GROSS MOTOR DEVELOPMENT AMONG CANADIAN INFANTS OF ASIAN AND EUROPEAN ETHNIC BACKGROUNDS

by

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ABSTRACT

Background and Purpose: Differences in the motor development of children of various ethnic backgrounds have been reported in the literature, yet no studies have examined similarities and differences in the development of motor skills among Canadian infants of different ethnic origins. The primary purpose of this study was to compare the motor development of infants of Asian and European ethnic backgrounds, the two most highly represented ethnic groups in British Columbia. Two secondary research questions addressed the conflicting evidence surrounding the effect of sex and socioeconomic status on motor development. Null hypotheses were tested for the three research questions.

Subjects: Test scores from 300 infants of European background and 35 infants of Asian background formed the data set for analysis. Infants aged 2.5 to 12.5 months were developing typically.

Methods: Using a cross-sectional design, this study evaluated similarities and differences in motor development to answer the research questions. The Harris Infant Neuromotor Test (HINT) was used to assess infant neuromotor development. Three sets of data were used: 1) retrospective data from infants who had participated in the completed HINT normative study; 2) data from infants who are participating in an ongoing study entitled Training & Outcomes for Early Identification of Infants with Neuromotor Delays; and 3) data from additional infants of Asian background who were recruited to increase the size of that group.

Results: Factorial ANOVA of the primary hypothesis indicated that there were no differences in motor development between infants from these two ethnic backgrounds.

Analysis of the secondary hypotheses indicated no difference in infant motor development based on sex or maternal education; the latter served as an indicator of socioeconomic background.

Discussion: Although specific limitations must be considered, the results of this study clearly indicate no difference in the motor development of Canadian infants of Asian and European ethnic backgrounds.

Conclusion: Clinicians can be confident with the use of the HINT when used to screen infants of Asian and European backgrounds for developmental delay. HINT results for other ethnic groups should be interpreted with caution until further information is available.

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CO-AUTHORSHIP STATEMENT

This thesis contains a study that was conducted by the candidate, Tanja A. Mayson, under the supervision of Dr. Susan R. Harris (Professor, School of Rehabilitation Sciences), Dr. Catherine L. Backman (Associate Professor, School of Rehabilitation Sciences), and Dr. Virginia E. Hayes (Professor, University of Victoria School of Nursing). The collection of data specific to this project, analysis, and documentation of the study was primarily the work of the candidate.

Chapter 1 represents a manuscript submitted to *Pediatric Physical Therapy*, and is co-authored with Dr. Susan R. Harris and Dr. Catherine L. Backman. The contributions of the candidate to this manuscript include: refining the research question and designing the literature search strategy, with the assistance of my co-authors; conducting the literature search and selecting relevant data; synthesizing the findings; as well as preparing the initial draft of the manuscript, and incorporating co-author suggestions into subsequent versions.

Chapter 2 represents a manuscript that will be submitted to *Physical Therapy*, and is co-authored by Catherine L. Backman, Susan R. Harris, and Virginia E. Hayes. The contributions of the candidate to this manuscript include: coordinating the research design under the direction of the co-authors; coordinating recruitment and data collection, with the assistance of clinicians acting as infant assessors; collecting data, for a portion of the data set; meeting with the project statistician, to collaboratively identify appropriate statistical analysis and interpretations; as well as preparing the initial draft of the manuscript and incorporating co-author suggestions into subsequent versions.

For both chapters/manuscripts, the candidate is the primary author and identified as the corresponding author for journal submissions.

Chapter 3 is a summary chapter and not intended to be a manuscript for publication.

The above statement was written by Tanja A. Mayson and agreed upon by the undersigned.

Dr. Susan R. Harris

Dr. Catherine L. Backman

Dr. Virginia E. Hayes

1. INTRODUCTION[1]

1.1. Overview of the Thesis

This thesis consists of three chapters: (1) a manuscript introducing the study, its purpose, and a review of current knowledge; (2) a manuscript examining similarities and differences in motor development in Canadian infants of European and Asian backgrounds; and (3) overall conclusions, significance and future research implications.

1.2. Introduction and Purpose of the Review

Research has shown benefits of early identification of children with atypical or delayed development.[1,2] Although results of early intervention are conflicting,[2-5] identification, in conjunction with referral to appropriate services, can maximize developmental outcomes.[1,6] Many discriminative motor tools compare children's development to: (1) a normative sample that is not ethnically diverse[7] (or whose ethnic make up is not discussed),[8] (2) a normative sample that represents some but not all of a country's ethnic backgrounds,[9] or (3) a normative sample consisting of children of diverse ethnic backgrounds that represent each ethnic origin in proportion to the actual population.[10-12] Variations in gross motor development of children of different ethnic origins have been documented in the literature,[13] including differences in motor development among children of different ethnic backgrounds living within countries such as Israel[14] and the United States (US).[15-20]

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[1] A version of this chapter has been submitted for publication. Mayson TA, Harris SR, Backman CL. Similarities and Differences in Gross Motor Development Between Children of Asian and European Ethnic Backgrounds on Four Discriminative Motor Assessments: A Literature Review. *Pediatric Physical Therapy.*

Therefore, even if tests have been standardized on samples representative of ethnically diverse populations, they may not accurately represent the gross motor development of one specific ethnic origin included in the normative sample; i.e., if one ethnicity comprises a majority of a normative sample, the mean comparison data will be skewed toward their results.

For example, an ethnically diverse sample consisting of mostly European children will likely have a mean score closer to the mean of the European sub-group than to the means of sub-groups of other ethnic origins. European children are therefore more likely to have a score that is closer to the normative sample mean than children from other ethnic origins. Children from other ethnic origins may have motor skill levels that are typical of their own ethnic origin yet may appear advanced or delayed when compared to the normative data, leading to incorrect conclusions regarding their development.

Three studies have evaluated the motor development of Native American and Alaskan Native children, two different subgroups of American aboriginal children.[15-17] After assessing 44 Native American children, aged 24 to 35 months, using the Peabody Developmental Motor Scales (PDMS),[21] a standardized test with norms from a representative sample of 2000 American children, Crowe et al. reported that the Native American children scored significantly lower than the age-matched, ethnically-diverse normative group.[15] Similarly, when the Motor Scale of the Bayley Scales of Infant Development, 2nd Edition (Bayley-II),[10] another standardized test with a representative sample of 1700 American children, was administered to 39 Native American children aged 24 to 39 months, the Native American children scored significantly lower than the age-matched, ethnically diverse normative sample.[16] In contrast, when 102 children of

Alaskan Native origin (ranging in age from two weeks to 6 years) were assessed using the Denver-II,[22] a standardized test for which the normative sample included 2000 African-American, European-American, Hispanic-American, but not Native American children, Alaskan Native children were found to be precocious in gross motor development when compared to the age-matched, ethnically-diverse normative sample.[17] Had these children been compared to a normative sample of children from their own ethnic background, they might have been found to be developing at the same rate as their ethnic peers.

This review examines similarities and differences in neuromotor development among children of European and Asian origins, two well-represented ethnic groups in Canada and the US. Knowledge gained through this review will foster better understanding of child development and help clarify whether the comparison scores used in discriminative tools and other norm-referenced measurement tools are appropriate.

1.3. Method Used to Conduct the Review on Differences in Motor Development Among Ethnic Groups

CINAHL, EBM Databases, EMBASE, ERIC, Medline, and PsychINFO databases were searched for articles related to motor development of children of European and Asian backgrounds. Subject headings and keywords included: motor development; motor skills; child development; psychomotor performance; ethnic groups; Asian continental ancestry group; Asians; culture; race; continental population groups; cross-cultural comparison; European continental ancestry group; ethnic groups; and ethnicity. Search terms relating to development were combined with 'or' as were search terms

relating to ethnicity. The results of the grouped searches for development and ethnicity were then combined with 'and' to retrieve articles pertaining to the development of children of different ethnic backgrounds. Lastly, the search was limited to studies of individuals aged 0-18 years, where possible. No limits were set for year of publication.

Inclusion criteria were original research or secondary analysis of previous original results; studies that used gross motor, discriminative, standardized tests or motor milestone achievement in participants below the age of 18 years; and participants of East or South-East Asian origin.

1.4. Results

1.4.1. Differences in Ethnicity

A review of article titles yielded 32 articles. After reviewing the articles' abstracts, 11 articles met the inclusion criteria. Searching the articles' references led to 6 additional articles that met criteria for this review. Of the articles retrieved, 16 included results of standardized tests and one reported on motor milestone achievement. Those reporting standardized test results used only four of the many available discriminative motor tools to compare similarities and differences in motor development of children of European and Asian descent living throughout the world: the Denver Developmental Screening Test[23] (DDST) and its revised version, the Denver II Developmental Screening Test (Denver II),[22] the Movement Assessment of Infants (MAI),[7] the Bayley-II,[10] and the Movement Assessment Battery for Children (MABC).[11] Results based on using these four tools to assess children from different ethnic groups will be discussed, followed by a review of the motor milestone achievement study.

The Denver Developmental Screening Test

A simple, clinically relevant tool used to screen for and detect early signs of developmental delay in infants and preschool-aged children, the Denver Developmental Screening Test (DDST)[23] examines four developmental areas: gross motor, fine motor-adaptive, language, and personal-social behavior. The DDST was standardized on a sample of 1000 "white", "Spanish", and "black" children under 6.5 years of age in Denver, Colorado.[23] Ueda[24,25] used the DDST to assess 615 children aged 16 days to 6 years 4 months in Japan, comparing their scores to the DDST normative data. The Japanese children attained gross motor skills significantly later than their American peers. For items "lifts head in prone", "head to 45 degrees in prone", "head to 90 degrees in prone", "chest up with arm support in prone", "rolls over", and "walks up steps", the age at which 50% of Japanese children passed the item was more than .3 times later than their American peers, or 1.1 to 8.6 months later. For these same items, the age at which 90% of Japanese children passed them was at least 0.2 times later than their American peers, or 1.1 to 13.1 months later.

Williams[26] administered the DDST to 6006 children between the ages of 2 weeks and 6.5 years in the Philippines and found that children in Metro-Manila achieved two-thirds of the items significantly later than their American peers. These results prompted the author to create a slightly different and more appropriate test for screening children in the Philippines, the Metro Manila Developmental Screening Test, with its own normative data and its own criteria for "typical development" in this population.

Williams and Williams[27] conducted a cross-cultural comparison of children by administering the DDST in the Philippines, Japan, and the Netherlands. Age at which

50% of children passed each item was compared. Children from Metro-Manila were delayed in attainment of most items compared to their American and Dutch peers and were most similar in age of skill attainment to their peers in Okinawa and Tokyo.

Miller et al.[28] used the DDST to assess a sample of 25 randomly selected Southeast Asian refugee children between 13 months and 5 years of age who were living in the US. Although there were differences between these children and the Denver normative sample in three DDST dimensions (fine motor-adaptive, personal-social, and language), there were no differences in gross motor skills.

Others have reported results that do not show such consistent differences. Chen[29] used the DDST to compare development of 126 Malaysian children from birth to 6 years of age to the DDST normative data. Although Malaysian children were slightly slower in their gross motor skills during the first year of life, they were more advanced than their American peers during their second year. Similarly, two other studies that examined the re-standardization of the DDST for use with Chinese children found that, when assessing 1041 children aged 1 to 72 months living in Shanghai[30] and 6886 children aged 1 to 72 months living in six northern Chinese cities,[31] Chinese children aged 1 to 72 months were advanced in some gross motor skills (e.g., "pull to sit, no head lag", "bears some weight on legs") whereas their American counterparts were more advanced in other gross motor skills (e.g., "prone, head up 45 degrees", "roll over").

Sriyaporn and colleagues[32] used the DDST to assess 1442 children in Bangkok who were 2 weeks to 6 years of age. Although the 25th percentile gross motor scores for the Bangkok sample were similar to those from the Denver sample, they were more delayed at the 75th to 95th percentile for each test item.

The Denver II[22] was created to address concerns that had arisen from the DDST. The revision included modification of 21 items and addition of 43 new items. The normative sample consisted of more than 2000 children living in Colorado who were "white", "Hispanic", or "black".[9] Even with creation of the revised version of the DDST, Lim and colleagues stated that a substantially different version of the Denver II needed to be created to accurately assess children in Singapore.[33]

The Movement Assessment of Infants

A standardized measure used to identify infants with neuromotor delays or disorders, the Movement Assessment of Infants[7] (MAI) evaluates four components of neuromotor behavior in the first year of life: muscle tone, primitive reflexes, automatic reactions, and volitional movements. The initial profiles created for this tool were based on a sample of 57 infants of which 55 were of European background.[7]

Toy and colleagues[20] used the MAI to assess 30 full-term, 6-month-old Asian-American infants without known risk factors, and compared their scores to those in Washington and Deitz's[34] study of predominantly European background age-peers. No between-group differences were found in muscle tone items. However, in the primitive reflexes section, Asian-American infants had less advanced scores than their peers of European background on two items – the Moro and Galant reflexes. Asian-American infants also had a greater frequency of less optimal scores in the automatic reactions section of the MAI than infants of European background in the earlier study,[34] although overall scores for this section were similar between groups. Lastly, significant differences between groups were identified in the volitional movement section. Asian-

American infants received a much higher percentage of scores indicating "volitional movements appear immature for age".

When Toy et al.[20] used the 6-month profile created from Washington and Deitz'[34] study, they noted that although 56% of the European background infants attained a risk score of zero, indicating no risk points, none of the Asian-American infants scored zero. Also, risk scores of $\geq$6 fall outside the range of scores for the Washington and Dietz[34] study and, if used as a cut score for typical development, 40% (12 of 30) of Asian-American infants would have been considered to be outside the typical range.

The Bayley Scales of Infant Development

The Bayley Scales of Infant Development (BSID) are standardized scales used to assist in identifying children with delays, to measure change in development, as well as assist in the planning and evaluation of intervention.[35] The Bayley-II[10] was created due to an identified need for revising the initial test's norms.[36] The revised edition includes two different scales, motor and mental, as well as an infant behavior record.[10] The normative data for the second edition came from a sample of 1200 American children, with each age group stratified for gender, ethnicity, geographic region, and parental education. Ethnic backgrounds of children in the normative sample included "white", African- American, and Hispanic, as well "other ethnic backgrounds" that included Asian-American, Native American, and Pacific Islanders in the same proportions of children aged 1 to 42 months in the US population according to the 1988 US census.[10]

Pomerleau and colleagues[37] used the Bayley-II to assess motor development of young children adopted in Quebec, Canada. Children adopted from China and East Asia

were compared to children adopted from Russia. On arrival in Canada, Asian children had a higher psychomotor developmental index (PDI) than their Russian peers and, within the Asian sub-group, East Asian children had higher PDI scores than their Chinese peers. Over the following 6 months, the PDI scores for all children continued to improve, although not in a linear fashion. The East Asian children maintained their lead over the Chinese children, whereas the gap between Russian and Chinese children grew wider. Of note, the PDI scores for all infants in this study were 0.33 SD to 1.67 SD below the mean scores of the BSID-II normative sample.

The Movement Assessment Battery for Children

A standardized tool used to evaluate motor skills in children aged ≥4 years, the MABC[11] evaluates both fine and gross motor skills and was standardized on 1234 American children representative of the general population, including children of different ethnic backgrounds, e.g. "white", "black" and "other" ethnic origins in approximately the same proportions as existed in the US in the 1980s.[11] Miyahara et al.[38] assessed the suitability of the MABC for Japanese children. One hundred and thirty-three children, ages 7 to 11 years, participated. In the three age bands administered (7-8 years of age; 9-10 years of age; 11-12 years of age), 29% of items yielded a significant difference ($p < 0.01$) between American and Japanese children. When examining the results for each age band separately, a trend became apparent. Older children had more item scores that were significantly different from their American peers than did younger children, with the direction for these differences due mostly to superior American performance. Overall, 45% of 11- year olds fell below the 5th percentile American

norms, leading the authors to suggest that the MABC's norms might not be appropriate for Japanese children.

Chow and colleagues[39] administered the MABC to 255 Hong Kong children, ages 4 to 6 years. In contrast to Mihayara and colleagues' results, [38] Chow et al.[39] found that Chinese children had significantly more advanced performance than their American counterparts on items related to manual dexterity and dynamic balance, whereas the American children demonstrated more advanced performance on items relating to projection and reception of moving objects.

When Chow, Hsu, Henderson, Barnett & Lo[40] incorporated the scores from these 255 children with those of 544 other children aged 4 and 6 years from Taiwan, and compared them to the American normative sample, both within- and cross-cultural differences were significant on all items of the MABC. Effect sizes, however, were too small to be considered meaningful. The authors reported that descriptive analysis of the cut-off scores for identification of delays suggested that certain items would need to be adjusted prior to using this test in a Chinese population.

In Singapore, Wright and colleagues[41] investigated the usefulness of the MABC Checklist, a second part of the MABC package by assessing 212 children 7 or 8 years of age. Although the percentage of children having movement disorders was quite similar to the value obtained in the normative sample, quite a few items needed modification to enable their completion in Singaporean children.

Motor Milestone Achievement Differences

The foregoing summary of studies illustrates motor development differences among children of various ethnic backgrounds with data supporting discrepancies between children of European and Asian backgrounds. Not only did the rate of skill acquisition differ among children of different ethnic origins but limited evidence also suggests that elements in the sequence of skill acquisition may also differ. A sample of 72 infants from Hong Kong rolled from supine to prone prior to rolling from prone to supine,[42] contrary to the sequence identified in a Canadian normative study. [8]

This literature review illustrates differences in rate and sequence of gross motor skill attainment among children of different ethnic origins and highlights why it may be inappropriate to compare children to an ethnically diverse, representative sample of the general population. In addition to ethnic background, other factors may affect children's rate and sequence of gross motor development, such as nutrition, early postural experience, parental expectations, sex, and socioeconomic status (SES).[13]

1.4.2. Differences Other Than Ethnicity

Other than ethnic background, the factors most studied in relation to gross motor development are SES and sex.

Sex

Although sex is thought to be related to motor development, studies analyzing sex differences in gross motor development throughout the world have reported conflicting results. Some studies have reported no differences in motor development between boys

and girls,[19, 43] whereas others have shown inconsistent variations in rate of motor development.[44,45] When examining differences in motor development of boys and girls of Asian background, results were also contradictory with two studies showing no difference[38, 42] and one study demonstrating differences between sexes in certain motor skills.[39] In the Canadian context, a preliminary analysis conducted with the HINT normative data determined that there were no significant differences in HINT total scores between male and female infants at each monthly age level (S. R. Harris, personal communication, Dec. 2004).

Socioeconomic Status

SES can be estimated in a variety of ways, including parental income, parental occupation, and parental education. Conflicting evidence has been reported regarding the relationship between SES and motor development. One study indicated that children from a low socioeconomic background attained gross motor skills at a quicker rate than their higher socioeconomic background peers,[19] whereas another study found that this rate reversed after age 18-24 months at which time infants from the higher socioeconomic group achieved skills quicker.[46] Yet a recent Canadian study of more than 3 million children of unspecified ethnic origins determined that there was a strong and consistent association between poor developmental attainment, as measured by an unnamed motor and social assessment, and living in low-income housing.[47] Mothers' education is thought to be highly correlated with a variety of child development measures and with child rearing conditions.[47,48] To and colleagues[47] also reported that children with poor developmental attainment were more likely to have mothers with limited education.

In children of Asian background, motor development studies of infants from families of different SES have also reported conflicting results. One study reported that children whose fathers' occupations and parental education represented a lower familial SES attained gross motor skills earlier than their higher SES peers,[25] yet others reported that infants' age of rolling over, was not influence by maternal education.[42] Results of a preliminary analysis of 412 Canadian infants' total scores on the Harris Infant Neuromotor Test (HINT) determined that there was no relationship between maternal education and HINT total scores among this sample.[49]

Other Differences

Many factors, in addition to ethnic background, sex and SES, may affect children's rate and sequence of gross motor development. These include nutrition, early postural experience, parental expectations, sex, and socioeconomic status,[13] but are beyond the scope of this manuscript.

1.5. Research Questions

Results of this literature review on differences in motor development among infants from different ethnic backgrounds led to the development of one primary research question and two secondary research questions.

1.5.1. Primary Research Question (Chapter 2)

Research question 1: Are there differences in infant motor development, as measured by HINT total scores, among Canadian resident infants from two different ethnic origins: Asian vs. European?

1.5.2. Secondary Research Questions (Chapter 2)

Research question 2a: Are there differences in infant motor development, as measured by HINT total scores, among Canadian resident infants of different sexes?

Research question 2b: Are there differences in infant motor development, as measured by HINT total scores, among Canadian resident infants of different SES, as estimated by maternal education?

1.6. Summary and Implications for Research and Practice

In 2000, the Canadian Institute of Child Health[50] reported that 7.7% of Canadian children lived with a disability. Infant motor development is an important indicator of neurological integrity[51] and can be used to identify children at risk for neurodevelopmental delay[12] and disability. Although the evidence supporting early intervention effectiveness is conflicting,[2-5] the best chance for positively influencing children's developmental outcome is to identify children with delays as promptly as possible in order to begin intervention.[1,6] Although children with significant delays are generally easy to identify early in life, it is more difficult to identify children with milder delays.[51] Considering that these may be the children for whom early intervention services have the most benefit, it is crucial that they be identified as early as possible.[52]

Early identification requires reliable and valid discriminative tools that have been standardized on a normative sample representative of the population. The sample should include the same proportions of children of different ethnic origins as in the general population. By using such a comparison group, however, it is possible that children are being compared to scores that are not typical of development of those of their ethnic origin and that they are therefore incorrectly identified as advanced, typical or delayed. Although differences in motor development of children may be due to various factors,[13,19,44] the literature reviewed suggests differences in rate of motor development among children of various ethnic origins, including those of Asian and European descent.[14-20, 24-27, 29-33, 37-41] Limited support suggests also that certain developmental milestones, such as rolling,[42] may differ between infants of Asian and European origin.

Considering the number of standardized, discriminative motor tools in existence, it was puzzling that only four tools were represented in the reviewed literature. More than half of these articles were published over 10 years ago and the majority relate to the original DDST, an outdated tool. This speaks to the lack of available research on the appropriateness of normative data for currently–used, discriminative motor assessments.

Therefore, caution is advised when interpreting results from discriminative motor assessment tools with children of different ethnic backgrounds until there is enough evidence surrounding the motor development of children of various backgrounds living within one country. Further examination of similarities and differences in neuromotor development among children of different ethnic groups living within each country is needed to help facilitate identification of children with delays and ensure that they are being compared to an appropriate normative sample. This, in turn, will help provide

children and their families with the support they need to achieve a desirable state of physical, mental, and social well-being, leading to full participation in society or, more simply put, "health".[53]

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2. EXAMINING SIMILARITIES AND DIFFERENCES IN GROSS MOTOR DEVELOPMENT BETWEEN CANADIAN INFANTS OF ASIAN AND EUROPEAN ETHNIC BACKGROUNDS[1]

2.1. Overview

In this second chapter, the study conducted to answer the research questions posed in the introductory chapter is described. For this reason, Chapter 2 restates the context and summarizes literature, but more succinctly than in Chapter 1. This chapter will present the background, method results, limitations, and discuss the significance of the findings. A more comprehensive discussion, beyond the scope of most journals, will be presented in Chapter 3.

2.2. Background and Purpose of the Study

The terms ethnic origin, culture and race are often used interchangeably although, when defined correctly, refer to different constructs. As used in the Canadian census, ethnic origin is defined as the ethnic origin or cultural origins of a person's ancestors,[1] and is the term used throughout this thesis. Prior research has demonstrated similarities and differences in gross motor development across cultures,[2] including children of Asian and European origins,[3-19] the two most frequently occurring ethnic groups in British Columbia (BC), Canada.[20]

Differences have been found both in the rate of motor development of children of Asian background when compared with their peers of European background,[3-17] and in the sequence of certain motor milestones, such as rolling.[18]

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[1] A version of this chapter has been submitted for publication. Mayson TA, Backman CL, Harris SR, Hayes VE. Similarities and Differences in Gross Motor Development Between Infants of Asian and European Ethnic Backgrounds. *Phys Ther.*

Because early identification of infants with atypical and delayed development, in conjunction with referral to appropriate services, can maximize developmental outcomes,[21-23] discriminative tests to identify delays must be able to accurately and reliably identify infants with delays. Many discriminative tests used to identify motor delay compare children's development to: (1) a normative sample that is not ethnically diverse[24] or in which ethnic origin is not discussed,[25] (2) a normative sample that represents some but not all of a country's ethnic backgrounds,[26] or (3) a normative sample consisting of children of diverse ethnic backgrounds that represent each ethnic origin in proportion to the actual population.[27-29]

However, even if tools have been standardized on a normative sample representative of an ethnically diverse population, they may not accurately represent the gross motor development of one specific ethnic origin included in the normative sample. For example, if one ethnicity makes up a majority of a normative sample, the mean comparison data will be skewed toward their results. This may create the appearance of delayed or advanced motor skills in infants of other ethnic backgrounds and may lead to incorrect conclusions regarding development of those infants assessed with that test. This highlights the need for a thorough understanding of the development of children of different ethnic backgrounds when interpreting assessment results.

Because the Harris Infant Neuromotor Test (HINT) was one of the tests that included a normative sample of children of diverse ethnic backgrounds with proportional representation of predominant ethnic origins, we used the HINT to assess infants' motor development. The HINT is a reliable and valid screening tool designed to detect early signs of developmental delay in healthy, low-risk infants.[30] Many screening tools are available to identify infants with neuromotor delays but all have problems that limit their clinical use. The HINT was developed to fill the gaps in identifying early motor deficits as well as early cognitive delay[31] and is

divided into three parts: (1) background information, including questions regarding variables to be analyzed in this study: infant's ethnic origin, age, and sex and maternal education level; (2) caregiver's perception of how the child is developing, and (3) infant assessment to be completed by an early childhood professional and consisting of 21 items regarding motor behaviors. The HINT total score is calculated by summing the scores for the 21 individual motor behavior items. The range of possible scores is 0 to 76. A lower HINT score reflects higher level of motor skill, i.e., older infants are expected to demonstrate lower scores than younger infants.

Canada is a multicultural country yet, with the exception of a study on babies adopted from abroad,[3] no other studies have examined similarities or differences in motor development among Canadian children of different ethnic backgrounds. Lack of information regarding motor development of Canadian children of European and Asian origins led to development of the primary research question that follows. Two secondary research questions addressed conflicting results in the literature regarding the influence of sex[12, 13, 15, 32-35] and socioeconomic status (SES)[6, 15, 32, 36-38] on motor development. Maternal education has been found to be correlated with a variety of child development measures and with child rearing conditions,[37,39] and was therefore selected as a proxy for estimating SES.

2.2.1. Primary Research Question and Hypothesis

Research Question 1: Are there differences in infant motor development, as measured by HINT total scores, between Canadian resident infants from European and Asian ethnic origins?

Hypothesis 1: There will be no differences in infant motor development, as measured by HINT total scores, between Canadian resident infants of European and Asian ethnic origins.

2.2.2. Secondary Research Questions and Hypotheses

Research Question 2a: Are there differences in infant motor development, as measured by HINT total scores, between Canadian resident infants of different sexes?

Hypothesis 2a: There will be no differences between girls and boys, as measured by HINT total scores, among Canadian resident infants of European and Asian ethnic origins.

Research Question 2b: Are there differences in infant motor development, as measured by HINT total scores, among Canadian resident infants of different SES as estimated from maternal education?

Hypothesis 2b: There will be no differences among infants born to mothers with different levels of education, as measured by HINT total scores, among Canadian resident infants of European and Asian ethnic origins.

2.3. Methods

2.3.1. Design

A descriptive, cross-sectional, observational design was used to examine similarities and differences in gross motor development of Canadian resident infants of two different ethnic origins. Three sets of data were used in this study: 1) retrospective data from infants who had participated in the completed HINT normative study;[29] 2) data from infants who are participating in an ongoing study entitled Training and Outcomes for Early Identification of Infants with Neuromotor Delays;[40] and 3) data from additional infants of Asian background recruited to increase the size of that group. In the HINT normative study,[29] 412 infants from five Canadian provinces were assessed. Their ages at assessment ranged from 2 months 16 days to 12 months 15 days. In the Training and Outcomes for Early Identification of Infants with Neuromotor

Delays project,[40] 100 typical and 100 at-risk babies are currently being tested at four time intervals: 4 to 6.5 months, 10 to 12.5 months, 23.5 to 25.5 months and 33.5 to 38.5 months of age. Infants are being assessed on the HINT as well as on three other measurement tools at the first two assessment periods. To be included in the Asian group, infants had to have both parents with either East Asian or Southeast Asian background and be between the ages of 2 months 16 days and 12 months 15 days. Infants of European background had to have both parents with a European background and be between the ages of 2 months 16 days and 12 months 15 days.

2.3.2. Participants and Protocol

Sample size calculations indicated that with data available on 300 infants of European background, 35 infants of Asian background would be needed to show a clinically significant effect size of 0.5 with a power of 0.8 at the 0.05 significance level (Appendix I). Review of previously collected data indicated that total HINT scores were available for 20 infants of exclusively Asian background, thus requiring recruitment of 12 additional Asian infants.

As with the other two studies,[29, 40] recruitment for this project occurred through physicians' offices and word of mouth, utilizing a recruitment poster (Appendix II) and pamphlet (Appendix III) to advertise the study. Interested parents were provided a letter of introduction (Appendix IV). If the legal guardian agreed to participate, s/he was asked to sign a consent form (Appendix V). Study participation was based on consecutive convenience sampling. Ethics approval was received from the University of British Columbia's Behavioural Research Ethics Board (Appendix VI).

Inclusion criteria for infants for the current analysis were birth weight greater than 2500 grams, gestational age of 38 to 42 weeks, absence of any major maternal health risk factors

during pregnancy, no post-natal infant health conditions or anomalies, age at assessment of 2 months 16 days to 12 months 15 days, Canadian residency, and parent self-reported ethnic background as East Asian, Southeast Asian, or European. To remove additional confounders, exclusion criteria were preterm birth (less than 38 weeks gestation), low birth weight (less than 2500 grams), history of maternal substance use during pregnancy, or history of maternal or infant high-risk health conditions (e.g., genetic anomalies or cardiac defects).

Infants were grouped according to ethnic origin, based on parental self-report, the same method used for the current Canadian census,[20] regardless of being first, second, third, or subsequent generation Canadian. Comparison groups were based on the most highly represented groupings in BC, as in the most recent available census data collected in 2001.[20] These groups were European origin which comprise 40.3% of the single ethnic origin responses given in BC in the 2001 census, and East Asian and Southeast Asian origins (including such origins as Chinese, Japanese, Korean, and Filipino) comprising 20.4% of the single ethnic origin responses in BC in the 2001 census (see Table 2.1). When considering these percentages, one must keep in mind that the Canadian census also provides individuals with the possibility of listing 'Canadian' as an ethnic origin, a subgroup with which 24.3% of BC residents identified.[20] It is, however, likely that many different ethnicities are represented within this 'Canadian' subgroup, making it difficult to know with certainty the ethnic origins of this group.

According to Statistics Canada,[41] the term "Asian origin" encompasses three subgroups: East Asian/Southeast Asian, South Asian, and West Asian. The subgroup of East Asian/Southeast Asian comprises 20.4% of British Columbians, with South Asians making up the third largest ethnic group (7.4%).[20] The subgroup of East/Southeast Asian was selected from the broader term, Asian, to limit variability within this group while focusing on the largest non-

European group in the province. Interestingly, the 2001 census classified individuals who considered themselves to be 'Asian' within the East/Southeast Asian subgroup.[41]

The HINT assessment form includes the following ethnic origins as options: Asian, Black, Caucasian, East Indian, Hispanic, Native American/First Nations, and Other. For this study, infants were classified according to HINT data as being of European descent if their parents were Caucasian, and as East Asian or Southeast Asian if their parents were Asian. For the remainder of this thesis, this subgroup (East/Southeast Asian) will be referred to simply as the Asian group.

In the current study, age was considered a continuous variable measured in months and days. In addition to infant age, two other potential explanatory variables were considered: infant sex and maternal education. Sex is a two-level categorical variable: girl and boy. For this study, maternal education was a categorical variable with four levels: less than high school completion, high school completion, some college/university, bachelor's degree, or graduate studies.

2.3.3. Measurement: The Harris Infant Neuromotor Test

The HINT is a quick, reliable and valid screening tool for the early identification of developmental delay in infants.[30] Inter-rater, intra-rater and test-retest reliability intra-class coefficients for the HINT ranged from 0.98 to 0.99.[30] The HINT also has strong concurrent validity with the Bayley II Motor and Mental Scales with respective 12-month correlation coefficients of $r = -0.73$ ($p<0.01$) and $r = -0.89$ ($p<0.01$).[30] The HINT's predictive validity to the Bayley II at 17-22 months was $r = -0.11$ ($p<0.01$) for the Mental Scale and $r = -0.49$ ($p<0.01$) for the Motor Scale, demonstrating modest predictive validity to the Bayley-II Motor Scale.[30]

The HINT is appropriate for infants between 2.5 and 12.5 months of age. The child's age is categorized into monthly levels by rounding the age up to the next month once the child is 16 days past that month, i.e., a child who is 6 months 16 days is considered to be 7 months of age whereas a child who is 6 months 15 days of age would be categorized as 6 months of age.

2.3.4. Data Analysis

The HINT total score was selected as the dependent variable with child's ethnicity, sex, and maternal education as the fixed independent factors. Because infant motor development and infant age are strongly correlated, age also had to be considered as an independent variable. To address this issue, HINT scores were converted to *z*-scores to allow comparison among children of different ages. The *z*-score was calculated by subtracting the mean HINT total score for each age in months from the infant's HINT total score and dividing this number by the standard deviation identified for each age in months. The infants' ages were converted from months and days into months, to one decimal point, with the digit following the decimal point representing the fraction based on a month of 30 days. For example, a child born at 5 months and 15 days was said to be 5.5 months old.

Data were analyzed using the Statistical Package for the Social Sciences (SPSS for Windows version 10.0). Descriptive statistics, including frequency tables and cross-tabulations, were used to compare European and Asian infant groups according to age, sex, and maternal education. Chi-square tests were used to examine differences between groups in age, sex, and maternal education.

A general linear univariate model with one continuous dependent variable and three fixed independent categorical factors was used to analyze between group differences. The HINT z-

score was the dependent variable and the independent factors were infant ethnicity, infant sex and maternal education. Using a three-way analysis of variance (ANOVA), main effects and interactions were examined.

2.4. Results

2.4.1. Sample Description

The study sample consisted of 300 infants of European background and 35 infants of Asian background. Data for the 300 infants of European background and 17 infants of Asian background were obtained from the HINT normative study. Data for 6 of the infants of Asian background were obtained from the Training and Outcomes of Early Identification of Infants With Neuromotor Delays research project, of which 3 were purposively recruited based on ethnic origin for the present analysis. The additional 12 infants of Asian background were recruited only for the present study.

The sample included infants aged 3 to 12 months (see Table 2.2). A chi-square test determined that there was no significant difference ($p = 0.851$) in infant age between ethnic groups. Tables 2.3 and 2.4 illustrate the distribution of infant sex and maternal education in each of the groups. A second chi-square test indicated no significant difference ($p = 0.232$) in infants' sex between ethnic groups. There was, however, a significant difference in maternal education levels between ethnic groups, as indicated by results of a third chi-square test ($p = 0.002$), with maternal education more advanced in the Asian background group than in the European origin group.

2.4.2. Analysis of Differences

Tables 2.5 through 2.8 illustrate HINT *z*-scores by infant ages, ethnicity, sex and maternal education. When analyzing interaction effects, results of the three-way ANOVA indicated no significant differences, with a *p*-value of 0.88 when considering the effect of all three fixed variables (ethnicity, sex, and maternal education), as seen in Table 2.9. When analyzing main effects, there was no significant difference in *z*-scores between infants of European and Asian background ($p = 0.18$). Results also indicated no significant differences in z-scores among infants with mothers of different levels of education ($p = 0.56$) or between infants of different sex ($p = 0.66$).

2.5. Discussion

2.5.1. Group Differences

Results of this study indicate that the two groups of infants were similar in representation for age and sex. The groups were different, however, in levels of maternal education, an estimator of SES.[37, 39] Most infants of Asian background had mothers who had completed university, whereas infants of European background demonstrated a greater variety of maternal education levels. The advanced level of education in such a high percentage of participants of Asian background is not representative of the Canadian population as a whole,[42] although it is not known if levels of maternal education vary among ethnic groups in Canada. When deciding whether the lack of representation of different levels of education is of concern, one must also consider that previous analyses of the HINT normative data,[38] as well as the results of this study, failed to show any difference in motor development based on maternal education, suggesting

that, even if the Asian group had been more diverse in levels of maternal education, the study results likely would not have varied.

2.5.2. Ethnic Differences in Motor Development between Asian and European Infants

Analyses of differences in motor development were conducted to answer the primary research question: Are there differences in infant motor development, as measured by HINT total scores, among Canadian resident infants from Asian and European ethnic origins?
In support of the null hypothesis, results indicated that there were no differences in motor development between infants of Asian and European background living within BC, when assessed on the HINT.

When examining the current study results, one must consider that differences in motor development of children of different ethnic backgrounds living within the same country have been demonstrated in Israel[43] and the US.[4, 32, 44-47] To date, only one study has been published on Canadian children of different ethnic backgrounds, i.e. Russian and Asian infants newly adopted in Canada.[2] Those results should be interpreted with caution, however, as the children in the study had been newly adopted and a high percentage arrived with health concerns, which may have negatively affected their development.

In the literature reviewed in Chapter 1, 17 studies comparing motor development between children of Asian and European ethnic backgrounds were identified. Only one study reported no differences in motor skills between these two groups.[19] In the other 16 studies, the direction of differences varied with more than half indicating delays in motor development of children of Asian background compared to normative data[3-8,11,12,18] and the other studies having results that

were not consistent enough to provide a blanket statement about the children's motor development.[9,10,13-17]

When comparing the current study results to those in the literature, two additional factors must be considered: the location in which the children resided and the measurement tool used to assess motor performance. Of the studies reviewed, only three involved children living outside of Asia, as in the current study: two studies took place in the US[4,19] and one took place in Canada.[3] Like the current study results, Miller and colleagues reported no differences in motor development between children of Asian and European background living in the US. In contrast, the results of the other US study[4] and the other Canadian study[3] suggested delayed development in children of Asian background when compared with their European background peers. The other 14 studies took place in Asia and all indicated differences in the motor development of children of Asian and European backgrounds. These studies are reviewed in more detail in Chapter 1.

The second factor to consider is the measurement tool used in each study. None of the published studies used the HINT, a newly available tool, to assess motor differences. Not only were the measurement tools different but the level of ethnic representation within each normative sample varied.[24-29] Of the tools used in the studies reviewed, only one, the Bayley-II,[27] included a normative sample that represented ethnic origins in the same percentages as the country of origin, as was true also in the HINT normative sample.

Results from the study that used the Bayley-II did, however, find a difference in motor development between Asian and European infants.[3] Two possible reasons for the different results come to mind. The most likely reason is the fact that Pomerleau and colleagues' sample was comprised of adopted infants, a high percentage of whom had health concerns which may have

negatively affected their development, whereas the current study included only healthy, full-term babies. It is also possible that the difference may stem from the lower representation of children of Asian origin in the US,[48] where the BSID-II was standardized. Whereas Asians comprise 4% of the US population, they represent more than 8% of residents of Canada[49] where the HINT was standardized.

In summary, results from our study clearly indicate that there were no differences in motor development of BC infants of Asian and European backgrounds, in contrast to the majority of published studies. With results indicating no difference in the motor development of infants of East/Southeast Asian and European backgrounds living in BC, the possibility of a type II error must be considered. In the present study, the likelihood of this type of error is quite small as the power of 0.8 used to calculate sample size is within the range recommended for this type or research.[50] Also, the observed differences between groups are so small that even if a larger sample detected a statistically significant difference, the difference between groups would likely not be clinically important.

2.5.3. Sex Differences in Motor Development

The first of two secondary research questions asked: Are there differences in infant motor development, as measured by HINT total scores, among Canadian resident infants of different sexes? As with ethnicity, the research literature is contradictory in its findings about motor development differences in infants of different sex. Some studies have indicated motor differences in children of different sexes living throughout the world,[34, 35] whereas others have shown no differences.[32, 33] When looking specifically at children of Asian background, the results are no clearer.[12,13,15] The present study, however, clearly indicates no differences in motor

development between BC infants of Asian origin and those of European origin, in support of null hypothesis #2a. These results are corroborated by a preliminary analysis of the HINT total scores of the 412 Canadian infants in the HINT normative study (S.R. Harris, personal communication, Dec. 2004).

2.5.4. Maternal Education Differences in Motor Development

The last of the research questions (#2b) asked: Are there differences in infant motor development, as measured by HINT total scores, among Canadian resident infants of different SES, as estimated from maternal education? The literature is similarly contradictory regarding the effects of SES in children of varying ethnic backgrounds,[32, 36, 37] as well as in infants of Asian background.[6,15] Results from the present study support null hypothesis #2b and suggest that maternal education, as a proxy for SES, does not relate to motor development. These results are similar to those identified in an analysis of the HINT normative data, which also indicated no differences in total HINT score in infants with varying levels of maternal education.[38]

2.5.5. Study Limitations

In addition to unequal representation of levels of maternal education between the groups of infants of Asian and European origins, two other limitations must be considered. First is the lack of information on specific ethnic origin. As demonstrated by Pomerleau and colleagues[3] and Lim et al.,[11] differences in development may have occurred among children from specific countries within the large groupings of European and Asian origins. Unfortunately, this type of analysis was not possible in the current study due to failure to initially collect data on countries of origin.

Another potential limitation was the need to merge three data sets, from three different data collection phases, in order to have enough infants in the Asian group, which may have resulted in several other limitations: 1) the data collection was not designed prospectively to answer these particular research questions; 2) the data were collected over a period of 6 years; 3) the participants were not randomly selected but identified using convenience sampling; and 4) the HINT data were collected by a variety of different assessors. Fortunately, all assessors had completed a HINT training course in which inter-rater reliability was assessed and found to be satisfactory, with ICCs ranging from 0.72 to 0.98 (and exceeding 0.93 for 7 of the 8 workshops in which raters were trained). The one lower ICC was likely due to lack of heterogeneity of infant ages in this training course, i.e. three of four infants assessed were the same age.

2.6. Clinical Implications and Directions for Future Research

This was the first study to analyze similarities and differences in motor development in healthy Canadian infants of different ethnic backgrounds. As expected when observing z-scores in a normal distribution, this study's overall sample mean, as well as each ethnic group's mean, were very close to 0, with a standard deviation of 1, indicating a sample representative of the typical population.

Although previous studies support differences in rate and sequence of some motor development milestones in children of Asian and European backgrounds, results of this study indicated that there were no differences in motor development between infants of Asian and European backgrounds living in Canada. Further research is needed to better understand the similarities and differences in motor development in infants of other Canadian ethnic backgrounds to ensure that comparison scores of discriminative motor tools are appropriate. By

analyzing clinically relevant data, the findings from this study and that of future research will provide early childhood professionals with much needed information to aid in making sound decisions when using screening tools on infants of different ethnic backgrounds.

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Table 2.1. Ethnic Origin Classifications (Statistics Canada, 2002)[41]

East and South East Asian Origins		**European Origins**			
Asian	Malaysian	Albanian	Dutch	Italian	Romanian
Burmese	Mongolian	Austrian	Estonian	Kosovar	Russian
Cambodian	Taiwanese	Basque	European	Jewish	Serbian
Chinese	Thai	Belgian	Finnish	Lithuanian	Sicilian
Filipino	Tibetan	Bosnian	Flemish	Luxembourger	Slovak
Hmong	Vietnamese	Bulgarian	Frisian	Macedonian	Slovenian
Indonesian		Byelorussian	German	Maltese	Spanish
Japanese		Croatian	Greek	Montenegrin	Swedish
Khmer		Cypriot	Gypsy (Roma)	Norwegian	Ukrainian
Korean		Czech	Hungarian	Polish	Yugoslav
Laotian		Danish	Icelandic	Portuguese	

Table 2.2. Number of Infants of Each Ethnic Origin by Age

	Age in Months										
Ethnicity	3	4	5	6	7	8	9	10	11	12	Total
Asian	3	5	3	5	5	4	1	4	4	1	35
% Within Ethnicity	8.6%	14.3%	8.6%	14.3%	14.3%	11.4%	2.9%	11.4%	11.4%	2.9%	100%
European	30	32	29	34	33	27	26	23	36	30	300
% Within Ethnicity	10%	10.7%	9.7%	11.3%	11.%	9%	8.7%	7.7%	12%	10%	100%
Total	33	37	32	39	38	31	27	27	40	31	335
	9.9%	11%	9.6%	11.6%	11.3%	9.3%	8.1%	8.1%	11.9%	9.3%	100%

Chi-Square = 4.81, df = 9, $p = 0.85$

Table 2.3. Sex and Number of Infants of Each Ethnic Background

	Sex		
Ethnicity	Female	Male	Total
Asian	14	21	35
% Within Ethnicity	40%	60%	100%
European	152	148	300
% Within Ethnicity	50.7%	49.3%	100%
Total	166	169	335
	49.6%	50.4%	100%

Chi-Square: = 1.427, df = 1, $p = 0.23$

Table 2.4. Maternal Education and Number of Infants of Each Ethnic Origin

	Maternal Education				
Ethnicity	Less Than High School	High School Degree	Some College/ University	Bachelors' or Graduate Degree	Total
Asian	1	3	5	26	35
% within ethnicity	2.9%	8.6%	14.3%	74.3%	100%
European	27	24	76	123	300
% within ethnicity	9.0%	24.7%	25.3%	41.0%	100%
Total	28	27	81	149	335
	8.4%	23.0%	24.2%	44.5%	100%

Chi-Square = 14.337, df = 3; $p = 0.002$

Table 2.5. HINT *z*-Scores by Infant Age in Months

Age in Months	N	Mean	Standard Deviation
3	33	-0.09	0.99
4	37	-0.19	0.96
5	32	-0.05	1.12
6	39	-0.08	1.00
7	38	0.01	0.93
8	31	-0.11	0.99
9	27	0.06	0.99
10	27	-0.04	1.09
11	40	-0.05	1.01
12	31	0.10	1.03
Total	335	-0.06	1.00

Table 2.6. HINT *z*-Scores by Infant Ethnicity

Ethnicity	N	Mean Z-Score	Standard Deviation
Asian	35	-0.10	1.00
European	300	-0.05	1.02
Total	335	-0.06	1.00

Table 2.7. HINT *z*-Scores by Infant Sex

Sex	N	Mean Z-Score	Standard Deviation
Female	166	-0.04	0.96
Male	169	-0.07	1.04
Total	335	-0.06	1.00

Table 2.8. HINT *z*-Scores by Level of Maternal Education

Maternal Education	N	Mean Z-Score	Standard Deviation
Less Than High School	28	-0.05	0.62
High School	77	-0.05	1.03
Some College/University	81	-0.03	1.10
Bachelors or Graduate Degree	149	-0.08	0.98
Total	335	-0.06	1.00

Table 2.9. Three-Way ANOVA of Among-Participant Effects with HINT *z*-Score as the Dependent Variable

	Fixed Factors						
	Child's Ethnicity	Child's Sex	Maternal Education	Ethnicity and Sex	Ethnicity and Maternal Education	Sex and Maternal Education	Ethnicity and Sex and Maternal Education
Sum of Squares	1.84	0.2	2.09	0.24	3.83	1.91	0.25
Degrees of Freedom	1	1	3	1	3	3	2
Mean Square	1.84	0.2	0.7	0.24	1.28	0.64	0.13
F	1.82	0.2	0.69	0.23	1.26	0.63	0.12
Significance	.178	.656	.560	.630	.288	.598	.883

3. CONCLUSION

3.1. Overview

The objective of this study was to examine potential similarities or differences in motor development of East/Southeast Asian and European infants. Chapter 1 reviewed relevant background literature to set the stage for the study, and Chapter 2 presented the study method and results. Chapter 3 will discuss the rationale for studying infant screening tools, and the need to carefully appraise the normative data for motor screening tools, then place the study findings, limitations, significance and clinical implications into the broader context of pediatric practice and, finally, propose topics for future research.

3.2. Background and Rationale for the Study

Why screen infants for development delays? The Canadian Institute of Child Health reported that 7.7% of Canadian children live with a disability.[1] Being able to identify children with developmental delays is of great importance because it can lead to needed treatment or intervention and possibly decrease the impact of the developmental delay on child and family functioning.[2]

Two processes are used to assist in identifying infants with delays. Surveillance is a flexible, ongoing process in which professionals observe children during the provision of health care[3] and typically has been carried out by primary healthcare practitioners. Screening entails a concise assessment aimed at identifying children who should receive more rigorous services or assessments.[4] This can result in a definitive diagnosis, lead to development of a plan of intervention or recommendation for further assessment, or provide reassurance that development is within the range for typical

infants.[2] In 2001, the Committee on Children with Disabilities of the American Academy of Pediatrics recommended that all infants and young children be screened for developmental delays.[2] At this screening stage, one or more additional healthcare practitioners may become involved, including physical therapists, occupational therapists, speech/language pathologists, psychologists, nurses, and infant development consultants, among others.

To achieve their purpose, screening tools must have strong psychometric properties including satisfactory sensitivity, specificity, validity, and reliability, and have been standardized on diverse populations.[2] Imbedded in these criteria is the concept of having an appropriate comparison group or normative sample. Normative samples are typically structured to represent characteristics in a population that may affect the outcome being assessed, such as age, sex, geographical region of residence, socio-economic factors such as parental education, and racial or ethnic background. Despite efforts to obtain a representative normative sample, norms may not accurately represent the development of any one specific group included in the sample. For example, if persons of one ethnicity make up a majority of a normative sample, the mean comparison data could be skewed towards their results. This may create the appearance of delayed or advanced motor skills in infants of other ethnic backgrounds and, in turn, may lead to incorrect conclusions regarding those infants' development. This highlights the need for knowledge in two specific areas. First, information is required on whether there are differences in the development of children of different ethnic origins, sexes, parental education, and place of residence. Second, practitioners who make decisions based on the results of screening tests need to critically examine the norms upon which the tests

are based. Discriminative motor assessments are an example of one type of screening tool and are the focus of this thesis.

3.3. Status of Current Knowledge and Working Hypotheses

The literature regarding potential differences in motor development of children of Asian and European background is inconclusive.[5-21] Except for one study that assessed motor development of Russian and Asian children newly adopted to Canada,[5] no other studies have been published regarding the development of Canadian children of different ethnic backgrounds.

Therefore, the present study, which examined similarities and differences in motor development of children of Asian and European ethnic backgrounds, the two most highly represented ethnic groups in British Columbia,[22] is both timely and necessary.

In addressing the primary research question, study results reported in Chapter 2 indicate no differences in motor development between these two groups, supporting the null hypothesis. These results are in agreement with those of only one of 17 studies reviewed.[6] Interestingly the study by Miller and colleagues[6] was also conducted in North America, whereas the vast majority of the other studies were conducted in Asia.[7-15,17-21]

Two secondary questions were also posed to examine whether there were differences in the motor development of children of different sexes or different socioeconomic levels, using maternal education as a proxy. These questions were important because previous studies, as reviewed in Chapter 1, do not provide conclusive evidence of differences in motor development based on sexes[8, 13, 14, 23-26] or

socioeconomic levels.[14,18,26-29] Null hypotheses based on both of these secondary questions were supported in the present study, as reported in Chapter 2, in concurrence with two of three articles in the literature pertaining to differences in motor development between sexes[13,14] and in concurrence with one of two articles pertaining to differences in motor development between socioeconomic levels[14] among children of Asian background. The one study that reported a significant difference in the motor development of children of different sexes reported that girls were more advanced than boys on all tested motor items except for projection and reception items.[8] And the only study that reported a significant difference in the motor development of children of different SES demonstrated that children of a higher SES achieved many early motor milestones at a later time than their lower SES peers.[18]

3.4. Strengths and Limitations of the Thesis Research

This thesis provides a thorough review of available literature on ethnicity and motor development while also considering factors such as socioeconomic status (SES) and sex, providing some insight into possible reasons for discrepancies in motor development. The study reported in Chapter 2 is the first known research project to analyze similarities and differences in motor development in healthy Canadian infants of different ethnic backgrounds. Study results include HINT *z*-scores that are very close to 0 for each of the ethnic group means and to the study sample as a whole, indicating that the sample included in this study is representative of the typical population.

Three limitations should, however, be considered when interpreting and applying this study's results. First, the two ethnic groups differed slightly in demographic

characteristics other than ethnicity. Although both groups were similar in representation of different ages (each month from 3 to 12) and both sexes, they differed in levels of maternal education. However, results did not indicate any difference in motor development based on maternal education, suggesting that the between-group differences in maternal education levels did not affect the study's results. In this study, maternal education was used as a proxy for SES.[29,30] It is not known whether the lack of difference found in HINT scores using maternal education to estimate socioeconomic level would hold true for other indicators of SES that were not collected in the demographic portion of the HINT.

A second potential limitation is the use of three different sources of data. Limitations arising from this include the retrospective nature of the data collection, the lack of random selection of participants, and the prolonged time span over which data were collected (2000 to 2006). This merging of three data sets also meant that multiple assessors screened the infants. Fortunately, all assessors had completed a HINT training course in which intra-class correlation coefficients (ICC) ranged from 0.73 to 0.98, demonstrating good inter-rater reliability. This suggests that the use of multiple assessors has not limited the study results or their interpretation.

Lastly, the impossibility of blinding the assessor to the infants' ethnic origin could possibly have skewed the results, particularly in the last phase of data collection when the assessor was specifically recruiting infants of Asian background to answer the primary research question. Considering the researcher's selection of the null hypothesis, it is possible that the assessor (who was also the primary investigator) systematically over-or under-scored the performance of Asian infants to achieve typical performance.

3.5. Overall Significance to Pediatric Physical Therapy and Applications of the Research Findings

This thesis is significant in two ways. First, it provides clinicians with a thorough review of the literature surrounding differences and similarities in motor development between children of two different ethnic backgrounds. Secondly, the study described in Chapter 2 provides information specific to the motor development of Canadian infants of Asian and European backgrounds, a topic that is pertinent to pediatric physical therapists involved in screening infants for developmental delay. Having a better understanding of similarities and differences in the development of Canadian children of Asian and European backgrounds gives clinicians the information needed to make valid interpretations when using the HINT to assess these groups of children. The lack of information on specific ethnic origins within the European and Asian subgroups should be kept in mind, however, as it is possible that differences in development may have occurred among children from specific countries within the large groupings of European and Asian origins. Unfortunately, this type of country-specific analysis was not possible in the current study due to the fact that the HINT demographic data do not include countries of origin. Clinicians who use the HINT should also be cautious when interpreting scores from Canadian children of ethnic backgrounds other than Asian and European because no studies have been published regarding similarities or differences in motor development of Canadian children of these ethnic backgrounds.

When considering the impact of the results presented in Chapter 2, clinicians should also bear in mind that the tool used in this study, the HINT, included a normative

sample that represented the ethnic diversity of the Canadian population. When interpreting data from other screening tools, motor or otherwise, the clinician should study the ethnic make-up of the normative sample and determine whether it is an appropriate comparison sample for the Canadian population.

By having a better understanding of similarities and differences in motor development of infants of different ethnic backgrounds, as well as in-depth knowledge of key characteristics of the normative samples used in motor and other screening tools, clinicians will be better able to make sound decisions regarding the need for further assessment and/or intervention, based on their results.

3.6. New Ideas and Future Research

Although Canada is a multicultural country, no previous studies were found in the literature regarding similarities and differences in development of Canadian-born children of different ethnic backgrounds. While evidence is now available on the lack of differences in motor development between children of Asian and European backgrounds, the current study was limited to two ethnic groups and one broad developmental criterion. Future research is required to elucidate the conflicting results published in the literature thus far.

Further studies to consider include the following examples. First, it would be relevant to examine differences in specific motor milestones, rather than motor development as a whole, in infants of Asian and European backgrounds. Second, one might also study whether there are similarities and differences in HINT scores in Asian

children living in Canada versus those living in Asia, as well as considering whether being a first generation Canadian impacts results. In addition to considering geographical location, a third study might compare HINT scores based on country of origin within the Canadian ethnic groups of Asian and European backgrounds. This information would be important to examine because of the possibility that persons of one country make up the majority of an ethnic subgroup and are therefore skewing the mean scores towards their results. In BC, for example, most persons of Asian origin are of Chinese background[22] and may therefore be influencing mean scores for the Asian subgroup. This could possibly lead to incorrect conclusions regarding the development of infants of other Asian backgrounds. Another potential study would involve examining whether other screening tools commonly used to identify infants with motor delays would identify any differences between infants of Asian and European backgrounds, while considering the ethnic diversity of the normative samples of each screening tool. Lastly, it would be pertinent to study the development of infants of other ethnic groups in the Canadian population, including those of South Asian and Aboriginal origins , the third and fourth most highly represented ethnic origins in British Columbia.[22]

3.7. Conclusion

Research has shown benefits of early identification of children with atypical or delayed development.[31,32] Although the effectiveness of early intervention has not been consistently demonstrated in the literature,[32-35] identification, in conjunction with referral to appropriate services, can maximize developmental outcomes[31,36] and have positive benefits for families, including enhancing parents' capacity to care for, teach, and

advocate for their child, thus diminishing stress, and improving supports.[37] It is hoped that this will be the first of many studies to evaluate similarities and differences in motor development of Canadian children. By having a better understanding of motor development of Canadian children of Asian and European ethnic backgrounds, pediatric clinicians will be better equipped to accurately identify and refer children with delays for early intervention, a first step in helping to augment the quality of life of children and their families.[37]

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Appendix I: Sample Size Calculation

MEMORANDUM

TO: Tanja Fuchs

FROM: Jonathan Berkowitz

DATE: June 27, 2006

RE: Description of Sample Size Calculation

The sample size for this study was based on a two-group comparison of mean HINT scores between children with Caucasian ethnicity and children with Asian ethnicity. Given the large disparity in availability of subjects, the sample size computation did not use a 1:1 ratio of subjects per group. With a large pool of children background children (300) and the challenges of recruiting Asian children, a ratio of 8.5:1 (Caucasian:Asian) was used.

Using a 5% significance level (two-tailed) and 80% power, in order to have a sample size sufficient to detect a moderate effect size of 0.5 (i.e. clinically relevant), samples of 296 Caucasian and 35 Asian children were required.

*** END ***

Study Procedures:
Your baby will be assessed with the HINT, a screening test that is designed to evaluate the baby's muscle tone, baby reflexes, and movement patterns. Examples of items from this test include feeling your baby's muscles and gently moving the baby's arms and legs to evaluate muscle tone, having your baby turn her/his head from side-to-side to look for one of the baby reflexes that occurs during head-turning, and watching how your baby moves against gravity when positioned on her/his back and stomach.

The assessment will take about 20-30 minutes and may require that your baby's shoes and socks be removed for certain test procedures. All assessments will take place in a setting that is convenient and comfortable for you and your infant. If you agree to participate, the total time commitment is of no more than one hour.

Eligibility for the Study:
Because the goal of this study is to collect information on typical infants, we are not testing infants who were born prematurely (less than 37 weeks of pregnancy), who weighed less than 5 1/2 pounds (or 2,500 grams) at birth, or who had any other worrisome medical conditions at birth or thereafter. We are also excluding infants whose mothers drank alcohol or used prescription or other drugs during the pregnancy or who had any other serious condition during pregnancy (such as being hospitalized for a major illness).

Risks:
There are no known risks associated with having your baby assessed using the HINT and none of the test procedures are painful or uncomfortable. Some infants become briefly irritable when a paper tape measure is placed around their heads to measure their head size (circumference). There is a slight possibility that your infant may become chilled if it is necessary to remove her/his clothing for certain test items.

Benefits:
The results of this assessment, which will be administered by a health professional with specific training in infant movement and play, will tell you more about your baby's development. The health professional who does the assessment will discuss with you how your baby performs on the test after it is completed. In the event that any concerns are identified about your baby's movement or motor development, you will be informed of programs where your baby can receive a more comprehensive assessment.

Alternative Assessments:
If you decide not to have your baby assessed on the HINT, you can still ask for and receive information about other programs that offer infant assessment in your community.

Confidentiality:
Any information resulting from this research study will be kept strictly confidential. All documents will be identified only by code number and kept in a locked filing cabinet. Your baby will not be identified by name in any reports of the completed study.

The data from this study will be retained for at least five years. When not needed, data collection forms will be destroyed by shredding, as will consent forms. Electronic data will also be retained for seven years. When not required, they will be erased from hard-drives, data sticks, and CDs. Assessment scores, without any information that can link the scores to your baby, will be kept in a data base of HINT test scores, so that we can compare future babies' test scores to the scores of groups of babies already tested.

Appendix V: Letter of Consent

Parent Consent:
I understand that my infant's participation in this study is entirely voluntary and that I may refuse to have my infant participate or I may withdraw her/him from the study at any time without any consequences to my continuing medical care.

I acknowledge that I have received a copy of this consent form.

By signing below, I am volunteering to participate in this study

Signature (please sign) _____

Name (please print your name) _____

Date _____

Thank you very much for your help.