE AND GROSS MOTOR SKILLS AND READING ABILITY OF CHILDREN IN GRADES THREE AND FOUR, IN A NEW BRUNSWICK, ON-RESERVE FIRST NATION ELEMENTARY SCHOOL

by

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ABSTRACT

This study examines the relationship between physical literacy, motor coordination, language, and reading in an on-reserve, First Nation elementary school with children in grades three and four, while controlling for potentially confounding factors such as language, and nonverbal abilities. The Jebsen Hand Function Test provided one indicator of motor coordination (manual dexterity). The Physical Literacy Assessment for Youth’s (PLAY) Fundamental Skills tool provided a physical literacy score and five indicators of motor coordination (run, locomotor, object control upper and lower body, and balance, stability and body control). The Wechsler Individual Achievement Test – III provided two indicators of basic reading (Word Reading and Pseudoword Decoding subtests). Basic reading was controlled for language (Clinical Evaluation of Language Fundamentals – 5) and nonverbal abilities (Coloured Progressive Matrices). The thesis hypothesizes that motor coordination will have a correlation with basic reading ability. To determine this hypothesis, correlation, partial correlations, and independent t-tests were conducted. The results of the current study indicated that there was no association between fine and gross motor skills and basic reading. This is an exploratory study with a limited number of participants.
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List of Symbols, Nomenclature or Abbreviations

BSBCS – Balance, Stability and Body Control Score
BSS – Balance, Stability Score
BCS – Body Control Score
CELF–5 – Clinical Evaluation of Language Fundamentals – 5th Edition
CPM – Coloured Progressive Matrices
CS4L – Canadian Sport for Life
DH – Dominant Hand
JHFT – Jebsen Hand Function Test
WIAT–III – Wechsler Individual Achievement Test—3rd Edition (Canadian)
LS – Locomotor Score
MC – Motor Coordination
NVLD – Nonverbal Learning Disabilities
NDH – Non-dominant Hand
OCUBS – Object Control, Upper Body Score
OCLBS – Object Control, Lower Body Score
PL – Physical Literacy
PLAY – Physical Literacy Assessment for Youth
PLAYfun – Physical Literacy Assessment for Youth – Fundamental Skills
PLAYbasic – Physical Literacy Assessment for Youth – Basic
PLAYparent – Physical Literacy Assessment for Youth – Parent
PLAYcoach – Physical Literacy Assessment for Youth – Coach
PLAYself – Physical Literacy Assessment for Youth – Self
PLAYinventory – Physical Literacy Assessment for Youth – Inventory

VMC – Visual-Motor Coordination

VSI – Visual-Spatial Integration

WCS – Word Classes Subtest

WR – Word Reading

WRS – Word Reading Speed

PWD – Pseudoword Decoding

PWDS – Pseudoword Decoding Speed

RS – Running Score

Task 1 – PLAYfun Task 1, Run a Square

Task 2 – PLAYfun Task 2, Run There and Back

Task 3 – PLAYfun Task 3, Run, Jump and Land on Two Feet

Task 4 – PLAYfun Task 4, Crossovers

Task 5 – PLAYfun Task 5, Skip

Task 6 – PLAYfun Task 6, Gallop

Task 7 – PLAYfun Task 7, Hop

Task 8 – PLAYfun Task 8, Jump

Task 9 – PLAYfun Task 9, Overhand Throw

Task 10 – PLAYfun Task 10, Strike with Stick

Task 11 – PLAYfun Task 11, One Handed Catch

Task 12 – PLAYfun Task 12, Hand Dribble Stationary and Moving Forward

Task 13 – PLAYfun Task 13, Kick Ball

Task 14 – PLAYfun Task 14, Foot Dribble Moving Forward
Task 15 – PLAYfun Task 15, Balance Walk (Heel, to, Toe) Forward
Task 16 – PLAYfun Task 16, Balance Walk (Toe, to, Heel) Backward
Task 17 – PLAYfun Task 17, Drop to Ground and Back Up
Task 18 – PLAYfun Task 18, Lift and Lower

TS – PLAYfun Total Score

T1 – JHFT Task 1, Writing
T2 – JHFT Task 2, Card Turning (Simulated Page Turning)
T3 – JHFT Task 3, Small Common Objects
T4 – JHFT Task 4, Simulated Feeding
T5 – JHFT Task 5, Checkers
T6 – JHFT Task 6, Large Light Objects
T7 – JHFT Task 7, Large Heavy Objects

T – JHFT Total
CHAPTER ONE: INTRODUCTION

1.1 Introduction

The relationship between motor coordination and reading skills in children has been studied over the last three and a half decades by researchers in Canada, Norway, the United Kingdom, the United States, Australia, and the Netherlands. Despite a number of published studies on the relationship between these two areas, there are no conclusive results on whether reading and language development is connected to motor coordination. This research project aims to further investigate the connection between these two areas in a new population, that of children in grades three and four attending an on-reserve elementary school in a New Brunswick First Nations community. There have not yet been definitive results in previous studies, and this study aims to further analyze the connection between motor coordination and reading skills with a somewhat different group of children from another community.

This chapter will identify and describe the proposed study. It will define and describe motor coordination and reading, and explicate the connection between the two. A discussion of the Canadian First Nation peoples will describe the particular community who were invited to participate in this research. The research method and hypotheses will also be outlined.

1.2 Motor Coordination

Fundamental motor skills are recognized as the basics of movement which ought to be trained and strengthened, because they are not automatic (Tsangaridou &
As a consequence, it is essential to understand the broader concept of motor coordination as being where “the actions of one body part are controlled together with the movements of another body part” (Schmidt & Lee, 2011, p. 41). Thus motor coordination results from the collation of individual motor skills working synchronously.

Motor tasks may be separated into a variety of categories. According to Fels et al. (2014) five different categories of motor tasks may be differentiated: (1) gross motor skills; (2) fine motor skills; (3) bilateral body coordination; (4) timed performance in movements; and (5) object control. Examples of each of the five categories are as follows: First, gross motor skills: catching a ball (Fels et al., 2014; Healthy Active Living and Obesity Research Group, 2013; Kriellaars, Kozera, & Robillard, 2013; Larouche, Boyer, Tremblay, & Longmuir, 2014; O’Hare & Khalid, 2002; Wocadlo & Rieger, 2008), balance walk (heel-to-toe) forward (Fels et al., 2014; Grissmer, Grimm, Aiyer, Murrah, & Steele, 2010; Kriellaars et al., 2013; O’Hare & Khalid, 2002; Wocadlo & Rieger, 2008), flexibility (seat and reach) (Larouche et al., 2014), and strength (plank position) (Fels et al., 2014; Larouche et al., 2014; Wocadlo & Rieger, 2008). Second, fine motor skills: writing and copying (not tracing) words, and producing a mental illustration of an image and then reproducing it (Fels et al., 2014). Third, bilateral body coordination: running (Fels et al., 2014; Healthy Active Living and Obesity Research Group, 2013; Kriellaars et al., 2013; Larouche et al., 2014; O’Hare & Khalid, 2002; Wocadlo & Rieger, 2008). Fourth, timed performance in movements: simulated feeding, and obstacle course (hop, jump, run, catch and throw a ball) (Healthy Active Living and Obesity Research Group, 2013; Jebsen, Taylor, Trieschmann, Trotter, & Howard, 1969; Larouche et al., 2014; Noonan, Miller, Eng, & Chan, 2012; Taylor, Sand, & Jebsen, 1973). Finally, object
control could be dribbling a basketball (Fels et al., 2014; Healthy Active Living and Obesity Research Group, 2013; Kriellaars et al., 2013; Larouche et al., 2014; O’Hare & Khalid, 2002; Wocadlo & Rieger, 2008). Each of these motor tasks may be observed by another while a child is performing them. Schmidt and Lee (2011) defined motor behavior as a person’s action that may be observed directly by another person. For this research measuring children's motor behaviors, the Jebsen Hand Function Test (JHFT) was utilized to measure fine and gross motor skills (Taylor et al., 1973). Hand function is evaluated during regular activities of daily living using standardized tasks, for instance writing, and picking up large heavy cans (Jebsen et al., 1969; Noonan et al., 2012; Taylor et al., 1973). The outcomes are calculated by recording the time taken to finish each task. The longer the time necessary to complete the assessment subscales, the more limitations the participant may have (Poole, 2011). The Physical Literacy Assessment for Youth - Fundamental Skills (PLAYfun) tool is used to measure children’s physical literacy level, and gross motor skills by examining fundamental movement and sport skills using standardized tasks: for example, running, jumping and kicking a ball (Kriellaars & Robillard, 2013a). This is one of the first research studies in the area of physical literacy which has incorporated the PLAYfun tool to assess children’s physical literacy skills.

1.3 Reading

Being able to understand verbal and written materials is essential to functioning in modern life as an independent, contributing member of society. Not only does one need to have adequate reading and writing skills, but also one needs to be able to understand,
interpret and use the information. The combination may be understood as literacy in a broader context.

There does not appear to be one universally agreed upon definition or conception of literacy (UNESCO, 2015). Conceptualizations of literacy for education and as a means of communication have varied, with differing schools of thought having developed different ways of describing the scope of a literacy education, and factors which ought to be taken into consideration. It has been variously described as a skill, competence, capacity and as a practice. UNESCO (2015) defines literacy “as the ability to use written language as a means of communication in a plurality of contexts.” Literacy learning and education is understood as a process to be guided by the communication needs of the learner:

Literacy is the ability to identify, understand, interpret, create, communicate and compute, using printed and written materials associated with varying contexts. Literacy learning is a continuum, enabling individuals to achieve their goals, develop their knowledge and potential and participate fully in the community and wider society. (UNESCO, 2005, p. 21)

The Canadian Council on Learning (2015) defines literacy as “learning to read and write (text and numbers), reading and writing to learn, and developing these skills and using them effectively for meeting basic needs,” in accordance with the (UNESCO, 2005) definition.

Reading is a component of literacy, and is defined as the capacity to take out visual information, for example from a book, and understand the meaning of the text (Rayner, Pollatsek, Ashby, & Clifton Jr., 2012). Researchers identified five significant
skills in learning to read: comprehension, vocabulary, fluency, phonics, and phonemic awareness (National Reading Panel (U.S.) & National Institute of Child Health and Human Development (U.S.), 2000). This research analyzed only reading fluency because as in the research referred to before, four factors are significant in the process of learning to read. In this study the focus is on reading as a final result, not on the process of learning how to read. Reading fluency is the ability to identify words quickly and accurately (Hasbrouck & Tindal, 2006; Meyer & Felton, 1999; Nathan & Stanovich, 1991; Torgesen, Rashotte, & Alexander, 2001); and word reading accuracy is the ability to identify or decode words accurately (Torgesen & Hudson, 2006). Three factors appeared as being included in the establishment of reading fluency: reading accuracy, naming speed, and language comprehension (Barth, Catts, & Anthony, 2009; Bowers, 1993; Hudson, Pullen, Lane, & Torgesen, 2008; Hulme & Snowling, 2013; Torgesen et al., 2001).

This research project focuses on reading rather than on the broader concept of literacy because previous research showed controversial results of correlation between reading and motor coordination, and no studies have examined the correlation between literacy and motor coordination.

1.4 Connection Between Motor Coordination and Reading

There are divergent results from research on the relationship between reading skills and motor coordination (Cameron et al., 2012; Carlson, Rowe, & Curby, 2013; Grissmer et al., 2010; Iversen, Berg, Ellertsen, & Tønnessen, 2005; Rigoli, Piek, Kane, & Oosterlaan, 2012; Schoemaker, Lingam, Jongmans, van Heuvelen, & Emond, 2013), and
on whether reading and language development may be affected by motor coordination issues (Carlson et al., 2013; Gooch, Hulme, Nash, & Snowling, 2014; Grissmer et al., 2010; Iversen et al., 2005; O’Hare & Khalid, 2002; Rigoli et al., 2012; Rommelse et al., 2009; Zwicker, Missiuna, & Boyd, 2009). Some researchers in the area found no relationship between reading challenges and motor skills (Gaysina, Maughan, & Richards, 2010; Rigoli et al., 2012). However, Iversen et al.’s (2005) study found more than half of the children from two groups of poor readers (one of them children with severe dyslexia), showed high rates of motor coordination deficits, in particular within the sub-area of manual dexterity, and the ability to execute continuous and precise fine-motor activities. Also, Rigoli et al.’s (2012) study with a normative population group suggested that motor coordination and academic achievement relationship is assumed particularly with aiming and catching skills, and motor coordination has an indirect influence on academic outcomes via working memory. Prior research investigating motor coordination, working memory, and academic outcomes has involved atypical population groups, however further research using a normative population is necessary in order to provide better comprehension of relationships found in children with development coordination disorder (Rigoli et al., 2012). To date, no review of the literature has revealed any similar research having been conducted with Canadian and First Nations populations, and thus the decision was made to focus this research on New Brunswick First Nations elementary school students.
1.5 First Nations Elementary-aged School Children

The participants in this research study are children in grades three and four attending an on-reserve, First Nation elementary school in New Brunswick. This population was chosen because previous research in the area of motor coordination and reading did not include such a population. I had been volunteering with children at a First Nation elementary school. Having established a good working relationship over a number of months, and given the dearth of such research, I invited this population to participate in the research project via information sent to the school community: the school principal and staff, and all parents and guardians of children attending the school in grades three and four. Once the research project has concluded, results will be shared with the school principal, who may then disseminate the research findings to the school community.

The Aboriginal population in Canada was reported by Statistics Canada in 2011 as being 1.4 million, making up 4.3% of the total Canadian population. First Nations single identity are 60.8%, Métis single identity are 32.3%, and Inuit single identity are 4.2%. In 2011, 851,560 people identified as a First Nations person in Canada, representing 2.6% of the total Canadian population. Numerous First Nations people live in Ontario and the western provinces; however they constituted the majority of the total population of the Northwest Territories, Yukon, Manitoba, and Saskatchewan (Turner, Crompton, & Langlois, 2013).

Aboriginal peoples include persons of Indian, Inuit or Métis descent regardless of where they reside and whether or not their names appear on an official register. The term “Aboriginal” fails to reflect the distinctions among First Nations, Inuit and Métis peoples, who have their own histories, cultures and languages, so an attempt
has been made to limit use of the term in this Policy to instances where a global
term is appropriate. Indian peoples commonly identify themselves by distinct
country names such as Mi’kmaq, Dene or Haida, and as First Nations. In the
international context, the term comparable to *Aboriginal peoples* is *Indigenous peoples*. (Canadian Institutes of Health Research, Natural Sciences and Engineering
Research Council of Canada, & Social Sciences and Humanities Research Council
of Canada, 2014, p. 111)

In 2011, 637,660 First Nations people were recorded by the 2012 Aboriginal Peoples
Survey as Indians, constituting 74.9% of all First Nations people. One quarter of all First
Nations people are not recorded as Indians. Of the individuals who reported being
Registered Indians, approximately one-half (49.3%) resided on an Indian reserve or
Indian settlement (Bougie, Kelly-Scott, & Arriagada, 2013). Aboriginal people made up
3.8% of the population in 2006, 3.3% in 2001, and 2.8% in 1996 (Turner et al., 2013).
The annual growth rate of the aboriginal population in the coming years is projected to be
more than twice the rate estimated for the Canadian population as a whole (Katzmarzyk,
2008). The Aboriginal population grew by 232,385 people (20.1%) between 2006 and
2011, compared with 5.2% for the non-Aboriginal population. The core numbers of
Aboriginal people lived in Ontario, Manitoba, Saskatchewan, Alberta, and British
Columbia. Aboriginal people constituted the major part of the population of Nunavut and
the Northwest Territories (Turner et al., 2013).

The Aboriginal population in Canada is younger than the non-Aboriginal
population (Turner et al., 2013). The median age of the Aboriginal population is 28 years,
13 years younger than the median of 41 years for the non-Aboriginal population in every
province and territory. This is because of higher fertility rates and shorter life expectancy (Turner et al., 2013). The literature also reports that Aboriginal people have experienced “elevated rates of obesity, diabetes, cardiovascular disease, and other chronic conditions, as well as increased morbidity and mortality in comparison to the general population, addressing the level of physical inactivity among these populations is critical for improving their health and well-being” (Foulds, Warburton, & Bredin, 2013, p. 601; Health Canada, 2015). The 2011 National Household Survey revealed that there were 392,105 Aboriginal children aged 14 and below in Canada, amounting to 7.0% of all children in Canada, and 28.0% of the Aboriginal population. In contrast, there were 5.2 million non-Aboriginal children aged 14 and below in Canada, representing 16.5% of the non-Aboriginal population (Turner et al., 2013). Furthermore, there were more than 254,515 Aboriginal youth aged 15 to 24, representing 18.2% of the entire Aboriginal population, and 5.9% of entirely youth in Canada. Non-Aboriginal youth totaled just under 4.1 million, and accounted for 12.9% of the non-Aboriginal population (Turner et al., 2013). Finally, approximately 82,690 Aboriginal people were seniors aged 65 and above, accounting for 5.9% of the total Aboriginal population. However, this was fewer than half of the percentage of 14.2% for seniors in the non-Aboriginal population (Turner et al., 2013).

In 2006 there were 12,385 First Nations people in New Brunswick. They represented 1.8% of the total First Nations population in Canada and 1.7% of the population of New Brunswick (Kozlowski, Sinha, & Levi, 2011). According to (Statistics Canada, 2006), there were 4,450 First Nations children (aged zero to fourteen) in New Brunswick. However, in 2011 there were 22,615 Aboriginal people in New Brunswick,
representing 1.6% of Aboriginal people in Canada. First Nations people in New Brunswick grew for a total of 16,120, representing 1.9% of First Nations people in Canada and 2.2% of people in New Brunswick (Turner et al., 2013). First Nations youth (to the age of 18 years old) represented 3% of the youth population in New Brunswick (Kozlowski et al., 2011). The median age of First Nations people in Canada was 26 and in New Brunswick 28 years old (Turner et al., 2013).

1.6 Research Objectives

The research objective of this project examining the relationship between motor coordination and reading in children has been identified as follows:

To determine whether there is a correlation between fine and gross motor coordination abilities and basic reading skills in children in grades three and four, attending an on-reserve, First Nation elementary school in New Brunswick.

1.7 Hypothesis

The present study will examine the relationship between fine and gross motor coordination abilities, language, and basic reading skills in First Nation children between grade three and grade four, from a normative sample whilst controlling for potentially confounding factors such as language, and nonverbal abilities. It was hypothesized that motor coordination (as measured by running, locomotion, object control, balance, stability and body control, and hand function) would be correlated with basic reading (as measured by Word Reading (WR) and Pseudoword Decoding (PWD) subtests).
1.8 Conclusion

This study will examine the relationship between physical literacy levels through the evaluation of fine and gross motor coordination abilities and basic reading skills of children in grades three and four, in an on-reserve, First Nation elementary school in New Brunswick. To date, there is no such body of research on this subject related to this population. This chapter has introduced the concepts of motor coordination and reading, and the connection between them. A description of First Nations people in Canada and in New Brunswick has been provided, and this study’s research objectives, and hypothesis have been presented.

Next, in chapter two, a review of the literature will be presented, including the concepts and assessments of motor coordination and reading, and the relationship between each of them. Chapter three will focus on this research study’s methodology. Participants were invited to participate in an assessment of motor coordination activities and reading. The present study will examine the relationship between fine and gross motor coordination abilities, language, and basic reading skills, from a normative sample while controlling for potentially confounding factors such as language, and nonverbal abilities. Assessment of the data will be conducted using IBM SPSS Statistics 21. Correlations, partial correlations, and independent t-tests will be conducted.
2 CHAPTER TWO: LITERATURE REVIEW

The purpose of this study is to examine, evaluate and compare children’s physical literacy levels through the evaluation of fine and gross motor coordination abilities, and their basic reading skills. The invited population consisted of children in grades three and four attending an on-reserve First Nation elementary school in New Brunswick. This chapter reviews the literature that examines both the concept of literacy and reading, as well as physical literacy and motor coordination. The social determinants of health will also be discussed here, given their relationship to health outcomes. To date, a review of the literature has revealed no similar research having been conducted with Canadian and First Nations populations, and thus the decision to focus this research on New Brunswick First Nations elementary schools students.

There is debatable research on the relationship between reading skills and motor coordination, (Cameron et al., 2012; Carlson et al., 2013; Gaysina et al., 2010; Grissmer et al., 2010; Iversen et al., 2005; Rigoli et al., 2012; Schoemaker et al., 2013), and on whether reading and language improvement may be influenced by motor coordination (Carlson et al., 2013; Gooch et al., 2014; Grissmer et al., 2010; Iversen et al., 2005; O’Hare & Khalid, 2002; Rigoli et al., 2012; Rommelse et al., 2009; Zwicker et al., 2009). On the one hand Gaysina et al. (2010) and Rigoli et al. (2012) did not discover any link between reading difficulties and motor skills. However, they failed to control for potential language difficulties. On the other hand Iversen et al. (2005) conducted a study with two groups of poor readers (one of them with children with severe dyslexia) compared to good reading controls, and 50% of the children in both groups of poor readers showed motor coordination difficulties.
2.1 The Concept of Physical Literacy

Physical literacy is a fundamental part of an individual’s overall education, and some would argue that there should be a lifelong opportunity for this important element of education (Whitehead, 2007). Similar to reading and arithmetic, which develop a literary or numerical vocabulary, physical literacy improves a “movement vocabulary” of fundamental movement skills and fundamental sport skills (Kriellaars & Robillard, 2013a). However, despite the importance of physical literacy having been identified, in Canada only 17% of the population are conscious of the term physical literacy. Different authors have proposed various definitions of physical literacy, and no agreement is obvious (Tremblay & Lloyd, 2010).

Early definitions of physical literacy from the late 1960’s suggested a holistic approach by affirming that physically literate individuals move efficiently, creatively, competently, and with enthusiasm (Roetert & Jefferies, 2014). According to Whitehead (2007), the "critical philosophical debate began in the mid-1990s, and there is now interest worldwide in the promotion of physical literacy both during compulsory education and indeed throughout life" (p. 283). Whitehead also noted that the term physical literacy has been utilized over the last two decades in the United Kingdom to validate the practice of physical education. Later Whitehead identified the characteristics of a physically literate individual:

An individual moves with poise, economy and confidence in a wide variety of physically challenging situations. Furthermore the individual is perceptive in 'reading' all aspects of the physical environment, anticipating movement needs or
possibilities and responding appropriately to these, with intelligence and imagination. (Whitehead, 2001, p. 131)

Whitehead in the United Kingdom and the Healthy Active Living and Obesity Research Group in Canada have the same position related to the concept of physical literacy: “as appropriate to each individual’s endowment, physical literacy can be described as the motivation, confidence, physical competence, knowledge and understanding to maintain physical activity throughout the life course” (Whitehead, 2007, p. 287; see also Healthy Active Living and Obesity Research Group, 2013, p. 5; Roetert & Jefferies, 2014, p. 39; Whitehead, 2010, p. 11). For all that, a child who has not yet developed a high level of physical literacy will generally avoid physical activity, have low confidence in their physical skills, and will not be motivated to join in organized physical activity (Healthy Active Living and Obesity Research Group, 2013; Whitehead, 2010). Physical and Health Education Canada and the Canadian Sport Policy have the same position concerning the physical literacy definition; individuals who are physically literate “move with competence and confidence in a wide variety of physical activities in multiple environments that benefit the healthy development of the whole person” (Mandigo et al., 2009, p. 6; see also Federal Provincial and Territorial Sport Commitee, 2012, p. 7).

Different from these last definitions, other researchers Larouche, Boyer, Tremblay, and Longmuir, (2014); Tremblay and Lloyd, (2010), view physical literacy as the basis of skills or tools — social/cognitive, behavioural, and fitness associated — that children need to have or improve in order to obtain the intrinsic benefits of taking part in physical activity and sport for life-long pleasure and achievement. In contrast with all the definitions presented previously, more recently, physical literacy has been defined by
Canadian Sport for Life (CS4L) as “having the fundamental movement skills, fundamental sports skills and motivation that enable an individual to read their environment and make appropriate decisions while moving confidently and with control in a wide range of physical activities in both indoor and outdoor environments” (Way, Balyi, Trono, Harber, & Jurbala, 2014, p. 73). For instance, being capable to execute a fundamental movement skill can allow future favourable circumstances for recreational or competitive activities, such as diving, kayaking, sailing, and surfing, even if the person does not know how to swim (Higgs et al., 2010). Similarly with Way et al.’s (2014) definition, *Active for Life* describes physical literacy as developing children’s fundamental movement skills for example, running, hopping, throwing, catching, and jumping (Kelly Graham & Pask, 2013). Emerging at the same time as Way et al.’s description of physical literacy, Whitehead has recently revised her own definition of physical literacy (2014):

> Physical literacy can be described as the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life. (Whitehead, 2014)

This differs from her previous definition in that here she mentions one’s responsibility for engagement and value of physical activity throughout life (Whitehead, 2014).

### 2.1.1 Fundamental Movement Skills and Fundamental Sport Skills

Fundamental movement skills have been described as underpinning physical literacy (Way et al., 2014). The acquisition and training of fundamental movement skills are the elementary foundations for the development and improvement of physical literacy (Higgs et al., 2010). The major movement skills across the three skill groups and four
physical environments are locomotor skills (climbing, jumping, running, skating, swimming); object control skills (kicking, throwing, catching, dribbling (feet, hands, stick), striking (with a bat, racquet, stick)); balance movements (balancing/centering, floating, landing, sinking/falling). These basic movement skills may be improved through four activities thereby providing a base for all other sports. Way et al. (2014) describes four categories as follows:

1. Athletics: run, jump, throw.
2. Gymnastics: ABCs of athleticism (agility, balance, coordination and speed). Including dance adds to rhythmic abilities.
3. Swimming: for water safety reasons; for balance in a buoyant environment; and as the foundation for all water-based sports.
4. Skating, slip and slide movements: on ice, snow or water, the need to develop stability is required (p. 24).

Fundamental movement skills may be acquired through a variety of organized and unorganized sport and physical activities (Federal Provincial and Territorial Sport Commitee, 2012, p. 9). For this to occur, an appropriate learning situation provided by a parent, coach or leader is needed (Kriellaars & Robillard, 2013a). Fundamental movements skills and fundamental sports skills should be presented through enjoyable activities and short games (Way et al., 2014). The enhancement of youths’ fundamental motor skills is one of the most significant consequences of early youthful education (Tsangaridou & Genethliou, 2014).

Physical literacy is accepted as a prerequisite for lifetime involvement in, and positive outcomes from sport. Physical literacy is initiated in childhood and developed
during one’s life. It is not only a driver of performance for the athlete, but serves also as the basis for active living and health for everybody (Federal Provincial and Territorial Sport Commitee, 2012). With a sound base of basic movement skills, a child may develop strengths and capacity in a variety of sports. For example, in order to appreciate baseball, basketball, cricket, football, netball, handball, rugby and softball, catching skills must be learned (Way et al., 2014).

2.2 The Concept of Motor Coordination

Fundamental motor skills are viewed as the elementary building blocks of motion and should be taught and strengthened, because they are not automatically learned (Tsangaridou & Genethliou, 2014). The definition of motor coordination has altered over the years. Three decades ago, motor coordination was defined as making the eyes and hands or fingers work together to perform a task quickly (Winefordner, 1980). Examples of motor coordination include controlling objects; gathering parts; working with a typewriter; performing surgery quickly and accurately executing precise actions rapidly (Winefordner, 1980). According to Schmidt and Lee (2011):

Movement coordination is how the actions of one body part are controlled together with the movements of another body part. Many types of coordination exist, such as the coordination of two or more joints in a limb (as when one is reaching for a cup) or of different limbs simultaneously (as of the arms and legs during walking), or even more subtle coordination’s (such as the movements of the eye and head while one is reaching for a glass in the cupboard). For
movements that are oscillatory, one measure of coordination is to describe the temporal phasing between the two body parts (p. 41).

According to Schmidt and Lee (2011), it is possible for the child’s motor behavior to be observed directly by another person. Therefore, motor behavior and motor skills may be categorized according to several dimensions, for example (1) continuous (e.g. running)/serial (e.g. kicking a ball)/discrete (e.g. playing a piano), describing the degree to which the movement has a fixed start and finish, and (2) open (e.g. penalty shot in ice hockey)/closed (e.g. bowling), in relation to the degree to which the environment is consistent (Schmidt & Lee, 2011).

Six categories of motor tasks have been identified by Fels et al. (2014), and others. The first category is (1) gross motor skills that include the large, force-producing muscles of the trunk, arms, and legs, and are used to reach a timed task or an objective, for example: throwing a ball, and jumping. Gross motor development frequently embraces movement behaviors that are used to change a body from one position to another and to project and receive objects, principally balls (Ulrich, 2000). Also, all physical abilities similar to strength, agility, flexibility, and balance, which are needed to execute a task are incorporated in this category. The second category is (2) fine motor skills, which are tasks where fine motor precision and integration are required (Fels et al., 2014). Therefore, conferring to Carlson et al. (2013) fine motor skills are organized by two separate elements: visual-motor coordination (VMC), and visual-spatial integration (VSI). VMC includes controlling small finger movements, while VSI focuses on generating a mental representation of an image and replicating it with precise, small muscle movements. VSI skills include these tasks: writing, and copying (not tracing)
words and pictures onto a new piece of paper (Carlson et al., 2013). The third category is (3) bilateral body coordination, this takes account of all body coordination tasks, and bilateral motor coordination of lower and upper body extremities. Next, the fourth category is the (4) timed performance in movements. These are gross and fine motor skills or object control tasks in which the period a person takes to execute a number of movements is measured. These movements are separated into simple repetitive movements performed as fast as possible, and sequenced movements take account of alternating patterns of additional complex actions performed as fast as possible (Fels et al., 2014). The fifth and last category is (5) object control, where skills need to be performed including an object to be controlled, for example ball skills (Fels et al., 2014; Kriellaars et al., 2013). It is essential to understand that the motor skills from one category may have components of other categories (Fels et al., 2014). Tsangaridou and Genethliou (2014) defend that learning gross motor movement abilities and activities is a critical element of every child’s developmental process.

2.3 The Concept of Literacy

The level of literacy of children is one significant indicator of the success of a society (Wilms, 1999). In Canada, “literacy refers to broader learning and the mastery of information ‘to work within the knowledge (information) societies that will dominate the twenty-first century’. In this view, literacy has a clear functional role within the context of a globalizing world” (UNESCO, 2006, p. 148). For Gulati (2013) literacy is the person’s ability to read and write, understand new ideas, and apply math when needed. Literacy is more than the treatment of letters and words as purely mechanical domain
(Freire & Macedo, 1987). However, some countries consider children who complete up to a certain level of schooling to be literate. For example, in Angola, the Republic of Moldova, and Suriname, literacy is defined as the ability to read without difficulty or with difficulty, a letter or a newspaper. But in urban areas in China, a literate person is one who knows at least 2,000 characters, whereas in rural areas a literate person is one who knows at least 1,500 characters. By contrast in India, a literate person is one aged seven or older who can both read and write with understanding in any one language. In the same way, in Mexico, a literate person is one who has the ability to read and write a message in Spanish. In Russia, people who indicated that they could neither read nor write were referred to as illiterate (UNESCO, 2006).

Since the beginning of the last century, Canada had the goal of improving the abilities of its citizens in literacy, numeracy, and life skills. As a result, in Canada, the literacy rate increased from 83% in 1901 to 95% in 1931 (UNESCO, 2006). In 2003, Canadians were scored on a five-level scale in the International Adult Literacy and Skills Survey (Canadian Council on Learning, 2008). However, approximately half of Canadian adults scored below Level 3 (correspondent to high school completion), while approximately 60% of Aboriginal Canadian adults fell below this threshold (Gulati, 2013). Gulati noted a slight difference in literacy proficiency between Aboriginal Canadians’ gender: for instance, literacy scores are somewhat higher for females than males.

Literacy goes beyond merely reading or writing. “Literacy is a human right and at the core of Education for All. Literacy skills are essential in today’s knowledge societies, conferring benefits on individuals, communities and nations” (UNESCO, 2006, p. 27).
2.3.1 The Concept of Reading

Reading is a complex skill that is required for success in almost all societies where most information is communicated through writing. Reading is the capacity to extract visual information from the printed materials and understand the significance of the text (Rayner et al., 2012). Reading is a complex process comprising a number of individual skills and abilities that work together to aid in the comprehension of written words. A meta-analysis of the literature on scientifically-based reading instruction identified five skills that should be targeted as part of formal instruction due to their significance in learning to read (National Reading Panel (U.S.) & National Institute of Child Health and Human Development (U.S.), 2000). These skills consist of comprehension, vocabulary, fluency, phonics, and phonemic awareness.

This research analyzed only reading fluency because, as in the research referred to before, four factors are significant in the process of learning to read. In this study the focus is on reading as a final result, not on the process of learning how to read. Reading fluency, and reading accuracy—a constituent of reading fluency—is described below. As this research focuses on reading only and not on literacy generally, only reading fluency is addressed here.

2.3.1.1 Reading Fluency

Reading fluency is defined as the ability to identify written words quickly and accurately (Hasbrouck & Tindal, 2006; Meyer & Felton, 1999; Nathan & Stanovich, 1991; Torgesen et al., 2001). However, other authors involved the use of parsing strategies, prosody, or expression in the definition (Allington, 1983; Hudson, Lane, &
Pullen, 2005; Kame’enui & Simmons, 2001; National Reading Panel (U.S.) & National Institute of Child Health and Human Development (U.S.), 2000; Zutell & Rasinski, 1991). More recently Shaywitz and Shaywitz (2008) defined reading fluency as the ability to read words accurately, rapidly, and with appropriate expression to allow attention to be allocated to reading comprehension. It can be conceptualized as a connection between the two main components of reading: word decoding and comprehension. Fluency connects to accuracy and automaticity in decoding, and also to comprehension (Zutell & Rasinski, 1991). Furthermore, research into the correlation between word reading accuracy and reading fluency has found a causal relationship between the two (Bowes, 1993; Torgesen et al., 2001).

### 2.3.1.1.1 Reading Accuracy

Word reading accuracy is the capacity to recognize or decode words accurately (Torgesen & Hudson, 2006). According to Ehri (1997), the reader might use a variety of methods to read words correctly. For example, readers must retrieve the sounds corresponding to each word’s letters to sounds, and combine them in to a pronounceable whole read words by sight, identify words by analogy to known words, or use context and background knowledge to guess the word’s pronunciation and meaning. The practice of these methods requires knowledge of the alphabetic principle (e.g., knowledge of how graphemes map onto phonemes), the capacity to blend sounds, the capacity to store and retrieve a large number of words from memory, and the capacity to use the meaning of text to simplify word recognition (Ehri & McCormick, 1998; Torgesen & Hudson, 2006).
Furthermore, research into the correlation between word reading accuracy and reading fluency has found a causal relationship (Bowers, 1993; Torgesen et al., 2001). Bowers (1993) observed the factors related to reading rate in a sample of poor and average readers followed longitudinally from second through fourth grade. Results from regression analyses seeking to determine the unique contributions of phonological awareness, naming speed, and word identification to text reading rate revealed that word identification contributed 19%, 7%, and 20% of the unique variance in reading rate, respectively, across grades 2, 3, and 4 after controlling for phonological awareness and naming speed. How automatically readers can identify the words in a passage has a large role to play in how fluently they read. In earlier work it was revealed that the size of a reader’s sight word vocabulary, or the proportion of words in any given passage that can be recognized by sight, plays a crucial role in how quick and accurate a reader is, particularly for students who are below average in reading rate (Torgesen et al., 2001).

### 2.3.1.1.2 Language Comprehension Skills

From previous research, three factors arise as being involved in the establishment of reading fluency: reading accuracy, naming speed, and language comprehension (Barth et al., 2009; Bowers, 1993; Hudson et al., 2008; Hulme & Snowling, 2013; Torgesen et al., 2001). For instance, reading accuracy is a significant predictor of reading comprehension, and these two skills are closely correlated in children with common language development, and particular language impairment (Freed, Adams, & Lockton, 2015).
Learning to read involves mapping spoken language onto a writing system (Nation & Snowling, 2004). The importance of phonological awareness in the early stages of reading acquisition is therefore unsurprising. However, as children progress beyond the first few years of school, other aspects of linguistic awareness become important to the development of word reading and reading comprehension (Nation & Snowling, 2004). Previous research suggests that the more “enriched” a word’s representation is, the more rapidly it may be identified (Buchanan, Westbury, & Burgess, 2001; Pexman, Lupker, & Hino, 2002). Several studies have established word recognition and language comprehension account for approximately 45-85% of the variance in reading comprehension (Catts, Hogan, & Adlof, 2005; Hoover & Gough, 1990). Although word recognition and language comprehension skills are highly correlated and together account for a large amount of the variance in reading comprehension, several studies have also shown that these are relatively independent skills (Catts et al., 2005; Hoover & Gough, 1990). These studies also suggest that the unique contribution of each skill changes over time (Catts et al., 2005). In early grades, reading comprehension is mostly explained by word recognition skills. As students move to more linguistically complex texts in later grades, the contribution of listening comprehension increases, whereas the contribution of word recognition decreases.

In a nine-year longitudinal study investigating the language and literacy skills development of 604 children, Catts et al. (2005) found that word recognition skills uniquely accounted for a significant amount of variance in reading comprehension over and above what it shared with language comprehension. Specifically, word recognition accounted for 27% of the unique variance in second grade reading comprehension, 13%
in fourth grade, and 2% in eighth grade. In contrast, language comprehension accounted for 9% of the unique variance in reading comprehension in second grade, 21% in fourth grade, and 36% in eighth grade. Hoover and Gough (1990) obtained similar findings in their longitudinal study that followed children from first grade through fourth grade.

2.3.2 The Social Determinants of Health from Prenatal Stages Onwards

Many factors influence the health of populations. Good health is associated with the historical, political, economic and social contexts into which people are born (Reading & Wien, 2009). There are underlying inequities in population health related to the places and conditions where people live, learn, work, and play which affect health determinants and health outcomes. Mikkonen and Raphael (2010) recognized 14 social determinants of health in Canada:

- Aboriginal status, disability, early life, education, employment and working conditions, food insecurity, health services, gender, housing, income and income distribution, race, social exclusion, social safety net, and unemployment and job security (Mikkonen & Raphael, 2010, p. 9).

A poor socio-economic background during this stage has a direct impact, increasing the risks to health. This happens through the relation between adverse environmental influences and developmental processes. A deprived environment is associated with poor maternal diet, smoking, alcohol abuse, and raised risk of infection in the mother during the prenatal period, and also with poor growth of the child in the postnatal period. In those countries going through large-scale epidemics and civil unrest or war, these kinds of risks increase greatly (Marmot & Wilkinson, 2005). Considering the socioeconomic
variables, the odds ratios indicate that if income increases, it is likely that being unhealthy decreases. In terms of the odds ratio for employment, status is reflective of the ‘healthy worker’ effect, with those individuals not in the labour force reporting they are more likely to be unhealthy than the employed. Regarding education, individuals with high school education or postsecondary education are less likely to report being unhealthy, as compared to those with less than high school education (Wilson & Rosenberg, 2002, p. 2023).

The lack of optimal development has consequences not only for adult health, but also for the health of succeeding generations through the environments created by physically, emotionally, mentally, or spiritually unhealthy adults (Reading & Wien, 2009, p. 25). In terms of the education factor, children at the end of third grade with low literacy skills typically have less access to the regular curriculum, require long-term support, and fall further behind their peers in literacy achievement and curricular knowledge (Sloat, Beswick, & Wilms, 2007). The negative ramifications of poor literacy skills are persistent and well documented: poor self-esteem, low motivation, behavioral difficulties, academic underachievement, and reduced occupational and economic status (Sloat et al., 2007), all of which could lead to compromised health.

In the Aboriginal context, many Aboriginal people consider that health is itself and with others, balanced and harmoniously supported and organized by spiritual law and the reward of Mother Earth (Wilson & Rosenberg, 2002). Nevertheless, for Aboriginal youth, social determinants are often compromised in the current social and economic context within which Aboriginal children live. Social determinants of health have repeatedly been reported as being weak in First Nations populations at all stages of life,
including for the youngest. Health resources have a considerable impact on children’s stages of development. Children and young people in particular, given the lifelong implications of challenges in early life, need a healthy environment in order to optimize brain development and learning skills (Reading & Wien, 2009, p. 25). Social factors impact health at every level, with perhaps the most considerable impact occurring when children grow up in less than optimal living conditions.

2.4 Assessment of Physical Literacy

It is important to measure physical literacy accurately in order to understand current physical literacy levels. To assess children's physical literacy, the present study used the Physical Literacy Assessment for Youth (PLAY) program. This assessment was developed by Canadian Sport for Life (CS4L) with the expertise of Dr. Dean Kriellaars of the University of Manitoba, and incorporates six PLAY tools as follows: PLAYfun (Kriellaars et al., 2013), PLAYbasic (Kriellaars & Robillard, 2013a), PLAYself (Kriellaars & Robillard, 2013d), PLAYcoach (Kriellaars & Robillard, 2013b), PLAYparent (Kriellaars & Robillard, 2013c), and PLAYinventory (Canadian Sport for Life, 2013).

This research used the PLAYfun tool only as it was the most appropriate for this study. The PLAYfun tool assesses a child in 18 fundamental skills and tasks; for example running, jump, throwing, kicking and balance. These 18 fundamental skills are divided in five subsections: (1) running; (2) locomotor; (3) object control, upper body; (4) object control, lower body; and (5) balance, stability, and body control. Each skill and task is recorded based on a scale divided into four categories: Initial (0 – 24), emerging (25 –
49), competent (50 – 74), and proficient (75 – 100) (Kriellaars et al., 2013). As a result, it is possible to measure children’s physical literacy scores, and to study the relationship between their gross motor skills and reading abilities.

The PLAYbasic tool is a simplified version of PLAYfun that is useful in providing a quick assessment of five key movements skills of a child’s physical abilities (Kriellaars & Robillard, 2013a). The PLAYself, PLAYparent and PLAYcoach are not skill assessments: they are forms used to complement the skill assessments, PLAYfun and PLAYbasic (Kriellaars & Robillard, 2013b, 2013c, 2013d). The PLAYself tool is completed by children and youth to assess their own perception of their physical literacy (Kriellaars & Robillard, 2013d). The PLAYparent and the PLAYcoach are forms used by parents and coaches to record their perception of their child’s level of physical literacy. They includes questions about the child’s ability, confidence, participation and more (Kriellaars & Robillard, 2013b, 2013c). Finally, PLAYinventory is a form used to record and track a child’s leisure-time activities throughout the year (Canadian Sport for Life, 2013).

2.5 The Assessment of Motor Coordination

This study used the Jebsen Hand Function Test (JHFT) to assess children’s motor coordination. This assessment is an objective hand function assessment, first standardized for adults, and then standardized for children above five years old (Taylor et al., 1973). The intention of the JHFT is to measure fine and gross motor aspects of hand function normally used in activities of daily living using standardized tasks. It was adapted for children aged above six years and adults who have impairments in their hand(s) (Noonan
et al., 2012; Poole, 2011). The assessments are always presented in the same order. Weighted and non-weighted hand function is assessed through writing a sentence, turning over cards, picking up small common objects and placing them inside a coffee can, simulating feeding by placing beans inside a coffee can, stacking checkers one on top of another, picking up large light cans, and picking up large heavy cans. Children are required to perform all of the subtests with both the right and left hand, with the non-dominant hand measured first (Jebsen et al., 1969; Noonan et al., 2012; Taylor et al., 1973). The results are measured by recording the time taken to accomplish each task (rounded to the nearest second), and the total time to assess a child is 20 minutes. The longer the time required to finish the assessment subscales, the more limitations the participant may display. These subscale scores may be compared to the normative tables conferring to age and sex (Poole, 2011).

2.6 The Assessment of Reading

This research evaluated and compared children’s fine and gross motor coordination abilities, and compares them with their basic reading skills. To assess children’s reading ability we have used the Wechsler Individual Achievement Test—Third Edition Canadian (WIAT–III; Wechsler, 2009), because, according to scholars in the field (Moll, Loff, & Snowling, 2013; Rigoli et al., 2012; Sloat et al., 2007; Wilkinson-Smith & Semrud-Clikeman, 2014), this assessment is a valid, reliable, norm-referenced measure that gives a direct evaluation of reading abilities. The WIAT–III is an individually administered, diagnostic achievement test that includes 16 subtests designed to measure listening, speaking, reading, writing, and mathematics skills (Wechsler,
The WIAT–III includes reading subtests which measure both low-level (word recognition) and high-level (comprehension) skills at the level of the subword, word, and connected text” (Wechsler, 2010b, p. 4). This research measured only the low-level skills: word recognition. According to Wechsler (2009a), basic reading is assessed by two subtests: a two minute word reading (WR) and a two minute pseudoword decoding (PWD) subtest.

2.6.1 Word Reading (WR) and Pseudoword Decoding (PWD) Subtests

The WR subtest assesses speed and accuracy of decontextualized word recognition, while the PWD subtest measures the ability to decode nonsense words (Wechsler, 2009a). Therefore, these evaluations assess a variety of spelling-sound patterns and relate to a more in-depth item and sub-item level skills examination (Wechsler, 2010b). As a result, “a measure of word reading speed (WRS) was added in response to research findings that speed limitations in naming words and pseudowords is characteristic of students with dyslexia” (Wechsler, 2010b, p. 5). Different subtests are used to measure untimed and timed word reading, and the timed subtest guidelines direct the participant to read rapidly, while the untimed subtest guidelines do not. Therefore, research in that area notes that guidelines may alter the student’s performance if one asks them to read rapidly.

The word reading subtest is used to assess reading speed and accuracy under conditions that promote reading without compromising speed or accuracy. This subtest does not include guidelines about how the participant must read, but only inform her or him to read aloud (Wechsler, 2010b). As a result, reading rate and reading accuracy must
be assessed individually. Even though word reading accuracy is a crucial part of the reading process, it is not adequate for judging fluency, which is crucial for comprehension (Wechsler, 2010b). To conclude, the WR subtest has been frequently used in studies examining the relationship between motor skills and academic outcomes (Alloway, 2007; Carlson et al., 2013; Rigoli et al., 2012).

2.7 The Assessment of Controls

As control measures we also wish to assess children's language skills using the Clinical Evaluation of Language Fundamentals – Fifth Edition (CELF–5; Wiig, Semel, & Secord, 2013a), and children’s non-verbal skills using the Coloured Progressive Matrices (CPM; J. C. Raven, 1976; J. Raven, Raven, & Court, 1998). The CELF–5 word classes subtest (WCS) assesses children for sentence comprehension by rating their capacity to comprehend relationships between words on the bases of semantic class features, function, or place or time of occurrence (Wiig et al., 2013a). Several researchers, for example Corriveau & Goswami (2008), Freed et al., (2015), and Gooch et al. (2014) used this assessment to study language and reading associations. Individual differences in language comprehension skills may account for individual differences in reading fluency. Language comprehension refers to the reader’s ability to construct meaning. This skill might impact on fluency in one of two ways. First, readers might adjust their reading rate in order to more fully understand what has just been read. Individual differences might be caused by variations in readers’ abilities to process different text types, make inferences, incorporate background knowledge, process sentence structures, and make connections between meanings of words and sentences (Torgesen & Hudson, 2006). Second, previous
research suggests that words are read faster in context than in isolation (Jenkins, Fuchs, van den Broek, Espin, & Deno, 2003) and that for beginning readers and struggling readers, context assists word identification (Bowey, 1985; Pring & Snowling, 1986). Previous research into the predictive relationship between reading fluency and language comprehension has found small but significant independent contributions of language to reading fluency for beginning readers (Geva & Zadeh, 2006; Torgesen et al., 2001).

The CPM assessment asks children to complete patterns using reasoning skills which evaluated how well the children understand the meaning of visual information and recognize relationships between visual concepts (J. Raven et al., 1998). Several authors contemplate the influence of possible confounding factors, such as nonverbal learning disabilities (NVLD), attention deficit hyperactivity disorder (ADHD) symptoms, socioeconomic status (SES), age, and gender (Alloway, 2007, 2011; Corriveau & Goswami, 2008; Dewey, Kaplan, Crawford, & Wilson, 2002; Fels et al., 2014; Grissmer et al., 2010; Iversen et al., 2005; Larouche et al., 2014; Margari et al., 2013; Rigoli et al., 2012; Schoemaker et al., 2013; Wilkinson-Smith & Semrud-Clikeman, 2014).

2.8 Bases of a Relationship Between Motor Coordination and Reading

There are inconclusive research findings on the relationship between reading skills and motor coordination (Cameron et al., 2012; Carlson et al., 2013; Grissmer et al., 2010; Iversen et al., 2005; Rigoli et al., 2012; Schoemaker et al., 2013), and on whether reading and language development may be affected by motor coordination issues (Carlson et al., 2013; Gooch et al., 2014; Grissmer et al., 2010; Iversen et al., 2005; O’Hare & Khalid, 2002; Rigoli et al., 2012; Rommelse et al., 2009; Zwicker et al., 2009).
The research in this area is not conclusive, and despite a number of studies having been conducted, there is little agreement on the relationship. Also, previous research investigating motor coordination and academic outcomes has included atypical population groups (Alloway, 2007; Schoemaker et al., 2013; Wocadlo & Rieger, 2008). Therefore, further investigation using a normative population is necessary. Rigoli et al. (2012) noted that correlational studies using normative samples are important in order to provide a better understanding of relationships found in children with development coordination disorder (Rigoli et al., 2012).

Gaysina et al. (2010) and Rigoli et al. (2012) did not find any association between reading problems and motor skills. However, they failed to control for possible language difficulties. In contrast, Iversen et al. (2005) conducted a study with two groups of poor readers (one of them children with severe dyslexia) compared to good reading controls, and 50% of the children in both groups of poor readers showed motor coordination difficulties. These children showed difficulties particularly in the sub-area of manual dexterity as well as in balance, but not in ball-skills. The high rate of motor coordination deficits suggests that all children with reading difficulties should be screened for possible motor deficits (Iversen et al., 2005).

To date, no review of the literature has revealed any similar research having been conducted with Canadian or First Nations populations, and thus the decision to focus this research on New Brunswick First Nations elementary school students. The purpose of this study is to examine, evaluate, and compare children’s physical literacy levels, fine and gross motor coordination abilities, and their basic reading skills in grades three and four in a New Brunswick First Nations population.
The motor coordination and the physical literacy assessments were conducted by Manny Pereira, graduate student researcher and author of this study. The reading assessments were conducted by a trained grade three school teacher working at the school where the study took place. The principal of the school was invited to be present during these evaluations.

Schedules and details of data collection—when and how it was collected—were determined in conjunction with the school principal. Collaboration with the school principal and school community ensured that the research design and method met all expectations to ensure an inclusive process, particularly in accordance with the principles of research with First Nations communities in Canada: ownership, control, access, and possession (OCAP). Further details of this process are described in the next chapter.

2.9 Conclusion

The relationship between reading skills and motor coordination is inconclusive (Cameron et al., 2012; Carlson et al., 2013; Grissmer et al., 2010; Iversen et al., 2005; Rigoli et al., 2012; Schoemaker et al., 2013), and on whether reading and language development may be influenced by motor coordination issues (Carlson et al., 2013; Gooch et al., 2014; Grissmer et al., 2010; Iversen et al., 2005; O’Hare & Khalid, 2002; Rigoli et al., 2012; Rommelse et al., 2009; Zwicker et al., 2009). Due to these controversial and inconclusive results, it is important to further pursue research in this area, and here we compare children’s physical literacy levels, fine and gross motor coordination skills, and their basic reading skills in grade three and four children in a New Brunswick First Nations population.
In this chapter, the concept of physical literacy as used in this research project was identified as “the foundation of skills or tools that children need to possess or develop to receive the inherent benefits of taking part in physical activity and sport for life-long enjoyment and success” (Larouche et al., 2014). This study measured physical literacy level and gross motor skills with the PLAYfun tool. Moreover, this chapter relied upon the definition of movement coordination as controlling the movements of a single body part together with the actions of a different body part (Schmidt & Lee, 2011). I measured the fine motor skills with the Jebsen Hand Function Test (JHFT). Finally, in this chapter reading fluency was defined as the ability to identify words quickly and accurately (Hasbrouck & Tindal, 2006; Meyer & Felton, 1999; Nathan & Stanovich, 1991; Torgesen et al., 2001), and whether reading and language development may be correlated with motor coordination issues (Carlson et al., 2013; Gooch et al., 2014; Grissmer et al., 2010; Iversen et al., 2005; O’Hare & Khalid, 2002; Rigoli et al., 2012; Rommelse et al., 2009; Zwicker et al., 2009).

The next chapter of this thesis will describe the methodology used for this research project on the relationship between children’s physical literacy levels, their motor coordination abilities and their basic reading skills.
3 CHAPTER THREE: METHODOLOGY

This chapter will describe the methodology used to evaluate and compare children’s physical literacy levels through the evaluation of fine and gross motor coordination abilities, and their basic reading skills in a population consisting of children in grades three and four attending an on-reserve First Nation elementary school in New Brunswick.

3.1 Experimental Design

This research was conducted at one, on-reserve elementary school in New Brunswick. External constraints limited the data collection, which was completed in April and May, 2015. Due to these limitations and the limited population of the small school, the study group for this research project consisted of 15 students from grades three and four. All components of the research program took place on site at the school, in the community room and in a small office. Children were recruited through invitations from the researcher to participate which were sent home to their parents and guardians by the school. An invitation to participate in the study was also submitted to the school for inclusion in the school’s newsletter and on their website. The students were already acquainted with the main researcher who had been volunteering at the school with the children, staff, and school community for the previous six months prior to the commencement of the research study. See Appendix J for more specific details of letter of invitation, information for parents and guardians, and permission consent form.

The project is unique in terms of the participants; inclusion criteria required participants to be between grades 3 and 4, enrolled at a New Brunswick, on-reserve First
Nation elementary school. Children were evaluated over a total of three weeks in order to accommodate them all, which consisted of a 45 minute evaluation session per child (see Table 1).

**Table 1: Project timeline**

<table>
<thead>
<tr>
<th>Week</th>
<th>Protocol</th>
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<tbody>
<tr>
<td>1</td>
<td>Reading</td>
</tr>
<tr>
<td>2</td>
<td>Reading and motor skills</td>
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<tr>
<td>3</td>
<td>Motor skills</td>
</tr>
</tbody>
</table>

### 3.2 Research Design

The study was administered in accordance with the guidelines of the *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans* (Canadian Institutes of Health Research et al., 2014). It was reviewed by the Faculty of Kinesiology Ethics Committee, and subsequently by the University of New Brunswick Research Ethics Board, and is on file as REB 2015-041.

The three weeks of reading and physical activity evaluation was divided between reading, motor coordination and physical literacy assessments. I administered and scored all assessments in accordance with their respective administration and scoring manuals. This research adhered to *First Nations Principles of OCAP* (ownership, control, access, and possession), which are discussed as an expression of self-determination in research. Ownership refers to the relationship of First Nations to their cultural knowledge, data,
and information. This principle states that a community or group owns information collectively in the same way that an individual owns his or her personal information. The principle of control affirms that First Nations, their communities, and representative bodies are within their rights in seeking control over all aspects of research and information management processes that impact them. First Nations’ control of research may include all stages of a particular research project from start to finish. The principle extends to the control of resources and review processes, the planning process, and management of the information. First Nations must have access to information and data about themselves and their communities, regardless of where it is currently held. The principle also refers to the right of First Nations communities and organizations to manage and make decisions regarding access to their collective information. This may be achieved, in practice, through standardized, formal protocols. While ownership identifies the relationship between a people and their information in principle, possession or stewardship is more concrete. It refers to the physical control of data. Possession is a mechanism by which ownership can be asserted and protected (First Nations Centre, 2007).

To ensure adherence with the principles of OCAP, and to learn more thoroughly about conducting respectful and ethical research with this population, I, the principal investigator, along with my supervisor participated in a research session for investigators on June, 10th, 2014, at the University of Moncton. This event was organized by the New Brunswick Office of the Child and Youth Advocate, and was entitled Toward a Better Collaboration Between Researchers and First Nations. I volunteered in the physical education programme at an elementary school located in a First Nations community for
six months prior to the commencement of this research project. That experience helped me to establish a positive and respectful relationship with the students, school staff and school community.

Throughout my graduate studies, I committed to being informed about, and respectful of, the First Nation communities’ relevant customs and codes of research practice that applied, including the limits of disclosure and the community’s access to data, and made every effort to ensure adherence to the First Nations Principles of OCAP (ownership, control, access, and possession).

3.3 Assessment of Physical Literacy

I used the PLAYfun tool to assess physical literacy in the participants (Kriellaars et al., 2013). This assessment was developed by CS4L in consultation with Dr. Dean Kriellaars of the University of Manitoba. The PLAYfun tool assesses a child in 18 fundamental skills and tasks divided in five subsections. It allows for the measurement and development of a child’s physical literacy score, and for the purposes of this research, for the examination of the relationship between gross motor skills and reading ability.

Physical literacy levels in Canadian children may be measured with several tools: the PLAYfun tool (Kriellaars et al., 2013), the Passport for Life program (Physical and Health Education Canada, 2013), and the Canadian Assessment of Physical Literacy (Healthy Active Living and Obesity Research Group, 2013). These three assessments have a variety of task abilities to be measured, and different rating system criteria. In the same way, these three different assessments are graded on a four-point rubric, so they
have a similar scale divided in four categories which allow for the calculation of the child’s physical literacy score. For example, the PLAYfun tool is divided in initial, emerging, competent, and proficient categories. The Passport for Life program is divided in emerging, developing, acquired, and accomplished sections. The Canadian Assessment of Physical Literacy is divided in beginning, progressing, achieving, and excelling groups.

I chose the PLAYfun tool to measure children’s physical literacy score because of the number of tasks in this tool compared with the Passport for Life and the Canadian Assessment of Physical Literacy assessments. The first reason is that PLAYfun tool has 18 different fundamental movement skills/tasks to find the physical literacy score, while the Passport for Life program and the Canadian Assessment of Physical Literacy have nine and five tasks, respectively. Within the run category, the PLAYfun tool has three different tasks, while the Passport for Life program and the Canadian Assessment of Physical Literacy have one and no tasks, respectively. Next, considering the locomotor category, the PLAYfun tool has five different tasks, while the Passport for Life program and the Canadian Assessment of Physical Literacy have one and four tasks, respectively. Then, considering the object control, upper body category, the PLAYfun tool has three different tasks, while the Passport for Life program and the Canadian Assessment of Physical Literacy have one and two tasks, respectively. Regarding the object control, lower body category, the PLAYfun tool has two different tasks, while both the Passport for Life program and the Canadian Assessment of Physical Literacy have one task only. Finally, considering the balance, stability and body control category, the PLAYfun tool has four different tasks, while the Passport for Life program and the Canadian
Assessment of Physical Literacy have one and zero tasks, respectively. I chose the PLAYfun tool to measure the physical literacy score and gross motor skills, because there were more tasks available when compared with the common tasks in the Passport for Life, and the Canadian Assessment of Physical Literacy. Having more tasks allowed me to conduct more correlations between gross motor skills and reading. This is an advantage because it allows for the coverage of a larger segment of gross motor skills, and more specific movements.

3.3.1 Physical Literacy Assessment for Youth - Fundamental Skills (PLAYfun)

The PLAYfun tool was used to administer and score the results in accordance with the published administration and scoring manuals (Kriellaars et al., 2013). Appendix A within this document has a description of the specific details of instructions and procedures associated with this assessment.

I used the PLAYfun tool to measure physical literacy accurately in order to understand the children’s current physical literacy levels. The PLAYfun tool assesses a child in 18 fundamental skills/tasks divided in five subsections: (1) running - run a square; run there and back; and run, jump and land on two feet; (2) locomotor - crossovers; skip; gallop; hop; and jump; (3) object control, upper body: overhand throw; strike with stick; one-handed catch; and hand dribble stationary and moving forward; (4) object control, lower body: kick a ball; and foot dribble moving forward; and (5) balance, stability, and body control: balance walk (heel-to-toe) forward; balance walk (toe-to-heel) backward; drop to ground and back up; and lift and lower (Kriellaars et al., 2013). Each
skill or task is recorded based on a scale divided into four categories: Initial (0 – 24), emerging (25 – 49), competent (50 – 74), and proficient (75 – 100). The higher the physical literacy score, the higher the physical literacy competence the participant has (Kriellaars et al., 2013).

3.4 Assessment of Motor Coordination

The Jebsen Test of Hand Function (JHFT) was used to administer and score the results in accordance with the published administration and scoring manuals (Jebsen et al., 1969; Taylor et al., 1973). See Appendix B for more specific details of instructions and procedures associated with this assessment.

Taylor et al. (1973) standardized the JHFT for children aged above five years of age. This assessment measures fine and gross motor aspects of hand function (Noonan et al., 2012; Poole, 2011). Hand function is measured through writing a sentence, turning over cards, picking up small common objects and placing them inside a coffee can, simulating feeding by placing beans inside a coffee can, stacking checkers one on top of another, picking up large light cans, and picking up large heavy cans. Children are asked to perform all of the subtests with both the right and left hand, with the non-dominant hand tested first (Jebsen et al., 1969; Noonan et al., 2012; Taylor et al., 1973). The outcomes are measured by recording the time taken to complete each task. The longer the time necessary to finish the test subscales, the more incapacity the participant has (Poole, 2011).
3.5 Assessment of Reading

3.5.1 Wechsler Individual Achievement Test—Third Edition (WIAT–III)

Canadian

An experienced teacher from the school with an extensive background in assessment administered the reading evaluation and the controller tests to all the children. I was present during the reading and controller evaluations, although I did not participate in the assessment. The WIAT–III, WR and PWD subtests were administered and scored in accordance with the published administration and scoring manuals (Wechsler, 2009a, 2009b, 2009c, 2010a, 2010b). See Appendix C for more specific details of instructions and procedures associated with this assessment.

I utilized the WIAT–III (Wechsler, 2009a) to assess the children's reading ability (Moll et al., 2013; Rigoli et al., 2012; Sloat et al., 2007; Wilkinson-Smith & Semrud-Clikeman, 2014). The WR and PWD subtests assess the basic reading. The WR subtest assesses speed and accuracy of decontextualized word recognition, while the PWD subtest measures speed, accuracy, and the ability to decode nonsense words (Wechsler, 2009a). The participant receives a word card and a pseudoword card during the administration of the WR and PWD subtests, respectively (Wechsler, 2009b, 2009c).
3.6 Assessment of Controls

3.6.1 Clinical Evaluation of Language Fundamentals – Fifth Edition

(CELF–5) – Word Classes Subtest (WCS)

The CELF–5 was used to administer and score the results in accordance with the published administration and scoring manuals (Wiig et al., 2013a; Wiig, Semel, & Secord, 2013b, 2013c, 2013d). See Appendix D for more specific details of instructions and procedures associated with this assessment.

The CELF–5 is an individually-administered clinical tool for the identification, diagnosis, and follow-up evaluation of language and communication disorders in students ages 5-21 years. The CELF–5 includes 16 subtests; however this research only used the WCS (Wiig et al., 2013a). The CELF–5 WCS assesses children for sentence comprehension by rating their capacity to comprehend relationships between words on the basis of semantic class features, function, or place or time of occurrence (Wiig et al., 2013a).

3.6.2 Coloured Progressive Matrices (CPM)

The Coloured Progressive Matrices, or CPM, assessment was used to administer and score the results in accordance with the published administration and scoring manuals (J. C. Raven, 1976; J. Raven et al., 1998). See Appendix E for more specific details of instructions and procedures associated with this assessment.

The CPM assessment asks children to complete patterns using reasoning skills which evaluate how well the children understand the meaning of visual information and recognize relationships between visual concepts (J. Raven et al., 1998). “Children whose
lower reading scores are consistent with their lower NVLD have been referred to as low achievers or garden variety poor readers” (National Reading Panel (U.S.); National Institute of Child Health and Human Development (U.S.), 2000, Chapter 2, p. 106).

3.7 Procedure

An experienced teacher from the school with an extensive background in assessment administered the reading evaluation and the controller assessments to all the children. The school principal requested that the teacher be the individual who administered the reading tests because of her experience with the testing and her familiarity with the children. I was present during the assessments. For all the children, the Jebsen Hand Function Test and the Physical Assessment of Physical Literacy assessments were administered by me.

The teacher and I had practice in administering the respective assessments prior to the final evaluation. I had six years of experience teaching physical education to children in Portugal from 2007 to 2013. I am knowledgeable and familiar with pedagogy, and comfortable working with children engaged in physical activity, education, and sport. In order to further enhance inter-tester reliability, I included preparatory video-analyses of measuring procedures and scoring was undertaken. I conducted all measurements at a local school in the same test-room and with the same test-kit, following the administering procedures described in the assessments’ manuals. See Appendix A, B, C, D and E.

3.8 Statistical Analysis

To determine if there is a relationship between fine and gross motor skills and reading ability of children, correlation, partial correlations, and independent t-tests were
Conducted. Correlation is used in order to analyze the strength of the relationship between two variables, while partial correlation includes confounding variable for a more exact effect of the relationship between the desirable variables (Field, 2009).

Motor coordination was measured by running, locomotion, object control, balance, stability and body control, and hand function. These would be correlated with basic reading that was measured by Word Reading (WR) and Pseudoword Decoding (PWD) subtests. Partial correlations were conducted to include non-verbal abilities (CPM) and language (CELF) as confounding variables. Independent t-tests were performed when comparing the results between males and females. The Pearson correlations were used with a \( p < 0.05 \). Because of the small sample size, the threshold of the confidence level was set at \( p < 0.05 \). All data will be analyzed using IBM SPSS software, because this software program is able to conduct correlation, partial correlations, and independent t-tests (Pallant, 2007).

Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity and homoscedasticity. Normality Scores on each variable should be normally distributed. This was checked by examining the histograms of scores on each variable. Scatterplots of the variables of interest visually showed a linear relationship, with a straight line, not a curve. Homoscedasticity showed that the variables were evenly spread in a reasonable cigar shape relationship and visually appeared linear (Pallant, 2007). It is therefore safe to proceed with calculating Pearson’s correlation coefficients.
3.9 Conclusion

This chapter has described the methodology used in this research project which evaluated and compared grade three and four children’s physical literacy levels through the evaluation of fine and gross motor coordination abilities, and their basic reading skills at an on-reserve First Nation elementary school in New Brunswick. The following chapter will present these results.
In order to evaluate and compare children’s physical literacy levels, their fine and gross motor coordination abilities and basic reading skills were evaluated. The population consisted of grade three and four children attending an on-reserve First Nation elementary school in New Brunswick. This chapter will present the results of the evaluations.

4.1 Participation

A total of 15 children (ten females and five males) met eligibility criteria to participate in this study, and all 15 returned parental consent forms. The average age of the participants was 8.7, SD ± .88 years.

4.2 Normality

The data was found to be normal according to the Shapiro-Wilk test of normality, excepting for six variables: JHFT NDH Task 3 small common objects; JHFT NDH task 5 checkers; PLAYfun task 9, overhand throw; PLAYfun task 11, one, handed catch; PLAYfun task 16, balance walk (toe, to, heel) backward; and PLAY BSS. These variables did not respect normality, so the variables were transformed using the inverse, square, and log10 technique according to Tabachnick & Fidell (2007). However, only two of six variables were normally distributed using the inverse technique: JHFT - NDH task 3, small common objects and JHFT – NDH, task 5 checkers. For these two transformed variables, the Pearson correlation showed a strong correlation, so the
transformed variables are acceptable to use. The other four variables worsened with the transformations; as a result I decided to keep the original variables.

### 4.3 Sex Differences on the PLAYfun Tasks

Gender might play a role in coordination, as indicated by (Alloway 2007, 2011) that males are more likely to have worse results with coordination than females. Independent sample t-test was conducted to see whether there were differences between males and females in the different PLAY tool tasks and scores, in order to assess if physical literacy scores were skewed according to gender. All the PLAYfun physical literacy scores of running, locomotor, object control – upper body, object control – lower body, balance, stability and body control, and physical literacy score were located at the emerging category for males and females, excepting for males running score that was located in the competent category. Of the 18 tasks, there were no significant differences between males and females. However, on average, males had a greater score in PLAYfun task 14, foot dribble moving forward ($M = 45.00, SE = 1.97$) than to females ($M = 35.50, SE = 3.41$). This difference was significant $t(12.81) = -2.41, p < .05$; it did represent a large-sized effect $r = .56$.

**Table 2: Results of Independent Sample T-Test for PLAYfun by gender**

<table>
<thead>
<tr>
<th>PLAYfun tasks</th>
<th>Gender</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>Std. Error Mean</th>
<th>Mean difference</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
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<td>11.11</td>
<td>3.51</td>
<td>9.63</td>
<td>-1.80</td>
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<td>Count</td>
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Task 17  F  10  31.10  18.30  5.79  11.90  -1.18  .26  
  M  5  43.00  18.59  8.31  

Task 18  F  10  52.30  6.27  1.98  1.10  -.28  .78  
  M  5  53.40  8.96  4.01  

Total Score  F  10  42.56  6.93  2.19  5.75  -1.41  .18  
  M  5  48.31  8.47  3.79  

Note. **p < .05

4.4  Sex Differences on the JHFT Tasks

Independent sample t-tests were conducted to determine the difference between males and females in the different JHFT tasks. The results were measured by recording the time taken to accomplish each task (rounded to the nearest second). The longer the time required to finish the assessment subscales, the more limitations the participant may display (Poole, 2011).

Table 3: Results of Independent Sample T-Test for JHFT by gender

<table>
<thead>
<tr>
<th>JHFT Tasks</th>
<th>Gender</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
<th>Mean difference</th>
<th>t</th>
<th>p</th>
</tr>
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<tbody>
<tr>
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<td>52.43</td>
<td>12.56</td>
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</tr>
<tr>
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<td>M</td>
<td>5</td>
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</tr>
<tr>
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<td>-----</td>
<td>-----</td>
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<td>0.11</td>
<td>0.91</td>
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<td>1.91</td>
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<td>0.60</td>
<td>0.56</td>
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<td>4.90</td>
<td>2.19</td>
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<td></td>
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<td>1.16</td>
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<td>0.14</td>
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<tr>
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<td>3.10</td>
<td>3.44</td>
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<td>0.59</td>
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<tr>
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<td>5.61</td>
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<td>-0.55</td>
<td>2.02</td>
<td>0.06</td>
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<td>4.31</td>
<td>.48</td>
<td>.21</td>
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</tbody>
</table>
### 4.5 Sex Differences on the Reading and Controller Assessments

Independent sample t-tests were conducted to see the difference between males and females in the different reading and controller assessments.

**Table 4: Results of Independent Sample T-Test for nonverbal abilities, language and reading by gender**

<table>
<thead>
<tr>
<th>Tests</th>
<th>Gender</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
<th>Mean difference</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPM</td>
<td>Female</td>
<td>10</td>
<td>28.10</td>
<td>4.28</td>
<td>1.35</td>
<td>-1.70</td>
<td>.73</td>
<td>.48</td>
</tr>
<tr>
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<td>Male</td>
<td>5</td>
<td>26.40</td>
<td>4.16</td>
<td>1.86</td>
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<td></td>
</tr>
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<td>3.13</td>
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<td>-.20</td>
<td>.10</td>
<td>.92</td>
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<td>23.40</td>
<td>4.62</td>
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<td>33.20</td>
<td>11.25</td>
<td>3.56</td>
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<td>.68</td>
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<td>19.60</td>
<td>13.12</td>
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<td>1.80</td>
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<td>.82</td>
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<td>21.40</td>
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<td>2.58</td>
<td>-.64</td>
<td>.54</td>
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<td>21.25</td>
<td>9.39</td>
<td>4.70</td>
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<td></td>
</tr>
</tbody>
</table>

*NDH - Non-Dominant hand; DH - Dominant hand; T - Total; T1 - Task 1, Writing; T2 - Task 2, Turning over 3-by-5-inch cards (simulated page turning); T3 - Task 3, Picking up small common objects; T4 - Task 4, Simulated feeding; T5 - Task 5, Stacking checkers; T6 - Task 6, Picking up large light objects; T7 - Task 7, Picking up large heavy objects.*

Note. *Excluding writing.
Levene’s Test for Equality of Error Variances determines whether the error variance of the dependent variable is equal across all the groups. Almost all of the values were non-significant, indicating equal variance among females and males across the factors at each time point. The PLAY Task 1, PLAY Task 14, JHFT DH T2 were significant, so the values of equal variances not assumed were utilized.

As I discussed in 3.8 above, preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity and homoscedasticity. Normality scores on each variable should be normally distributed. This was checked by examining the histograms of scores on each variable. Scatterplots of the variables of interest visually showed a linear relationship, with a straight line, not a curve. Homoscedasticity showed that the variables were evenly spread in a reasonable cigar shape relationship and visually appeared linear (Pallant, 2007). It is safe to proceed with calculating Pearson’s correlation coefficients.

### 4.6 PLAYfun and Reading Correlation and Partial Correlation

Scatterplots were visualized and analyzed and almost all the variables were acceptable to procedure with correlations. Scatterplots are in Appendix F, G, H, and I.

**Table 5: Correlation between PLAYfun and Reading, controlled for language and nonverbal abilities**

<table>
<thead>
<tr>
<th>Control Variables</th>
<th>PLAYfun Tasks</th>
<th>WR TRS</th>
<th>WRS TRS</th>
<th>PWD TRS</th>
<th>PWDS TRS</th>
<th>WCS TRS</th>
<th>CPM TRS</th>
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<td>.037</td>
<td>.163</td>
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<td>-.118</td>
<td>-.359</td>
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<td>Task 14</td>
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<td>.055</td>
<td>.404</td>
<td>.211</td>
<td>.482*</td>
<td>.459*</td>
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<td>-.074</td>
<td>-.014</td>
<td>.102</td>
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<td>.019</td>
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</table>
A correlation was conducted between PLAYfun and reading. There was a positive significant relationship between PLAYfun task 5, skipping and the word classes subtest, \( r = .584, p \) (two-tailed) < .05. This indicates that skipping score increased and the word classes subtest score increased.

At the same time, partial correlations were applied controlling by language (CELF assessment) and nonverbal abilities (CPM assessment). In that situation, first, there was a negative significant relationship between the PLAYfun task 9, overhand throw and the word reading speed, \( r = -.588, p \) (two-tailed) < .05. This indicates that overhand throw score increased and the word reading speed score decreased. Second, there was a negative significant relationship between the object control, upper body score and the word reading, \( r = -.579, p \) (two-tailed) < .05. This indicates that object control, upper body score increased and the word reading score decreased. All the other variables were not correlated. Scatterplots are in Appendix F.

**Table 6: Correlation among female gender between PLAYfun and reading, controlled for language, and nonverbal abilities**

<table>
<thead>
<tr>
<th>Control Variables</th>
<th>PLAYfun Tasks</th>
<th>WR TRS</th>
<th>WRS</th>
<th>PWD TRS</th>
<th>PWDS</th>
<th>WCS TRS</th>
<th>CPM TRS</th>
</tr>
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<td>None -a</td>
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<td>.535</td>
<td>.317</td>
<td>.645**</td>
<td>.389</td>
<td>.433</td>
<td>.433</td>
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</table>
A correlation was conducted between PLAYfun and reading only for female gender, whereas the sample size for male gender (2 of 5) led to inconclusive results. There was a positive significant relationship between the PLAYfun task 3, run, jump and land on two feet and the pseudoword decoding, \( r = .645 \), \( p \) (two-tailed) < .05. This indicates that run, jump and land on two feet score increased and the pseudoword decoding score increased; PLAYfun task 14, foot dribble moving forward was significantly positive correlated with pseudoword decoding, \( r = .675 \), and word classes subtest, \( r = .717 \); the PLAYfun task 14, foot dribble moving forward was also positive correlated with nonverbal abilities, \( r = .759 \) (all \( p < .05 \)). This indicates that foot dribble moving forward score increased and pseudoword decoding score, word classes score, and nonverbal abilities increased; and there was a negative significant relationship between the PLAYfun task 17, drop to ground and back up and the word reading speed, \( r = -.642 \), \( p \) (two-tailed) < .05. This

<table>
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<th>Task</th>
<th>RS</th>
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<th>BSS</th>
<th>BCS</th>
<th>BSBCS</th>
<th>WCS TRS &amp; CPM TRS</th>
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<td>.675**</td>
<td>.230</td>
<td>.717**</td>
<td>.759**</td>
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</tr>
<tr>
<td>RS</td>
<td>.269</td>
<td>.165</td>
<td>.575*</td>
<td>.272</td>
<td>.113</td>
<td>.189</td>
</tr>
<tr>
<td>OCLBS</td>
<td>.344</td>
<td>.126</td>
<td>.579*</td>
<td>.187</td>
<td>.454</td>
<td>.576*</td>
</tr>
<tr>
<td>BSS</td>
<td>-.530</td>
<td>-.508</td>
<td>-.587*</td>
<td>-.535</td>
<td>-.234</td>
<td>-.338</td>
</tr>
<tr>
<td>BCS</td>
<td>-.487</td>
<td>-.620*</td>
<td>-.379</td>
<td>-.501</td>
<td>.222</td>
<td>-.242</td>
</tr>
<tr>
<td>BSBCS</td>
<td>-.564*</td>
<td>-.609*</td>
<td>-.552*</td>
<td>-.573</td>
<td>-.052</td>
<td>-.329</td>
</tr>
</tbody>
</table>

Note. Correlation indicated by \( NS = \) not significant \((p > .05)\), \( * p < .1, ** p < .05 \)

a. Cells contain zero-order (Pearson) correlations.
indicates that drop to ground and back up increased and the word reading speed score decreased.

At the same time, partial correlations were applied controlling by language (CELF assessment) and nonverbal abilities (CPM assessment). In that situation, all the variables were not correlated. Scatterplots are in Appendix G.

### 4.7 JHFT and Reading Correlation

Initial analyses were completed to guarantee no violation of the assumptions of normality, linearity and homoscedasticity (Pallant, 2007).

**Table 7: Correlation between JHFT and reading, controlled for language and nonverbal abilities**

<table>
<thead>
<tr>
<th>Control Variables</th>
<th>JHFT Tasks</th>
<th>WR TRS</th>
<th>WRS TRS</th>
<th>PWD TRS</th>
<th>PWDS TRS</th>
<th>WCS TRS</th>
<th>CPM TRS</th>
</tr>
</thead>
<tbody>
<tr>
<td>-none.*</td>
<td>NDH T2</td>
<td>.011</td>
<td>-.097</td>
<td>-.029</td>
<td>-.336</td>
<td>-.468</td>
<td>-2.289</td>
</tr>
<tr>
<td></td>
<td>NDH T5</td>
<td>.511*</td>
<td>.565**</td>
<td>.395</td>
<td>.458</td>
<td>-.066</td>
<td>.209</td>
</tr>
<tr>
<td></td>
<td>NDH T6</td>
<td>.686**</td>
<td>.491*</td>
<td>.484*</td>
<td>.429</td>
<td>.449*</td>
<td>.455*</td>
</tr>
<tr>
<td></td>
<td>DH T1</td>
<td>-.208</td>
<td>-.432</td>
<td>-.257</td>
<td>-.486</td>
<td>-1.68</td>
<td>-1.172</td>
</tr>
<tr>
<td></td>
<td>DH T3</td>
<td>.614**</td>
<td>.664**</td>
<td>.567**</td>
<td>.656**</td>
<td>.366</td>
<td>.323</td>
</tr>
<tr>
<td></td>
<td>DH T5</td>
<td>-.380</td>
<td>-.534**</td>
<td>-.338</td>
<td>-.229</td>
<td>-1.70</td>
<td>-.354</td>
</tr>
<tr>
<td></td>
<td>DH T6</td>
<td>.083</td>
<td>-.212</td>
<td>.180</td>
<td>-.480*</td>
<td>.037</td>
<td>.124</td>
</tr>
<tr>
<td></td>
<td>T3 T</td>
<td>.466*</td>
<td>.334</td>
<td>.540**</td>
<td>.572**</td>
<td>.254</td>
<td>.316</td>
</tr>
<tr>
<td></td>
<td>T5 T</td>
<td>.444*</td>
<td>.426</td>
<td>.318</td>
<td>.460</td>
<td>-.182</td>
<td>.068</td>
</tr>
<tr>
<td></td>
<td>T6 T</td>
<td>.605**</td>
<td>.304</td>
<td>.484*</td>
<td>.198</td>
<td>.388</td>
<td>.435</td>
</tr>
</tbody>
</table>

| WCS TRS & CPM TRS | NDH T5  | .482*  | .542*   | .310    | .490    |
|                   | NDH T6  | .661** | .412    | .326    | .317    |
|                   | NDH T   | .523*  | .235    | .175    | -.135   |
|                   | DH T2   | .564** | .317    | .288    | .191    |
|                   | DH T3   | .668** | .651**  | .549*   | .609**  |
|                   | DH T6   | -.033  | -.292   | .118    | -.556*  |
|                   | T3 T    | .382   | .249    | .475    | .522*   |
|                   | T5 T    | .521*  | .431    | .318    | .540*   |
a. Cells contain zero-order (Pearson) correlations.

*Note. Correlation indicated by $NS = \text{not significant (} p > .05\text{), } ^* p < .1, \ ** p < .05$

A correlation was conducted between JHFT and reading. There was a positive significant relationship between the non-dominant hand task 5, stacking checkers one on top of another and the word reading speed, $r = .565$, $p \text{ (two-tailed)} < .05$. This indicates that non-dominant hand stacking checkers one on top of another time score increased and the word reading speed score increased; there was a positive significant relationship between the non-dominant hand task 6, picking up large light objects and the word reading, $r = .686$, $p \text{ (two-tailed)} < .05$. This indicates that non-dominant hand picking up large light objects time score increased and the word reading score increased; dominant hand task 1, writing a sentence was significantly positive correlated with word reading, $r = .614$, and word reading speed, $r = .664$; the dominant hand task 1, writing a sentence was also significantly positive correlated with pseudoword decoding, $r = .567$, and pseudoword decoding speed, $r = .656$ (all $p$s < .05). This indicates that dominant hand writing a sentence time score increased and word reading score, word reading speed score, pseudoword decoding score, and pseudoword decoding speed score increased; there was a negative significant relationship between the dominant hand task 5, stacking checkers one on top of another and the word reading speed, $r = -.534$, $p \text{ (two-tailed)} < .05$. This indicates that the dominant hand stacking checkers one on top of another time score increased and the word reading speed score decreased; task 3, picking up small common objects total was significantly positive correlated with pseudoword decoding, $r = .540$, and pseudoword decoding speed, $r = .572$ (all $p$s < .05). This indicates that picking up
small common objects total time score increased and pseudoword decoding score, and pseudoword decoding speed score increased; and there was a positive significant relationship between the task 6, picking up large light objects total and the word reading, \( r = .605, p \text{ (two-tailed)} < .05 \). This indicates that picking up large light objects total time score increased and the word reading score increased.

At the same time, partial correlations were applied controlling by language (CELF assessment) and nonverbal abilities (CPM assessment). First, there was a positive significant relationship between the non-dominant hand task 6, picking up large light objects and the word reading, \( r = .661, p \text{ (two-tailed)} < .05 \). This indicates that picking up large light objects time score increased and the word reading score increased; there was a positive significant relationship between the dominant hand task 2, card turning (simulated page turning) and the word reading, \( r = .564, p \text{ (two-tailed)} < .05 \). This indicates that card turning (simulated page turning) time score increased and the word reading score increased; and dominant hand task 3, picking up small common objects was significantly positive correlated with word reading, \( r = .668, \) and word reading speed, \( r = .651 \); the dominant hand task 3, picking up small common objects was also positive correlated with pseudoword decoding speed, \( r = .609 \) (all \( p < .05 \)). This indicates that picking up small common objects time score increased and word reading score, word reading speed score, and pseudoword decoding speed score increased. Scatterplots are in Appendix H.

**Table 8: Correlation among female gender between JHFT and reading, controlled for language, and nonverbal abilities**
A correlation was conducted between JHFT and reading for female gender. The same was done for the male gender, but led to inconclusive results due to the limited number of male participants. Among females, there was a negative significant relationship between the non-dominant hand task 2, card turning (simulated page turning) and the pseudoword decoding speed, $r = -0.733$, $p$ (two-tailed) $< 0.05$. This indicates that non-dominant hand card turning (simulated page turning) time score increased and the pseudoword decoding speed score decreased; there was a negative significant relationship between the task 2, card turning (simulated page turning) total and the pseudoword decoding speed, $r = -0.771$, $p$ (two-tailed) $< 0.05$. This indicates that card turning (simulated page turning) total time score increased and the pseudoword decoding speed score decreased; and task 3, picking up small common objects total was significantly positive correlated with pseudoword decoding, $r = 0.643$, and nonverbal abilities, $r = 0.774$ (all $p$s $< 0.05$). This indicates that

<table>
<thead>
<tr>
<th>Control Variables</th>
<th>JHFT Tasks</th>
<th>WR TRS</th>
<th>WRS TRS</th>
<th>PWD TRS</th>
<th>PWDS TRS</th>
<th>WCS TRS</th>
<th>CPM TRS</th>
</tr>
</thead>
<tbody>
<tr>
<td>-none-“a”</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NDH T2</td>
<td>-0.257</td>
<td>-0.289</td>
<td>-0.304</td>
<td>-0.733**</td>
<td>-0.189</td>
<td>-0.145</td>
<td></td>
</tr>
<tr>
<td>DH T1</td>
<td>-0.076</td>
<td>-0.439</td>
<td>-0.225</td>
<td>-0.548</td>
<td>0.600†</td>
<td>0.254</td>
<td></td>
</tr>
<tr>
<td>DH T2</td>
<td>0.023</td>
<td>-0.110</td>
<td>-0.299</td>
<td>-0.648†</td>
<td>-0.120</td>
<td>0.072</td>
<td></td>
</tr>
<tr>
<td>DH T5</td>
<td>-0.525</td>
<td>-0.629†</td>
<td>-0.403</td>
<td>-0.452</td>
<td>0.134</td>
<td>-0.214</td>
<td></td>
</tr>
<tr>
<td>T T2</td>
<td>-0.135</td>
<td>-0.222</td>
<td>-0.326</td>
<td>-0.771**</td>
<td>-0.169</td>
<td>-0.046</td>
<td></td>
</tr>
<tr>
<td>T T3</td>
<td>0.602†</td>
<td>0.302</td>
<td>0.643**</td>
<td>0.462</td>
<td>0.564†</td>
<td>0.774**</td>
<td></td>
</tr>
</tbody>
</table>

a. Cells contain zero-order (Pearson) correlations.

Note. Correlation indicated by $NS = $ not significant ($p > .05$), † $p < .1$, ** $p < .05$
picking up small common objects total time score increased and the pseudoword decoding score, and nonverbal abilities decreased.

At the same time, partial correlations were applied controlling by language (CELF assessment) and nonverbal abilities (CPM assessment). In that situation, there was a negative significant relationship between the non-dominant hand task 2, card turning (simulated page turning) and the pseudoword decoding speed, r = -.827, p (two-tailed) < .05. This indicates that non-dominant hand card turning (simulated page turning) time score increased and the pseudoword decoding speed score decreased; there was a negative significant relationship between the dominant hand task 2, card turning (simulated page turning) and the pseudoword decoding, r = -.877, p (two-tailed) < .05. This indicates that dominant hand card turning (simulated page turning) time score increased and the pseudoword decoding score decreased; and there was a negative significant relationship between the task 2, card turning (simulated page turning) total and the pseudoword decoding speed, r = -.940, p (two-tailed) < .05. This indicates that card turning (simulated page turning) total time score increased and the pseudoword decoding speed score decreased. Scatterplots are in Appendix I.
5 CHAPTER FIVE: DISCUSSION

5.1 Overview

The purpose of this study is to examine, evaluate and compare children’s physical literacy levels through the evaluation of fine and gross motor coordination abilities, and their basic reading skills in grade three and four children in a New Brunswick First Nations population. This is one of the earliest research studies in the area of physical literacy which has incorporated the PLAYfun tool to assess children’s physical literacy skills. The relationship between reading skills and motor coordination is controversial (Cameron et al., 2012; Carlson et al., 2013; Grissmer et al., 2010; Iversen et al., 2005; Rigoli et al., 2012; Schoemaker et al., 2013), and on whether reading and language development may be influenced by motor coordination issues (Carlson et al., 2013; Gooch et al., 2014; Grissmer et al., 2010; Iversen et al., 2005; O’Hare & Khalid, 2002; Rigoli et al., 2012; Rommelse et al., 2009; Zwicker et al., 2009).

For this research measuring children's motor behaviors, the Jebsen Hand Function Test (JHFT) was used to measure fine and gross motor skills (Taylor et al., 1973). Hand function was evaluated during regular activities of daily living using standardized tasks, for instance writing, and picking up large heavy cans (Jebsen et al., 1969; Noonan et al., 2012; Taylor et al., 1973). The outcomes have been calculated by recording the time taken to finish each task. The longer the time necessary to complete the assessment subscales, the more limitations the participant may have (Poole, 2011). The PLAYfun tool was used to measure children’s physical literacy level, and gross motor skills by
examining fundamental movement and sport skills using standardized tasks such as running, jumping and kicking a ball (Kriellaars & Robillard, 2013a).

5.2 Correlation Between Fine Motor Skills and Basic Reading

For the Jebsen Hand Function Test (JHFT), seven correlations (p < 0.05) were found with word reading (WR), word reading speed (WRS), pseudoword decoding (PWD), and pseudoword decoding speed (PWDS) in a total of 64 possible correlations. These correlations were: non-dominant hand stacking checkers one on top of another time score increased and the word reading speed score increased; non-dominant hand picking up large light objects time score increased and the word reading score increased; dominant hand writing a sentence time score increased and word reading score, word reading speed score, pseudoword decoding score, and pseudoword decoding speed score increased; dominant hand stacking checkers one on top of another time score increased and the word reading speed score decreased; picking up small common objects total time score increased and pseudoword decoding score, and pseudoword decoding speed score increased; picking up large light objects total time score increased and the word reading score increased.

With these results there were mostly no association between these fine motor elements and reading scores. First, WR is correlated just in two different tasks out of a total of 14 possible correlations: WR is correlated with dominant hand task 3; and WR is correlated with non-dominant hand task 6. Second, the WRS is similar to WR situation. WRS is correlated just in three different tasks out of a total of 14 possible correlations: WRS is correlated with dominant hand task 3; WRS is correlated with dominant, and
non-dominant hand task 5. Third, PWD is correlated just in one task of a total of 14 possible correlations: PWD is correlated with dominant hand task 3. Fourth, the PWDS is similar to PWD situation. PWDS is correlated just in one task of a total of 14 possible correlations: PWDS is correlated with dominant hand task 3.

Similar to the seven correlations found before, only five correlations (p < 0.05) were found between JHFT and the four previous mentioned reading outcomes, in a total of 64 possible correlations, when controlled for language (CELF assessment) and nonverbal abilities (CPM assessment). These partial correlations were: picking up large light objects time score increased and the word reading score increased; card turning (simulated page turning) time score increased and the word reading score increased; picking up small common objects time score increased and word reading score, word reading speed score, and pseudoword decoding speed score increased.

With these results there were mostly no association between these fine motor elements and reading scores. First, WR is correlated just in three different tasks out of a total of 14 possible correlations: WR is correlated with dominant hand task 2; WR is correlated with dominant hand task 3; and WR is correlated with dominant hand task 3. Second, WRS is correlated just in with one task of a total of 14 possible correlations: WRS is correlated with dominant hand task 3. Third, PWD is correlated just with one task of a total of 14 possible correlations: PWD is not correlated with any task. Fourth, PWDS is correlated just with one task of a total of 14 possible correlations: PWDS is correlated with dominant hand task 3.

Carlson et al. (2013) refers to associations between kindergarten visual-spatial integration (VSI) skills and reading outcomes at age ten, but only in one of three
longitudinal datasets, and in other study the same author refers to associations between preschool VSI skills and kindergarten reading skills. In this study, word reading is correlated with two JHFT fine motor tasks of 14 tasks. However, the correlations increase to 3 tasks, when controlled for nonverbal abilities and language. Although the JHFT content validity is questioned by Poole (2011), this test was chosen due to its accessibility, non-time-consuming, and ease of use. VSI relies more on synchronized hand-eye movements than visual-motor coordination (VMC). On the one hand, VMC is theorized as fine motor coordination with a visual part. These skills are captured by various sensorimotor tasks such as tracing, finger tapping, and imitative hand movements. On the other hand, VSI from the environment must be processed and integrated with fine motor movements; including incorporating visual judgments of object position and directionality with fine motor output. VSI skills are often captured with tasks that involve writing, and copying (Carlson et al., 2013). In the JHFT, the hands are tested individually; however many tasks of daily living are bilateral, for example, tying a bow or buttoning. Also, page turning and simulated feeding tasks do not duplicate the actual tasks of real life (Poole, 2011).

These results partially confirm research in the area which found no relationship between reading challenges and fine motor skills (Gaysina et al., 2010; Rigoli et al., 2012). However, findings from Iversen et al.’s (2005) study differs from these results, where the researchers found difficulties in the sub-area of manual dexterity in 50% of the children in two groups of poor readers (one of them children with severe dyslexia), compared to good reading controls. A possible explanation for the difference between my results and Iversen et al.’s (2005) is that I used Taylor et al.’s (1973) standardized JHFT
for children. This test measured not only fine, but also gross motor aspects of hand function (Noonan et al., 2012; Poole, 2011).

When analyzing only female gender, for JHFT, one correlation was found with PWDS in a total of 64 possible correlations. With these results there were mostly no association between these fine motor elements and reading scores in female gender. PWDS is correlated just with one task of a total of 14 possible correlations: PWDS is correlated with non-dominant hand task 2, which is the task of turning over cards.

The similar situation occurs when controlled for language (CELF assessment) and nonverbal abilities (CPM assessment) to this situation, only two correlations were found between JHFT and the four previous mentioned reading outcomes, in a total of 64 possible correlations. With these results there were mostly no association between these fine motor elements and reading scores in female gender. PWDS is correlated with two tasks of a total of 14 possible correlations: PWDS is correlated with dominant, and non-dominant hand task 2.

5.3 Correlation Between Gross Motor Skills and Basic Reading

Iversen et al. (2005) conducted a study with two groups of poor readers (one of them children with severe dyslexia) compared to good reading controls, and 50% of the children in both groups of poor readers showed motor coordination difficulties. These children showed difficulties in the sub-area of balance, but not in ball-skills tasks. In my study, the results are different, because children do not show difficulties in the sub-area of balance. Iversen’s study had two more balance tasks, and a smaller sample size compared with this research.
For PLAYfun no correlations were found with WR, WRS, PWD, and PWDS in a total of 72 possible correlations. With these results there was no association between these gross motor elements and reading scores.

Similar to this situation, only two correlations were found between PLAYfun and the four previous mentioned reading outcomes, of a total of 72 possible correlations, when controlled for language and nonverbal abilities. With these results there was mostly no association between these gross motor elements and reading scores. WRS is correlated in one task, when controlling for nonverbal abilities (CPM assessment) and language (CELF assessment). The PWD, and PWDS are not correlated with any task in a total of 18. First, WRS is correlated only with one task of a total of 18 possible correlations: WRS is correlated with task 9, overhand throw. Second, WR is correlated only with the object control upper body subtotal score.

When analyzing only female gender PLAYfun, three correlations were found for WRS and PWD, in a total of 72 possible correlations. With these results there was mostly no association between these gross motor elements and reading scores. First, WRS is correlated only with one task of a total of 18 possible correlations: WRS is correlated with task 17, drop to the ground and back up. Second, PWD is correlated with the task 3, run, jump, then land on two feet, and task 14, foot dribble moving forward.

However, no correlations were found between PLAYfun and the 4 previous mentioned reading outcomes, of a total of 72 possible correlations, when controlled for language and nonverbal abilities. With these results there was no association between these gross motor elements and reading scores.
5.4 Limitations

One of the most conspicuous limitations of this study is the pressure of a shortened timeline, and also the small sample size. The study was originally designed to include more schools and children in grades three and four, which would have required considerably more time than was available for this research project. Thus, this study was conducted in one school only. Scheduling of the data collection has also posed a challenge due to the combination of public holidays, professional development days for school staff, half-day school days on Wednesdays, and conflicting events occurring at the school. In addition, at this particular school, children engage in physical education five days per weekday for 30 minutes, which is more frequent than in the majority of other similar schools in the province. This frequency of physical education might affect the physical literacy and motor coordination scores in a positive way.

Another concern is related to the assessment used during this study to measure fine motor skills. Initially, I planned to use the Movement Assessment Battery for Children (2), the Bruininks-Oseretsky Test of Motor Proficiency (2) or the Beery-Buktenica Developmental Test of Visual-Motor Integration to measure fine motor skills. These tests results could be different, in a positive way, compared with the results achieved with the PLAYfun and the JHFT because the previously mentioned tests have different outcomes. For example, two of the outcomes of the Movement Assessment Battery for Children (2) are the coordination of two hands performing a single task and eye-hand coordination as required in the control of a pen; one outcome of the Bruininks-Oseretsky Test of Motor Proficiency (2) relates to the coordination of visual tracking with movement of arms and hands; and Beery-Buktenica Developmental Test of Visual-
Motor Integration measures the ability to match motor movement with an external visual stimulus. However, it was not possible to buy either of these assessments due to their prohibitive costs. As a result of this constraint, I used the Jebsen Hand Function Test (JHFT), and this assessment was more limited: it does not measure a variety of aspects in the fine motor skills. For example, VMC that includes controlling small finger movements, and VSI focuses on generating a mental representation of an image and replicating it with precise, small muscle movements. This assessment also required children to handwrite in cursive, rather than print.

The next concern relates to the furniture used in the evaluation tasks, primarily the desks and the chairs at the school. Some of the children were affected during the JHFT by furniture limitations. They could not sit in the chairs with their feet flat on the floor because of the larger chairs and higher tables available in the available space provided by the school principal at the available times. This situation might affect the results during the measures. Another factor related to space was that the school had only the community room available to do the JHFT and PLAYfun assessments. This location is part of the access corridor between the gym and the classrooms, and it was not possible to control people passing through the room. However, any time that a person came to the community room, I stopped the evaluations until the person left the room. Students’ concentration might have been affected by this distraction factor.

In the PLAYfun assessment, I used the PLAYfun 100mm scale to mark each skill or task in a scale divided into four categories: initial (0mm – 24mm), emerging (25mm – 49mm), competent (50mm – 74mm), and proficient (75mm – 100mm). This allowed me to be more specific when defining the child's ability for each task. However, it was
difficult for me to distinguish marks that were in between (e.g. 45mm or 48mm).

Moreover, this test has not been validated or used in the literature, and the PLAYfun is an assessment to measure the physical literacy score regardless of age. Therefore, it will be difficult for children to achieve the competent and proficient marks described in the PLAYfun rating system. Also, it is natural to expect some changes in the measures of reading and motor skills over a longer time frame due to natural physical growth and development of children. Since the testing was only three weeks in duration, changes in growth should be minimal, however growth cannot be controlled for in either the PLAYfun and JHFT assessment without a control group. This research project did not have a control group.

Finally, special consideration for this population is cultural sensitivity and awareness. I have attempted to better understand and develop knowledge about the unique cultural elements of First Nation communities by volunteering and working at one particular school over the previous academic year. This unique opportunity to be involved in school activities has allowed me to develop a positive relationship with children, school staff, and some parents. I am also familiar with the Tri-Council Policy Statement, a document governing research protocol and ethics for all research, including a specific focus on research with aboriginal populations. I participated in training for conducting research with aboriginal populations during my studies in both course work and in extra-curricular workshops. This combination has helped me work towards developing cultural sensitivity for the unique participants in my research project.
5.5 Future Recommendations

The limited research in the literature involving young First Nations children, motor coordination, and reading areas leaves many opportunities for future research contributions.

This is a novel project, imperfect in nature by the limited number of participants drawn from a small school. This research was conducted at one elementary school in New Brunswick. External constraints such as a limited sample and the inaccessibility of another assessment tool to the researcher (due to financial constraints) of a more recent motor coordination assessment, limited the data. Due to these limitations and the population of the small school, the study group of students from grades three and four was 15 participants. The First Nation population was chosen because previous research in the area of connections between motor coordination and reading did not include such a community. This research area may deliver more robust results by increasing the number of participants.

This is one of the earliest research projects in the area of physical literacy which has incorporated the PLAYfun tool to measure children’s physical literacy skills. As such, there remains considerable potential for other research projects to also use the tools in their studies, and to relate their work to this preliminary study.

In this study correlation, partial correlations, and independent sample t-tests were conducted. In future research, correlation clustering could be used in order to discover the natural grouping of statistically correlated features. However, to perform this clustering significant number of sample instances are required, which, in this study, was a challenge to gather. This analysis will help to capture the dependency between various related
features and their contribution towards overall decision/outcome. It also helps to filter out the non-significant and redundant features, hence getting better approximation on decision making by removing noise and improving the overall efficiency of the clustering algorithm.

In order to come to a statistically significant conclusion one needs to analyze enough data in order to extract the meaningful pattern, which could be generalized to unseen data of a similar nature. Performing statistical modeling such as clustering on limited data leads to under-fitting scenario. A model under fits when it is too simple with regards to the data it is trying to model. In our case, with few examples, it gets more difficult for statistical models to generalize the whole domain. For example, it will be unjustified to generalize to an entire country being English speaking based on evaluating only a few people. Nevertheless, a great amount of data with noise might lead to over fitting. If a model is over fit, it takes into account too many details about what is being observed, and small changes on such object may cause the model to lose precision.

5.6 Cautions

There are a number of cautions in interpreting this data. First, the nonexistence of a group of control of children places the reliance upon test norms to ascertain appropriate performance levels. This may lead to an underestimation of actual levels of impairment, as test norms become outdated. Second, the results are preliminary and based on a small sample size and therefore caution should be exercised when making any generalizations and conclusions.
5.7 Conclusion

Despite the limitations of this project, it demonstrated some encouraging results which could be explored further with a more robust study population in the future. The dearth of research with First Nation populations, and particularly children, makes this a unique contribution to the literature. There remains a strong need for further research on children’s health and wellness in all areas from physical literacy to literacy in this underserved and under-researched population. Further research in the area of physical literacy—also an under-researched concept, particularly a research project using the PLAYfun tool—will build upon this preliminary study.

For the researcher, it was a positive and special experience. Working with children from the Canadian First Nation community went beyond any of my expectations. As a Portuguese citizen, where such aboriginal populations do not exist, the whole experience was new, unique and very rewarding. That the school principal had the freedom and independence to determine the children’s curriculum, particularly with regard to frequency of physical education and activity, was a completely different experience from my home country. In many other jurisdictions the curriculum is more tightly regulated by educational policy, which restricts the flexibility of school principals to provide more time for physical education and activity. The school principal will be in receipt of the conclusions of this research project, and will have the opportunity to circulate the findings to his school staff, students, and the community.

The purpose of this study was to examine, evaluate, and compare children’s physical literacy levels, fine and gross motor coordination abilities, and their basic reading skills in grades three and four in a New Brunswick First Nations population. To
determine that correlation, partial correlations, and independent t-tests were conducted. The results of the current study indicated that there was no association between fine and gross motor skills and basic reading. This is a unique project, limited in nature by the dearth of participants drawn from a small school, using a relatively new measurement tool (PLAYfun). These results are preliminary and based on a small sample size, and therefore caution ought to be exercised in interpreting and generalizing the results. The findings in this project serve as a significant contribution, one of the first to attempt empirical research using physical literacy measurements, to an area with restricted and inconclusive evidence-based research to-date.


Appendix A

PLAYfun Workbook (Kriellaars et al., 2013)

The PLAYfun assessment is administered and scored in accordance with the published administration and scoring manual of Kriellaars et al. (2013).

The PLAYfun tool assesses a child in 18 fundamental skills/tasks divided in five subsections:

(1) Running;

•PLAYfun Task 1 - Run a Square
•PLAYfun Task 2 - Run There and Back
•PLAYfun Task 3 - Run, Jump and Land on Two Feet

(2) Locomotor;

•PLAYfun Task 4 - Crossovers
•PLAYfun Task 5 - Skip
•PLAYfun Task 6 - Gallop
•PLAYfun Task 7 - Hop
•PLAYfun Task 8 - Jump

(3) Object Control, Upper Body;

•PLAYfun Task 9 - Overhand Throw
•PLAYfun Task 10 - Strike with Stick
•PLAYfun Task 11 - One-Handed Catch
•PLAYfun Task 12 - Hand Dribble Stationary and Moving Forward
(4) Object Control, Lower Body;

• PLAYfun Task 13 - Kick Ball
• PLAYfun Task 14 - Foot Dribble Moving Forward

(5) Balance, Stability, and Body Control.

• PLAYfun Task 15 - Balance Walk (Heel-to-Toe) Forward
• PLAYfun Task 16 - Balance Walk (Toe-to-Heel) Backward
• PLAYfun Task 17 - Drop to Ground and Back Up
• PLAYfun Task 18 - Lift and Lower
Q1 Run a square

“I want you to run a square around the pylons. I want you to run a square as best you can. Ready? Run now.”

Equipment: For this task, you'll need 4 pylons (each 3 metres apart in a square formation)

<table>
<thead>
<tr>
<th>Rating System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developing</td>
</tr>
<tr>
<td>Initial: Presence of numerous major gaps during execution:</td>
</tr>
<tr>
<td>• Mature running form not present</td>
</tr>
<tr>
<td>• Person is substantially overshooting or undershooting pylon placements</td>
</tr>
<tr>
<td>• Slipping, tripping and/or stumbling is present</td>
</tr>
<tr>
<td>Emerging: Limited number of major gaps, but able to execute basic sequencing of the task:</td>
</tr>
<tr>
<td>• Rounds corners with numerous steps</td>
</tr>
<tr>
<td>• While changing direction, shuffle or stutter-steps are present</td>
</tr>
<tr>
<td>• Mature running form present</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
Q2 - Run there and back

“I want you to run a straight line to the pylon, stop, turn around and run back. I want you to run to the line, turn around and run back as best you can. Ready? Run now.”

Equipment: For this task, you'll need 2 pylons (5 metres apart)

<table>
<thead>
<tr>
<th>Rating System</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Developing</strong></td>
<td><strong>Acquired</strong></td>
</tr>
<tr>
<td>Initial: Presence of numerous major gaps during execution:</td>
<td>Competent: Basic level of execution with minor sequencing errors:</td>
</tr>
<tr>
<td>• Stumbles, slips or trips repeatedly • Does not exhibit flow in transitions • Movement is disjointed</td>
<td>• Motion is along a straight line there and back</td>
</tr>
<tr>
<td>• Oversteps lines • Slow speed • Running form missing key features</td>
<td>• Good speed (jog to run)</td>
</tr>
<tr>
<td></td>
<td>• Pivoting turn that is not fluid or quick, but is successful</td>
</tr>
<tr>
<td></td>
<td>• Mature running form is evident</td>
</tr>
<tr>
<td>Emerging: Limited number of major gaps, but able to execute basic sequencing of the task:</td>
<td>Proficient: Overall proficiency is depicted by the quality of the movement:</td>
</tr>
<tr>
<td>• Arm movements and leg movements only synchronized in some phases, not all</td>
<td>• Sprint speed • Accelerates rapidly</td>
</tr>
<tr>
<td>• Sliding stop or shuffle-step stop</td>
<td>• Decelerates in control to a momentary stop</td>
</tr>
<tr>
<td>• Basic features of mature running form observed</td>
<td>• Pivots and changes direction in a continuous manner</td>
</tr>
<tr>
<td>• Rounded turnaround is evident</td>
<td>• Arms and legs used purposefully for propulsion</td>
</tr>
</tbody>
</table>
Q3 Run, jump, then land on two feet

“I want you to run, jump at the pylon and then land on two feet. I want you to run, jump and land on two feet the best you can – just like a long jump. Ready? Go now.”

Equipment: For this task, you'll need 2 pylons (5 metres apart)

<table>
<thead>
<tr>
<th>Rating System</th>
<th>Developing</th>
<th>Acquired</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial:</strong> Presence of numerous major gaps during execution:</td>
<td></td>
<td>Competent: Basic level of execution with minor sequencing errors:</td>
</tr>
<tr>
<td>• Not able to sequence the leap from one foot during the run</td>
<td>• Able to leap from one foot to land on two feet</td>
<td></td>
</tr>
<tr>
<td>• Very tentative in all sequencing of movements</td>
<td>• Limited distance travelled • Slow running speed (jog)</td>
<td></td>
</tr>
<tr>
<td>• Twists trunk or performs a twirling action</td>
<td>• Transition from jog to leap may not result in loss of speed</td>
<td></td>
</tr>
<tr>
<td>• Lands on a single foot • Low speed and distance travelled</td>
<td>• Upper body remains vertical during entire task to ensure landing</td>
<td></td>
</tr>
<tr>
<td><strong>Emerging:</strong> Limited number of major gaps, but able to execute basic sequencing of the task:</td>
<td></td>
<td>Proficient: Overall proficiency is depicted by the quality of the movement:</td>
</tr>
<tr>
<td>• Segmented action between the run, jump and landing</td>
<td></td>
<td>• Able to accelerate to a good speed and shift from a single leg (hop) with smooth transition</td>
</tr>
<tr>
<td>• Exhibits offset landing or multiple contacts on landing</td>
<td>• No loss of speed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Powerfully drives body upward with hip action of opposite leg and toe off of planted foot</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Aerial phase shows re-orientation of body for landing with arms moving forward</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Very good distance travelled • Well-controlled landing on two feet</td>
<td></td>
</tr>
</tbody>
</table>
Q4 Crossovers

“I want you to perform crossover steps from this pylon to the next. I want you to perform a crossover, or grapevine, step from here to there. Please do the best you can. Ready? Go now.

Equipment: For this task, you'll need 2 pylons (5 metres apart)

<table>
<thead>
<tr>
<th>Rating System</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Developing</strong></td>
</tr>
<tr>
<td>Initial: Presence of numerous major gaps during execution:</td>
</tr>
<tr>
<td>• Does not perform crossover steps (side shuffles, or other incorrect movement)</td>
</tr>
<tr>
<td>• Performs half the crossover step (front leg crossing over, or rear, but not both)</td>
</tr>
<tr>
<td>Emergent:</td>
</tr>
<tr>
<td>Emerging: Limited number of major gaps, but able to execute basic sequencing of the task:</td>
</tr>
<tr>
<td>• Crossover steps are inconsistent but evident</td>
</tr>
<tr>
<td>• Speed of progression is slow • Upper body isn't participating</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
Q5 Skip

“I want you to skip step from this pylon to the next. Skip as best you can. So, I want you to skip from here to there. Ready? Go now.”

Equipment: For this task, you'll need 2 pylons (5 metres apart)

<table>
<thead>
<tr>
<th>Rating System</th>
<th>Initial: Presence of numerous major gaps during execution:</th>
<th>Acquired: Competent: Basic level of execution with minor sequencing errors:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Fails to perform skip action</td>
<td>• Has basic skipping action with limited, but consistent, arm action</td>
</tr>
<tr>
<td></td>
<td>• Upper limb action is disconnected with lower body</td>
<td>• Low amplitude and speed • May exhibit ramp-up in form • Body is tall</td>
</tr>
<tr>
<td></td>
<td>• Speed highly variable or very low</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Shuffle-like motion of legs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Poor lower and upper body control</td>
<td></td>
</tr>
<tr>
<td>Emerging: Limited number of major gaps, but able to execute basic sequencing of the task:</td>
<td>Proficient: Overall proficiency is depicted by the quality of the movement:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Leg action consistent with a skip • Arms at side or slightly reciprocating</td>
<td>• Uses arms and legs in a reciprocal pattern with good limb excursions (elbow bent)</td>
</tr>
<tr>
<td></td>
<td>• Synchrony of arms to legs may be limited, but not flailing</td>
<td>• Exhibits fluid and consistent skip action from first to last step</td>
</tr>
<tr>
<td></td>
<td>• Initiation of skip takes a few steps and skip is inconsistent or lost in stopping</td>
<td>• Good speed</td>
</tr>
<tr>
<td></td>
<td>• Trunk angle variable</td>
<td></td>
</tr>
</tbody>
</table>
Q6 Gallop

“I want you to gallop from this pylon to the next. Front gallop as best you can. So, I want you to perform a gallop from here to there. Ready? Go now.”

Equipment: For this task, you'll need 2 pylons (5 metres apart)

<table>
<thead>
<tr>
<th>Rating System</th>
<th>Initial: Presence of numerous major gaps during execution:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Lift off or aerial phase not present</td>
</tr>
<tr>
<td></td>
<td>• Body faces sideways rather than forward</td>
</tr>
<tr>
<td></td>
<td>Competent: Basic level of execution with minor sequencing errors:</td>
</tr>
<tr>
<td></td>
<td>• Consistent aerial phase with synchronized upper limbs</td>
</tr>
<tr>
<td></td>
<td>• Speed may be slow and amplitude low</td>
</tr>
<tr>
<td></td>
<td>• Flow of gallop steps may be intermittent</td>
</tr>
<tr>
<td></td>
<td>Emerging: Limited number of major gaps, but able to execute basic sequencing of the task:</td>
</tr>
<tr>
<td></td>
<td>• Lift off or aerial phase present but inconsistent</td>
</tr>
<tr>
<td></td>
<td>• Upper arm motion not fluidly connected to lower limbs</td>
</tr>
<tr>
<td></td>
<td>• Unable to have consistent flow</td>
</tr>
<tr>
<td></td>
<td>• May falter in speed (slow to reacquire step)</td>
</tr>
<tr>
<td></td>
<td>• Body may twist</td>
</tr>
<tr>
<td></td>
<td>Proficient: Overall proficiency is depicted by the quality of the movement:</td>
</tr>
<tr>
<td></td>
<td>• Fluid action of upper and lower body in synchrony</td>
</tr>
<tr>
<td></td>
<td>• Immediate transition from start to gallop action</td>
</tr>
<tr>
<td></td>
<td>• Trunk facing forward entire distance • Amplitude and speed are very good</td>
</tr>
</tbody>
</table>
Q7 Hop

“I want you to hop from this pylon to the next. I want you to hop as best you can. Please hop from here to there. Ready? Hop now.”

Equipment: For this task, you'll need 2 pylons (5 metres apart)

<table>
<thead>
<tr>
<th>Rating System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developing</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td><strong>Initial:</strong> Presence of numerous major gaps during execution:</td>
</tr>
<tr>
<td>• Fails to maintain single leg support and touches down opposite foot</td>
</tr>
<tr>
<td>• Performs a jumping action</td>
</tr>
<tr>
<td>• Upper body and lower body in asynchrony</td>
</tr>
<tr>
<td><strong>Emerging:</strong> Limited number of major gaps, but able to execute basic sequencing of the task:</td>
</tr>
<tr>
<td>• Inconsistent distances and low amplitude of displacement (horizontal or vertical)</td>
</tr>
<tr>
<td>• Balance control problems evident during progression</td>
</tr>
<tr>
<td>• Starting is stutter-like</td>
</tr>
<tr>
<td>• Stopping is sloppy and possibly over-hopping or premature ending</td>
</tr>
<tr>
<td><strong>Competent:</strong> Basic level of execution with minor sequencing errors:</td>
</tr>
<tr>
<td>• Able to hop on one leg from start to end with medium distance hops</td>
</tr>
<tr>
<td>• Evident aerial phase • May not employ opposite leg to assist</td>
</tr>
<tr>
<td>• Distance may vary from hop to hop in mid-range</td>
</tr>
<tr>
<td>• Start and stop control may be limited</td>
</tr>
<tr>
<td><strong>Proficient:</strong> Overall proficiency is depicted by the quality of the movement:</td>
</tr>
<tr>
<td>• Substantial hopping distance that is consistent in distance in mid-range</td>
</tr>
<tr>
<td>• Immediate transition to hopping and immediate hop to stationary position at end</td>
</tr>
<tr>
<td>• Continuity in motion</td>
</tr>
<tr>
<td>• Good horizontal and/or vertical speed</td>
</tr>
<tr>
<td>• Uses opposite lower limb and upper body in synchrony with the other lower limb</td>
</tr>
</tbody>
</table>
Q8 Jump

“I want you to jump from this pylon to the next. I want you to jump as best you can. Please jump from here to there. Ready? Jump now.

Equipment: For this task, you'll need 2 pylons (5 metres apart)

Rating System

<table>
<thead>
<tr>
<th>Developing</th>
<th>Acquired</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial: Presence of numerous major gaps during execution:</td>
<td>Competent: Basic level of execution with minor sequencing errors:</td>
</tr>
<tr>
<td>• Does not perform a two-foot jump</td>
<td>• Performs a continuous jumping action from start to finish</td>
</tr>
<tr>
<td>• Performs an offset landing or takeoff with staggered feet</td>
<td>• Limited arm action</td>
</tr>
<tr>
<td>• Unable to perform more than one jump in a row</td>
<td>• Lower body triple flexion (hip, knee, ankle used for propulsion)</td>
</tr>
<tr>
<td></td>
<td>• Distance travelled is limited (less than one full step)</td>
</tr>
<tr>
<td></td>
<td>• Speed may be limited due to limited jump distance</td>
</tr>
</tbody>
</table>

| Emerging: Limited number of major gaps, but able to execute basic         | Proficient: Overall proficiency is depicted by the quality of the        |
| sequencing of the task:                                                  | movement:                                                               |
| • Able to jump, but exhibits inconsistent distances each jump            | • Jumping distance is substantial (length of body)                       |
| • Upper body may be rigid                                                  | • Evident lower body triple flexion (hip, knee, ankle used for propulsion) |
| • Arms not participating in jump motion                                  | • Arm swing evident and propulsive • Fluid start and stop • Speed of      |
| • May show balance control problems during task                          | transport is very good                                                   |
Q9 Overhand throw

“I want you to overhand throw the ball at the wall and make it bounce back over the top of your head. I want you to throw the ball as best you can. Please try to throw the ball against the wall as best you can. Ready? Throw now.” Note: sidearm throw is acceptable and can be assessed as competent or proficient

Equipment: For this task, you'll need:

- A large wall (target area) • 1 pylon (2 metres away from the wall) • Tennis ball (or similar)

### Rating System

<table>
<thead>
<tr>
<th>Developing</th>
<th>Acquired</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial: Presence of numerous major gaps during execution:</td>
<td>Competent: Basic level of execution with minor sequencing errors:</td>
</tr>
<tr>
<td>• Throw fails to produce ball motion in the desired direction</td>
<td>• Trajectory and speed of ball is adequate</td>
</tr>
<tr>
<td>• Insufficient distance/velocity</td>
<td>• Sequencing of lower body, trunk and upper body is present but limited</td>
</tr>
<tr>
<td>• Limb motion restricted to a single joint or upper limb</td>
<td>• Weight shift is minimal • Follow-through present but limited</td>
</tr>
<tr>
<td>• No coordination with trunk or lower limbs</td>
<td>• Trunk rotation present but limited</td>
</tr>
<tr>
<td>• No weight shift • Trunk rotation absent</td>
<td></td>
</tr>
</tbody>
</table>

Emerging: Limited number of major gaps, but able to execute basic sequencing of the task:

- Ball is sent with poor speed or trajectory (one of the two)
- Basic sequencing of lower body to trunk to upper limb action is evident
- Weight transfer limited
- May appear disjointed in sequencing of limb motion
- Very limited follow-through

Proficient: Overall proficiency is depicted by the quality of the movement:

- Velocity of ball is good • Trajectory of ball is well controlled
- Upper and lower body sequencing is present
- Weight shift is pronounced from trail to lead leg
- Follow-through is present and fluid • Very evident trunk rotation
Q10 Strike with stick

“I want you to strike the ball. I want you to strike the ball as best you can. Please try to strike the ball as best you can. Ready? Strike now.”

Equipment: For this task, you'll need:

- A baseball tee (adjustable height)
- A baseball bat (or similar)
- Tennis ball (or similar)

Rating System

<table>
<thead>
<tr>
<th>Developing</th>
<th>Acquired</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial:</strong> Presence of numerous major gaps during execution:</td>
<td><strong>Competent:</strong> Basic level of execution with minor sequencing errors:</td>
</tr>
<tr>
<td>- Grasp of implement inappropriate (cross-over hands, uses a single limb to swing, etc.)</td>
<td>- Swinging action evident with good speed</td>
</tr>
<tr>
<td>- No coordination between upper and lower body</td>
<td>- Limited weight transfer</td>
</tr>
<tr>
<td>- No weight shift</td>
<td>- Wind-up and follow-through limited but present</td>
</tr>
<tr>
<td>- Swinging action is weak and trajectory of implement wavers</td>
<td>- Sequencing of weight transfer, to trunk rotation, to arm swing is present but may be modest and slightly disjointed</td>
</tr>
<tr>
<td>- Limited wind-up and follow-through</td>
<td></td>
</tr>
<tr>
<td><strong>Emerging:</strong> Limited number of major gaps, but able to execute basic sequencing of the task:</td>
<td><strong>Proficient:</strong> Overall proficiency is depicted by the quality of the movement:</td>
</tr>
<tr>
<td>- Elements of the swinging action present but not all the sequences of weight transfer, trunk rotation and arm swing are evident</td>
<td>- Powerful swinging action with good speed of implement</td>
</tr>
<tr>
<td>- Dominance of one arm relative to the other</td>
<td>- Strong stepping action and weight transfer from trailing to leading leg</td>
</tr>
<tr>
<td>- Upper limbs don't work together</td>
<td>- Synchronized and sequenced weight transfer, to trunk rotation, to upper limb rotation</td>
</tr>
<tr>
<td></td>
<td>- Implement trajectory is well controlled with excellent wind-up and follow-through</td>
</tr>
</tbody>
</table>
**Q11 One-handed catch**

“I want you to catch the ball that I throw to you with only one hand. You can use whichever hand you like, but only one hand. I want you to catch the ball with one hand the best you can. Please try to catch the ball the best you can. Ready? Catch now.”

**Equipment:** For this task, you'll need:

- 2 pylons (3 metres apart – child at one, assessor at the other)
- Tennis ball (or similar)

<table>
<thead>
<tr>
<th>Rating System</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Developing</strong></td>
</tr>
<tr>
<td>Initial: Presence of numerous major gaps during execution:</td>
</tr>
<tr>
<td>• Unable to track the incoming ball</td>
</tr>
<tr>
<td>• Does not move hand to ball purposefully</td>
</tr>
<tr>
<td>• Shows an elbow-flexion-style of a clutching catch</td>
</tr>
<tr>
<td>• Bats at ball to only make contact</td>
</tr>
<tr>
<td>Emerging: Limited number of major gaps, but able to execute basic sequencing of the task:</td>
</tr>
<tr>
<td>• Tracks incoming ball poorly</td>
</tr>
<tr>
<td>• Moves hand to ball but fumbles or bobbles during catch and/or drops ball</td>
</tr>
<tr>
<td>• Uses “stiff” limb motion during catch</td>
</tr>
</tbody>
</table>
Q12 Hand dribble stationary and moving forward

“I want you to dribble the ball three times at the first pylon, and then I want you to dribble from the first pylon to the next. Dribble the ball as best you can. So, dribble three times at the first pylon and then dribble the ball to the next pylon and stop. Ready? Dribble now. ”

Equipment: For this task, you'll need:

• 2 pylons (4 metres apart) • Basketball (or similar)

<table>
<thead>
<tr>
<th>Rating System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developing</td>
</tr>
<tr>
<td>Initial: Presence of numerous major gaps during execution:</td>
</tr>
<tr>
<td>• Unable to control the ball when stationary or moving</td>
</tr>
<tr>
<td>• Hand-eye coordination is non-existent</td>
</tr>
<tr>
<td>Competent: Basic level of execution with minor sequencing errors:</td>
</tr>
<tr>
<td>• Able to control the ball when stationary and moving</td>
</tr>
<tr>
<td>• Lacks fluid changes from stationary to moving and moving to stationary</td>
</tr>
<tr>
<td>• Hand-eye coordination is adequate</td>
</tr>
<tr>
<td>Emerging: Limited number of major gaps, but able to execute basic sequencing of the task:</td>
</tr>
<tr>
<td>• Able to control the ball when either stationary or moving (one or the other, but not both)</td>
</tr>
<tr>
<td>• Hand-eye coordination is limited</td>
</tr>
<tr>
<td>Proficient: Overall proficiency is depicted by the quality of the movement:</td>
</tr>
<tr>
<td>• Well-controlled dribble in place for each repetition</td>
</tr>
<tr>
<td>• Exhibits a fluid change from stationary to moving</td>
</tr>
<tr>
<td>• Body, lower limbs and upper body are synchronized</td>
</tr>
<tr>
<td>• Hand-eye coordination is strong</td>
</tr>
</tbody>
</table>
Q13 Kick ball

“I want you to kick the ball at the wall. You can kick the ball with one foot – whichever foot you like. I want you to kick the ball with one foot as best you can. Try to kick the ball above the marker on the wall. Please try to kick the ball as best you can above the marker. Ready? Kick now.”

Equipment: For this task, you'll need:

• A large wall (target area) • 1 pylon (4 metres away from the wall) • Soccer ball (or similar)
• Marker on wall placed 1 metre above the ground

Rating System

<table>
<thead>
<tr>
<th>Developing</th>
<th>Acquired</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial: Presence of numerous major gaps during execution:</td>
<td>Competent: Basic level of execution with minor sequencing errors: • Ball is directed appropriately • Speed of ball is good</td>
</tr>
<tr>
<td>• Misses the ball due to a lack of coordination and timing</td>
<td></td>
</tr>
<tr>
<td>• No synchrony between upper and lower body</td>
<td></td>
</tr>
<tr>
<td>• Support leg and foot are poorly planted</td>
<td></td>
</tr>
<tr>
<td>• Whip-like kicking action with no follow-through</td>
<td></td>
</tr>
<tr>
<td>• No speed or ball control • Kicks with toe</td>
<td></td>
</tr>
</tbody>
</table>

Emerging: Limited number of major gaps, but able to execute basic sequencing of the task:

• Speed of ball is slow

• Some evidence of directional control is present

• Foot contact reasonably solid

Proficient: Overall proficiency is depicted by the quality of the movement:

• Ball is powerfully propelled in a controlled direction

• Upper body leads lower body • Strong follow-through is present
Q14 Foot dribble moving forward

“I want you to dribble the ball from one pylon to the next. I want you to dribble the ball as best you can. Please try to dribble the ball as best you can from here to there. Ready? Go now.”

Equipment: For this task, you’ll need:
- 2 pylons (5 metres apart) • Soccer ball (or similar)

<table>
<thead>
<tr>
<th>Rating System</th>
<th>Developing</th>
<th>Acquired</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial: Presence of numerous major gaps during execution:</td>
<td></td>
<td>Competent: Basic level of execution with minor sequencing errors:</td>
</tr>
<tr>
<td>• Ball control is absent or rudimentary • Ball is lost for majority of movement • Foot-eye control is disjointed</td>
<td>• Ball in control through most of the distance</td>
<td>• Starts and stops at lines</td>
</tr>
<tr>
<td></td>
<td>• Body and ball separation varies through movement</td>
<td>• Body may twist to allow the contact leg to lag and maintain contact with the ball</td>
</tr>
<tr>
<td></td>
<td>• May exhibit some control limitations during initiation and stopping of ball</td>
<td>• May not face forward the entire distance</td>
</tr>
<tr>
<td>Emerging: Limited number of major gaps, but able to execute basic sequencing of the task:</td>
<td></td>
<td>Proficient: Overall proficiency is depicted by the quality of the movement:</td>
</tr>
<tr>
<td>• Able to exhibit some ball control in a stuttering manner</td>
<td>• Ball trajectory is in control for the entire distance</td>
<td>• Body and ball separation is well maintained during each step</td>
</tr>
<tr>
<td>• Initiation and stopping of ball may be absent or very limited (ball travels past the second pylon)</td>
<td>• Ball start and stop is fluid and well controlled</td>
<td>• Trunk faces forward the entire distance</td>
</tr>
</tbody>
</table>
Q15 Balance walk (heel-to-toe) forward

“I want you to walk 'heel-to-toe' from one pylon to the next while keeping your balance. Walk as quickly as you can while keeping your balance. Walk from here to there while keeping your balance. Ready? Walk now.”

For this task, you'll need:

• 2 pylons placed 2 metres apart (or a 2-metre line on the floor)

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<th>Rating System</th>
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<tbody>
<tr>
<td></td>
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<tr>
<td>Developing</td>
</tr>
<tr>
<td>Initial: Presence of numerous major gaps during execution:</td>
</tr>
<tr>
<td>• Loses balance repeatedly • Does not use arms to balance</td>
</tr>
<tr>
<td>• Poor or inconsistent placement of feet from step to step</td>
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<tr>
<td></td>
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</table>

Emerging: Limited number of major gaps, but able to execute basic sequencing of the task:

• Able to demonstrate features of balance control
• Tentative stepping action • Non-fluid
• Major balance control problems during stepping
• May lose balance once or twice in all steps

Proficient: Overall proficiency is depicted by the quality of the movement:

• Quickly walks along the line in a fluid continuous motion
• Very minor balance adjustments may be evident at ankles
• There may be slight upper limb wavering
Q16 Balance walk (toe-to-heel) backward

“I want you to walk backward 'toe-to-heel' from one pylon to the next while keeping your balance. Walk backward as quickly as you can while keeping your balance. Walk backward from here to there while keeping your balance. Ready? Walk now.”

Equipment

For this task, you'll need: • 2 pylons placed 2 metres apart (or a 2-metre line on the floor)

Rating System

<table>
<thead>
<tr>
<th>Developing</th>
<th>Acquired</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial: Presence of numerous major gaps during execution:</td>
<td>Competent: Basic level of execution with minor sequencing errors:</td>
</tr>
<tr>
<td>• Loses balance repeatedly • Doesn't use arms to balance</td>
<td>• Able to maintain balance through all steps</td>
</tr>
<tr>
<td>• Poor or inconsistent placement of feet from step to step</td>
<td>• Shows good foot placement, but may be slow</td>
</tr>
<tr>
<td></td>
<td>• Exhibits minor balance control problems through some of the steps</td>
</tr>
<tr>
<td></td>
<td>• Upper limb wavering may be evident</td>
</tr>
<tr>
<td>Emerging: Limited number of major gaps, but able to execute basic sequencing of the task:</td>
<td>Proficient: Overall proficiency is depicted by the quality of the movement:</td>
</tr>
<tr>
<td>• Able to demonstrate features of balance control</td>
<td>• Performs a “cat walk” along the line in a fluid continuous motion</td>
</tr>
<tr>
<td>• Tentative stepping action • Non-fluid</td>
<td>• Very minor balance adjustments may be evident at ankles</td>
</tr>
<tr>
<td>• Major balance control problems during stepping</td>
<td>• There may be slight upper limb wavering</td>
</tr>
<tr>
<td>• May lose balance once or twice in all steps</td>
<td></td>
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</table>
Q17 Drop to the ground and get back up

“I want you to drop to the ground and come right back up. I want you to drop to the ground and get back up as best you can. Ready? Go now.”

Equipment For this task, you'll only need floor space

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<tr>
<th>Rating System</th>
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<tbody>
<tr>
<td>Developing</td>
</tr>
<tr>
<td>Initial: Presence of numerous major gaps during execution:</td>
</tr>
<tr>
<td>• Sits down tentatively one limb at a time</td>
</tr>
<tr>
<td>• Kneels first, then slowly sequences limbs to ground</td>
</tr>
<tr>
<td>Emerging: Limited number of major gaps, but able to execute basic sequencing of the task:</td>
</tr>
<tr>
<td>• Places each limb down in succession but smoothly</td>
</tr>
<tr>
<td>• Doesn't drop to floor</td>
</tr>
</tbody>
</table>
Q18 Lift and Lower

“I want you lift up the ball above your head and then lower it back down to the ground. I want you to lift and then lower the ball as best you can. Ready? Go now.”

Equipment For this task, you'll need:

- Floor space
- 1 ball

Rating System

<table>
<thead>
<tr>
<th>Developing</th>
<th>Acquired</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial: Presence of numerous major gaps during execution:</td>
<td>Competent: Basic level of execution with minor sequencing errors:</td>
</tr>
<tr>
<td>• Has difficulty reaching the object • Fumbles in the lift or lower • Drops the object</td>
<td>• Able to control ball during lift and lower</td>
</tr>
<tr>
<td>• Exhibits right-to-left shifts in lift or substantial body twisting</td>
<td>• Transition between lift and lower segments is slightly choppy</td>
</tr>
<tr>
<td>• Some sway</td>
<td>• Some sway</td>
</tr>
<tr>
<td>Emerging: Limited number of major gaps, but able to execute basic sequencing of the task:</td>
<td>Proficient: Overall proficiency is depicted by the quality of the movement:</td>
</tr>
<tr>
<td>• Transition between lift and lower segments is broken and not fluid</td>
<td>• Fluid and controlled reach with momentary pause at lift</td>
</tr>
<tr>
<td>• Exhibits swaying or minimal body-twisting</td>
<td>• Secure grasp and synchronized lifting action from all body parts</td>
</tr>
<tr>
<td></td>
<td>• May be a stoop or squat lift</td>
</tr>
<tr>
<td></td>
<td>• Well-controlled descent and low-impact contact with ground</td>
</tr>
</tbody>
</table>
Appendix B

JHFT Subtests (Jebsen et al., 1969; Taylor et al., 1973)

The JHFT assessment is administered and scored in accordance with the published administration and scoring manuals (Jebsen et al., 1969; Taylor et al., 1973):

Seven subtests are chosen to provide a broad sampling of hand function:

1. Writing,
2. Turning over 3-by-5-inch cards (simulated page turning),
3. Picking up small common objects,
4. Simulated feeding,
5. Stacking checkers,
6. Picking up large light objects,
7. Picking up large heavy objects.

Each of the subtests was designed to be administered in precisely the same manner to each subject. The results are measured objectively using a stopwatch. This technique allows for a continuum of scores. Each subject is seated in a chair in front of a desk in a well-lighted room. Questions are answered after the instructions are given to be certain that the instructions were understood. The subtests are always presented in the same sequence and are always performed with the non-dominant hand first. (The subtest descriptions below are written for a right-handed subject.) The test is administrated without modification from the adult test with the exception of using table and chair highlights appropriate to the size of the child.
The same materials and instructions are used as in adult's test. . . . Whereas the adult test is standardized with each subject seated in a chair with a seat height of 46 cm, at a desk 76 cm high, no attempt is made to specify the desk or chair height in our test other than the children, when seated, is in a comfortable position, with the chair and desk compatible with their size. The chair and desk heights are those used in the child's school classroom. Time measures for both dominant and non-dominant hands are obtained for each of the seven tasks (Taylor et al., 1973).

In scoring, a summary score is computed which totals the subject's performance on six of the seven subtests for each hand (writing excluded). In scoring tests of subjects, an arbitrary limit of three minutes is placed on performance for each subtest. Thus, if the subject perseveres with the task but is unable to complete it or if she or he cannot attempt the task, she or he is arbitrarily assigned a score of 180 seconds on that subtest.
SUBTEST 1: WRITING

Procedure

The subject is given a black ball-point pen and four 8-by-11-inch sheets of unruled white paper fastened, one on top of the other, to a clip board. The sentence to be copied has 24 letters and is of third-grade reading difficulty. * The sentence is typed in all capital letters and centered on a 5-by-8-inch index card. The card is presented with the typed side faced down on a bookstand. After the articles are arranged to the comfort of the subject (see Instructions), the card is turned over by the examiner with an immediate command to begin. The item is timed from the word “go” until the pen is lifted from the page at the end of the sentence. The item is repeated with the dominant hand using a new sentence.

Instructions

“Do you require glasses for reading? If so, put them on. Take this pen in your left hand and arrange everything so that it is comfortable for you to write with your left hand. On the other side of this card (indicate) is a sentence. When I turn the card over and say “Go”, write the sentence as quickly and as clearly as you can using your left hand. Write, do not print. Do you understand? Ready? Go.”

For Dominant Hand

“All right, now repeat the same thing, only this time using your right hand. I’ve given you a different sentence. Are you ready? Go.”
SUBTEST 2: CARD TURNING (SIMULATED PAGE TURNING)

Procedure

Five 3-by-5-inch index cards, ruled on one side only, are placed in a horizontal row 2 inches apart on the desk in front of the patient. Each card is oriented vertically, 5 inches from the front edge of the desk. This distance is indicated on the side edge of the desk with a piece of tape. Timing is from the word “Go” until the last card is turned over. No accuracy of placement after turning is necessary. The item is repeated with the dominant hand.

Instructions

“Place your left hand on the table please. When I say “Go”, use your left hand to turn these cards over one at a time as quickly as you can, beginning with this one (indicate card to extreme right). You may turn them over in any way that you wish and they need not be in a neat pattern when you finish. Do you understand? Ready? Go.”

Dominant Hand

“Now the same thing with the right hand beginning with this one (indicate extreme left card). Ready? Go.”
SUBTEST 3: SMALL COMMON OBJECTS

Procedure
An empty 1-pound coffee can is placed directly in front of the subject, 5 inches from the front edge of the desk. Two 1-inch paper clips (oriented vertically), two regular-sized bottle caps (each 1-inch in diameter, placed with the inside of the cap facing up), and two United States pennies are placed in a horizontal row to the left of the can. The paper clips are to the extreme left and the pennies, nearest the can. The objects are 2 inches apart. Timing is from the word “Go” until the sound of the last object striking the inside of the can is heard. The item is repeated with the dominant hand. The layout for the dominant hand is a mirror image of the one described, with the objects to the right of the can.

Instructions
“Place your left hand on the table please. When I say “Go”, use your left hand to pick up these objects one at a time and place them in the can as fast as you can beginning with this one (indicate paper clip on the extreme left). Do you understand? Ready? Go.”

Dominant Hand
“Now the same thing with the right hand beginning here (indicate paper clip now on the extreme right). Ready? Go.”
SUBTEST 4: SIMULATED FEEDING

Procedure
Five kidney beans of approximately 5/8-inch length are placed on a board* clamped to the desk in front of the subject 5 inches from the front edge of the desk. The beans are oriented to the left of center, parallel to and touching the upright of the board 2 inches apart. An empty 1-pound coffee can is placed centrally in front of the board. A regular teaspoon is provided. Timing is from the word “Go” until the last bean is heard hitting the bottom of the can. The item is repeated with the dominant hand, the beans being placed to the right of center.

Instructions
“Take the teaspoon in your left hand please. When I say “Go,” use your left hand to pick up these beans one at a time with the teaspoon and place them in the can as fast as you can beginning with this one (indicate bean on the extreme left). Do you understand? Ready? Go.”

Dominant Hand
“Now the same thing with the right hand beginning here (indicate bean on the extreme right). Ready? Go.”
SUBTEST 5: CHECKERS

Procedure

Four standard sized (1-1/4 inch diameter) red wooden checkers are placed in front of and touching a board *clamped to the desk in front of the subject, 5 inches from the front edge of the desk. The checkers are oriented two on each side of the center in a 0000 configuration. Timing is from the word “Go” until the fourth checker makes contact with the third checker. The fourth checker need not stay in place. The item is repeated with the dominant hand.

Instructions

“Place your left hand on the table please. When I say “Go”, use your left hand to stack these checkers on the board in front of you as fast as you can like this, one on top of the other (demonstrate). You may begin with any checker. Do you understand? Ready? Go.”

Dominant Hand

“Now the same thing with the right hand. Ready? Go.”
SUBTEST 6: LARGE LIGHT OBJECTS

Procedure - Five empty No. 303 cans are placed in front of a board* clamped to the desk in front of the subject 5 inches from the front edge of the desk. The cans are spaced 2 inches apart with the open end of the can facing down. Timing is from the word “Go” until the fifth can has been released. The item is repeated with the dominant hand.

Instructions

“Place your left hand on the table please. When I say “Go”, use your left hand to stand these cans on the board in front of you, like this (demonstrate). Begin with this one (indicate can on extreme left). Do you understand? Ready? Go.”

Dominant Hand

“Now the same thing with the right hand beginning here (indicate extreme right can). Ready? Go.”
SUBTEST 7: LARGE HEAVY OBJECTS

Procedure

Five full (1 pound) No. 303 cans are placed in front of a board* clamped to the desk in front of the subject 5 inches from the front edge of the desk. The cans are spaced 2 inches apart. Timing is from the word “Go” until the fifth can has been released. The item is repeated with the dominant hand.

Instructions

“Now do the same thing with these heavier cans. Place your left hand on the table. When I say “Go”, use your left hand to stand these cans on the board as fast as you can. Begin here (indicate can on extreme left). Do you understand? Ready? Go.”

Dominant Hand

“Now the same thing with your right hand beginning here (indicate can on far right). Ready? Go.”

* A wooden board 41-1/2 inches long, 11-1/4 inches wide and 3/4-inch thick was secured to the desk with a “C” clamp. The front edge (3/4-inch thickness) of the board was marked at 4-inch intervals for easy reference when placing objects. A center piece of plywood, 20 inches long, 2 inches high, and 1/2-inch thick, was glued to the board 4-5/8 inches from the right end and 6 inches from the front of the board (this is for a secretary-type desk with a right-sided knee hole). The front of the center upright should be marked at 2-inch intervals beginning 1-inch from each end for convenience in placing objects.
Appendix C

WIAT–III (Wechsler, 2009a, 2009b, 2009c, 2010a, 2010b)

The WIAT–III assessment is administered and scored in accordance with the published administration and scoring manuals (Wechsler, 2009a, 2009b, 2009c, 2010a, 2010b):

A word card and a pseudoword card are given to the student during the administration of the WR and PWD subtests, respectively.
WR Subtest

A word card is given to the student during the administration of the WR. The student reads aloud from a list of words that increase in difficulty. The subtest yields two scores - one for accuracy and one for speed. The WRS total score reflects the number of words the student read in 30 seconds, regardless of accuracy. The examiner records the student’s progress after 30 seconds and continues administration until the discontinue rule is met or the last item is administered. The list of words is a read without a time limit. The WR subtest does not include instructions about how the student should read, but simply instructs the student to read aloud.

1. To begin administration, show the Word Card to the student and say, “I want you to read these words out loud.”

2. Point to the first word and say; “Start here and read across this way” (sweep your finger from left to right across the first row and then the next row). “If you finish this page, turn to the next page” (turn card over to demonstrate). Give the Word Card to the student, point to the first word, and say, “Go ahead”. Start timing.
PWD Subtest

A pseudoword card is given to the student during the administration of the PWD subtests. The student may determine the position of the card while reading. The student reads aloud from a list of pseudowords that increase in difficulty. The list of pseudowords is read without a time limit. The examiner records the student’s progress after 30 seconds and continues administration until the discontinue rule is met or the last item is administered. Similar to the WR subtest measure, this subtest is designed to assess pseudoword decoding speed (PWDS) and accuracy by encouraging the student to read as he or she typically does, without directing the student to read faster, slower, or more carefully than usual.

1. To begin administration, say, “I want you to read some words that are not real words, but read them as if they were”. Give the pseudoword card to the student and proceed to Sample A.

2. Sample Items

   A. Point to the sample item ak on the Pseudoword Card and say, “Say this word”. If the student does not respond correctly, say, “The word is ak” (\'ak\).

   B. Point to the sample item mib and say, “Say this word”. If the student does not respond correctly, say, “The word is mib” (\'mib\).

3. Point to the next word and say; “Start here and read across this way” (sweep your finger from left to right across the first row and then the next row). “If you finish this page, turn to the next page” (turn card over to demonstrate). Point to Item 1 and say, “Go ahead”. Start timing.
Appendix D

CELF–5 (Wiig et al., 2013a, 2013b, 2013c, 2013d)

The CELF–5 assessment is administered and scored in accordance with the published administration and scoring manuals (Wiig et al., 2013a, 2013b, 2013c, 2013d):

For this task the researcher uses a record form and the stimulus book 1. The purpose of the word classes test is to measure the ability to understand the relationship between associated words. The researcher says some words and shows some pictures to the student. The student selects the two pictures or words that go together best from three or four orally presented words. The word classes test has 40 items; for items 1-9, pictures are paired with the oral presentation.

Word Classes for ages 5-10 include items presented with visual stimuli in Stimulus Book 1, as well as items that are presented verbally only from the Record Form. Items 1-8 have three pictures per item and Items 9-12 have four pictures per item. Present each item to the student by naming each picture. On stimulus pages with three pictures, start naming with the picture on the lower left side of the page (picture A), move to the picture on the upper middle portion of the page (picture B) and finally, move to the picture in the lower right corner (picture C). On stimulus pages with four pictures, start naming with the picture in the upper left corner (picture A), move to the upper right (picture B), then move to the lower left corner (picture C), and end with the lower right (picture D). You may point to the pictures as you name them.

Demonstration
Turn to Stimulus Book 1 page WC Demo. Introduce the item by saying, “I am going to say some words and show you some pictures. Two of the words go together. Look and listen as I say the words: puppy, frog, dog” (point to the pictures as you name them). “Puppy and dog” (point) “are the two words that go together best”. Proceed to Trial 1.

Trial 1 – “Now let’s do it again. Two of these words go together. Look and listen carefully to the words I say, then tell me the two words that go together: milk, apple, banana”. If the student responds by identifying the words apple and banana, proceed to Trial 2. If the student requests a repetition, does not respond within 10 seconds, or identifies two unrelated words, say, “Listen carefully to the words: milk, apple, banana. Two of them go together best. Do you know which ones they are?” If the student responds incorrectly, say, “The two words that go together are apple and banana.” Proceed to Trial 2.

Trial 2

Turn to Stimulus Book 1 page WC Trial 2. Say, “Now let’s do some more. Remember, tell me the two words that go together best” (pause): “cat, whiskers, nest.” If the student identifies the words cat and whiskers, proceed to the Test Items. If the student requests a repetition, does not respond within 10 seconds, or identifies two unrelated words, say, “Listen carefully to the words:” (pause) “cat, whiskers, nest. Two of them go together best. Do you know which ones they are?” If the student responds incorrectly, say, “The two words that go together are cat and whiskers”. Proceed to Test Item 1.

Test Items
Start at Item 1. Say, “Here are some more. Look, listen, and tell me which two words go together.” For each item, show the stimulus page and say the words indicated in the Record Form.

Note. Before Item 9, read the instructions on the Record Form informing the student there are four words to choose from for the rest of the Test Items. Before Item 13, read the instructions on the Record Form informing the student that the remaining items do not have pictures.
Appendix E

CPM (J. C. Raven, 1976; J. Raven et al., 1998)

The CPM assessment was administered and scored in accordance with the published administration and scoring manuals (J. C. Raven, 1976; J. Raven et al., 1998):

The coloured progressive matrices (CPM) consists of 36 items in three sets of 12: A, AB, and B. It is designed for use with children and old people, for anthropological studies, and for clinical work. The CPM can be used to assess the degree to which people can think clearly, or the level to which their intellectual functions have deteriorated. The three sets of 12 problems constituting the CPM are arranged to assess the chief cognitive processes of which children under 11 years of age are usually capable. The items of the CPM are arranged to assess mental development up to the stage when person is sufficiently able to reason by analogy to adopt this way of thinking as a consistent method of inference. Presenting the test as coloured illustrations printed in a book, or as boards and movable pieces, makes the problem to be solved obvious with the least possible verbal explanation. Manipulation of the material is not essential for success, as a person need only indicate the chosen figure to be inserted in the problem to be completed.

Group administration:

Not more than 8 or 9 people should be tested at one time. For these sessions the test administrator needs:

1. To set aside about 90 minutes, though most people will finish in half this time.
2. A poster sized reproduction of each of the first two items of Set A. These should be printed to a flip-chart board in such a way that problem A1 hides problem A2, but A1 can be turned over to expose A2.

3. For each person taking the test - two pencils, a CPM (either CPM-C or CPM-P) Test Booklet, and a copy of the appropriate CPM answer sheet, remembering that this is not identical for the two versions of the Test.

4. (If the Crichton Vocabulary Scale is to be administered) a CVS answer sheet for each person to be tested.

**DO** Before the session starts, enter the name and particulars of each person taking the test on the answer sheets and distribute the test booklets and answer sheets about the room (perhaps alternating CPM-C and CPM-P) in such a way as to prevent copying. When those to be tested come in, make sure that each sits in the correct place.

**SAY** Do not open the test booklets until you are asked to do so.

Explain that the Progressive Matrices Test measures the ability to perceive and think clearly.

**DO** Show them which is the CPM Test Booklet, the CPM answer sheet, and the CVS answer sheet.

**SAY** Open your CPM Test Booklets at the first problem (A1).

**DO** Turn to the enlargement of problem A1.

**SAY** It is like this. At the top it says “A” - that means Set A . . . and you have a column here . . .

**DO** Pick up an answer sheet.

**SAY** . . . on your answer sheet, for Set A.
DO  Make sure everyone has located the column. Go back to the enlargement of problem AI.

SAY  This is problem AI. You can see what it is. The upper part is a pattern with a bit missing. Each of these pieces below . . .

DO  Point to each of the six in turn.

SAY  . . . is the right shape to fit into the space but they do not all complete the pattern.

Number I . . .

DO  Point to the bit and then to the gap on the pattern.

SAY  . . . is the right shape but is quite the wrong pattern. Numbers 2 and 3 . . .

DO  Point to options 2 and 3.

SAY  . . . are wrong. They fit the space but are not the right pattern. In fact, Number 2 is not a pattern at all. And Number 3 is quite wrong. What about Number 6? Is it the right pattern?

DO  Illustrate that the pattern is almost the same as the one above.

SAY  But it does not go all over, and will leave a gap in the pattern. Put your fingers on the one that is correct.

DO  Check that all have chosen correctly. If not, explain more fully.

SAY  Yes, Number 4 is the right one. So the answer to AI is “4”. Write “4” (Easy-score answer sheet - put a short single line through the figure “4”) at the side of Number I in the first column of your answer sheet. Please do not mark the test booklet. Do not turn over yet.

DO  Wait until everyone has finished and check that they have done it correctly.
SAY  On every page of the booklet there is a pattern with a piece missing. You have to choose which of the pieces below is the right one to complete the pattern. When you think you have found the right piece, write (Easy-score answer sheet - put a short single line through) its number next to the problem number on your answer sheet. If you make a mistake, or want to change your answer, put a cross through the incorrect answer, and then write (Easy-score answer sheet - put a single line through) the number of correct answer.

1. Do not try to rub out the incorrect answer.
2. Do not write on the test booklets themselves.
3. The problems are simple at the beginning and get harder as you go on.
4. There is no catch. If you pay attention to the way the answers to the easy problems are found, you will find the later ones less difficult.
5. Try each in turn, from the beginning right to the end of the booklet, recording your answers, make sure you are doing so in the right column and next to the right number for the problem you are working on.
6. Work at your own pace.
7. Do not miss any out. If you are not sure, guess, as guesses are sometimes right. If you get stuck, move on to the next problems and then come back to the one you had difficulty with.
8. You can have as much time as you like.
9. Turn over and try problem A2.

DO  Allow everyone sufficient time to find and record their answer to problem A2.
SAY The right answer is Number 5. Has everyone written (Easy-score answer sheet - put a short single line through) “5” against Number 2 in the first column of their answer sheet?

DO Check that everyone has done this correctly.

SAY Go on like this by yourself until you get to the end of the booklet. I will come round to see that you are getting on all right. Any questions? Remember, do not try to rub out mistakes. Put a cross through your incorrect answer and then write (Easy-score answer sheet - put a short single line through) the number of the correct answer. Turn over to problem A3 and start.

DO Note the time.

Go round the room checking that all have correctly entered their answers to the first five problems. If anyone has not grasped the nature of the problem, redemonstrate problem A1, but on no account help with the content of the problems.

At the end of 15 minutes, begin to check that the answers are being recorded in the right place. Problems are frequently omitted and this can displace subsequent answers upwards on the answer sheet.

At the end of 20 minutes, ask those taking the test(s) to ring (put a circle round) the number of the problem they are working on just then.
Correlation between PLAYfun and Reading, controlled for language and nonverbal abilities

There was a positive significant relationship between PLAYfun task 5, skipping and the word classes subtest, $r = .584$, $p$ (two-tailed) < .05. This indicates that skipping score increased and the word classes subtest score increased.

There was a negative significant relationship between the PLAYfun task 9, overhand throw and the word reading speed, $r = -.588$, $p$ (two-tailed) < .05. This indicates that overhand throw score increased and the word reading speed score decreased.
There was a negative significant relationship between the object control, upper body score and the word reading, $r = -0.579$, $p$ (two-tailed) < .05. This indicates that object control, upper body score increased and the word reading score decreased.
Appendix G

Scatter Plots Correlations

Correlation between PLAYfun and reading among female gender, controlled for language, and nonverbal abilities.

There was a positive significant relationship between the PLAYfun task 3, run, jump and land on two feet and the pseudoword decoding, $r = .645$, $p$ (two-tailed) < .05. This indicates that run, jump and land on two feet score increased and the pseudoword decoding score increased.

PLAYfun task 14, foot dribble moving forward was significantly positive correlated with pseudoword decoding, $r = .675$, and word classes subtest, $r = .717$; the PLAYfun task 14, foot dribble moving forward was also positive correlated with nonverbal abilities, $r = .759$ (all $p$s < .05). This indicates that foot dribble moving forward score increased and pseudoword decoding score, word classes score, and nonverbal abilities increased.
There was a negative significant relationship between the PLAYfun task 17, drop to ground and back up and the word reading speed, $r = -.642$, $p$ (two-tailed) < .05. This indicates that
drop to ground and back up increased and the word reading speed score decreased.
Appendix H

Scatter Plots Correlations

Correlation between JHFT and Reading, controlled for language and nonverbal abilities

There was a positive significant relationship between the non-dominant hand task 5, stacking checkers one on top of another and the word reading speed, $r = .565$, $p$ (two-tailed) $< .05$. This indicates that non-dominant hand stacking checkers one on top of another time score increased and the word reading speed score increased.

There was a positive significant relationship between the non-dominant hand task 6, picking up large light objects and the word reading, $r = .686$, $p$ (two-tailed) $< .05$. This indicates that non-dominant hand picking up large light objects time score increased and the word reading score increased.
Dominant hand task 3, picking up small common objects was significantly positive correlated with word reading, $r = .614$, and word reading speed, $r = .664$; the dominant hand task 3, picking up small common objects was also significantly positive correlated with pseudoword decoding, $r = .567$, and pseudoword decoding speed, $r = .656$ (all ps < .05). This indicate that dominant picking up small common objects time score increased and word reading score, word reading speed score, pseudoword decoding score, and pseudoword decoding speed score increased.
There was a negative significant relationship between the dominant hand task 5, stacking
checkers one on top of another and the word reading speed, \( r = -0.534, \ p \) (two-tailed) < 0.05. This indicates that the dominant hand stacking checkers one on top of another time score increased and the word reading speed score decreased.

Task 3, picking up small common objects total was significantly positive correlated with pseudoword decoding, \( r = 0.540 \), and pseudoword decoding speed, \( r = 0.572 \) (all \( ps < 0.05 \)). This indicates that picking up small common objects total time score increased and pseudoword decoding score, and pseudoword decoding speed score increased.
There was a positive significant relationship between the task 6, picking up large light objects total and the word reading, $r = .605$, $p$ (two-tailed) < .05. This indicates that picking up large light objects total time score increased and the word reading score increased.

There was a positive significant relationship between the non-dominant hand task 6, picking up large light objects and the word reading, $r = .661$, $p$ (two-tailed) < .05. This indicates that picking up large light objects time score increased and the word reading score increased.
There was a positive significant relationship between the dominant hand task 2, card turning (simulated page turning) and the word reading, $r = .564$, $p$ (two-tailed) < .05. This indicates that card turning (simulated page turning) time score increased and the word reading score increased.

Dominant hand task 3, picking up small common objects was significantly positive correlated with word reading, $r = .668$, and word reading speed, $r = .651$; the dominant hand task 3, picking up small common objects was also positive correlated with pseudoword decoding speed, $r = .609$ (all ps < .05). This indicates that picking up small common objects time score increased and word reading score, word reading speed score, and pseudoword decoding speed score increased.
Appendix I

Scatter Plots Correlations

Correlation between JHFT and reading among female gender, controlled for language, and nonverbal abilities

There was a negative significant relationship between the non-dominant hand task 2, card turning (simulated page turning) and the pseudoword decoding speed, $r = -.733$, $p$ (two-tailed) < .05. This indicates that non-dominant hand card turning (simulated page turning) time score increased and the pseudoword decoding speed score decreased.

There was a negative significant relationship between the task 2, card turning (simulated page turning) total and the pseudoword decoding speed, $r = -.771$, $p$ (two-tailed) < .05. This indicates that card turning (simulated page turning) total time score increased and the pseudoword decoding speed score decreased.
Task 3, picking up small common objects total was significantly positive correlated with pseudoword decoding, $r = .643$, and nonverbal abilities, $r = .774$ (all ps < .05). This indicates that picking up small common objects total time score increased and the pseudoword decoding score, and nonverbal abilities decreased.
There was a negative significant relationship between the non-dominant hand task 2, card turning (simulated page turning) and the pseudoword decoding speed, $r = -0.827$, $p$ (two-tailed) < .05. This indicates that non-dominant hand card turning (simulated page turning) time score increased and the pseudoword decoding speed score decreased.

There was a negative significant relationship between the dominant hand task 2, card turning (simulated page turning) and the pseudoword decoding, $r = -0.877$, $p$ (two-tailed) < .05. This indicates that dominant hand card turning (simulated page turning) time score increased and the pseudoword decoding speed score decreased.
There was a negative significant relationship between the task 2, card turning (simulated page turning) total and the pseudoword decoding speed, $r = -0.940$, $p$ (two-tailed) < .05. This indicates that card turning (simulated page turning) total time score increased and the pseudoword decoding speed score decreased.
Appendix J

Letter of Invitation, Information for Parents & Guardians, & Permission (consent) Form

Principal,

April 14, 2015

Dear :

I am a master’s student studying in the Faculty of Kinesiology at the University of New Brunswick. I am working on my thesis, and am writing to invite you and some of your students in participate in my research. My research seeks to better understand the relationship between physical literacy, the coordinated movement of body parts (also known as motor coordination), and literacy in Grade 3 and Grade 4 children attending an elementary school in New Brunswick First Nations communities. It involves evaluating motor skills and literacy of the children.

I am writing to ask if your school would be interested in participating in this project. Participation will involve a reading evaluation with your students during the month of April. The total time per child is 45 minutes. The reading evaluations take approximately 20 minutes, which includes ten minutes on an individual basis, and ten minutes with all the children together, and the physical literacy component, which takes 25 minutes individually. If you are interested, please let me know. I will then contact you to arrange a meeting to discuss the study in detail, and to seek your input into the research proposal.

This project is on file with the University of New Brunswick’s Research Ethics Board, 2015-041 and by the Faculty of Kinesiology’s Research Ethics Committee.

Please let me know if you would have any questions, or would like further information in order to further consider this invitation, and whether you and your school are interested in participating in my research. Should you wish to speak to my supervisor, Dr. Gabriela Tymowski, she may be reached at tymowski@unb.ca or at (506) 447-3231. Should you have any concerns about this process, you may contact Dr. Steven Turner, Chair of the UNB Research Ethics Board at (506) 453-5189 or ethics@unb.ca

Thank you very much for your consideration. I look forward to hearing from you.

Sincerely,

Manny Pereira
(506) 447-3178
manny.pereira@unb.ca
Letter of Invitation, Information for Parents & Guardians, & Permission (consent) Form

Dear Parents and Guardians,

I am a master’s student at the University of New Brunswick, in the Faculty of Kinesiology. I would like to invite your child to participate in my research, which is interested in learning more about the relationship between reading and the coordinated movement of body parts in grade three and four children who attend an on-reserve, First Nation elementary school in New Brunswick. This would involve assessing your child’s reading skills, and some physical activity skills.

Participating in this research might help your child directly, as the school staff will learn more about class reading and physical skills related to coordination. Participating in this research might also help you and your child’s teachers, as we are hoping to learn more about the relationship between reading and physical skills. The results might influence how teachers use the curriculum in the school to better help the children both on an individual and a group basis.

I will do these reading and physical activity skill evaluations. My supervisor, Dr. Gabriela Tymowski, will be with me for the evaluations, and the principal is also invited to observe the evaluations.

WHAT? This current evaluation will include: reading, running, jumping, & kicking a ball.
Children will be thanked for their participation with some small gifts of stickers, pens & pencils.

WHERE? At your child’s school
WHEN? April 2015
WHO? Children in Grades 3 & 4
COST? None – Free of charge

Another component of the study is the skills assessment. Children will be assessed one at a time for approximately 10 minutes of reading, and another 10 minutes with the class as a whole. There will be a 25 minute assessment measuring a number of skills in movement, which will take place in the school gymnasium.

If you agree to your child’s participation in this study, please sign the coloured permission form attached here, and return it to your child’s teacher at school. Your support is important and very much appreciated! Please note also that your child may stop participating at any time during the study, without anything happening, if she or he does not want to continue. Her or his information also collected will be destroyed.
The school supports your child’s participation in this research study. If you have any questions please contact me at any time, or any of the other individuals mentioned here.

Thank you very much for considering your child’s participation in this research study.

Sincerely,

Manny Pereira
(506) 447-3178
manny.pereira@unb.ca

Further Information:

If you would like more details, or if you have any questions about the assessment please contact me, my supervisor, or the principal, (contact information is below). The results of your child’s evaluations will only be seen by me, my supervisor, and the principal. The information gathered from all children will be combined so that no individual will be identifiable, only group information, for the final research project. This project has been reviewed by the Research Ethics Board of the University of New Brunswick and is on file as REB 2015-041. Please contact Dr. Steven Turner, chair of the UNB Research Ethics Board, if you have any questions or concerns regarding this research.

Principal, @ (506)

Dr. Gabriela Tymowski, Ph.D. Dr. Steven Turner
Associate Professor Chair, UNB Research Ethics Board
University of New Brunswick University of New Brunswick
tymowski@unb.ca ethics@unb.ca
(506) 447-3231 (506) 453-5189

PLEASE KEEP THIS INFORMATION LETTER, & RETURN THE FOLLOWING PAGE, IF YOU AGREE TO YOUR CHILD’S PARTICIPATION.
Permission (consent) Form for Parents & Guardians

PLEASE RETURN THIS FORM TO YOUR CHILD’S TEACHER


Graduate student:  Manny Pereira
Sports and Exercise Science - Faculty of Kinesiology
manny.pereira@unb.ca
(506) 447-3178

I give permission for my son/daughter ______________________________ (child’s name) who is in Grade 3 or Grade 4 at … School to participate in this study conducted by Manny Pereira. I understand the nature of this project and agree that my child may participate. I am not waiving any of my legal rights by signing this form.

I understand that if my child does not want to participate, or decides that she or he would like to stop participating, that she or he may do so at any time, without any penalty of any kind.

My signature below indicates my consent.

________________________  __________________________
Name of child             Date of birth

________________________  __________________________
Phone number             Date:

________________________  __________________________
Name of parent or guardian  Signature of parent or guardian
Curriculum Vitae

Candidate’s full name: João Manuel de Carvalho Pereira

