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AFFORDANCES IN EARLY MOTOR DEVELOPMENT: THE ROLE OF CONTEXTUAL FACTORS

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AFFORDANCES IN EARLY MOTOR DEVELOPMENT: THE ROLE OF CONTEXTUAL FACTORS

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ABSTRACT

Early motor development is a complex phenomenon characterized by a high degree of inter- and intra-individual variability. The primary objective of this work was to test a conceptual model of early motor development that considers the key contextual factors relating to the home environment, infant characteristics, and caregiving practices. Given the lack of appropriate measures targeting these contextual factors, a secondary objective was to develop and run preliminary analyses of two new measures that assess these factors in relation to the motor development of infants aged 4 to 10 months of age.

Following the initial item generation phases, exploratory principal components analyses with varimax rotations were run to determine a factor structure for each measure, followed by a confirmatory factor analysis. These measures were then incorporated into the larger conceptual model, which tested the extent to which these contextual factors explained the variability observed in motor developmental scores as measured by the Alberta Infant Motor Scale. Using structural equation modeling, these direct effects, as well as indirect effects mediated through the Daily Activities of Infants Scale are discussed. The measurement model demonstrated good fit indices ($\chi^2 = 477.9$, $df = 369$, $p < 0.01$; IFI; 0.940; TLI 0.927; CFI 0.938; RMSEA 0.04) indicating the model fits the data. Analysis of path coefficients revealed that the contextual factors did not explain a significant portion of the variance in early motor development (32%). The factor *Opportunities in the Playspace* was found to explain 24% of the variance in scores and was significant.

Although the results of this work do not provide strong evidence for a role of contextual factors in motor development, they do raise questions about the use of linear statistical analyses to measure non-linear processes and the developmental variations of infants born full-term and those born preterm. Full-term infants are known to be resilient and it is suggested that the subtle determinants, such as those concerning contextual factors, might play a more important role in a population of infants who are vulnerable or considered to be at risk.

Keywords: motor development, full-term, contextual factors, environment, infant characteristics, factor analysis, structural equation modeling

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AHEMD	Affordances in the Home Environment for Motor Development
AIMS	Alberta Infant Motor Scale
AMOS	(statistical software)
ANOVA	Analysis of Variance
CFI	Comparative Fit Index
CHIEF	Craig Hospital Inventory of Environmental Factors
CI	Confidence Interval
CTS	Carey Temperament Scale
DAIS	Daily Activities of Infants Scale
DB	Doreen Bartlett (supervisor)
df	degrees of freedom
DMQ	Dimensions of Mastery Questionnaire
DST	Dynamic Systems Theory
ECI	Early Coping Inventory
EFA	Exploratory Factor Analysis
EOQ	Environmental Opportunities Questionnaire
FIML	Full Information Maximum Likelihood
HOME	Home Observation for Measurement of the Environment
ICC	Intraclass Correlation Coefficient
ICQ	Infant Characteristics Questionnaire
IFI	Incremental Fit Index
KMO	Kieser-Meyer-Olkin
ML	Maximum Likelihood
MQE	Mastery of Quality of the Environment
NGST	Neuronal Group Selection Theory
OEYC	Ontario Early Years Centre
PCA	Principal Component Analysis
RMSEA	Root Mean Square Error of Approximation
SD	Samantha Doralp (PhD candidate)

SD	Standard Deviation
SEM	Structural Equation Modeling
SES	Socioeconomic Status
SPSS	(statistical software)
TLI	Tucker-Lewis Index
UWO HSREB	The University of Western Ontario Health Sciences Research Ethics Board
WHO	World Health Organization

CHAPTER 1

General Introduction

Early infancy is a period characterized by an incomparable amount of development and growth. Through various processes of change, during the first year of life, infants proceed from being relatively passive and having very little voluntary motor control to crawling and walking and behaving as active participants in their daily lives. This transition to purposeful and voluntary movement involves adapting a variety of strategies for moving around in their surroundings. Given this rapid period of growth and development, the study of infancy presents unique challenges to investigators, as it requires careful consideration of a host of continuously evolving variables. This difficulty is what makes studying the field inherently interesting. Furthermore, such studies are ideally suited for suggesting interventions that have the potential to optimize outcomes. Research within this field has focused on studying how infants and young children can get off to a promising start in the first few years of life (Shonkoff, 2003). The early understanding of the factors influencing *motor* development stemmed from neuromaturationist theories that emphasized the important role of biological maturation. Since then, more contemporary theories have highlighted the utility of considering a broader perspective, which includes contextual factors. The diminished enthusiasm for biological determinism is the result of research demonstrating that biological maturation explains only a portion of what is observed in the motor development of infants. These newer frontiers in motor developmental research highlight that there is still much to be learned about the factors associated with and the processes influencing early motor development. The purpose of this introductory chapter is to describe several theories of early motor development, review what is known about factors influencing motor development and describe, in broad terms, the development and plans for testing a model to further understand motor development in infancy.

THEORIES OF EARLY MOTOR DEVELOPMENT

Neuromaturation as a Stepping Stone

The early understanding of infant motor development was largely influenced by the neuromaturationist perspective. This theory, pioneered by Gesell, proposed that the

nervous system was the causal agent in the motor developmental process (Gesell, 1939). Motor maturation was viewed as an intrinsic and rigid process, with predestined patterns of development thought to be uninfluenced by external factors, such as the environment. In the 1930s, Coghill, a neuro-embryologist studying the development of Amblystoma salamanders, correlated neural maturation processes with the functional motor behaviour observed in salamanders (Coghill, 1933). As stated by Thelen and Adolph, Coghill theorized that behaviour was a "direct readout" of the underlying neural structures, and that these neural changes were "autonomous products of growth, inherent and lawful, not influenced by function" (Thelen & Adolph, 1992, p.370).

Shortly thereafter, research conducted by Gesell and McGraw supported comparable notions in the field of human motor development. Gesell attributed developmental order to biological destiny (Gesell, 1939; Thelen & Adolph, 1992). Gesell (1939) identified the reciprocal interweaving of antagonistic muscle groups as a characteristic illustration of the intrinsic organizational properties expressed in infant development. He hypothesized that the sequence of development is invariant between individuals, although the rate at which this occurs may vary. This variation was strictly attributed to the genetic background of the individual (Heriza, 1991). In addition, he admitted that while the environment may temporarily influence the rate of development, biological factors are ultimately in control (Heriza, 1991). Thus, genetics revealed a prescriptive process of development. This "biological determinism" (Thelen & Adolph, 1992, p.370) is arguably rigid and Gesell supported the notion that the orderly behaviour of children could be classified and labeled with ease (Thelen & Adolph, 1992).

Unlike her rival, McGraw considered variation to be an important part of development; she was acutely aware of the amount of variation present, both between and within infants (Touwen, 1995). Nonetheless, and paradoxically, in her work, McGraw (1989) emphasized the structural foundations of behaviour with the processes of cortical differentiation leading to purposive behaviour. Her observations revealed a high degree of similarity in the type and timing of achievement of motor milestones (Dalton & Bergenn, 1995).

The neuromaturationist perspective embodied four assumptions about normal motor development. Firstly, movement progresses from gross and largely uncontrolled

reflex patterns to refined, voluntary movements. Secondly, motor development progresses in a cephalocaudal direction. Thirdly, control of motor development progresses in a proximal to distal manner. And finally, the sequence and rate of development is consistent among infants (Piper & Darrah, 1994).

Primitive Reflexes

The emergence and integration of primitive reflexes as a popular indicator for motor development illustrates the incorporation of the neuromaturationist theory into clinical practice. The Primitive Reflex Profile (Capute et al., 1978) was developed to assess the presence or absence of evoked reflexes, as well as the determination of whether the reflexes are normal. The profile states that "the simplest purposeful motor movements and postural changes depend upon the appearance and subsequent integration of primitive reflexes" (Capute et al., 1978, p.4). From this perspective, delayed integration of reflexes is viewed as an indicator of motor dysfunction (Capute et al., 1978), since this process of integration is believed to be guided by cortical maturation. Given this, a host of intervention programs were developed to target moderating reflexes to enhance motor function. Although reflex profiles provide a clinical tool to assess neural development relating to motor behaviour, the stereotyped guidelines ignore the complex and often variable nature of the responses of infants (Touwen, 1984). Touwen blatantly stated that "the infant is not a reflex being" (Touwen, 1984, p.119). Furthermore, Bartlett (1997) found no relationship between scores on the Primitive Reflex Profile and early motor development in infancy, providing empirical evidence for Touwen's view. If reflexes are not the only means of understanding early infant behaviour, then theories of infant motor behaviour must extend beyond the limited perspective of the neuromaturation model to reveal other influential factors.

Developmental Direction

Preliminary observations of young infants and popular notions held by pediatric physical and occupational therapists highlighted that maturation proceeds in a cephalocaudal and proximo-distal direction. Voluntary control over movement was found to begin with the head, and proceed downwards to the trunk, pelvis, and lower limbs

(reviewed in Piper & Darrah, 1994). Similarly, shoulder and trunk control were found to precede more complex movements of the upper and lower limbs. These early observations have since been contradicted with more recent work identifying more mature movements in the lower body occurring prior to mastery of upper body movements (Fetters et al., 1988) and proximal and distal control occurring concurrently, rather than sequentially (Horowitz & Sharby, 1988).

Sequence and Rate of Development

Early developmental norms were based on the notion that the timing of milestones, as well as the sequence in which children acquired them, was universal (Thelen & Adolph, 1992). The majority of research literature suggests that while there is some variability (Piper & Darrah, 1994), ranges have been adopted to account for this slight variability observed across infants. It is generally accepted that the sequence is consistent (T.O. Maguire, personal communication, July 2009). This provides a basis for making developmental predictions and evaluations of future outcomes based on earlier performance. Nonetheless, differences in individual rates of acquisition result in a less linear process and ultimately make predictions more difficult (Darrah et al., 1998).

Although the universality of these developmental characteristics provided strong evidence for the case of neuromaturation, scientists in the 1980s became wary of the rigidity of a purely deterministic framework and began theorizing about the influence of an interactive component on development. During this time, Prechtl (1984) argued for an interaction between structure and function that goes beyond the minimal requirement of neural maturation. The epochal shift in focus towards functionality altered the course of motor developmental research.

Dynamic Systems Theory: Functional Perspective on Motor Development

The application of Dynamic Systems Theory (DST) to infant motor development contributed to a significant theoretical shift in the motor development literature. A key concern about previous prescriptive theories of motor development was their lack of recognition of real-world variability, which was perceived to result from factors both

internal and external to the infant (Thelen et al., 1987). Introduced in 1987 by Esther Thelen and colleagues, DST proposed motor development to be a multidimensional, emergent phenomenon (Thelen et al., 1987). From the perspective of this theory, development progresses as a complex process, intricately interconnecting factors associated with the infant with contextual factors. Development is considered as "a series of states of stability, instability, and phase shifts in the attractor landscape, reflecting the probability that a pattern will emerge under particular constraints" (Thelen, 1995, p.84). From this perspective, infants display the ability to adapt and self-correct for their constantly changing and developing bodies in the context of specific environments; hence, motor development is not prescriptive. Four popular and overlapping propositions capture the essence of this theory: behaviour results from the contributions of multiple subsystems, movements are influenced by the task, systems self-organize, and subsystems can develop asynchronously. Motivational, emotional, physical, social, and environmental states can all exert influences on a particular behaviour, both at one point in time and over time. Thus, the underlying complexity of early movement stems from the organization of all of these factors, enabling the infant to function as a cooperative unit, altering motor behaviours in context-specific manners (Piper & Darrah, 1994).

Multiple Subsystems

The first proposition states that complex motor behaviours are the result of interactions among multiple subsystems, which are theorized to function as a collective whole; individual components of the larger system do not function independently (Hadders-Algra, 2002; Thelen, 1995). Unlike the theory of neuromaturation that only considered the central nervous system, eight subsystems are thought to be involved in the organization of infant locomotion: reciprocal lower extremity activity, development of reciprocal muscle activity of flexor and extensor muscles, strength of extensors to oppose gravity, changes in body size and composition, antigravity postural control of head and trunk, decoupling of early reciprocal lower extremity movements, visual adaptations to moving around in the environment, and task-recognition and goal-directed motivation (for review, see Campbell, 2006). Moreover, the complexity of the interaction

among these subsystems becomes increasingly complicated when one considers the impact of the environment.

Task Influences

The second proposition of DST emphasizes that movements are influenced by the task. The host of subsystems are tuned to the contextual specifics of the environment, ensuring the optimization of function (Heriza, 1991). Thus, how an infant responds in a particular situation will vary, depending on the constraints imposed by the specific task in question in a specific environment. This key proposition highlights that the environment has the potential to either facilitate or limit motor development.

Self-Organization

The third proposition regarding self-organization identifies how these subsystems cooperate to produce movement. Bernstein's original observations on the patterns and sequences of movements led to theories describing movement as a collective, whereby the movement of individual joints and muscles does not occur independently, but as a larger, integrated whole (reviewed by Thelen et al., 1987). The 'collective' is comprised of multiple components within a system, which might include joints, muscle synergies, and lower motor neuron synapses (Piper & Darrah, 1994; Thelen, 1995), and each component is constrained by particular environmental and task contexts (Thelen & Ulrich, 1991). As such, movement is a product of the cooperation of multiple components within a system, which self-organize according to the situational constraints in the properties of several components. In this context of self-organization, Bernstein's concept of *functional synergy* rested on the primacy of function, as actions are directed towards goals (Thelen et al., 1987).

Asynchrony in Subsystems

The fourth and final proposition suggests that subsystems can develop asynchronously. Infants are learning how to adapt to their environment, and are doing so with constant changes in body size and mass, among other personal factors. A host of subsystems contribute to this dynamic interaction, and each specific contributor or

subsystem develops and advances at its own rate (Heriza, 1991). Thus, which factors are having a larger influence on development at a particular time may change. This asynchrony is believed to be a causal agent in the production of the high degree of variation seen in infant behaviours and is a stark contrast to the attested linearity and rigidity characteristic of the neuromaturation model.

Variability is now regarded as a hallmark of a healthy nervous system and characterizes normal motor development (Hadders-Algra, 2002). Variability in the motor repertoire provides a foundation for adaptive functioning and the development of an efficient motor repertoire. The absence of variation signifies pathology (Touwen, 1993), and so variation is not only normal, but crucial for normal motor development to occur. The non-linearity that is typical in early motor development exemplifies the tenets of the DST, emphasizing the often stochastic nature of developmental sequences.

With the formulation of the DST, a host of new and exciting research questions has arisen, highlighting the shift in focus regarding the factors influencing infant motor development. Now, not only is research directed towards the study of changes within the central nervous system and other infant characteristics, but also towards factors present within the environment, which has important implications for clinical practice. Strictly neural-based treatments, that sought to alter the reflex profile of infants, failed to consider other factors equally important in contributing to development, such as other infant characteristics and aspects of the environment. Thus, understanding the extent to which task constraints and other environmental variables influence early motor development is coming to the research forefront.

The Neuronal Group Selection Theory

Although the DST provided a solid theoretical framework for understanding motor development as arising from an interaction between the infant and the environment, it does not provide a description of how the developing organism develops its own operating system for functional behaviour (Campbell, 2006). Along these lines, the DST has been criticized for its lack of explicit recognition of the importance of the central nervous system. The Neuronal Group Selection Theory (NGST) strikes a balance

between Neuromaturation and DST. The theory is driven by the structural variability inherent in early brain circuitry (Sporns & Edelman, 1993). These circuits, which are organized into neuronal groups, are comprised of thousands of strongly interconnected neurons that share functional properties and discharge in a correlated fashion. These neuronal groups are considered the basic functional units of selection (Sporns & Edelman, 1993). Afferent information from behaviour and experience guides the selection of certain groups, which results in circuit modifications. This plasticity is expressed as development and further tunes the organism to adapt to environmental constraints (Hadders-Algra, 2000). The process underlying the NGST involves two underlying phases of variability: primary and secondary variability. Distinguished by the process of selection, they are characteristically different and differentially impacted by the environment.

Primary variability is evident during fetal life and very early infancy. The abundant variation observed during this phase is determined by primary neural repertoires. The purpose of this phase is to explore all motor possibilities, which is accomplished through self-generated activities that are not neatly tuned to the environment. These activities are highly variable, even for specific functions. General movements illustrate this point. These movements are observed in fetuses and very young infants and involve all parts of the body and do not display a characteristic pattern (Hadders-Algra, 2002). Essentially, the general movements are suggested to be an exploration of all potential movement properties, including velocities, amplitudes, forces, and possible combinations (ie. degrees of freedom; Hadders-Algra, 2002). This phase of abundant variability sets the stage for the next phase of development, during which the most efficient movement patterns are selected. This transition phase from primary to secondary variability is of particular interest in this study, as it identifies the transition from this random and relatively involuntary phase of movement, to the voluntary and purposeful movement that characterizes later stages of infancy. General movements have been observed until about 4 months of age (Hadders-Algra, 2002), and the transition from non-goal-directed general-movement activity into voluntary, goal-directed motility is a gradual process that lasts several weeks (Hadders-Algra, 2002, p.436). The earliest forms of goal-directed behaviour are observed as early as 2 months of age (Hadders-Algra,

2002). Selection results in a decrease in the amount of variability, and occurs at function-specific ages (Hadders-Algra, 2000).

The process of selection is characterized by a high degree of synaptic plasticity during which underlying circuits are reorganized. The result is the phase of secondary variability. Unlike the previous phase, the infant's repertoire is highly tuned to the environment, ensuring the ability to adapt each movement exactly and efficiently to task-specific conditions (Hadders-Algra, 2000), both at one point and over time.

REVIEW OF CURRENT LITERATURE

With the recent focus on the DST and NGST, research in the area of motor development is increasingly focusing on contextual factors. Bradley (1994) emphasized the important role that both the quality of parenting and a child's own characteristics have on early development. This idea captures the dynamic and transactional nature of the effects of both the external environment and the internal characteristics of infants on motor development. Research has demonstrated the important role that biology plays in development, but the literature is lacking in studies investigating the role of contextual factors such as the environment and infant characteristics. In the International Classification of Functioning, Disability, and Health, the World Health Organization (2001) suggests the importance of understanding the role of these contextual factors on human functioning.

Role of Biology in Motor Development

Early theories of neuromaturation emphasized the role of central nervous system maturation in early motor development. The observed universality of embryonic and fetal movements (Prechtl, 1984) supports early biological views of development. Gesell, a key contributor to this theory, suggested that motor behaviour is a result of a direct readout of the underlying neural structures (Thelen & Adolph, 1992). The justification for such claims arose from observations of developmental norms. Moreover, Gesell claimed that neural changes are due to the inherent and lawful product of growth, immune from

external influences (Thelen & Adolph, 1992). The benefit of this overly deterministic perspective was that children were resilient to potentially negative influences. Early work by McGraw with a twin set of twins, Johnny and Jimmy (McGraw, 1939), highlighted this apparent resilient nature of motor development in spite of severe environmental restrictions. Limiting the motor experiences of one twin, while concurrently providing motor experiences to the other, did not result in a significant difference in early abilities between the two twins. Deprivation studies, conducted by Dennis and Najarian (1957), supported the idea of the resilient nature of healthy children. In spite of her early observations, McGraw stated "once the laws of development have been determined the maturation concept may fade into insignificance" (McGraw, 1946, p.364).

The notion of biological destiny was also supported by observations of primitive reflexes. These reflexes were thought to provide a window into the evolution of motor function, as cortical maturation dictates the expression or inhibition of these involuntary movements (Capute et al., 1984). Moreover, the Primitive Reflex Profile was developed as a clinical tool for early identification of motor impairment. Interestingly, later work by Bartlett (1997) illustrated the converse to be true—that primitive reflexes are unrelated to motor development. If motor development is a phenomenon resulting merely from neurological and biological maturation, anthropometric characteristics such as body mass index, head proportion, and body length might be associated with gross motor developmental advance. It was found that these characteristics did not significantly impact motor development after about 6 weeks of age (Bartlett, 1998), highlighting the complicated nature of development and the potential role of external factors beyond the first few weeks of life. Although research does demonstrate an important role of biology, the volumes of contradictory studies suggest that there is more to early motor development than biological determinism.

Role of the Environment in Motor Development

According to the theoretical conceptualizations in the DST and NGST, motor development is highly tuned to the environment. The environment has the potential to either support or hinder motor development. Thus, understanding how the environment

can influence developmental advance is of particular interest, especially in the realm of rehabilitative therapy and early intervention.

The environment, which can be considered complex and multilayered, consists of progressively larger components ranging from the micro-environment to the macro-environment (Bronfenbrenner, 1995), each consisting of separate, yet interconnected, variables. For example, the micro-environment concerns the immediate surroundings, such as direct interaction with persons, objects and symbols (Bronfenbrenner, 1995), while the macro-environment includes larger community contexts. Another means of classification is to consider whether the environmental variables are proximal or distal, based on whether it has a direct or immediate impact on the child. Socioeconomic status and type of residence are, for example, considered more distal variables, while maternal responsivity and availability of appropriate play materials and opportunities for varied, daily stimulation serve as more proximal variables (Bendersky & Lewis, 1994).

Although the environment has repeatedly appeared as an important factor for motor development, which aspects of the environment can act to facilitate or hinder motor development are still under question. The concept of environmental risk (Abbott & Bartlett, 1999) highlights the potential impact of socioeconomic status (SES) on developmental outcome. It has also been shown previously that SES has a more direct link to early developmental outcomes than biological or medical complications (Sameroff & Chandler, 1975 cited in Bradley 1994). These relatively distal environmental variables have been suggested to impact development differently than proximal environmental variables (Bendersky & Lewis, 1994). More proximal variables, such as caregiving practices, have been shown to play an important role in influencing early development as demonstrated in early cross- and intra-cultural studies of motor precocity (Hopkins & Westra, 1988; Pridham et al., 2002; Solomons, 1978; Solomons & Solomons, 1975). Motor developmental precocity was found to be specific and mirror early handling practices of parents, such as parents encouraging sitting or standing behaviours (Super, 1976).

Although caregiving practices are known to influence development, there is still a question as to what caregiving practices can modulate development. Cross-cultural studies indicate that motor advances mirror specific caregiving practices (Super, 1976).

Maternal expectations have also been found to have a positive relation to the child's overall motor developmental performance (Diamond & LeFurgy, 1992). Recent work with the Daily Activities of Infants Scale (DAIS; Bartlett & Fanning, 2004), which focuses on the opportunities that parents provide for antigravity postural control and movement exploration, has suggested links to early motor development (Bartlett et al., 2008). Researchers agree that caregiving practices play an important role, yet much is to be determined about specific practices and their influence on developmental outcome.

In addition to caregiving practices, the proximal environment also includes the home environment. Research has shown that parental perceptions of the importance of various aspects of the home environment directly impact the structure of the child's environment (Parmar et al., 2004). For example, it was found that the differing Asian and Euro-American parents' ethnotheories of play and learning influenced the use of time and the provision of toys at home, as well as the children's environments for learning (Parmar et al., 2004). Little work has been conducted in this area, and thus the specific manner through which the home or family environment exerts its influence is yet to be determined.

Role of Infant Characteristics in Motor Development

In addition to the environment, there is also an avenue of research investigating the influence of infant characteristics on motor development. One example, exploratory activity, has been linked to perceptual and cognitive development (Gibson, 1988); yet work investigating its role in early motor development is limited. Motivation is thought to drive exploration and movement, with research demonstrating that movement is initiated by a motivated infant (von Hofsten, 2004). The positive influence of motivation has been demonstrated in children who are blind and display developmental delays. Delays in the initiation of movement were associated with later motor developmental delays (Levtzion-Korach et al., 2000). An infant must realize that a person or object is present before he or she is motivated to reach out and get it. Similarly, curiosity and creativity can facilitate exploration. A child who is curious about the environment will attempt to initiate an interaction with his or her surroundings. A creative child may find different ways to

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explore, not only the environment, but the manner in which they can interact with it. Most research concerning infant characteristics pertain to emotional and cognitive development. Thus, there is a lack of research investigating the influence of infant characteristics on motor development. Recently, researchers have tried to capture the special nature of this quality in studies investigating the features of play. Although there are many theories as to the functionality of play, the research converges on points of adaptive utility, exploration, and the fact that it is pleasurable (Stagnitti, 2004). These studies highlight the potential importance of infant characteristics in motor development and the active role that infants play in their surroundings.

Affordances: Linking the Infant to the Environment

The National Research Council and Institute of Medicine organized a committee in 1997 dedicated to conducting a review of human development in the first few years of life with the goal of establishing a strong knowledge base for use in policy, practice, professional development, and research (Shonkoff, 2003). The core concepts of development, as identified by the committee, include the dynamic interaction between biology and the environment, the role of children as active participants in their own development and the range of individual differences (Shonkoff, 2003).

Acknowledging the importance of the environment and infant characteristics is one step in conceptualizing the contextual influences on motor development. It also requires understanding *how* the infant responds to the environment during the period of great motor developmental advance in early infancy. The term *affordances* refer to what an environment offers, provides or furnishes for an infant, and the complementarity of this interaction. It links perception to action, and includes the appropriateness of an action on the surroundings (Gibson, 1988). Exploration leads to the discovery of affordances, thus, how an infant learns or perceives the affordances within an environment depends both on the innate capabilities of infants, along with their exploratory behaviour (Gibson, 1988).

Until this point, theorists have made advances in the conceptualization of motor development by using a holistic framework. What is necessary is a thorough

understanding of *how* these various factors, such as the infant and the environment, converge on motor developmental domains to synthesize a cohesive model of early motor development.

DEVELOPING A MODEL OF EARLY MOTOR DEVELOPMENT

This literature review demonstrates that during the reign of the neuromaturationist theory, research studies were dedicated to investigating the relationship between biology and motor development. Although our theoretical foundations have expanded, our knowledge base is yet to catch up. What is missing is an understanding of the influences on motor development from a holistic perspective. Motor development is a complex process. As such, there are a multitude of factors that have the potential to shift developmental course. Considering the principle of parsimony, an important aim should be to develop a model that considers the *key* contextual factors.

Developing a conceptual model of early motor development requires careful consideration of the constructs of interest, the relationships among the various constructs, and finally, a set of measures to evaluate them (Bartlett & Lucy, 2004). Measures evaluating the physical and neurological maturation of the infant have been developed. With increasing evidence suggesting that other factors may play an equally important role in influencing motor development, measures targeting the environment and infant characteristics are necessary. There are currently no relevant measures assessing the environmental or personal factors influencing early motor development for infants less than one year of age. Given this, the primary purpose of the work presented in this thesis is to develop and test a conceptual model of motor development, with secondary objectives to develop appropriate measures.

Measurement Development

For the purposes of measuring constructs in the conceptual model, a survey was conducted of available measures. Given the lack of relevant measures, the purpose of chapters 2 and 3 is to document the early development of two new measures—the

Environmental Opportunities Questionnaire (EOQ) and the Infant Characteristic Questionnaire (ICQ) — which are aimed at evaluating the home environment and infant characteristics. Currently, measures evaluating personal or environmental aspects are targeted at older populations, special populations (e.g. children with speech-language impairments), or other developmental domains (e.g. cognitive). Although these two new measures incorporate certain constructs already in use from other measures, they seek to capture the essence of the determinants of early motor development, specifically for infants aged 4 to 10 months.

The aim in developing these measures is to serve as a discriminative, as well as a predictive, index (Kirshner & Guyatt, 1985). The EOQ, which will address the affordances in the environment directly surrounding the infant, will serve as both a discriminative and predictive index. Some of the environmental variables considered in the measure are modifiable, and as such, can serve as points or targets of intervention. In contrast, the ICQ, which will address the intrinsic qualities infants display, will serve as both a discriminative and predictive tool. However, these inherent characteristics of an infant might not be so easily modified, and so, the purpose of this second tool is to ensure realistic goal setting, and perhaps a more realistic match between the environment and the nature of the infant. From this point, it is important to stress that the measures are being developed for the purpose of clinical use, and as such, are being developed with the consideration of future planning and delivery of early intervention, as well as feasibility of use with infants and their families, therapists, and other health care professionals.

Testing a Conceptual Model of Motor Development

The purpose of chapter 4 is to describe the testing of a model of early motor development that contains what are theorized as the key environmental variables and infant characteristics. The Daily Activities of Infants Scale (DAIS; Bartlett & Fanning, 2004) is also considered as a mediating variable between the contextual factors and motor developmental outcome. Given the limited information available regarding the role of contextual factors in early development, the aim is to determine how much of the inter–individual variability in the rate of development that we observe during the first year of

life is explained by these contextual factors. The current literature is limited to information about bivariate relationships between a host of infant or family factors and motor development; however, an understanding of the multivariate relationships among all of these factors has not been investigated and is necessary to provide a holistic conceptualization of the determinants of early motor development. Ultimately, the information gathered from this model testing supports a holistic approach to assessment and intervention, which will support the complex decision making process in which therapists have been engaged and challenged for years in clinical practice (American Physical Therapy Association, 2001).

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CHAPTER 2

Development of a Measure for Environmental Variables

INTRODUCTION

The study of early motor development is a challenging phenomenon as it involves investigating the acquisition and progression of motor abilities during a time of incomparable growth and development. As a suggested marker for child well-being (Eickmann et al., 2003), researchers are continually dedicating their work to understanding how various factors can facilitate optimal development in populations of infants and children who have developmental delay or disability. Early perspectives of development focused on neuromaturation, and as a result, the early literature is dominated by work investigating the role of biological factors in motor outcome. A shift towards a more holistic perspective marks more recent research in the field. The Dynamic Systems Theory (DST) supports this perspective by embracing variability and proposing motor development to be a multidimensional, emergent phenomenon (Thelen et al., 1987). Using this theoretical framework, development is believed to progress as a complex process, intricately interconnected with contextual factors. Development is considered as a "series of states of stability, instability, and phase shifts in the attractor landscape, reflecting the probability that a pattern will emerge under particular constraints" (Thelen, 1995, p.84). Although DST was introduced in 1985, the published research literature contains minimal improvement in the representation of contextual factors supporting early motor development.

The National Research Council and Institute of Medicine organized a committee in 1997 dedicated to conducting a review of human development in the first few years of life with the goal of establishing a strong knowledge base for use in policy, practice, professional development, and research (Shonkoff, 2003). One of the core concepts identified by the committee included the dynamic interaction between biology and the environment (Shonkoff, 2003). Research has demonstrated that biology only explains a small portion (5%) of the variance in developmental scores (Lima et al., 2004). Although the review described by Shonkoff (2003) emphasized this interaction in many developmental domains, motor development was not explicitly mentioned. This highlights that although the environment appears to be an important factor influencing developmental outcome, very little research exists that investigates the role of environmental factors in motor development.

An inherent difficulty in studying the role of the environment is that it is complex and multilayered, consisting of progressively larger components ranging from the micro-environment to the macro-environment (Bronfenbrenner, 1995). The concept of environmental risk (Abbott & Bartlett, 1999) and its impact on developmental outcome is well researched for socioeconomic status (SES). Some research has demonstrated a negative impact of poor SES on cognitive and motor development (Bacharach & Baumeister, 1998; de Barros et al., 2003), while others highlight a lack of influence on developmental outcome in full term infants (Solomons & Solomons, 1975). Socioeconomic circumstances have been shown to be more directly linked to development in low birthweight children than those with biological or medical complications (Sameroff & Chandler, 1975 cited in Bradley, 1994). Inconsistencies in the data might be the result of differences within the more immediate environment, and it has been demonstrated that distal environmental variables impact development differently than proximal environmental variables (Bendersky & Lewis, 1994). In addition, it has been suggested that environmental variables exert their influence during a particular window of development, with the greatest impact occurring after two months of age (Dennis & Najarian, 1957; Solomons & Solomons, 1975) and during the first year of life. Work is currently underway investigating what aspects of the more immediate environment, including caregiving practices and the home environment, can explain the variability observed in developmental scores and ultimately influence outcome.

Environmental factors represent opportunities that can act to facilitate or hinder motor development. Gibson (1988) introduced the notion of affordances and its relevance to early motor development, defining it as what an environment offers, provides or furnishes for an infant. Early cross- and intra-cultural studies of motor precocity suggest that caregiving practices serve an important role in influencing motor development (Hopkins & Westra, 1988; Pridham et al., 2002; Solomons, 1978; Solomons & Solomons, 1975), with the specific motor advances or delays in development mirroring early caregiving practices (Majnemer & Barr, 2005; 2006; Super, 1976). Significant relationships have been found linking sleep and awake infant positioning and the acquisition of early milestones (Vaivre-Douret et al. 2005), highlighting the critical influence of parental practices. Recent work with the Daily Activities of Infants Scale

(DAIS; Bartlett & Fanning, 2004), which measures opportunities for antigravity postural control and movement exploration, has suggested links of caregiving practices to motor development (Bartlett et al., 2008). Previous evidence suggests a significant positive relation between maternal prediction or expectations and infants' overall motor developmental performance (Diamond & LeFurgy, 1992). Deprivation studies have also demonstrated significantly delayed developmental quotients in children receiving little more than essential physical care (Dennis & Najarian, 1957).

In addition to caregiving practices, the structure of the home environment has also been suggested to play a role in influencing developmental outcome (Bradley, 1994; Gibson, 1988). Little research has been conducted looking at elements of the home environment alongside the parental factors mentioned earlier. How important a parent perceives various variables to be will directly impact the structure of the child's environment. For example, it was found that the differing Asian and Euro-American parents' ethnotheories of play and learning influenced the use of time and the provision of toys at home (Parmar et al., 2004). Furthermore, parents' cultural belief systems have been shown to influence the organization of infant's environments for learning (Parmar et al., 2004). The specific manner through which the home or family environment exerts its influence on motor development is yet to be determined.

According to DST and Neuronal Group Selection Theory (NGST; reviewed in Chapter 1), motor development is highly tuned to the environment and as a result, the environment has the potential to either support or hinder motor development. Thus, understanding how the environment can influence developmental advance is of particular interest; yet there is still much to be understood about the role of proximal environmental factors and their potential influence on motor developmental outcome. A gap in the literature is the lack of appropriate measurement tools of the proximal environment of interest to infants (Abbott & Bartlett, 1999). No measure currently exists to adequately assess the environment as it pertains specifically to motor development in infancy.

Given this, the primary purpose of this chapter is to report on the development of a new environmental measure, targeted to the motor development of infants aged 4 to 10 months of age. According to the literature, this represents a critical window during which the environment has been shown to have an impact on development (Dennis & Najarian,

1957; Solomons & Solomons, 1975). During the first year, motor maturation is characterized by the development of more complex movement repertoires, as well as variability that sets the stage for adapting a variety of strategies for moving around in the environment. Moreover, the acquisition of purposeful, voluntary movement involving locomotion (ie. movement from one place to another) occurs between the ages of 4 and 12 months, making it an ideal time for investigating the influence of various factors on motor outcome.

The purpose of this chapter is to describe the development of the *Environmental Opportunities Questionnaire (EOQ)*, which includes multiple phases identified as item selection, item scaling, item reduction, and reliability by Kirshner and Guyatt (1985). The *EOQ* addresses the affordances in the environment directly surrounding the infant and is intended to serve as both a discriminative and predictive index. Some of the environmental variables considered in the measure are modifiable, and as such, can serve as points or targets of intervention. Emphasizing the role of the environment in early development has important implications for clinical practice, as it suggests treatment options that are not only medical or biomedical in focus, but that can be implemented by altering the infant's existing home environment.

METHODS

Development of the *Environmental Opportunities Questionnaire* (EOQ) was divided up into three phases: Phase I (item selection and item scaling), Phase II (pilot testing and item reduction), and Phase III (factor analysis and reliability testing).

PHASE I

Item Selection

The initial selection of items for the EOQ was based on existing measures in the literature relating to aspects of the environment. A literature search revealed a limited set of measures assessing the environment for children. These measures included the Home Observation for Measurement of the Environment (HOME; Caldwell & Bradley, 1984),

Affordances in the Home Environment for Motor Development (AHEMD; Rodrigues & Gabbard, 2005), Craig Hospital Inventory of Environmental Factors (CHIEF; Harrison & Mellick, 2000), Test of Environmental Supportiveness (TOES; Bundy, 1999), and the Measure of the Quality of the Environment Scale (MQE; Fougeyrollas et al., 1999). In addition, the Daily Activities of Infants Scale (DAIS; Bartlett & Fanning, 2004) was considered for the purposes of preventing overlap during measurement construction. The DAIS captures the role of caregiving practices in terms of opportunities that parents provide for the development of antigravity postural control and movement exploration in facilitating motor development. As such, the EOQ attempts to cover other aspects of the home environment that are important to early motor development. Conceptually, it is hoped that the DAIS and the EOQ will together accurately reflect the most important environmental factors influencing early motor development.

Each existing measure was scanned and an item-by-item analysis was conducted by two independent researchers to evaluate the fit with the construct of interest (doctoral candidate [SD] and supervisor [DB]). The initial criteria for selection were based on two key points: the item is age appropriate (for infants aged 4 to 10 months), and it is hypothesized to be relevant for early motor development. This early selection process followed a more inclusive rather than exclusive approach for the purpose of not missing any potentially valuable items. Items were included if the underlying idea was relevant, irrespective of the specific wording. As a result of this more inclusive approach, many items were relatively identical or represented similar ideas. Following the compilation of this initial item list, items were grouped according to similarity, and item-summary titles were created to capture the essence of the item groups.

The existing items, now grouped, served as a starting point for developing items for the new measure. Items were deleted, modified, or included as is. Most items that were deleted were found to be redundant. Items that were modified were found to contain important indicators, but were either framed in a non-motor developmental manner or were missing information specifically related to the age group of interest. Other modifications related to word choice and the description of the tasks involved. Items that were included as is were found to be well-worded and highly relevant; as such, they were left as they were found in the existing measure. In addition, new items were

generated and added to the existing dimensions. The ideas for these new additions were developed from observing a series of infant assessments of infants aged 4 to 10 months of age in their home environments. The addition of items was proposed by one researcher (SD) and confirmed by a second (DB). The new lists of items for the measure were compiled into a separate document as the initial draft of the measures.

Item Scaling

According to the recommendations presented by Kirshner and Guyatt (1985), a 5-point Likert scale was selected. Each question was formatted to fit a similar structure, in which each question was preceded by the words 'to what extent'. According to the scaling, the numbers 1-5 indicate varying degrees of extent (5 = to a great extent; 4 = to a moderate extent; 3 = to a fair extent; 2 = to a small extent; 1 = not at all), and '0' represents 'not applicable'.

PHASE II

Pilot Testing of Preliminary Version

Following approval from The University of Western Ontario Health Sciences Research Ethics Board (HSREB; #12920E; Appendix 2-A), a sample of 19 parents and their infants (birth to 12 months) were recruited through the Fanshawe branch of the Ontario Early Years Centres (OEYC). The average age of the parents' infants was 7.8 months (SD 2.8) with a range of 3 to 11 months.

Parents were informed about the study through a flyer (Appendix 2-B). If parents were interested, they were provided with a letter of information and consent form (Appendix 2-C). Parents who signed the consent form were provided with a package containing the EOQ (Appendix 2-D) and a questionnaire addressing the acceptability and feasibility of the questionnaire, clarity of questions, question format, and whether they felt something additional needed to be included in the questionnaire (Appendix 2-E). All parents who received a questionnaire package completed the study. A home visit was also scheduled with parents. The purpose of the home visit was to provide an opportunity

for an independent assessor (SD) to fill out the EOQ to assess feasibility and appropriateness, as well as assess the need for revision or inclusion of additional items.

Item Reduction and Revision

Item elimination or revision was based on the analysis of the following: Spearman's Rho correlations, internal consistency, descriptive statistics, t-tests between the assessor's and parent's questionnaires, and comments regarding the acceptability and feasibility of the items from pilot testing. Correlations were computed and one of two items with correlations greater than 0.8 were considered for deletion. Items that reduced the internal consistency of the measure were deleted. Descriptive statistics were used to identify items that parents did not answer or items that did not provide sufficient discrimination. These items were revised or deleted as needed. Finally, the remaining items were reviewed in light of comments regarding acceptability and feasibility. Items were revised accordingly. A paired t-test was used to compare total score between assessor and parent-completed copies of the same.

PHASE III

Participants

Following ethics approval by The University of Western Ontario HSREB (#13370E; Appendix 2-F), the sample of 253 parents and their infants were recruited from the three branches of the Ontario Early Years Centres (OEYC) in London, Ontario. Parents were recruited over a period of 18 months (July 2007 – February 2009). Parents were informed about the study through a flyer (Appendix 2-G), and interested parents received a letter of information and consent form (Appendix 2-H).

A total of 253 parents and their infants were recruited for this portion of the study. Of this group, 207 completed this part of the study. A flow chart depicting participant recruitment and drop-out is shown in Figure 2-1. The sample comprised 112 boys (54.1%) and 95 girls (45.9%). The mean age of infants was 7.1 months (SD 1.8, range 3.2 – 10.9). The averages for gestational age and birthweight were 39.6 weeks (SD 1.5, range 33 – 43) and 3415 grams (SD 546, range 1185 – 4791), respectively. The corrected age

was used for infants with a gestational age less than 37 weeks. Corrected age was calculated by subtracting the number of premature weeks from the infant's actual age. For the factor analysis, all infants were included in the study, including infants older than 10 months and those younger than four months (following age correction). One infant was included who had a GA less than 34 weeks (Note: This infant was just over 7 months uncorrected age at the time of testing).

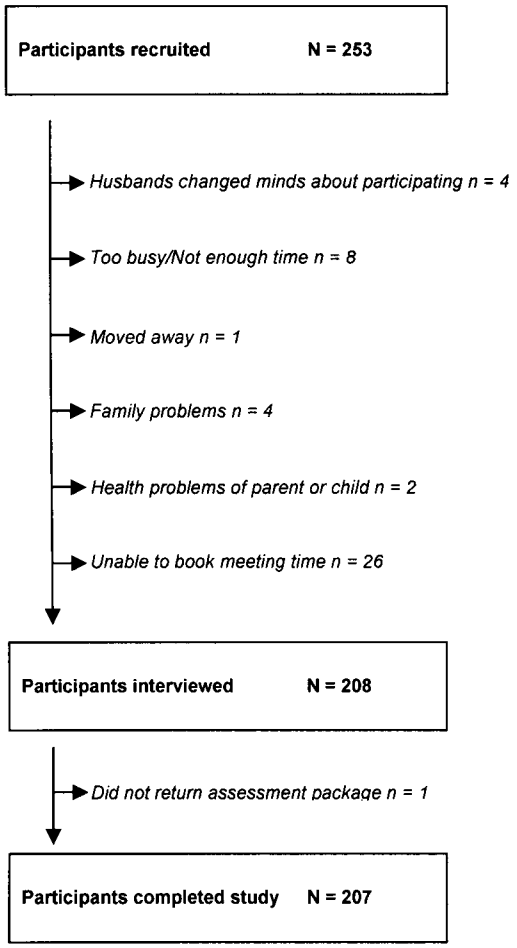


Figure 2-1. Flow chart depicting participant recruitment and drop-out

Parents completed the intermediate version of the questionnaire (Appendix 2-I) during a motor development assessment which was a part of another modeling study

(refer to chapter 4). The assessor (SD) read aloud each item on the measure, and with the provided scale, parents responded to each question in turn.

Factor Analysis of Intermediate Version

A series of screening analyses were conducted including internal consistency, correlation matrix evaluation, Keiser-Meyer-Olkin Test of Sampling Adequacy, Bartlett's Test of Sphericity, and tests for normality, linearity, and outliers.

An exploratory factor analysis (EFA) was conducted using Principal Components Analysis (Reise et al., 2000) with a Varimax Rotation (Costello & Osborne, 2005). Although item groups were created, an EFA was used to explore how these groups fit together into factors. Factor extraction was based on the scree plot, parallel analysis, and fit with the theoretical understanding of the items (Reise et al., 2000). Following this, item correlations were reviewed for fit to determine whether the existing factor structure was appropriate.

Reliability Testing

Test-Retest Reliability

A sub-sample of parents and their infants from the factor analysis study (UWO HSREB #13370E; Appendix 2-F) were recruited for the test-retest reliability component. Parents were notified about participating in this additional component through the letter of information (Appendix 2-H) and checked off an additional box on the consent form indicating consent. From the larger sample of 207 parents who completed the factor analysis study, 36 parents were recruited to participate and 34 parents completed the test-retest reliability. One parent was no longer able to participate in the follow up and the assessor was not able to get in touch with the other parent in a reasonable amount of time (interval was greater than 3 weeks).

Of those who participated, the average age of their child was 7.3 months (SD 1.8, range 4.4 – 10.2). The gestational age and birthweight averaged 39.4 weeks (SD 1.6, range 35 – 42) and 3313 grams (SD 421, range 2410-4026), respectively. The sample consisted of 19 boys (56% of sub-sample) and 15 girls (41% of sub-sample). All

respondents were the mother of the infant of interest. The target interval was 7 days, with the average interval between tests being 7 days (range 3 to 20 days). Retest was based on availability of the parent and contributed to variations in the time of retest among participants. Reliability was assessed for each factor, as well as the questionnaire as a whole, using the intraclass correlation coefficient (ICC) with a confidence interval of 95%. All statistical analyses for each phase were carried out using SPSS 17.0 for Windows.

Internal Consistency

Cronbach's alpha was used to assess internal consistency of each factor, as well as the entire questionnaire.

RESULTS

PHASE I

The initial selection of items resulted in a 43-item list. These items were grouped together and group names were developed. From the grouped items, new items were generated. A summary of the grouped item titles are listed in Table 2-1. A detailed listing of the 43 items can be found in Appendix 2-J. From this compilation, items were selected for the initial draft based on relevance to motor development and in a manner to ensure each item was unique. Items that seemed redundant were eliminated. During this phase, 13 items were deleted. Retained items were modified to fit the response options of the measure. The items were reviewed for clarity and readability by an outside editor and revisions were made according to these suggestions. The initial draft of items for the measure consisted of 30 questions (Appendix 2-K). The measure was finally analyzed for readability, and was found to have an 8.4 Flesch-Kincaid grade level. The version used for pilot testing is contained in Appendix 2-D.

Table 2-1. Summary of Grouped Items from Initial Item Selection of Environmental Opportunities Questionnaire (EOQ).

Title for Group of Items	*Number of Items*
Interaction with Others	6
Communication with Others	2
Parental Regulation	2
Parental Expectations and Involvement	7
Available Space	4
Layout of Space	8
Play Space	3
Availability of Toys	3
Variety of Toys	2
Challenge of Toys	3
Opportunity for Exploration	3
Total number of items	*43*

PHASE II

Acceptability and Feasibility

All respondents (n = 19) reported that the questionnaire was acceptable. Ninety-five percent (n = 18) of parents stated that the measure was feasible. In response to whether questions were clear and easy, 89% stated yes (n = 17). Two comments were made about difficulty understanding specific questions. These suggestions were used to guide modifications to the questions 6, 7, 18, 25, and 28. All parents found the format easy and 16% reported that the questionnaire did not address all necessary aspects of the home environment (n = 3). The average time to complete the questionnaire was 7.5 minutes (SD 3.6) with a range of 3 to 15 minutes.

Item Reduction

Item reduction was guided both by the statistical analysis and by the theoretical importance of items. The correlation matrices for each version highlighted 7 strong correlations (greater than 0.8) on the parent-completed version, and 21 on the assessor

completed version. These item pairs were reviewed and one item of the two was deleted or flagged for revision and clarification. The internal consistency of the parent-completed version and assessor version was 0.90 and 0.88 respectively. Items that reduced consistency in each version (9 items in parent and 7 items in assessor version) were compared and the item was either deleted or marked for revision. The mean and range of each item was used to indicate discrimination. Items with very low means (less than 1) or very high means (greater than 4) were deleted or marked for revision if the item was felt to be necessary. Items with small ranges were deleted. All items had 100% response rate, except for items on the second page, in which one parent did not fill out the entire second page of the measure.

A comparison of the parent-completed and assessor-completed EOQ indicated a difference between the two. For the parent-completed copy, the average item score was 3.8 (SD 0.6) and the average total score was 115.3 (SD 17.7). The assessor-completed copy had an average item score of 2.9 (SD 0.6) and an average total score of 85.9 (SD 18.4). Parents, on average, scored higher than the assessor.

Summary of Phase II

The summary of the revisions based on the pilot study can be found in Appendix 2-L. Phase I resulted in a 30-item questionnaire, which was reduced to 25 items in Phase II. Ten items were deleted, one item was split into two items, and four items were added. The result of item deletion and revision was a list of 25 items.

The assessor-completed copy and parent-completed copy were significantly different, with parents scoring their infant higher on average per item and for the total score. Administering the measure through an assessor was selected for Phase III due to its more conservative rating and also to reduce respondent burden in the larger study.

PHASE III

Factor Analysis

Data Screening for Factor Analysis

The internal consistency of the 25 items was 0.76. This value indicates that the data are appropriate for factor analysis (Tabachnick & Fidell, 2001). Item-total correlations indicated two items with negative loadings (item 10, -0.10; item 17, -0.05). The format of the questions was reviewed and these items were not recoded. Five items were found to slightly increase the alpha if deleted (items 1, 0.77; 2, 0.78; 6, 0.77; 8, 0.77; 10, 0.78). Given the very slight difference in Cronbach's alpha, these items were not deleted from the measure at this point and were retained for later analysis.

The non-parametric Spearman's Rho correlations did not reveal any high correlations greater than 0.9. In addition, a scan of the matrix revealed quite a few correlations above 0.3, indicating that the data are favourable for factor analysis (Comrey & Lee, 1992).

The Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) was calculated to be 0.76, which is considered good for factor analysis (Kaiser, 1974). Values above 0.5 indicate reasonable sampling. The anti-image correlation matrix was screened for items with values below 0.5 (Kaiser, 1974). Three items were found to be below 0.5, suggesting that these items will not contribute sufficiently to the factor solution. These items (1, 0.44; 8, 0.46; and 25, 0.47) were deleted from the measure. Two of these items were also found previously to reduce Cronbach's alpha. Bartlett's Test of Sphericity was found to be significant ($p < 0.001$). Following the deletion of the three items (1, 8, and 25), the KMO increased to 0.78.

The skewness and kurtosis were used as an initial check for normality. The majority of items were found to be within a reasonable range, although a few items were found to have a non-normal distribution. This eliminates the Maximum Likelihood procedure for factor analysis. Principal Component analysis is not sufficiently influenced by non-normal data if the sample size is sufficient (Dudzinski et al., 1975). Outliers were found in the data, but items were not modified or deleted to maintain the true format of

the data (Bollen, 1987). Screening of scatterplots for a random sample of item pairs indicated linearity in the data (Tabachnick & Fidell, 2007).

Exploratory Factor Analysis

Following the screening, 22 items were included in the factor analysis. The ratio of items to subjects was 1:9.4, which is considered appropriate (Fabrigar et al., 1999; Tabachnick & Fidell, 2001). An initial first pass, without factor extraction, was completed to view possible factor solutions. Three options were considered in the factor extraction: Kaiser Criterion, Scree plot and Parallel Analysis. The Kaiser criterion suggested 8 factors, explaining 64.9% of the variance. The Scree plot and Parallel Analysis suggested 3 factors, explaining about 39.0% of the variation. Taken together, with recommendations to over extract rather than under extract (Costello & Osborne, 2005), possible factor solutions were run using Principal Components Analysis (PCA) with both an orthogonal (Varimax) and oblique (Oblimin, Delta 0) rotation to determine best fit (Costello & Osborne, 2005). The oblique solutions produced factors that were only weakly correlated (0.01 – 0.17), and an orthogonal solution was selected. Testing the possible solutions and comparing against factor interpretability resulted in a three factor solution, which explained 39.0% of the variance.

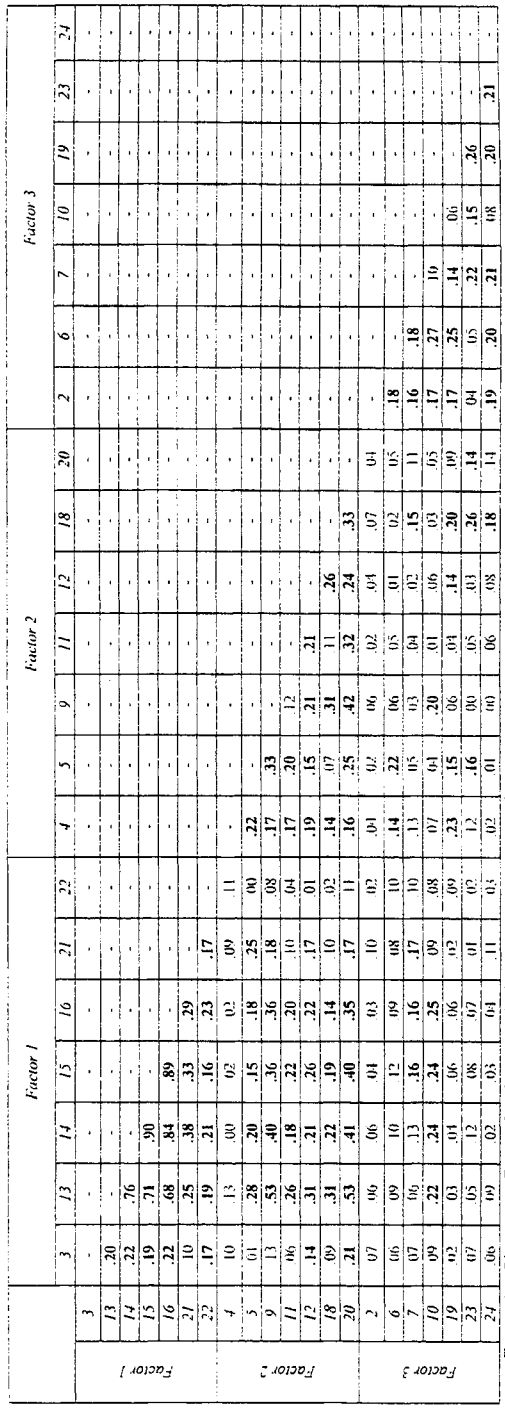
The factor loadings for the items can be found in Table 2-2. Given the exploratory nature of this work, item loadings found to be 0.4 or greater were considered sufficient (Ismail, 2008). One item did not load on any of the three factors (item 17). The content of this item, "do you modify the play space", is represented by other items (ie. items 13-16 that consider the set up of the play space) and was removed from the measure. Cross-loadings, identified as items having more than one loading greater than 0.4 (found only in one item; item 13), were managed by accepting the highest loading. Factor titles were developed based on the item loadings.

Table 2-2. Factor loadings for exploratory factor analysis of Environmental Opportunities Questionnaire (EOQ).

Content Item	*Factor Loading*		
	f1	*f2*	*f3*
2. Set aside a specific time to play with baby	.08	-0.18	**0.52**
3. Nervous when baby engages in new activity	**.40**	-0.00	-0.01
4. Access to variety of stationary toys	-0.23	**0.57**	0.19
5. Access to variety of movement-related toys	0.08	**0.53**	0.12
6. Encourage activities or play	-0.13	0.09	**0.64**
7. Alter involvement to suit baby's needs	0.18	0.09	**0.54**
9. Encourage baby to sit independently	0.27	**0.53**	-0.20
10. Access to well-suited space	-0.18	-0.16	**0.50**
11. Free to move in space in house	0.10	**0.53**	-0.06
12. Access to more than one type of floor texture	0.17	**0.44**	0.03
13. Access to furniture for pulling up	**0.71**	0.46	-0.11
14. Access to furniture for stepping sideways	**0.88**	0.29	-0.05
15. Furniture far apart to facilitate walking	**0.86**	0.25	-0.03
16. Furniture for climbing or stepping	**0.87**	0.20	0.01
17. Modify play space to suit baby's needs	-0.08	-0.13	0.31
18. Toys accessible	0.08	**0.53**	0.05
19. Encourage challenging toys	-0.04	0.29	**0.52**
20. Freedom to choose activity	0.24	**0.70**	-0.00
21. Clothes interfere with movement	**0.40**	0.27	0.02
22. Infant barefoot in house	**0.44**	-0.13	0.00
23. Knowledgeable about motor development	-0.01	0.27	**0.40**
24. Awareness of what child wants to do	0.05	0.12	**0.47**

A summary of the item correlations can be found in Table 2-3 indicating that the factor structure was appropriate. Items were considered to fit in the factor if the majority of correlations were significant. Items were flagged if they demonstrated higher correlations with items in another factor. The present factor solution did not result in any items being flagged, and as such, the factor structure was not changed.

Table 2-3.Correlation matrix for items according to factor structure for the Environmental Opportunities Questionnaire



		Factor 1							Factor 2										Factor 3						
		3	13	14	15	16	21	22	4	5	9	11	12	18	20	2	6	7	10	19	23	24
Factor 1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13	.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	14	.22	.76	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	15	.19	.71	.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	16	.22	.68	.84	.89	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	21	.10	.25	.38	.33	.29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	22	.17	.19	.21	.16	.23	.17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Factor 2	4	.10	.13	.00	.02	.02	.09	.11	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	.01	.28	.20	.15	.18	.25	.00	.22	-	-	-	-	-	-	-	-	-	-	-	-	-
	9	.13	.53	.40	.36	.36	.18	.08	.17	.33	-	-	-	-	-	-	-	-	-	-	-	-
	11	.06	.26	.18	.22	.20	.10	.04	.17	.20	.12	-	-	-	-	-	-	-	-	-	-	-
	12	.14	.31	.21	.26	.22	.17	.01	.19	.15	.21	.21	-	-	-	-	-	-	-	-	-	-
	18	.09	.31	.22	.19	.14	.10	.02	.14	.07	.31	.11	.26	-	-	-	-	-	-	-	-	-
	20	.21	.53	.41	.40	.35	.17	.11	.16	.25	.42	.32	.24	.33	-	-	-	-	-	-	-	-
Factor 3	2	.07	.06	.06	.04	.03	.10	.02	.04	.02	.06	.02	.04	.07	.04	-	-	-	-	-	-	-
	6	.06	.09	.10	.12	.09	.08	.10	.14	.22	.06	.05	.01	.02	.05	.18	-	-	-	-	-	-
	7	.07	.06	.13	.16	.16	.17	.10	.13	.05	.03	.04	.02	.15	.11	.16	.18	-	-	-	-	-
	10	.09	.22	.24	.24	.25	.09	.08	.07	.04	.20	.01	.06	.03	.05	.17	.27	.19	-	-	-	-
	19	.02	.03	.01	.06	.06	.02	.09	.23	.15	.06	.04	.14	.20	.09	.17	.25	.14	.06	-	-	-
	23	.07	.05	.12	.08	.07	.01	.02	.12	.16	.00	.05	.03	.26	.14	.04	.05	.22	.15	.26	-	-
	24	.06	.09	.02	.03	.04	.11	.03	.02	.01	.00	.06	.08	.18	.14	.19	.20	.21	.08	.20	.21	-

Factor 1 = Playspace; Factor 2 = Sensory Variety; Factor 3 = Parental Encouragement

The summarized measure with factor titles can be found in Table 2-4. In addition, the final factor analyzed version of the EOQ can be found in Appendix 2-M.

Table 2-4. Factor Analyzed Environmental Opportunities Questionnaire (EOQ). *Numbers in brackets indicate the question number in the version tested in Phase III.*

Opportunities in the Play Space
1. Does your baby have access to furniture for pulling up to a standing position? (13) 2. Does your baby have access to furniture that permits stepping sideways while holding on? (14) 3. Does your baby have access to furniture that is sufficiently far apart to facilitate walking movements? (15) 4. Does your baby have access to furniture that permits climbing or stepping (such as sofas, small tables, chairs, etc.)?(16) 5. Is your baby barefoot in the house? (22) 6. Do your baby's clothes get in the way with movement? (21) ** 7. Does it make you nervous when your baby engages in new or different activities? (3)
Sensory Variety
8. Overall, is your baby free to choose an activity by him or herself? (20) 9. Does your baby have access to a *variety* of stationary toys? (4) 10. Does your baby have access to a *variety* of movement-related toys? (5) 11. Do you encourage your baby to sit independently? (9) 12. Is your baby free to move in any space within the house, assuming that the space is safe? ((11) 13. Does your baby have access to more than one type of floor texture (carpet, wood, tile, linoleum, etc.)? (12) 14. Are the toys accessible to your baby so that he or she may choose when or with what to play? (18)
Parental Encouragement
15. Do you alter your level of involvement to suit the developmental needs of your baby? (7) 16. Does your baby have access to space that is well-suited to the level of movement he or she engages in? (10) 17. Do you encourage your baby to play with toys that challenge him or her to develop new motor skills? (19) 18. Do you feel knowledgeable about your child's motor development? (23) 19. Are you aware of what your baby wants to do at a particular time? (24) 20. Do you set aside a specific time to play with your baby? (2) 21. Do you encourage activities or play that will help your baby develop? (6)

** This item was not reverse coded. Reverse coding produced a negative corrected item-total correlation in the internal consistency calculation and significantly reduced Cronbach's alpha.

Reliability Analyses

Test-Retest Reliability

The intraclass correlation coefficients for each factor can be found in Table 2-5. The ICCs ranged from 0.83 to 0.95. The ANOVA calculations for each factor did not reveal significant differences between time 1 and time 2 ($p > 0.05$). Reliability for the entire measure was 0.92 (CI 0.84 – 0.96).

Internal Consistency

Each factor in the solution was tested for internal consistency. The Cronbach's alpha for the entire questionnaire consisting of 21 items was 0.79. The range for the three factors is 0.54 to 0.83. A summary can be found in Table 2-5.

Table 2-5. Intraclass correlation coefficients for test-retest reliability for factors in the Environmental Opportunities Questionnaire (EOQ).

EOQ Factor	*Test-retest reliability ICC (95% confidence*	*Internal consistency Cronbach's Alpha*	*Number of items*
Factor 1 Opportunities in the Play Space	0.95 (0.90 – 0.98)	0.83	7
Factor 2 Sensory Variety	0.83 (0.66 – 0.92)	0.66	7
Factor 3 Parental Encouragement	0.89 (0.78 – 0.95)	0.54	7
Total EOQ	0.92 (0.84 – 0.96)	0.79	21

DISCUSSION

The Environmental Opportunities Questionnaire (EOQ) was developed to address the lack of measures evaluating the home environment as it relates to motor development for infants between the ages of 4 and 10 months. The measurement development process, the first three phases of which are outlined in this paper, started with 43 items selected and generated from the literature and resulted in a measure with 21 items and three factors, labelled as *Opportunities in the Play Space*, *Sensory Variety*, and *Parental Encouragement*. The first two factors concern elements of the play space, while the third

factor concerns parental involvement and influence. This structure is similar to that currently used by the Affordances in the Home Environment for Motor Development (AHEMD; Rodrigues & Gabbard, 2005). Interestingly, these factors correspond with the physical (*Playspace* and *Sensory Variety*) and social (*Parental Encouragement*) aspects of the environment according to the International Classification of Functioning, Disability and Health (WHO, 2001). The EOQ has the potential to serve as an educational and clinical tool, providing information about the environment as it relates specifically to early motor development.

Factor Structure of the EOQ

The original exploratory factor analysis of the 22 items revealed a simple factor structure in which most items (except for one) loaded on one of three factors, resulting in a 21-item solution. Oblique rotations of the factor structure produced a set of uncorrelated factors, suggesting that the extracted factors represent independent constructs, potentially explaining different aspects of the environment. The three-factor solution does effectively organize the initial item groups into appropriate constructs that are thought to be important to early motor development. A variety of factor extractions were tested to determine what would result in an interpretable factor structure. The final factored solution (containing 21 items) demonstrated high test-retest reliability at 0.92 (CI 0.84 – 0.96) and a good degree of internal consistency of 0.79.

Opportunities in the Play Space

This factor consists of 7 items that capture opportunities that infants might have in their environment, as a result of the physical layout of furniture, clothing restrictions, or parental restrictions. Four items in this factor address furniture in the home environment. Access to furniture permits movement and opportunities for antigravity movement and has the potential to influence specific aspects of early development, as seen by early caregiving studies highlighting the positive impact of practicing specific movements during caregiving practices on sitting, standing, and walking (Bayley, 1969 obtained from Abbott & Bartlett, 1999; Cintas, 1988; Super, 1976). Moreover, access to stairs has been shown to influence the acquisition of stair climbing milestones (Berger et al., 2007).

Thus, these items can serve as indicators as to whether the environment is structured in a way that is ideally suited to the infant.

Two items within this factor concern clothing and whether the infant is barefoot. Comfortable and loose clothing can allow freedom of movement. Moreover, being barefoot provides an infant with opportunities to use the feet to grasp or hold onto surfaces, and might serve to facilitate movement around the environment. Bare feet have been suggested to allow for the development of intrinsic muscles of the feet and sensory input, as well as assist with balance reactions (Staheli, 1991).

The final item in this factor concerns whether a parent might be nervous if a child engages in a new activity. Overly cautious parents who limit the freedom of their child's movement might act as a hindrance, having an overall negative effect on early motor development. Overall, this factor demonstrated a high test-retest reliability of 0.95 (CI 0.90 – 0.98) and strong internal consistency score of 0.83, indicating that the items are stable over time and evaluating the same factor.

Sensory Variety

The developmental literature suggests that toys can influence motor development (Bober et al., 2001; deBarros et al, 2003; Parks & Bradley, 1991). This factor contains 7 items and is concerned with variety of toys, as well as exposure to a variety of situations within the home, such as different floor textures and rooms. Exposure to a variety of stimuli challenges an infant's movement repertoire and encourages adaptation (Csikszentmihalyi, 1990 in Bronson & Bundy, 2001) which can potentially facilitate motor development. This factor displayed high test-retest reliability of 0.83 (CI 0.66 – 0.92), but only moderate internal consistency at 0.66, suggesting a revision of existing items might enhance reliability.

Parental Encouragement

Unlike the previous two factors, this factor is focused on the influence of the parent. Consisting of 7 items, it contains items that pertain to parental knowledge and the extent to which a parent alters his or her behaviour to suit the infant. It was theorized that increased parental awareness and encouragement would act as a facilitating influence on

motor development. Parental expectations have been shown to be an important factor in motor development (Diamond & Lefurgy, 1992) and parental knowledge has been shown to influence the structure of the environment (Parmar et al., 2004). The test-retest reliability is high at 0.89 (0.78 – 0.95) although internal consistency of this factor is low at 0.54, suggesting more work needs to be done investigating this factor. Revisions to existing items are likely necessary to enhance the interpretability of this factor.

The three factors discussed above represent key aspects thought to be influencing early motor development, although the results for internal consistency suggest more work needs to be done on developing this measure.

The EOQ and Existing Measures

The EOQ was developed from items that were reviewed in the Home Observation for Measurement of the Environment (HOME; Caldwell & Bradley, 1984), Affordances in the Home Environment for Motor Development (AHEMD; Rodrigues & Gabbard, 2005), Craig Hospital Inventory of Environmental Factors (CHIEF; Harrison & Mellick, 2000), and the Measure of the Quality of the Environment Scale (MQE; Fougeyrollas et al., 1999). Thus, the EOQ is not the first measure to target the home environment. The CHIEF and MQE consider a range of environmental variables that were not found to be relevant to motor development. The HOME was found to be dated and similarly, not all items were found to be relevant to motor development. The AHEMD is a measure evaluating the home environment in relation to motor development, although items were not found to be ideally measured (such as counting the quantity of certain toys) and the target age was an older population of children. As such, despite the limitations previously identified, the EOQ has the potential to provide a unique contribution, through its focus on quality and variety, and on the parental role in providing an optimally-suited home environment. Moreover, as mentioned earlier, in combination with the parental contribution outlined in the DAIS, both the EOQ and DAIS have the potential to explain a portion of the variability observed in early motor development.

Clinical Relevance

Recent theories and research regarding motor development emphasize the importance of the environment, and the potential positive or negative effect it can have on the acquisition or progression of movement repertoires (for review, see Abbott & Bartlett, 1999; Bradley, 1994; Cintas, 1988). Without relevant and effective measurement tools, our understanding of environmental influences will remain limited. The EOQ was developed to address a gap in the literature, providing a means to evaluate the home environment with questions specific to supporting early motor development. Following its development, the EOQ (in particular, the factors relating to physical space and sensory variety) can be used in both research and clinical settings. As a research tool, it can be used to investigate the role that the environment plays in influencing development. Moreover, it can also serve as an educational tool, serving to inform parents and raise awareness as to the types of barriers and facilitators that can exist in the home. By their very nature, home environments are highly variable and difficult to evaluate. Providing a user friendly tool to guide parents' attention to various aspects of the environment is both useful to infants born full term, as well as special populations of infants, such as those born preterm or with identified impairments influencing motor development. Unlike biology, the home environment is a modifiable variable, and parents and clinicians can take action to make changes that have the potential to optimize outcomes. Planning interventions that target multiple facets of the child's experience increases the likeliness of achieving more optimal outcomes. The home environment represents a factor that is potentially easily modifiable by parents, and it is possible for changes to the environment to be made almost immediately. More work needs to be done on developing the EOQ for clinical and research use, although it has the potential to be of great benefit to parents, clinicians, and researchers alike.

Considerations for Implementation

During the pilot stage, the EOQ was developed as both a parent-completed tool and an assessor-completed tool. A comparison between the two revealed a significant difference according to a t-test. Moreover, the results highlighted that, on average, the independent assessor was more conservative compared to parent answers. Other similarly

developed measures such as the Test of Environmental Supportiveness (TOES; Bundy, 1999) and the AHEMD use parental reports, whereas the HOME is designed for completion by either a parent or an independent assessor. If designed as an assessor-completed measure, the EOQ will require home observation as well as an interview component with the primary caregiver. This format might not be feasible in all instances. As a parental report, parents will have the opportunity to review their home setting while completing the questionnaire, potentially providing a more reliable set of answers.

The data for this study were collected in conjunction with a larger study (see chapter 4), and as such, the EOQ was completed as a separate interview during an infant assessment. This method was chosen to alleviate respondent burden, as parents were required to take home and fill out a host of other surveys independently. Results from the pilot work also highlighted that the original 30-item questionnaire took approximately 7.5 minutes to complete, which suggests that the current structure is feasible for parents to complete on their own. During the interviews with parents when the measure was filled out, parents often asked questions about items. Given the interactive nature of the interview, it was possible for the assessor to clarify questions and if needed, provide more examples to illustrate the point of the question (such as more examples of movement-related toys). As such, it might be necessary to provide more concrete examples for questions if the EOQ is to be designed primarily as a parent self-report measure. Another consideration for interview-style completion is parental bias due to potential scrutiny of the assessor. It has been reported that interview-style questionnaires can bias parent's responses (Willinger & Eisenwort, 2005), although other studies have shown that parents can provide dependable reports in certain contexts relating to motor development (Bodnarchuk & Eaton, 2004).

The scaling of the measure was designed to evaluate the extent to which children have access to various items in the environment. Pilot work and comments made during interviews highlighted potentially key differences in conceptions of what is considered 'a great extent' and what is 'a small extent'. Thus, it might be of benefit to consider the utility of an independent assessor. More importantly, it might be of benefit to more precisely define what the scale means for each item, which reduces ambiguity, but also

increases respondent burden. Given this, developing a manual for the EOQ makes it more likely to be a measure completed by an independent assessor.

This discussion highlights the advantages and disadvantages of each version of the questionnaire. It is possible that the method of implementation of the EOQ is based on the clinical or research goals, and that both options are available. Ultimately, flexibility in how the measure is administered increases the likelihood of it being used by clinicians and researchers.

Limitations

The process of measurement development outlined in this chapter has some limitations. The factors identified in the EOQ represent three key areas that potentially influence motor outcome. It is possible that other unrepresented factors are also important. The measurement development process requires multiple iterations and at the present time, two revisions have been completed.

The 5-point Likert scale was chosen based on other parent report measures. A limitation of this work is that other scales were not tested for feasibility or fit. As such, it is possible that other scales might provide a more accurate evaluation of the variables of interest, although providing more response options would likely reduce test-retest reliability. Comments collected during the pilot study highlighted that some parents found the scale difficult to interpret. The wording of items was revised to provide a more appropriate fit to the scale, although more work might be necessary in this area.

At the present time, aside from evidence supporting the factor structure, the validity of the EOQ has not been determined. Linking the EOQ to motor development is the next important step in determining its utility as a measure evaluating the potential influence of home environment.

Conclusion

The EOQ is a measure developed to evaluate the home environment specifically as it relates to early motor development. The initial factor analysis revealed three key factors (*Opportunities in the Playspace*, *Sensory Variety*, and *Parental Encouragement*). These key constructs have been used in other measures evaluating the home environment,

but the EOQ provides a different viewpoint as it emphasizes quality of the environment and access to equipment and toys that have the potential to facilitate early motor development. The preliminary analyses reported here suggest more work needs to be done on the EOQ to strengthen its use for research or clinical purposes; however, it is adequate for use in its current form. The extent to which the environment influences early motor development is yet to be investigated. The development of a tool that has the potential to measure environmental constructs provides opportunities to advance our understanding of environmental influences with the eventual goal of using this information clinically for planning of interventions for infants who are not developing typically. Moreover, the EOQ also has the potential to also serve as an educational tool, raising awareness in parents of children who are born either full term or preterm. The home environment is a modifiable variable, and as such, it is imperative that we understand its influence on development so that parents, clinicians and researchers are one step closer towards optimizing developmental outcomes.

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CHAPTER 3

Development of a Measure Examining Infant Characteristics

INTRODUCTION

A challenge in the field of early motor development is explaining the large degree of variability observed during infancy. The inherent complexity of this period is the result of an incomparable amount of growth and understanding the factors that influence early outcomes is an increasingly important area of research. The National Research Council and Institute of Medicine was established in 1997 to review early human development, with the goal of understanding how children can get off to a promising start in the first few years of life (Shonkoff, 2003). In addition to discussing the influence of factors such as biology and the environment, this committee emphasized the role of children as active participants in their own development and the range of individual differences observed during early childhood (Shonkoff, 2003).

Individual differences and variability are key concepts emphasized within Dynamic Systems Theory (DST), which proposes that motor development is a multidimensional and emergent phenomenon (Thelen et al., 1987). Development progresses as a complex and transactional process among the various contextual factors, and DST assists in understanding how multiple components contribute and cooperate to produce behaviour and the changes associated with development (Thelen, 1995). From this viewpoint, development is considered as a "series of states of stability, instability, and phase shifts in the attractor landscape, reflecting the probability that a pattern will emerge under particular constraints" (Thelen, 1995, p.84). Variations in constraints include the ever-changing situation of the infant, who is learning and adapting to his or her environment amidst constant personal changes. In addition, each specific contributor or subsystem develops and advances at its own rate (Heriza, 1991), resulting in an asynchrony that further contributes to this variability. Ultimately, this suggests that the factors that will have a larger influence on development might change over time.

During the first 12 months of development, infants become active participants in their surroundings. This timeframe is also marked by the onset of purposeful, voluntary movement involving locomotion (ie. movement from one place to another). The motor repertoire of infants also becomes increasingly characterized by complex movements and movement variability that sets the stage for adapting a variety of strategies for moving around in the environment. Research has demonstrated that beyond the first 2 months of

age, other factors besides biology play an important role in influencing motor outcomes (Dennis & Najarian, 1957; Solomons & Solomons, 1975). Taken altogether, this suggests that the first year of life is an ideal time for investigating the influence of various factors on motor outcome.

The current DST perspective contrasts with early dominating neuromaturation theories which focused on the sole influence of biology. As a result, the current literature is saturated with studies focused on biological determinants and research concerning the influence of contextual factors on early development is limited. Although the observed universality of motor developmental sequences provides strong evidence for the case of neuromaturation, the strictly deterministic framework ignores the potential influence of interactive contextual components on development. Furthermore, studies have shown that biology explains only a small portion of the variance observed in developmental scores (Lima et al., 2004).

Affordances, which refers to what an environment offers, provides or furnishes for an infant, have the potential to explain a portion of the variability observed in infancy. They link perception to action, and include the appropriateness of an action on the surroundings (Gibson, 1988). How an infant learns or perceives the affordances within an environment depends on both the innate capabilities and characteristics of infants, such as their exploratory behaviour (Gibson, 1988). This suggests that infant characteristics have the potential to facilitate motor development.

Early work investigating exploratory activity has shown links to perceptual and cognitive development (Gibson, 1988); yet work is limited investigating its role in motor development. Motivation is thought to underlie movement (von Hofsten, 2004), and links between perception, motivation and movement have been found in studies with children who are blind and have motor developmental delays (Levtzion-Korach et al., 2000). These children demonstrate delays in the initiation of movement, suggesting that an infant must realize that a person or object is present before he or she is motivated to reach out and get it. Moreover, creativity and curiosity can act to facilitate exploration. A child who is curious about the environment might attempt to initiate an interaction with his or her surroundings. A creative child might also find different ways to explore, not only the environment itself, but the manner in which he or she interacts with it. Studies

investigating play attempt to capture the nature of curiosity and exploration. Although there are many theories regarding the functionality of play, the research converges on points of adaptive utility, exploration, and the fact that it is pleasurable (Stagnitti, 2004), and emphasizes the link between movement and motivation (von Hofsten, 2004).

Ultimately, there is much to be understood about the potential role that infant characteristics have on early motor development. Researchers have alluded to its importance (Bradley, 1994; Shonkoff & Meisels, 2000), yet the majority of studies do not address contextual factors. One potential reason for this gap in the literature is the lack of relevant measures targeting infant characteristics as they relate specifically to early motor development. At the present time, no measure exists to address this issue. A better understanding of infant characteristics can have a significant impact on planning interventions and ensuring that the environment is optimally suited to the child.

Given this, the primary purpose of this chapter is to report on the development of a new infant measure, targeted to the motor development of infants aged 4 to 10 months of age. The measure was developed in multiple phases, which include item selection, item scaling, item reduction, reliability, and validity as suggested for discriminative and predictive indices (Kirsher & Guyatt, 1985). The *Infant Characteristics Questionnaire (ICQ)*, which will address a variety of infant characteristics, will serve as a discriminative and predictive index. Although infant variables are not necessarily modifiable, they can serve as indicators for ensuring interventions complement the infant dynamic or that the environment is well suited to the characteristics of the infant.

The primary purpose of the tool is to ensure realistic goal setting, and perhaps a more realistic match between the environment and the nature of the infant. From this point, it is important to stress that the measure is being developed for the purpose of clinical use, and as such, is being developed with the consideration of future modes of planning and intervention, as well as feasibility for use with infants and their families by therapists and other health care professionals. In addition, the framework underlying the measure supports a holistic approach to assessment and intervention, which will support the complex decision making process that therapists have been engaged in for years in clinical practice (American Physical Therapy Association, 2001).

METHOD

The Infant Characteristics Questionnaire (ICQ) was development in three phases: Phase I (item selection and item scaling), Phase II (pilot testing and item reduction) and Phase III (factor analysis and reliability testing).

PHASE I

Item Selection

The generation of items for the ICQ was based on existing measures in the literature. Measures were chosen for review if any ideas, constructs, or items were found to be relevant. These included the Carey Temperament Scale (CTS; Carey & McDevitt, 1977), Dimensions of Mastery Questionnaire (DMQ; Morgan et al., 2005), Early Coping Inventory (ECI; Zeitlin et al., 1988), and Test of Playfulness (Bundy, 1997)[a]. The measures were scanned and each item was evaluated according to a set of criteria by two independent researchers (doctoral candidate [SD] and supervisor [DB]). The initial criteria for selection were based on whether the item is appropriate for infants aged 4 to 10 months, and relevant to early motor development. An inclusive rather than exclusive approach was used to ensure valuable items were not missed. The specific wording was not considered important at this phase. Selected items were compiled into an initial item list, and items were grouped according to similarity. Titles were created to capture the essence of the items within each group.

This initial listing was then used to develop new items. In addition, other items were generated from a series of infant assessments that involved direct observation of infants aged 4 to 10 months of age. The addition of items was proposed by one researcher (SD) and confirmed by a second (DB). Existing items were included as is, modified, or deleted. Items that were included as is were found to be well-worded and highly relevant. The modifications to items included framing questions in a manner relevant to motor development and the age group of interest. Other modifications were made regarding

[a] The Test of Playfulness was considered, but not used for practical reasons in this study (ie. lack of availability of the measure from the author without significant cost).

word choice and the descriptions of the tasks involved. Items that were redundant were deleted. The new lists of items for each measure were compiled into a separate document as the initial draft of the measures. Finally, an external reviewer was consulted to assess readability and clarity of the items. Items were revised as needed.

Item Scaling

Based on recommendations for both discriminative and predictive measures (Kirshner & Guyatt, 1985), a 5-point Likert scale was selected. The scale 1-5 indicated the extent to which the item was applicable to their infant (5 = to a great extent; 4 = to a moderate extent; 3 = to a fair extent; 2 = to a small extent; 1 = not at all). A score of '0' indicated that the question was not applicable. Each question was worded to fit with 'to what extent', which preceded the set of questions.

PHASE II

Pilot Testing of Preliminary Version

Approval for this phase was obtained from The University of Western Ontario Health Sciences Research Ethics Board (HSREB; #12920E; Appendix 2-A). A sample of 19 parents and their infants aged birth - 12 months were recruited to participate in this pilot study. The average age of the parents' infants was 7.8 months (SD = 2.8) with a range of 3 to 11 months.

Information regarding the study was made available through flyers (Appendix 2-B) distributed to the Fanshawe branch of the Ontario Early Years Centres (OEYC). Parents were also shown a letter of information and consent form (Appendix 2-C). Parents who expressed interest in the study signed a consent form and were provided with a package containing the ICQ (Appendix 3-A) and a questionnaire addressing the acceptability and feasibility of the questionnaire, as well as the clarity and format of the questions (Appendix 2-E). Parents also had an opportunity to comment on whether they felt something was missing from the measure. A home visit was scheduled with parents for an independent assessor (SD) to fill out the ICQ and also to assess measurement feasibility, appropriateness, and the potential need for revision or additional items.

Item Reduction and Revision

The elimination or revision of items was based on the following analyses: Spearman's Rho correlations, internal consistency calculations, descriptive statistics, t-tests between assessor's and parent's questionnaires, and comments regarding the acceptability and feasibility of the items.

Correlations were computed and items were considered for potential deletion if values were greater than 0.8. Items that reduced the internal consistency of the measure were considered for deletion. Descriptive statistics identified items that parents did not answer or items that did not provide sufficient discrimination. These items were revised or deleted as needed. Finally, the remaining items were reviewed in light of comments regarding acceptability and feasibility and items were revised accordingly. A paired t-test was used to compare the total score between the copies completed by the assessor and parent.

PHASE III

Participants

Approval for this final phase was obtained from The University of Western Ontario HSREB (#13370E; Appendix 2-F). Information regarding the study was made available through flyers (Appendix 2-G), and parents who expressed interest were provided with a letter of information and a consent form (Appendix 2-H).

A total sample of 253 parents and their infants was recruited for this. From this sample, 207 completed the study. Parents were recruited from the three branches of the Ontario Early Years Centres (OEYC) in London, Ontario from the period of July 2007 to February 2009. Figure 3-1 provides a summary of the reasons for participant attrition. The sample consisted of 112 boys (54.1%) and 95 girls (45.9%). The average age of infants was 7.1 months (SD 1.8, range 3.2 – 10.9). The means for gestational age and birthweight were 39.6 weeks (SD 1.5, range 33 – 43) and 3415 grams (SD 421, range 1185 – 4791), respectively. Infants that had just turned 10 months were included in the analysis, as well as infants that, following age correction, were less than four months old. One infant was included who had a GA less than 34 weeks.

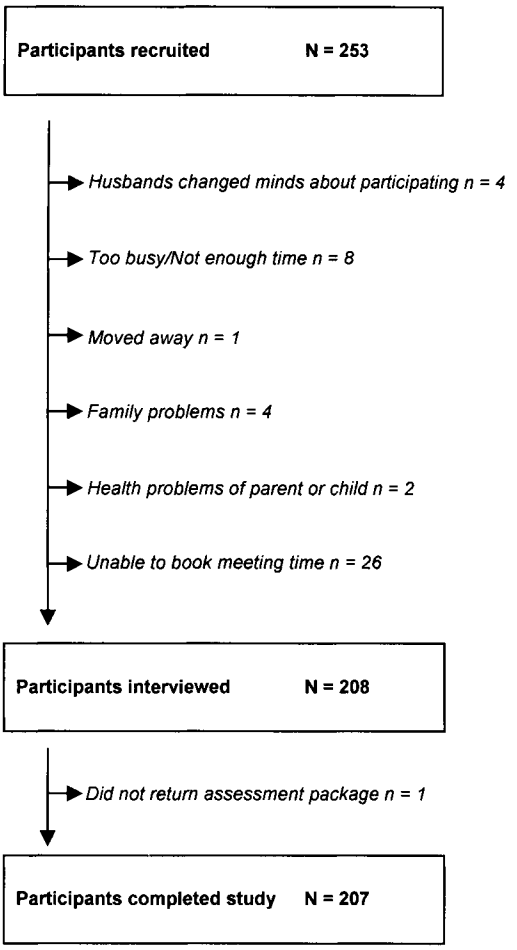


Figure 3-1. Flow chart depicting participant recruitment and drop-out.

Factor Analysis of Intermediate Version

Parents were asked to complete the intermediate version of the questionnaire (Appendix 3-B) independently. The questionnaire was provided as part of a package containing other questionnaires which were part of a separate modeling study (see chapter 4).

According to factor analysis guidelines (Tabachnick & Fidell, 2001), a series of screening analyses were completed prior to conducting the factor analysis to ensure suitability of the data, including checking the Cronbach's alpha, correlation matrix, Kaiser-Meyer-Olkin Testing of Sampling Adequacy, Bartlett's Test of Sphericity, and tests for normality, linearity and outliers.

An exploratory factor analysis (EFA) was conducted using Principal Components Analysis (Reise et al., 2000) with a Varimax rotation (Costello & Osborne, 2005). Although items were initially grouped, EFA was employed to determine how the groups of items fit into factors. Factors were extracted according to the scree plot, Parallel Analysis (Reise et al., 2000), and intelligibility of the factor loadings.

Reliability Testing

Test-Retest Reliability

A subsample of parents from the larger study was recruited to participate in the test-retest reliability of the measure (UWO HSREB #13370E; Appendix 2-F). Parents were asked to participate in this portion of the study while signing the consent form for the factor analysis portion of this project and interested parents provided additional consent by checking off the appropriate boxes on the consent form (Appendix 2-H).

A sample of 36 parents was recruited, and of these, 33 completed the test-retest reliability. The researcher was unable to get in touch with three parents, and after three weeks, they were removed from the study. The sample was comprised of 18 boys (55% of sample) and 15 girls (45% of sample). The mean age of the infants was 7.3 months (SD 1.7, range 4.4 – 10.2). The gestational age and birthweight averaged 39.5 (SD 1.6, range 35.0 – 42.0) and 3320 (SD 411, range 2410 – 4026), respectively. In all cases, the respondent was the mother.

The aim was an interval of 2 weeks between time 1 and time 2, but retest was dependent on when the parent completed and mailed in the additional form. The mean interval between tests was 7 days, with the longest interval being about 20 days. Reliability was measured for each factor and also for the total score using the intraclass correlation coefficient (ICC) with a 95% confidence interval.

Internal Consistency

Cronbach's alpha was used to determine the internal consistency of each factor and the total ICQ score. All statistical analyses were carried out using SPSS 17.0 for Windows.

RESULTS

PHASE I

The initial selection of items resulted in a 110-item list. From this selection, redundant items were deleted and new items were generated, which produced a list of 84 items. These remaining items were grouped according to similarity into 17 different subheadings, a summary of which can be found in Table 3-1. Details of the 84 items selected can be found in Appendix 3-C. These items were evaluated by an outside editor for readability and clarity. Items were revised or eliminated based on suggestions resulting in 75 items, which comprised the initial draft of the ICQ (see Appendix 3-D). These items were modified to fit the response options of the measure. The measure was analyzed for readability, and was found to have a 7.5 Flesch-Kincaid grade level. The version used for the pilot testing in phase II is contained in Appendix 3-A.

Table 3-1. Summary of Grouped Items from Initial Item Selection of Infant Characteristics Questionnaire (ICQ).

Title for Groups of Items	*Number of Items*
Level of Activity	6
Active versus Passive	7
New Situations/People	8
Exploration	5
Flexibility of Response	9
Awareness	6
Familiar Places	2
Unfamiliar Places	3
Playtime	8
Accomplishment	5
Engagement	4
New Situations	3
Familiar Situations	3
Attention	2
Movement Accomplishment	6
Toy/Task Accomplishment	4
Challenge	3
Total number of items	*84*

PHASE II

Acceptability and Feasibility

All respondents (n = 19) in the pilot study found the measure to be acceptable and feasible. Some parents (n = 3) commented on the length of the questionnaire, stating that it was hard to find time to complete the questionnaire. The average time to complete the measure consisting of 75 items was 21.4 minutes (SD = 13.2). Of those who responded to whether the questions were clear and easy (n=18), 67% said 'yes' (n = 12). Most participants who responded 'no' suggested providing examples to clarify questions (n = 5). In addition, all respondents found the format easy to follow. To the question, "did you feel anything was missing", 79% of parents responded 'no' (n = 15). Other important comments included querying suitability for young children (n =2), as well as expression of difficulty interpreting the scale given the wording of some items (n = 2).

Item Reduction

An initial review of the correlation matrices for each version indicated 17 strong correlations (greater than 0.8) on the parent-completed version, and 13 on the assessor-completed version. These item pairs were reviewed and one item of the two was considered for deletion. The internal consistency of the parent-completed version was 0.89 and 0.90 for the assessor-completed version. Items that lowered internal consistency were deleted or revised (22 items in assessor version and 26 items in parent version). The mean and range of each item was used to indicate discrimination. Items with very low means (less than 1) or very high means (greater than 4) were deleted or revised. Items with small ranges were deleted. Items that did not have a perfect response rate (6 questions in assessor copy and 12 in parent copy) were revised or deleted from the measure as necessary.

A comparison between the parent and assessor version of the measure was done by evaluating differences between the mean-total scores. This was the average of the total score for the 75 items. The average mean-total score for the assessor version was 3.08 (SD 0.35) and 3.49 (SD 0.60) for the parent version. Total scores were not used in this

evaluation due to missing data. These numbers also demonstrate that parents scored higher on average compared to an independent assessor.

Summary of Phase II

The details regarding the revisions made to the pilot version of the ICQ can be found in Appendix 3-E. The item generation of Phase I resulted in 75 items that were drafted for use in the pilot study. Following the item reduction analyses of Phase II, 42 items were deleted. No new items were added at this point. Thus, the result of Phase II was a measure consisting of 33 items. The majority of items were revised to enhance clarity and examples were provided.

The results of the comparison between the parent and assessor versions of the measure highlighted significant differences, with parents providing on average, higher scores. Nonetheless, the parent-completed version was selected as the preferred option for Phase III due to the difficulty in having an independent observer score an infant during a short assessment. In addition, other measures of this type are often parent-completed (Carey & McDevitt, 1977; Morgan et al., 2005; Zeitlin et al., 1988).

PHASE III

Factor Analysis

Data Screening for Factor Analysis

Cronbach's alpha, calculated with the 33 items, was found to be 0.87. This value indicates that the data are appropriate for factor analysis (Tabachnick & Fidell, 2001; Fabrigar et al., 1999). Item-total correlations indicated three items with negative loadings (item 10, -0.05; item 20, -0.05, and item 31, -0.06). The format of the questions was reviewed and the items were not recoded at this point. Five items were suggested to increase the alpha coefficient if deleted (items 8, 0.87; 10, 0.87; 19, 0.87; 26, 0.87; 31, 0.87). Given the very modest increase in the alpha value (changes at the third decimal place), these items were not deleted at this point in order to retain items for the factor analysis, but were flagged for future consideration.

The non-parametric Spearman's Rho correlations did not reveal any correlations greater than 0.9 and quite a few correlations were found above 0.3, another indication that the data are amenable to factor analysis (Tabachnick & Fidell, 2001). The correlation matrix was also screened for items that overall did not correlate with many items. Five items (8, 10, 19, 26, and 31) were found to produce only a few significant correlations with other items (8, 8 other items; 10, 4 other items; 19, 2 other items; 26, 7 other items; 31, 8 other items).

The Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) was calculated to be 0.83, suggested to be an appropriate value for factor analysis (Kaiser, 1974). Values above 0.5 indicate reasonable sampling and screening the anti-image correlation matrix is an effective means to determine whether individual items will contribute sufficiently to the factor solution (Kaiser, 1974). The matrix highlighted three items with values below 0.5 (10, 0.42; 19, 0.44; 26, 0.47). These items were also found to decrease the overall Cronbach's alpha and have poor correlations with other items, and were deleted from the measure. Bartlett's Test of Sphericity was found to be significant ($p < 0.001$). Following the deletion of these items, the KMO increased to 0.85 and Bartlett's Test of Sphericity was still significant ($p < 0.001$).

Although the majority of items did not have severe violations of the normality assumption, a few items did deviate from normality and so the Maximum Likelihood (ML) procedure was not used for factor analysis. The ML procedure is preferred, but is skewed in cases of severe non-normality. As a result, Principal Component Analysis (PCA) was used as the literature suggests that it is not sufficiently influenced by non-normal data if the sample size is sufficient (Dudzinski et al., 1975). Outliers were found in the data but items were not modified or deleted in order to maintain the true format of the data (Bollen, 1987). Screening a sample of scatterplots indicated linearity in the data, which is important in factor analysis given the dependence of factor analysis on correlations (Tabachnick & Fidell, 2007).

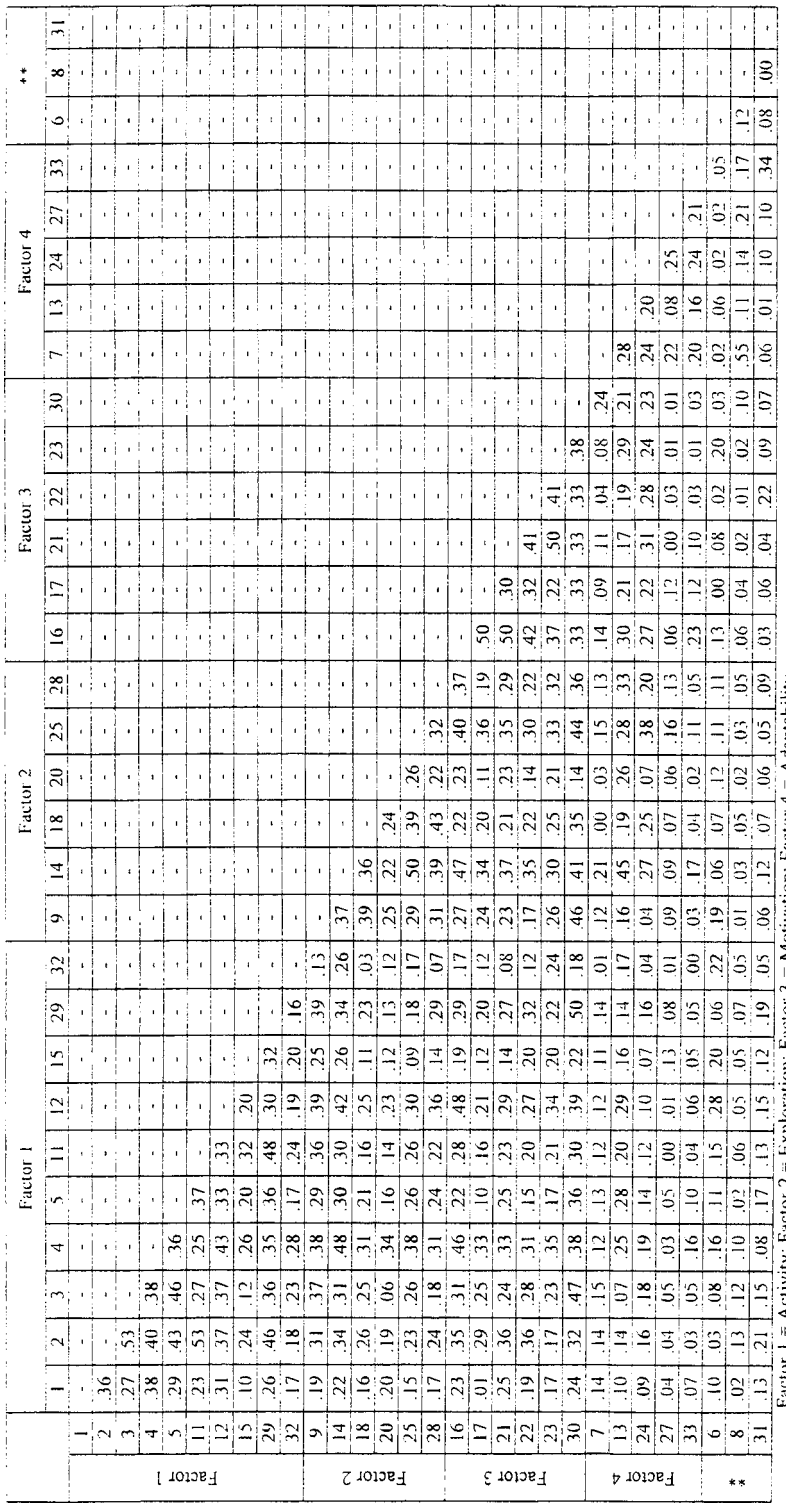
Exploratory Factor Analysis

The preliminary data screening resulted in the deletion of 3 items, leaving 30 items to be considered in the exploratory factor analysis. The ratio of items to subjects was just over 1:7. An initial first pass, without factor extraction, was done to view possible factor solutions. The three options that were initially considered for the factor solution were the Kaiser Criterion, scree plot, and a Parallel Analysis. According to the Kaiser criterion, which utilizes eigenvalues greater than 1 as a means of factor extraction, 9 factors existed, explaining 62.7% of the variation. The scree plot indicated factor options of potentially 3 to 6 factors, explaining 38.3 to 52.0% of the variation. Finally, the Parallel Analysis suggested 3 factors. Extracting too few factors and too many factors is considered problematic (Costello & Osborne, 2005). As such, each factor solution (3 – 9 factors) was run using Principal Component Analysis (PCA) with both an orthogonal (Varimax) or oblique (Oblimin, Delta 0) rotation to determine best fit (Costello & Osborne, 2005).

The factor structures provided with the 30 items did not produce meaningful factors, and the correlation matrix was consulted to assist with organizing the data and determining trends among the items. The correlation matrix (see Table 3-2) revealed that items 8 and 31, which were previously shown to reduce Cronbach's alpha, do not correlate well with the majority of the items. As a result, these items were deleted from the analysis and the factor analysis was rerun with 28 items. The final solution of four factors explained 44.4% of the variance.

The factor loadings for the 4 factors are listed in Table 3-3. Item loadings greater than or equal to 0.4 were selected and are considered sufficient given the exploratory purpose of this work (Ismail, 2008). One item did not load on any of the four factors (item 6). Cross-loadings, identified as items having more than one loading greater than 0.4 (found in six of the items: 3, 5, 13, 24, 25, and 30), were evaluated for best theoretical fit according to the items within each factor. All remaining items (27) demonstrated significant correlations between the factor-items (except for items 13 and 15). Based on the item loadings, the factor titles selected were Activity, Exploration, Motivation, and Adaptability.

Table 3-4. Correlation matrix for items according to factor structure for the Infant Characteristics Questionnaire.



		Factor 1												Factor 2										Factor 3										Factor 4										**		
		1	2	3	4	5	11	12	15	29	32	9	14	18	20	25	28	16	17	21	22	23	30	7	13	24	27	33	6	8	31
Factor 1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	.36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3	.27	.53	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4	.38	.40	.38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	.29	.43	.46	.36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	11	.23	.53	.27	.25	.37	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	12	.31	.37	.37	.43	.33	.33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	15	.10	.24	.12	.26	.20	.32	.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	29	.26	.46	.36	.35	.36	.48	.30	.32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	32	.17	.18	.23	.28	.17	.24	.19	.20	.16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Factor 2	9	.19	.31	.37	.38	.29	.36	.36	.25	.39	.13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	14	.22	.34	.31	.48	.30	.30	.42	.26	.34	.26	.37	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	18	.16	.26	.25	.31	.21	.16	.25	.11	.23	.03	.39	.36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	20	.20	.19	.06	.34	.16	.14	.23	.12	.13	.12	.25	.22	.24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	25	.15	.23	.26	.38	.26	.26	.30	.09	.18	.17	.29	.50	.39	.26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	28	.17	.24	.18	.31	.24	.22	.36	.14	.29	.07	.31	.39	.43	.22	.32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Factor 3	16	.23	.35	.31	.46	.22	.28	.48	.19	.29	.17	.27	.47	.22	.23	.40	.37	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	17	.01	.29	.25	.33	.10	.16	.21	.12	.20	.12	.24	.34	.20	.11	.36	.19	.50	-	-	-	-	-	-	-	-	-	-	-	-	-
	21	.25	.36	.24	.33	.25	.23	.29	.14	.27	.08	.23	.37	.21	.23	.35	.29	.50	.30	-	-	-	-	-	-	-	-	-	-	-	-
	22	.19	.36	.28	.31	.15	.20	.27	.20	.32	.12	.17	.35	.22	.14	.30	.22	.42	.32	.41	-	-	-	-	-	-	-	-	-	-	-
	23	.17	.17	.23	.35	.17	.21	.34	.20	.22	.24	.26	.30	.25	.21	.33	.32	.37	.22	.50	.41	-	-	-	-	-	-	-	-	-	-
	30	.24	.32	.47	.38	.36	.30	.39	.22	.50	.18	.46	.41	.35	.14	.44	.36	.33	.33	.33	.33	.38	-	-	-	-	-	-	-	-	-
Factor 4	7	.14	.14	.15	.12	.13	.12	.12	.11	.14	.01	.12	.21	.00	.03	.15	.13	.14	.09	.11	.04	.08	.24	-	-	-	-	-	-	-	-
	13	.10	.14	.07	.25	.28	.20	.29	.16	.14	.17	.16	.45	.19	.26	.28	.33	.30	.21	.17	.19	.29	.21	.28	-	-	-	-	-	-	-
	24	.09	.16	.18	.19	.14	.12	.10	.07	.16	.04	.04	.27	.25	.07	.38	.20	.27	.22	.31	.28	.24	.23	.24	.20	-	-	-	-	-	-
	27	.04	.04	.05	.03	.05	.00	.01	.13	.08	.01	.09	.09	.07	.06	.16	.13	.06	.12	.00	.03	.01	.01	.22	.08	.25	-	-	-	-	-
	33	.07	.03	.05	.16	.10	.04	.06	.05	.05	.00	.03	.17	.04	.02	.11	.05	.23	.12	.10	.03	.01	.03	.20	.16	.24	.21	-	-	-	-
**	6	.10	.03	.08	.16	.11	.15	.28	.20	.06	.22	.19	.06	.07	.12	.11	.11	.13	.00	.08	.02	.20	.03	.02	.06	.02	.02	.05	-	-	-
	8	.02	.13	.12	.10	.02	.06	.05	.05	.07	.05	.01	.03	.05	.02	.03	.05	.06	.04	.02	.01	.02	.10	.55	.11	.14	.21	.17	.12	-	-
	31	.13	.21	.15	.08	.17	.13	.15	.12	.19	.05	.06	.12	.07	.06	.05	.09	.03	.06	.04	.22	.09	.07	.06	.01	.10	.10	.34	.08	.00	-

Factor 1 = Activity; Factor 2 = Exploration; Factor 3 = Motivation; Factor 4 = Adaptability

Table 3-3. Factor solution for ICQ items following Principal Component Analysis and a Varimax rotation.

Content Item	*Factor Loading*			
	f1	*f2*	*f3*	*f4*
1. Move around in one position	**0.60**	0.04	0.08	0.00
2. Test limits of balance in one position	**0.63**	0.08	0.40	0.03
3. Grasp objects out of reach	**0.45**	0.17	0.42	-0.20
4. Active participant during play	**0.52**	0.30	0.38	0.12
5. Complete activities that s/he has started	**0.52**	0.43	0.01	0.09
6. Accept changes in place or position	0.34	0.17	-0.11	-0.03
7. Initial reaction to new/unfamiliar situation is reservation	0.21	-0.01	0.08	**0.56**
9. Prefer to explore physically	0.33	**0.62**	0.10	-0.02
11. Try new behaviours on his/her own	**0.62**	0.18	0.19	0.08
12. Explore body using variety of strategies	**0.53**	0.27	0.33	0.09
13. Adapt movements to situation	0.11	0.41	0.07	**0.52**
14. Change behaviour to solve problem	0.30	**0.49**	0.39	0.28
15. Tolerate a variety of positions	**0.43**	0.10	0.10	-0.01
16. Demonstrate awareness of effects of own behaviour	0.28	0.16	**0.64**	0.25
17. Anticipate events	0.02	0.13	**0.61**	0.15
18. Greet new toy with eagerness	0.04	**0.74**	0.28	-0.16
20. Get included when others are playing	0.13	**0.52**	-0.02	0.18
21. Get excited when s/he figures something out	0.19	0.10	**0.65**	0.07
22. Express delight in self-initiated body movement	0.21	-0.03	**0.75**	-0.03
23. Express delight in sensory exploration	0.13	0.21	**0.57**	-0.01
24. Get frustrated when cannot do something	-0.06	0.14	0.47	**0.43**
25. Balance independent behaviour with dependence on adults	0.08	**0.54**	0.45	0.22
27. Ignore voices/sounds when playing	-0.01	0.10	-0.05	**0.61**
28. Explore all parts of a new toy	0.16	**0.59**	0.24	0.11
29. Persistent when trying new activity/skill	**0.62**	0.14	0.33	-0.01
30. Try tasks even when difficult	0.24	0.43	**0.48**	-0.02
32. Quickly recover after stressful situations	**0.46**	-0.02	0.03	0.17
33. Give up on tasks when playing with adults	-0.05	-0.02	0.17	**0.67**
Total number of loadings	10	6	6	5

The factor title and item summary can be found in Table 4. In addition, the final version (including formatting) can be found in Appendix 3-F.

Table 3-4. Factor Analyzed Infant Characteristics Questionnaire. *The number in parentheses indicates the item number as previously identified in the factor analysis solution.*

Factor 1: Activity
1. Does your infant move around (for example, waving arms, kicking legs, shifting weight around, etc.) while in one position? (1)
2. Does your infant test his or her limits of balance while in one position? (2)
3. Does your infant try to grasp objects that are out of reach? (3)
4. Is your infant an active participant during play with you or others? (4)
5. Does your infant complete activities that he or she has started? (5)
6. Does your infant try new behaviours on his or her own? (11)
7. Does your infant explore his or her own body or objects using a variety of strategies? (12)
8. Does your infant tolerate being in a variety of positions? (15)
9. Is your infant persistent when trying a new activity or skill? (29)
10. Does your infant quickly recover after stressful situations? (32)
Factor 2: Exploration
11. Does your infant prefer to explore new surroundings or toys physically? (9)
12. Does your infant change behaviour or try something new when necessary to solve a problem or achieve a goal? (14)
13. Does your infant greet a *new* toy with eagerness? (18)
14. Does your infant try to get included when others are playing or initiate play with others? (20)
15. Does your infant balance independent behaviour with necessary dependence on adults to accomplish tasks? (25)
16. Does your infant explore all or most parts of a *new* object or toy before doing something else? (28)
Factor 3: Awareness and Enjoyment
17. Does your infant demonstrate awareness that his or her own behaviour has an effect on people or objects? (16)
18. Does your infant anticipate events? (17)
19. Does your infant get excited when he or she figures something out? (21)
20. Does your infant express delight or happiness in self-initiated body movement? (22)
21. Does your infant express delight or happiness in sensory exploration? (23)
22. Does your infant try tasks even when they are difficult? (30)
Factor 4: Adaptability
23. Is your infant's initial reaction to a new or unfamiliar situation reservation? (7)
24. Does your infant adapt his or her movements for different situations? (13)
25. Does your infant get frustrated or discouraged when he or she cannot do something? (24)
26. Does your infant ignore voices or other ordinary sounds when playing with a favourite toy? (27)
27. Does your infant give up on tasks when playing with or being assisted by adults? (33)

Reliability Testing

Test-Retest reliability

The test-retest intraclass correlation coefficients (ICCs) for each factor and the total score can be found in Table 3-5. The range found for the ICCs was 0.74 to 0.92. The difference between time 1 and time 2 was not significant for each factor ($p > 0.05$). Reliability for the entire measure was found to be 0.92 (CI 0.83 – 0.96).

Internal Consistency

Cronbach's alpha for each factor solution can also be found in Table 3-5. The Cronbach's alpha for the entire questionnaire (27 items) was 0.89 and the range for the four factors was 0.59 to 0.81.

Table 3-5. Test-retest reliability and Internal Consistency for ICQ Factors.

ICQ Factor	*Test-retest reliability ICC (95% confidence)*	*Internal Consistency Cronbach's Alpha*	*Number of items*
Factor 1: Activity	0.86 (0.72 – 0.93)	0.81	10
Factor 2: Exploration	0.92 (0.85 – 0.96)	0.76	6
Factor 3: Awareness and Enjoyment	0.84 (0.67 – 0.92)	0.78	6
Factor 4: Adaptability	0.74 (0.45 – 0.87)	0.59	5
Total ICQ	0.92 (0.83 – 0.96)	0.89	27

DISCUSSION

The Infant Characteristics Questionnaire (ICQ) was developed to address the lack of measures assessing unique infant traits that relate specifically to motor development. The multi-phase measurement development process, starting with a 75-item preliminary draft, resulted in a measure with 27 items and a 4-factor structure, each labelled as *Activity*, *Exploration*, *Awareness and Enjoyment*, and *Adaptability*. Each factor represents a characteristic that is thought to potentially facilitate early motor development. The ICQ

has the potential to serve as an educational tool for parents to raise awareness, as well as a clinical and research tool for clinicians and scientists.

Factor Structure of the ICQ

The exploratory factor analysis of the 27 items overall revealed a simple factor structure in which the majority of items (except for six items) loaded strongly on one factor, easing the interpretation of factor structure. Oblique factor analyses revealed that the factors are mildly correlated with one another, demonstrating that the extracted factors represent independent constructs, each explaining a separate part of the infant's character. The measure revealed an overall internal consistency of 0.89, and a test-retest reliability of 0.92 (CI 0.83 – 0.96). This value indicates that the chosen items do effectively work together to represent infant characteristics.

Activity

The first factor consists of 10 items with the majority of items addressing the level of activity an infant displays in a general sense. How the infant actively engages him or herself to move is emphasized in all questions. The purpose is to discriminate infants who are generally active compared to those who are more passive in regards to movement. The high internal consistency of 0.82 and high test-retest reliability of 0.86 suggest that the items are appropriately factored together and stable over time.

Exploration

The second factor consists of 6 items and contains items that relate to exploring new objects, or situations, as well as a curiosity or initiative for trying different tasks. It also taps into flexibility of response, such as how an infant responds to a situation, even when the situation is difficult. Exploration is another concept linked to affordances, as an infant who is more exploratory is more likely to discover affordances in the environment that have the potential to facilitate development. The internal consistency of this factor is 0.76, which is acceptable, but does suggest revisions might be necessary to make the factor stronger. The test-retest reliability is high at 0.92, suggesting that an infant's level of exploration is very consistent over time.

Awareness and Enjoyment

The third factor consists of 6 items, addressing aspects of enjoyment, anticipation and awareness. From the literature surrounding play, research suggests that pleasure and excitement are important components linked to higher activity (Stagnitti, 2004). The concept of awareness is also linked to enjoyment, as an awareness of personal successes can lead to excitement. The items in this factor pertain to a child's awareness of their role relative to their surroundings (including toys, other people, or actions). The concept of affordances links perception to action and the idea of awareness is closely linked to perception. Thus, a child's level of awareness or perception will have an impact on their movement and potentially their developmental trajectory. The internal consistency is acceptable at 0.78. The test-retest reliability of 0.84 suggests sufficient stability over time in this factor.

Adaptability

The fourth factor consists of 5 items and taps into how an infant ultimately handles different or difficult situations. This factor also contains items that tap into persistence. A high level of persistence is suggestive of success and children who display persistence are more likely to be successful with movement. A child who is not easily discouraged is more likely to continue attempts at walking or crawling. The internal consistency of this item is 0.59, which is low and suggests changes might be necessary to make this factor appropriate for clinical or research use. The test-retest reliability is moderate and suggests that the factor is sufficiently stable (Baumgartner & Jackson, 1999).

Adequacy of Sample Size

An important initial consideration when interpreting the value of a given factor solution is the sample size. According to MacCallum and colleagues (1999), a post hoc judgement about the adequacy of sample size should consider the values of communalities, number of items per factor, and the ratio of sample size to number of items in the entire measure. For this study, the ratio was 7.7 (27 items and 207 subjects). This ratio in this study is greater than the suggested minimum ratio of 5 (Gorsuch, 1983).The communalities were in the moderate range, and the number of items in each

factor ranged from three to 8. Taken together, these results suggest a sufficient solution. In other literature, a sample size of about 200 participants represents a fair sample (Comrey & Lee, 1992).

The ICQ and Existing Measures

The ICQ was originally developed from pooling items from the Carey Temperament Scale (CTS; Carey & McDevitt, 1977), Dimensions of Mastery Questionnaire (DMQ; Morgan et al., 2005), and the Early Coping Inventory (ECI; Zeitlin et al., 1988). The CTS emphasizes personality and temperament, the DMQ highlights the role of exploration and motivation, and the ECI focuses on adaptive behaviour. Moreover, these measures are used to assess infant characteristics in a general sense, by tapping into many developmental domains. As such, the ICQ can be a beneficial contribution, as it taps into all of the separate constructs presented in previous measures, while also tailoring items to relate specifically to motor development for a population of infants aged 4 to 10 months.

Clinical Relevance and Implications

In this study, the ICQ was completed by a sample of parents with infants, the majority of whom were born full term. Understanding how infant characteristics can influence early motor development in a population of full term infants is informative. Parent-completed reports provide opportunities for parents to observe their children in a structured way, which can be both educational and useful in integrating a child within a particular home environment. Parents might notice characteristics that were previously overlooked. The ultimate goal is to use this measure with a population of infants who are at risk for developmental delays. Play sessions have been shown to increase children's level of activity, responsiveness and independence (Taneja et al., 2002). The ICQ has common elements with play and play has been suggested to be important for early development (Stagnitti, 2004), although links specifically to motor development are yet to be determined. Moreover, the literature is lacking in studies devoted to understanding the role that infant characteristics play in motor development, and this gap in the

literature is likely due to the lack of a specific and relevant measure. Given this gap, the ICQ is well suited to address this issue and be used as a research and clinical tool.

Considerations for the ICQ

The initial pilot testing of the ICQ involved both a parent-completed version and an independent assessor-completed version. The results of the pilot study demonstrated difficulties in completing an independent assessment of infant characteristics in such a limited time. Thus, it was decided to develop the ICQ as a parent-completed report, which is the current format of the CTS, ECI and DMQ as well. Moreover, one of the purposes of the measure is to increase parental awareness of certain infant characteristics and the potential role they might play as a facilitator or hindrance to early motor development.

An area of concern in parental-reports is the issue of biased reporting. Previous studies have demonstrated that parental reports are accurate in a motor development context (Bodnarchuk & Eaton, 2004), although it is beneficial to provide guidelines for parents when completing the measure. The DMQ requires parents to observe a 45-minute play session, although this limited time interval might present problems when answering certain questions (for example, if certain behaviours are not observed). It might be of value to suggest parents review the questionnaire, observe their infant for a week (or another shorter time interval), and then complete the questionnaire based on their observations. During early pilot interviews with parents, many commented that they 'felt' their child would respond in a certain manner in particular situations. Moreover, some parents described that easier questions were often based on their ability to draw examples from memory. Thus, providing an opportunity to review the questionnaire can direct parent's attention to particular traits, which can later be evaluated. The original version of 75 items took about 22 minutes to complete, suggesting that a 28-item questionnaire should take approximately 10 minutes (or less). Having parents review the questionnaire initially and fill it out later might not present a significant increase in respondent burden, which is an important consideration in parent-completed measures. Moreover, this might reduce the amount of missing data and parents selecting 'not applicable' when they feel they are not sure about their answer.

Limitations

The process of measurement development outlined in this chapter has some limitations. The focus of the measure was to identify key determinants of early motor development, and as a result, constructs potentially of interest might be missing from the measure. Although the initial survey of relevant measures served as a guide, it is still possible that the ICQ does not consider all key motor developmental determinants relating to infant characteristics. The purpose of the measure was to target the most important constructs. The final four factors mirror early work by focus groups (Doralp, unpublished data) as to what the key determinants are for infants in the age group under investigation.

The Likert scale was chosen based on what seemed reasonable according to similar measures regarding early development. A further limitation of this work is that other scales were not tested for feasibility or fit. The pilot work did suggest that some parents found the scales hard to interpret based on the questions provided. The measure was revised in order to account for this, although it is possible that further modifications might be necessary to address this issue.

The most significant limitation of the measure is the potential lack of sufficient items in each construct. The first three factors display adequate levels of internal consistency, but the final one demonstrates a low level of consistency. Given these results, it might be necessary to review items and develop more items targeting the final factor, adaptability. During initial item selection, the number of items per factor was not considered and as a result, poses as a limitation in the final analysis.

A final limitation pertains specifically to the test-retest reliability. Upon initial recruitment, parents were provided the ICQ to fill out, and were subsequently contacted to set up the assessment session. The ICQ was collected at the assessment and parents participating in the test-retest reliability were provided with another ICQ form to fill out within a maximum of one week. Many parents did not fill out the date on the original ICQ, and as such, there is not sufficient data to estimate the average interval between assessments. Infant characteristics appear to be fairly consistent over time, although this is also undetermined. Future reliability studies will be necessary to satisfy the reliability requirement for testing the ICQ.

Conclusions

At present, the ICQ is the first measure targeted to evaluating infant characteristics as they relate specifically to motor development. The initial item selection process and factor analysis have revealed four key factors (*Activity*, *Exploration*, *Motivation*, and *Adaptability*) that are supported by the motor development literature. Preliminary reliability analyses are promising, but suggestive of more work needed to fine tune items within the key constructs; nonetheless, the ICQ is adequate for use in its current form. Linking the ICQ to motor outcome is a necessary next step in validating the measure as a tool for use in both research and clinical settings. The ICQ has the potential to be a valuable tool in the field of early motor development, both for infants born full term, and those at risk for developmental delay, including infants born preterm and infants with identified impairments affecting early motor development. Early motor development is a complex and highly variable phenomenon involving a multitude of influences, and the ICQ presents an exciting opportunity to investigate the role of these infant characteristics in motor outcome and their potential utility in planning effective therapeutic interventions.

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CHAPTER 4

Testing a Conceptual Model of Early Motor Development

INTRODUCTION

Early motor development is a complex process that is influenced by a host of variables. The first year of life is characterized by a critical transition whereby infants progress from being passive in their environments to a point where infants are active participants in their environment. Moreover, the initial year sets the stage for later motor performance, and as such, is critical for understanding how infants can get off to a promising start. The inherent inter- and intra-individual variability during this time of incomparable growth makes the study of early motor development difficult and challenging. The purpose of this chapter is to describe the testing of a conceptual model of early motor development that captures the theoretical framework embodied by the Dynamic Systems Theory (described in detail in chapter one). Understanding which factors have the potential to shift early trajectories can lead to uncovering possible sources of interventions for infants who are not developing typically. Early research has reported evidence that suggests that beyond the first 2 months of age, factors other than biology play an important role in influencing motor outcomes (Dennis & Najarian, 1957; Solomons & Solomons, 1975). As such, the first year of life is an ideal time for investigating the influence of various factors on motor outcome.

Interestingly, few studies have investigated the role of these factors in early motor development. A review conducted by The National Research Council and Institute of Medicine alludes to the importance of the environment, although references to early motor development are not made in their summary of current research (Shonkoff, 2003). The importance of the environment has been mentioned as an important consideration in the literature; however, the role of infant characteristics has been largely ignored. Infant characteristics are considered in other developmental domains, such as social and emotional development, but no work exists examining the role of these factors in early motor development.

The Dynamic Systems Theory

The Dynamic Systems Theory (DST) was the first to fully consider the importance of external factors in influencing motor development. Emphasizing inter- and intra-individual variability, the DST captures the reality that motor development is complex and variable. Wimmers and colleagues (1998) state that "developmental processes are not smooth and monotonous, but can be characterized by phenomena such as discontinuities, transitions, instabilities, and regressions, which are characteristic of non-linear dynamical processes" (pg.45). As such, it is a "noisy" phenomenon (Thelen, 1990) characterized by ever-changing characteristics in each of the multiple subsystems that contribute to development.

One of the key concepts outlined by DST is the notion of transition, during which a child's motor abilities are more amenable to change (Darrah & Bartlett, 1995; Newell et al., 2003) indicating behavioural flexibility (Spencer & Schoner, 2003). This point of transition occurs early in childhood and is suggested to be variable among children (Thelen, 1990). The origin of later motor developmental outcomes of infants born preterm has been linked to infancy (Bartlett & Piper, 1993), which highlights that this transitional phase is critical for the timing of the implementation of interventions (Darrah & Bartlett, 1995).

Darrah and Bartlett (1995) discuss the role of rate-limiting factors and their influence on development during this phase. The DST considers biology, but emphasizes more so the role that contextual factors can play in facilitating or hindering developmental trajectories. Children are found to self-adapt and respond in a context-specific manner, which highlights the non-prescriptive nature of development and the importance of contextual factors in shaping behaviour.

Affordances: The Role of Infant Characteristics within the Home Environment

Gibson (1988) introduced the term affordances, which refers to what the environment offers, provides or furnishes for an infant. In addition to the role of the environment, affordances consider the impact of the infant's perception on their actions

within the given environment. Thus, an infant's innate capabilities and characteristics, such as their motivation or exploratory behaviour, can influence how an infant learns or perceives affordances within the home environment.

The home environment consists of both the physical space and parental influences. Early evidence exists for the role of parental influences, through caregiving practices, on motor development (Lee, 1980; Schabel-Dickey, 1987) and cross- and intra-cultural studies of motor precocity link particular handling techniques to specific motor advancement (Hopkins and Westra, 1988; Pridham et al., 2002; Solomons, 1978; Solomons & Solomons, 1975). In an effort to clarify the key caregiving practices that influence early motor development, Bartlett and Fanning (2004) developed the Daily Activities of Infants Scale (DAIS) which address the opportunities that parents provide their children for the development of antigravity postural control and movement exploration. Preliminary work indicates links to motor development in populations of preterm infants (Doralp & Bartlett, unpublished data). Contrary to this, little research exists on examining the role of the playspace or play environment, and further, no literature addresses the role of infant characteristics on motor development.

Until this point, theorists have made advances in the conceptualization of motor development by using a holistic framework, such as that offered by the DST. What is necessary is a thorough understanding of *how* these various factors, such as the infant and the environment, converge on motor developmental domains to synthesize a cohesive model of early motor development.

MODEL HYPOTHESES

The purpose of this chapter is to test a conceptual model of early motor development, using structural equation modeling, which considers the role of key contextual factors (infant characteristics and the home environment) in early motor development, as well as the potential mediating role of caregiving practices. A complex and stimulating environment is hypothesized to have a potentially facilitatory role in early motor development. Moreover, an infant who is characterized as having a high degree of motivation and exploratory behaviour is hypothesized to be at an advantage and

score higher on measures of developmental outcome. Caregiving practices that result in greater opportunities for infants are hypothesized to result in better performance on outcome measures. Moreover, caregiving practices, such as those contained in the higher levels of the DAIS (Bartlett et al., 2008), have the potential to mediate the environmental and infant factors. Taken together, it is hypothesized that the environment, infant characteristics, and caregiving practices will be associated with early motor development and will therefore have the potential to facilitate early motor acquisition.

METHODS

Ethical Considerations

Approval for this study was obtained from The University of Western Ontario Health Sciences Research Ethics Board (HSREB; #13370E; Appendix 2-F). Information regarding the study was made available to parents attending the Ontario Early Years Centres (OEYC). Flyers (Appendix 2-G) were posted at three centres located in London, Ontario. Parents who expressed interest in participating were provided with a letter of information and consent form (Appendix 2-H).

Participants

Parents who were fluent in English with full-term infants between the ages of 4 and 10 months of age were recruited from the Ontario Early Years Centres (OEYC) from July 2007 to February 2009. A total of 253 parents and their infants were recruited and from this sample, 207 parents completed the study[1]. This cross-sectional sample consisted of 112 boys (54.1% of sub-sample) and 95 girls (45.9% of sample). Overall, the age of infant participants was 7.1 months (SD 1.8, range 3.2 – 10.9). The average birthweight and gestational age were 3415 grams (SD 421, range 1185 – 4791) and 39.6 weeks (SD 1.5, range 33 – 43), respectively. Infants who were just outside of the age range of interest were included in the analysis, as well as one infant with a GA less than

[1] This sample is the same outlined in phase III of chapters two and three. Details regarding participant attrition can be found in Figure 2-1 in chapter two or Figure 3-1 in chapter three.

34 weeks (Note: This infant was just over 7 months at the time of the assessment). Of the sample of 207 infants, 102 (49.3% of subsample) did not have any health problems. The remaining 105 infants (50.7%) did experience some form of health concerns (such as problems with feeding, digestion, sleeping or skin problems), although the extent to which the health problem affected the infant's daily activities was rated on average 1.1 (SD 1.5, range 0-6) on a scale of 0 to 6 (0 = not at all; 6 = to a very great extent). Detailed characteristics of the infant sample can be found in Table 4-1. Demographic information of the parents and the children can be found in Table 4-2.

Table 4-1. Characteristics of infants across age groups.

Characteristic	*Age, months*							
	< 4	***>4-5***	***>5-6***	***>6-7***	***>7-8***	***>8-9***	***>9-10***	***10+***
	n=3	*n=30*	*n=35*	*n=31*	*n=35*	*n=35*	*n=24*	*n=14*
Sex								
Boys	2	14	19	14	21	17	17	8
Girls	1	16	16	17	14	18	7	6
Age (months)								
mean	3.3	4.7	5.5	6.4	7.5	8.5	9.6	10.2
(SD)	(0.2)	(0.2)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)
GA (wks)								
mean	36.0	39.9	39.0	40.0	39.7	39.4	39.8	39.7
(SD)	(0.0)	(1.0)	(2.0)	(1.0)	(1.0)	(1.9)	(0.9)	(1.1)
BW(g)								
mean	2797	3538	3346	3545	3439	3238	3388	3578
(SD)	(298)	(471)	(612)	(461)	(491)	(664)	(515)	(462)

(GA = Gestational Age; BW = Birth weight)

Table 4-2. Parental demographic information for the study sample.

Demographic Variables	n (%) or mean (SD, range)
Parent Gender	
Mothers	207 (100%)
Fathers	0 (0%)
Relationship	
Married/living with partner	203 (98%)
Separated/not married	4 (2%)
Parent Age	30.9 (SD 4.1, range 18 – 44)
Education	
Less than high school	1 (0.5%)
High school	10 (4.8%)
Community College	72 (34.8%)
Bachelor's degree	77 (37.2%)
Post-graduate degree	26 (12.6%)
Professional or Clinical degree	21 (10.1%)
Ethnicity	
African American or Black	1 (0.5%)
Asian or Pacific Islander	3 (1.4%)
Hispanic/Latino	0 (0%)
Native American	0 (0%)
White	184 (88.9%)
Bi-racial	16 (7.8%)
Other	3 (1.4%)
Number of additional children in home	
0	148 (71.5%)
1	49 (23.7%)
2	10 (4.8%)
Number of adults in home (additional to parents)	
0	198 (95.7%)
1	8 (3.8%)
2	1 (0.5%)
Annual Family Income	
Less than 15,000	1 (0.5%)
15,000 to 29,000	4 (1.9%)
30,000 to 44,999	10 (4.8%)
45,000 to 59,999	20 (9.7%)
60,000 to 74,999	34 (16.4%)
75,000 or more	129 (62.3%)
Missing (did not respond)	9 (4.4%)

Missing Data

Missing data were handled using listwise deletion. Although this is not the best method of handling missing data, only 17 participants were removed from the original sample of 207 participants. The Mahalanobis distance was used to identify outliers for the entire data set, and an additional case was removed. In total, this represents 8.7% of the sample. The final sample, consisting of 189 participants, did not differ significantly from the original sample on sex, age, gestational age, and birth weight. Table 4-3 highlights descriptive information for the final sample and the removed subset.

Table 4-3. Comparison of final sample of participants to the sample of participants who were removed due to missing data.

	Final Participant Sample n = 189 *(SD, range)*	Participants with Missing Data n = 18 *(SD, range)*
Sex		
Boys	102 (54.0%)	10 (55.6%)
Girls	87 (46.0%)	8 (44.4%)
Age (months)	7.1 (1.8, 3.2 – 10.8)	7.1 (2.0, 4.4 – 10.9)
GA (weeks)	39.6 (1.5, 33 – 43)	39.4 (1.4, 36 – 41)
BW	3401 (550, 1185 – 4791)	3563 (483, 2835 – 4479)

(GA = Gestational Age; BW = Birth weight)

A key assumption for conducting SEM analyses is that the variables are normally distributed. Skewness and kurtosis statistics for all variables indicated no serious deviations from normality.

Measures

Environmental Opportunities Questionnaire

The Environmental Opportunities Questionnaire (described in chapter two) was developed to assess aspects of the immediate environment and comprised *Opportunities in the Playspace*, *Sensory Variety*, and *Parental Encouragement*. Items are presented in a Likert 5-point scale, where the numbers 1-5 indicate varying degrees of the extent to which an item represents the infant's environment (5 = to a great extent; 4 = to a

moderate extent; 3 = to a fair extent; 2 = to a small extent; 1 = not at all), and '0' represents 'not applicable'. Parents are asked in an interview format to answer questions accordingly. The excellent test-retest reliability for the entire measure is 0.92 (95% CI 0.84 – 0.96), with a range of 0.83 to 0.95 for the individual factors. The internal consistency was adequate at 0.79, with a wide range of 0.54 to 0.83 for the three factors.

Infant Characteristics Questionnaire

The Infant Characteristics Questionnaire (described in chapter three) was developed to assess aspects of the infant that are thought to potentially facilitate early motor development. The measure is comprised of the factors *Activity*, *Awareness and Enjoyment*, *Exploration*, and *Adaptability*. Items are also presented in a 5-point Likert scale, with the numbers 1-5 indicating varying degrees of extent (5 = to a great extent; 4 = to a moderate extent; 3 = to a fair extent; 2 = to a small extent; 1 = not at all), and '0' representing 'not applicable'. Parents are asked to complete the report based on the recent performance of their infant. Test-retest reliability was found to be excellent at 0.92 (95% CI 0.83 – 0.96), with a range of 0.74 to 0.92 for the separate factors. Internal consistency for the overall measure was high at 0.89 and ranged from 0.59 to 0.81 for the four factors.

Daily Activities of Infants Scale

The Daily Activities of Infants Scale (DAIS; Bartlett & Fanning, 2004) was used to assess the opportunities parents provide for their infants for the development of antigravity postural control and movement exploration. Over a 24-hour period, parents are asked to report on the predominant activity for each 15-minute block of time. The activity dimensions include feeding, bathing, dressing, carrying, quiet play, active play, outings, and sleeping. Each dimension is further divided into a three-point scale, with 'A' indicating the least opportunity and 'C' representing the most opportunity. A total score for the DAIS is calculated by summing the weighted scores for each subscale of the measure (weighted as A = 1, B= 2, and C = 3). Reliability for this measure is sufficient and determined to be 0.76 (95% CI 0.60 – 0.86) for inter-rater and 0.77 (95% CI 0.60 – 0.87) for test-retest reliability (Bartlett et al., 2008). The DAIS also demonstrates validity

with a part-correlation of 0.20 ($p < 0.01$) with scores on the Alberta Infant Motor Scale (AIMS; Piper & Darrah, 1994; Bartlett et al., 2008), when controlling for age.

The DAIS was incorporated into the conceptual model as a mediator (Baron & Kenny, 1986), as it is hypothesized to be dependent on both the infant and the parent. In order for this relationship to be accurate, four conditions must be met. A significant relationship must exist between the independent and dependent variable, between the independent variable and the mediator, and between the mediator and the dependent variable. Finally, when indirect pathways between the independent, mediator and dependent variables are controlled, the relationship between the independent and dependent must be reduced or equal to zero (Baron & Kenny, 1986).

Alberta Infant Motor Scale

Early motor development was measured using the Alberta Infant Motor Scale (AIMS; Piper & Darrah, 1994). The AIMS is a reliable and valid, norm-referenced, observational assessment that evaluates motor developmental sequences in the prone, supine, sitting and standing positions. It was constructed to evaluate the motor development of infants from birth through 18 months of age. Infants are evaluated on weight bearing, posture, and antigravity movement in a series of positions. Infants are credited with items that are observed during a session. Four subscale scores and a total score are calculated, which are converted to a percentile rank according to the infant's age.

The AIMS demonstrates excellent reliability with Pearson's correlation coefficients for a single occasion of 0.97 (SE 1.48) for infants 4 to 7 months and 0.98 (SE 1.11) for infants 8 to 11 months of age. Concurrent validity with the Peabody Developmental Motor Scales' gross motor raw scores and Bayley Scales of Infant Development raw scores were 0.98 and 0.93, respectively for infants 4 to 8 months of age, and 0.94 and 0.85 for infants 8 to 13 months of age. Criterion testing was completed to ensure that the primary assessor (SD) met a gold standard of evaluation (DB)[2]. The average percentage agreement was 87%, with a range of 85% to 90%.

[2] A selection of assessments (n = 4) were videotaped. The assessment completed by DB based on the videos was used as the gold standard to test the scoring credibility of the primary assessor (SD). Agreement

Data Collection Procedures

Parents were provided with a package containing the ICQ, DAIS, and a demographic questionnaire. Following completion of the package, a follow-up meeting was set up during which the infant's motor development was assessed and the EOQ was completed via parent interview. The aim was to assess all infants within one month of completing the questionnaire package. The mean interval was 12.2 days (SD 11.7, range 0 - 67 days[3]).

Preliminary Analysis of Study Measures

During the phase of measurement development (see chapters two and three), the EOQ and ICQ were initially factor analyzed using exploratory Principal Components Analysis with varimax rotation. This process identified sub-scales within the larger measure, which were used as latent endogenous constructs in the larger model. An item loading of 0.40 was considered sufficient for this preliminary step.

At this point, a confirmatory factor analysis (CFA) was conducted to ensure a solid factor structure and to determine overall fit of the proposed factor structure. The number of items in each factor was reduced to four items for both methodological and theoretical purposes. In terms of SEM, three indicators are known to be sufficient to capture the underlying construct (Kline, 2005). In addition, simpler models are more amenable to analysis given medium sample sizes (in the range of 100 – 200 cases; Kline, 2005). Furthermore, this allows for the trimming of items that do not capture the conceptualization of the given factor. Items that were deemed most theoretically relevant to the factor were flagged to be kept in the final factor solution. Following this, the EOQ and ICQ were tested independently. The schematic of the CFA model for the two measures can be found in Figure 4-1.

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was not calculated using total score, but the window of scored items, plus or minus two. The infants were 4, 6, 7, and 8 months of age.

[3] One parent was assessed 67 days after the package was listed as being completed, although during the assessment, the parent made changes to the questionnaire package accordingly. Disregarding this value, the maximum was 42 days.

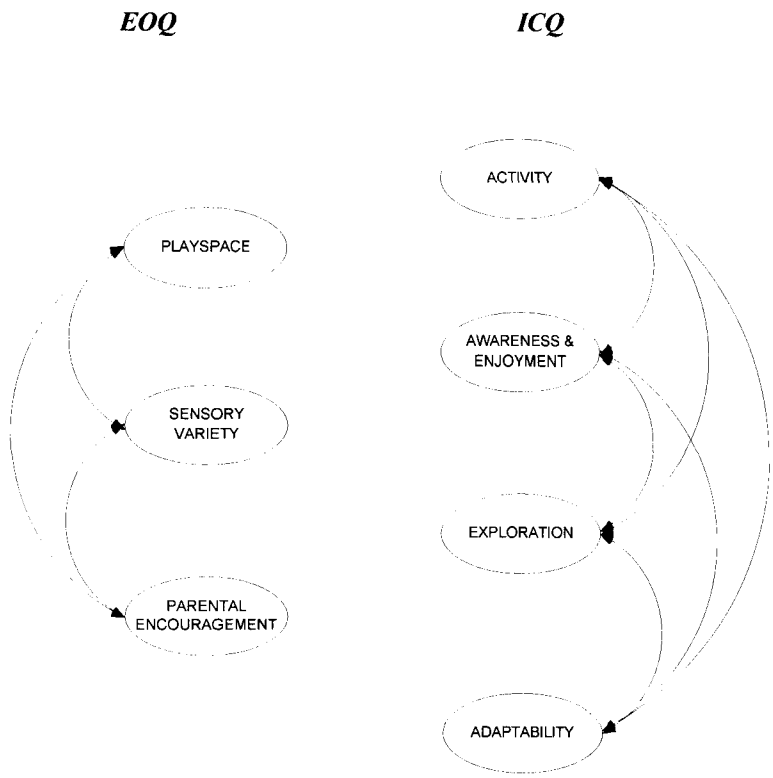

Figure 4-1. Schematic diagrams of the confirmatory factor analysis models used to test the factor structure of the Environmental Opportunities Questionnaire (EOQ) and Infant Characteristics Questionnaire (ICQ).

Testing the Conceptual Model

The conceptual model is comprised of a set of environmental factors, indicated by the EOQ, infant characteristics measured by the ICQ, and the AIMS as the outcome measure for early motor development. The DAIS is modeled as a mediator between the factors of the EOQ, ICQ, and motor development. A detailed outline of this model can be found in Figure 4-2.

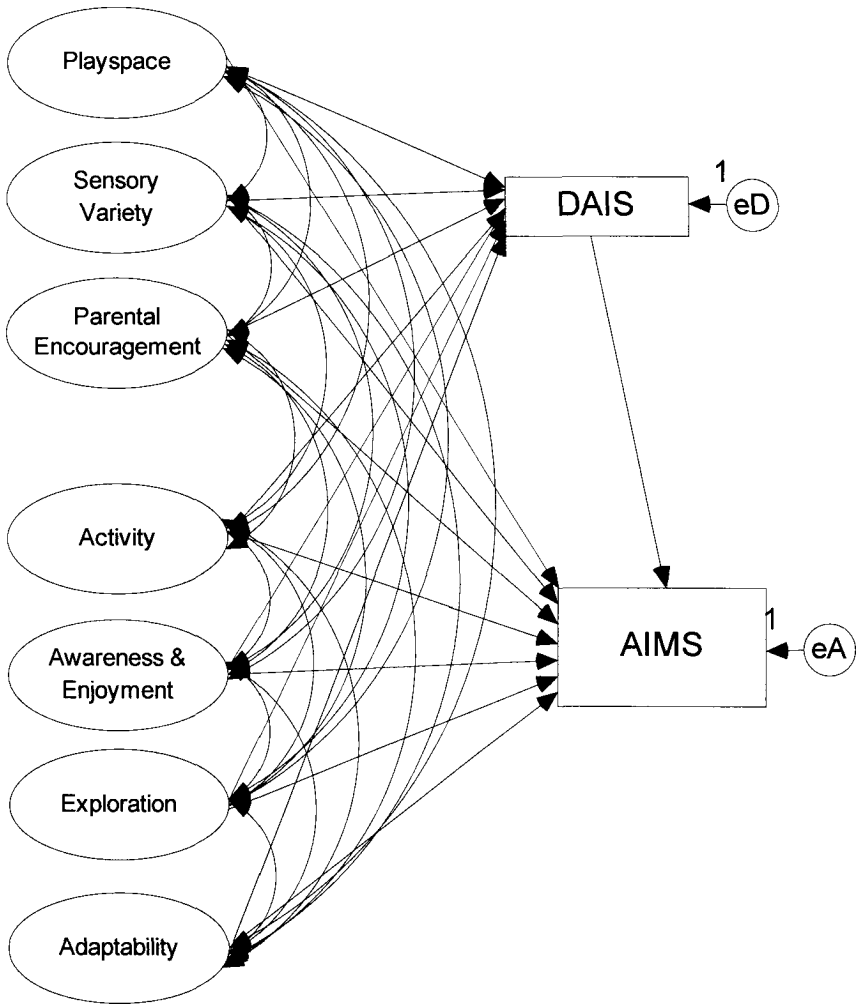

Figure 4-2. Measurement model with motor development as the outcome of interest and the Daily Activities of Infants Scale as a mediating variable for both environmental and infant characteristics. *Ellipses represent unobserved endogenous constructs. Rectangles represent observed exogenous constructs. Circles represent measurement error associated with exogenous variables. DAIS = Daily Activities of Infants Scale; AIMS = Alberta Infant Motor Scale*

Analysis

Statistical analyses were conducted using SPSS 17.0 and AMOS 17.0. Structural equation modeling was chosen as it allows for models with mediating variables and accounts for measurement error, unlike standard regression (Hoyle, 1991).

The Maximum Likelihood procedure was used to estimate parameters in the model. Missing data were handled via listwise deletion. Model fit was determined using a variety of fit indices. The Chi-square was considered, but given its sensitivity to sample size, was not used to reject the model (Hox & Bechger, 2000). The Tucker-Lewis Index (TLI; Tucker & Lewis, 1973), Incremental Fit Index (IFI; Bollen, 1989), Comparative Fit Index (CFI; Bentler & Bonnett, 1980), and the Root Mean Square Error of Approximation (RMSEA; Steiger, 1990) were used to determine fit. The TLI and CFI are suggested to have the best overall performance (Hox & Bechger, 2000) and use a scale from 0 to 1, with higher scores indicating higher levels of fit. Although values greater than 0.90 are considered acceptable (Bentler, 1990), a value of 0.95 is used to demonstrate a "good" fit of the model to the data (Hox & Bechger, 2000). The RMSEA provides an indication of how well a proposed model approximates the true model (Hox & Bechger, 2000) and adjusts for sample size and degrees of freedom (Browne & Cudeck, 1993). A value of 0 demonstrates a perfect fitting model and a value less than 0.05 indicates a good overall model fit. Results are interpreted to three decimal places as to not impute a high level of accuracy with model fit.

Statistical power, which is ideally greater than 0.80, is often estimated according to degrees of freedom (df) and sample size. The model outlined here contains 465 distinct sample moments. The number of distinct parameters to be estimated is 96, which results in a total of 369 df (465-96). Thus, the statistical power for a close fitting model with 100 df is 0.65 for a sample size of 100 and 0.96 for a sample size of 200 (Hancock & Freeman, 2001; MacCallum et al., 1996).

RESULTS

During the first phase, an initial confirmatory factor analysis (CFA) was performed on the EOQ and the ICQ measurement models at both the factor level and with the measure as a whole. As stated previously, the goal of this preliminary phase was to ensure that the factor structure of the measurement tools fit prior to linking both to the outcome of interest. Following this, the second phase involved testing the motor development conceptual model using the DAIS as a mediating variable.

Confirmatory Factor Analysis for the EOQ

The three factors, *Opportunities in the Playspace*, *Sensory Variety*, and *Parental Encouragement* were subjected to separate CFA. Item fit was determined by reviewing modification indices, factor loadings, although the focus was on evaluating theoretical relevance.

The *Opportunities in the Playspace* factor initially contained 7 items. The initial fit indices were high ($\chi^2 = 26.266$, df = 14, p = 0.024, IFI 0.985, TLI 0.977, CFI 0.985), although the RMSEA was only 0.068. The items 3 ("does it make you nervous when your baby engages in new activities"), 13 ("access to furniture for pulling up to standing"), and 21 ("baby's clothes interfere with movement") were deleted. Items 3 and 21 are negatively worded items and do not ideally fit with the theme of the factor, which is focused on the infant in the physical space of the home. Item 13 was removed as it severely decreased factor fit and item 16 ("access to furniture that permits climbing or stepping") which was retained was thought to potentially overlap.

The *Sensory Variety* factor initially also contained 7 factors. The initial fit indices were low ($\chi^2 = 30.863$, df = 14, p = 0.006, IFI 0.901, TLI 0.846, CFI 0.897, RMSEA 0.08) and multiple modifications were suggested. A modification to link the error terms between items 5 and 18 was suggested. These two items relate specifically to toys in the infant's environment and the change was made. The items 4 ("access to variety of stationary toys"), 9 ("encourage your baby to sit independently"), and 11 ("free to move in any space in the house") were deleted from the factor. Item 4 pertains to stationary toys which might be more relevant to fine motor development and demonstrated a low factor loading. Item 9 does not fit with the theme of the factor. Item 11 was found to lower the factor fit, and also, parents found this question difficult to answer.

For the final *Parental Encouragement* factor, the fit indices were initially low ($\chi^2 = 23.917$, df = 14, p = 0.047, IFI 0.884, TLI 0.811, CFI 0.874, RMSEA 0.061). A modification to add a link between the error terms for items 6 and 23 was suggested. These two items both specifically relate to development and this modification dramatically increased factor fit. Items 2 ("set aside a specific time to play"), 10 ("access

to well-suited space"), and 24 ("aware of what your baby wants to do") were deleted. These items lacked theoretical fit.

The changes that were made to each factor resulted in excellent fit indices, a summary of which can be found in Table 4-4. Although these fit indices are high, the power of the independent factor analyses is inherently low given the minimal degrees of freedom. For this reason, most of the decisions were based on theoretical fit.

Table 4-4. Summary of fit indices for each factor in the Environmental Opportunities Questionnaire following separate confirmatory factor analyes.

	Item	*Item Description*	*Parameter Estimate*	*Fit Indices*
Playspace	14	Access to furniture for stepping sideways	0.95	$\chi^2 = 0.366$ (df = 1), p = 0.833 IFI 1.00 TLI 1.00 CFI 1.00 RMSEA 0.00
	15	Furniture far apart to facilitate walking	0.95	
	16	Furniture for climbing or stepping	0.89	
	22	Baby barefoot in the house	0.25	
Sensory Variety	5	Access to variety of movement-related toys	0.54	$\chi^2 = 0.494$ (df = 1), p = 0.530 IFI 1.00 TLI 1.00 CFI 1.00 RMSEA 0.00
	12	Access to more than one type of floor texture	0.41	
	18	Toys accessible	0.60	
	20	Freedom to choose activity	0.57	
Parental Encouragement	6	Encourage activities or play	0.59	$\chi^2 = 0.707$ (df = 1), p = 0.401 IFI 1.00 TLI 1.00 CFI 1.00 RMSEA 0.00
	7	Alter involvement to suit baby's needs	0.38	
	19	Encourage challenging toys	0.43	
	23	Knowledgeable about motor development	0.63	

The overall EOQ contains 12 indicators (four per factor). The fit indices are good at $\chi^2 = 68.71$ (df = 49, p = 0.033), IFI 0.975, TLI 0.965, CFI 0.974, and RMSEA 0.046. The final model can be seen in Figure 4-3.

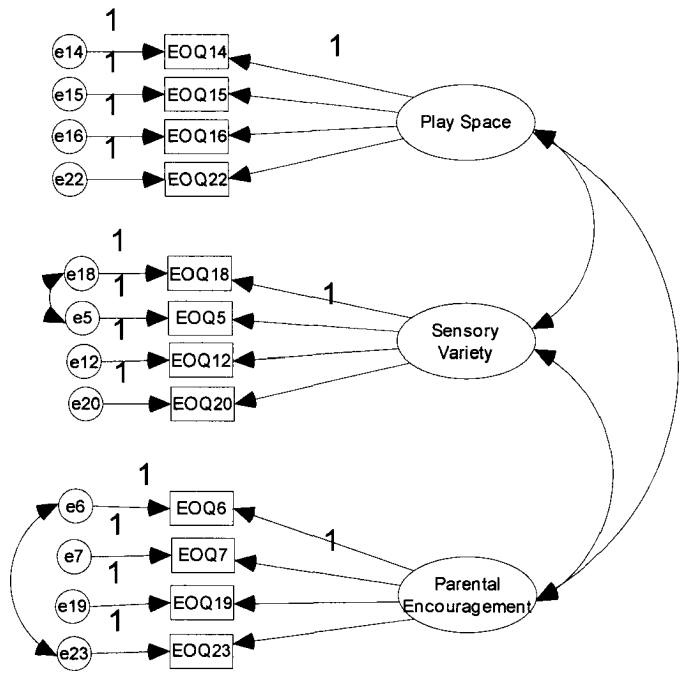

Figure 4-3. Confirmatory Factor Analysis result for the Environmental Opportunities Questionnaire indicating items and factor structure.

Confirmatory Factor Analysis for the ICQ

The four factors, *Activity, Awareness and Enjoyment*, *Exploration*, and *Adaptability* were subjected to separate confirmatory factor analyses and items were reviewed for fit based on conceptions of appropriateness, factor loadings, and modification indices.

The *Activity* factor originally comprised 10 items. The fit indices were low at values of $\chi^2 = 63.883$ (df = 35, p = 0.002,), IFI 0.940, TLI 0.922, CFI 0.939, and RMSEA 0.066. The modification indices indicated that the items 5 ("complete activities that he/she has started"), 11 ("try new behaviours on his/her own"), 29 ("persistent when trying a new activity"), and 32 (quickly recover after stressful situations") did not fit. Careful inspection of these items suggested that they might potentially belong to another unidentified latent factor, persistence, and were removed. At this point, this was not added as an additional factor in order to maintain model simplicity. Item 2 ("test limits of balance in one position") was eliminated due to the appearance of overlap with item one. Item 15 demonstrated a severe deviation from normality and was deleted.

The *Awareness and Enjoyment* factor was originally comprised of 6 items. The fit indices were moderate at $\chi^2 = 18.789$ (df = 9, p = 0.027,), IFI 0.963, TLI 0.937, CFI 0.962, and RMSEA 0.076. The RMSEA indicated that this factor model does not fit appropriately. A suggested modification was to link the error terms between items 16 and 17, which was considered appropriate given that both items relate to anticipation and awareness of surroundings. Item 23 ("delight in sensory exploration") was deleted due to the overlap with item 22 and item 30 ("infant try tasks even when they are difficult") did not fit with the theme of the factor.

The *Exploration* factor was composed of 6 items. These items together had good fit indices at $\chi^2 = 13.882$ (df = 9, p = 0.127,), IFI 0.980, TLI 0.966, CFI 0.979, and RMSEA of 0.054. The RMSEA indicates that the model is acceptable, but changes can be made for ensure a better fit. Item 9 ("prefer to explore new surroundings or toys physically") demonstrated theoretical overlap with item 28. Finally, item 18 ("greet a new toy with eagerness") did not provide a meaningful addition to the factor when the other items were considered. As such, these items were deleted and this enhanced the factor fit.

The final *Adaptability* factor consisted of 5 items. The original fit indices were $\chi^2 = 6.172$ (df = 5, p = 0.290,), IFI 0.983, TLI 0.963, CFI 0.982, and RMSEA 0.035. This indicates a well-fitting model. The item 13 was removed as it was the only positively worded item within the factor and was eliminated to allow for ease of interpretation of the factor.

All together, the changes resulted in excellent factor fit indices, a summary of which can be found in Table 4-5. Similar to the results of the EOQ, these fit indices are high. This is also due to the unavoidable low power resulting from minimal degrees of freedom, which is why the majority of decisions were based on theoretical fit.

Table 4-5. Summary of fit indices for each factor in Infant Characteristics Questionnaire following confirmatory factor analysis.

	Item	*Item Description*	*Parameter Estimate*	*Fit Indices*
Activity	1	Move around while in one position	0.52	$\chi^2 = 0.746$ (df = 2), p = 0.689 IFI 1.00 TLI 1.00 CFI 1.00 RMSEA 0.00
	3	Grasp objects that are out of reach	0.57	
	4	Active participant during play	0.77	
	12	Uses a variety of strategies	0.66	
Awareness and Enjoyment	16	Awareness that own behaviour effects people/objects	0.67	$\chi^2 = 1.116$ (df = 2), p = 0.291 IFI 0.999 TLI 0.996 CFI 0.999 RMSEA 0.025
	17	Anticipate events	0.45	
	21	Get excited when figure something out	0.72	
	22	Delight in self-initiated body movement	0.68	
Exploration	14	Change behaviour to solve a problem	0.77	$\chi^2 = 0.848$ (df = 2), p = 0.654 IFI 1.00 TLI 1.00 CFI 1.00 RMSEA 0.00
	20	Get included when others are playing	0.37	
	25	Balance dependence on adults to accomplish tasks	0.67	
	28	Explore all parts of a new object/toy	0.52	
Adaptability	7	Initial reaction to situation is reservation	0.39	$\chi^2 = 0.276$ (df = 2), p = 0.871 IFI 1.00 TLI 1.00 CFI 1.00 RMSEA 0.00
	24	Frustrated/discouraged when cannot do something	0.54	
	27	Ignore voices/sounds when playing	0.51	
	33	Give up on tasks when being assisted by adults	0.49	

For the ICQ as a whole, the fit indices were excellent at $\chi^2 = 100.486$ (df = 96, p = 0.357), IFI 0.993, TLI 0.991, CFI 0.993, and RMSEA 0.016. The final model can be found in Figure 4-4.

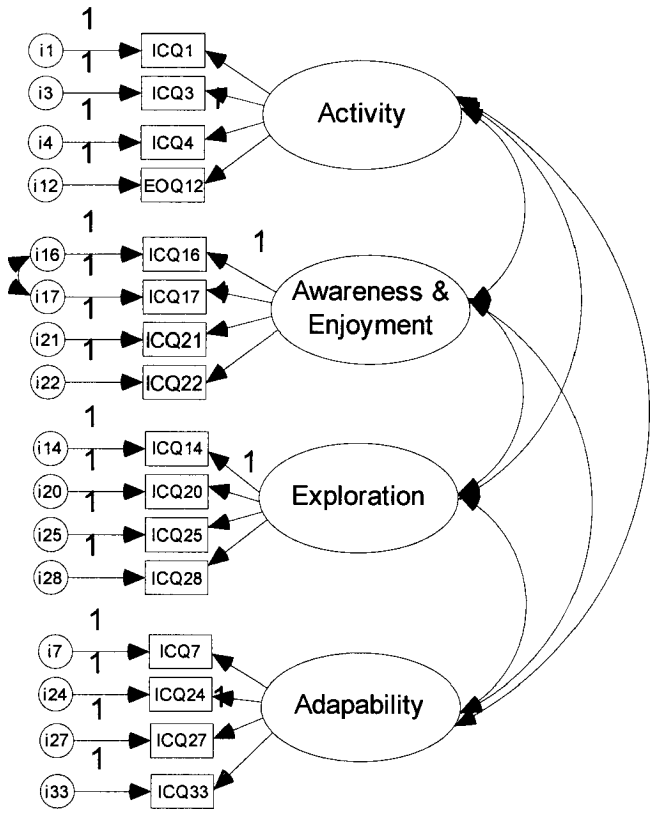

Figure 4-4. Confirmatory factor analysis result for Infant Characteristics Questionnaire indicating items and factor structure.

Testing the Conceptual Model of Motor Development

Variables of Interest

The conceptual model of motor development consists of the EOQ, ICQ, Daily Activities of Infants Scale (DAIS), and the outcome of interest, motor development which was measured using the Alberta Infant Motor Scale. The measurement components of the model are shown in Figure 4-2. The mean and standard deviations and correlation matrix can be found in Table 4-6 for each of the latent manifest variables.

Table 4-6. Means, standard deviations, ranges, and correlations among factors in the measurement model.

Factor	*M*	*SD*	*Range*	*Space*	*Sens*	*Parent*	*Act*	*Aw/En*	*Explor*	*Adapt*
Space	1.33	1.22	.25-4.75	-	-	-	-	-	-	-
Sens	3.80	0.73	1.75-5	0.49**	-	-	-	-	-	-
Parent	4.05	0.47	2.75-5	0.06	0.42*	-	-	-	-	-
Act	4.10	0.72	1.5-5	0.36**	0.79**	0.36**	-	-	-	-
Aw/En	2.98	1.10	0-5	0.42**	0.57**	0.25*	0.74**		-	-
Explor	3.04	0.94	.5-5	0.47**	0.63**	0.21	0.78**	0.76**	-	-
Adapt	2.66	0.78	.75-4.5	0.17	0.39*	0.07	0.37*	0.50**	0.58**	-

(M = mean; Space = Playspace; Sens = Sensory Variety; Parent = Parental Encouragement; Act = Activity; Aw/En = Awareness and Enjoyment; Explor = Exploration; Adapt = Adaptability)

Details regarding item loadings for each factor can be found in Table 4-7. This table contains unstandardized loadings (all of which were significant; $p < 0.01$), standard errors, standardized loadings, and the R^2 values.

The motor development scores, which were measured using the Alberta Infant Motor Scale (AIMS; Piper & Darrah, 1994), resulted in an average percentile rank of 39.29% (SD 25.9), which is below average. The range for the scores was 1.0 – 99.0%, demonstrating a wide range of abilities. The weighted scores for the DAIS had an average score of 128.7 (SD 24.4), with a range of 69 to 219.

Table 4-7. Measurement model details of each item within each factor.

		Unst. B	*SE*	*St. B*	R^2
	Opportunities in the Playspace				
14	Access to furniture for stepping sideways	4.66	1.31	0.95	0.91
15	Furniture far apart to facilitate walking	3.76	1.06	0.95	0.89
16	Furniture for climbing or stepping	3.47	0.98	0.89	0.80
22	Baby barefoot in the house	1.00	--	0.26	0.70
	Sensory Variety				
5	Access to variety of movement-related toys	1.17	0.31	0.45	0.20
12	Access to more than one type of floor texture	1.00	--	0.39	0.15
18	Toys accessible	1.02	0.25	0.52	0.27
20	Freedom to choose activity	2.15	0.47	0.68	0.46
	Parental Encouragement				
6	Encourage activities or play	0.62	0.19	0.41	0.17
7	Alter involvement to suit baby's needs	0.70	0.21	0.43	0.18
19	Encourage challenging toys	1.00	--	0.55	0.30
23	Knowledgeable about motor development	0.74	0.22	0.43	0.18
	Activity				
1	Move around while in one position	0.31	0.06	0.44	0.19
3	Grasp objects that are out of reach	0.69	0.10	0.58	0.34
4	Active participant during play	1.00	--	0.73	0.53
12	Uses a variety of strategies	1.13	0.13	0.72	0.51
	Awareness and Enjoyment				
16	Awareness that own behaviour effects people/objects	1.00	--	0.76	0.57
17	Anticipate events	0.72	0.10	0.52	0.27
21	Get excited when figure something out	0.74	0.09	0.66	0.43
22	Delight in self-initiated body movement	0.74	0.10	0.63	0.39
	Exploration				
14	Change behaviour to solve a problem	2.75	0.62	0.77	0.60
20	Get included when others are playing	1.00	--	0.36	0.13
25	Balance dependence on adults to accomplish tasks	2.61	0.60	0.68	0.46
28	Explore all parts of a new object/toy	1.39	0.35	0.53	0.28
	Adaptability				
7	Initial reaction to situation is reservation	1.01	0.33	0.37	0.14
24	Frustrated/discouraged when cannot do something	1.92	0.52	0.68	0.46
27	Ignore voices/sounds when playing	1.00	--	0.37	0.14
33	Give up on tasks when being assisted by adults	1.31	0.39	0.46	0.21

Unst. B = Unstandardized Loading; SE = standard error; St. B = Standardized Loading;

Model Fit and Direct Effects

The results of testing the complete conceptual model indicate a good fit. The Chi-square does indicate a significant result ($\chi^2 = 477.9$, df = 369, $p < 0.01$). This test statistic has been viewed as overly strict and as such, other fit indices are considered more informative. Values of fit indices above 0.90 indicate an acceptable model fit, although values above 0.95 are considered great model fit (Hox & Bechger, 2000). The values for IFI (0.940), TLI (0.927), and CFI (0.938) suggest an acceptable model fit. Values below 0.08 indicate acceptable levels for the RMSEA and levels below 0.05 indicate good fit, which was found for this model (0.04). Modifications were suggested for the model, but were not added at this point. Adding covariances that are not theoretically founded can inflate model fit and result in unrealistic models. The results indicate the data do fit the proposed model and interpretations can be made about path coefficients.

A summary of the path coefficients as they relate to the AIMS is listed in Table 4-8 and is represented in Figure 4-5. All factors, except for *Opportunities in the Playspace* (B = 0.49) were found to be non-significant. The amount of variance in motor development scores accounted for by the contextual factors was 32%, with the majority of the contribution stemming from the physical space of the play environment. The factor *Playspace* was found to explain 24% of the variance in developmental scores.

Table 4-8. Details of the structural model in relation to the Alberta Infant Motor Scale.

	Unst. B	*SE*	*St. B*	R^2
Playspace	38.8	15.7	0.49**	0.24
Sensory Variety	5.4	22.5	0.09	0.01
Parental Encouragement	6.7	8.5	0.12	0.01
Activity	-5.6	15.0	0.17	0.03
Awareness and Enjoyment	3.1	5.0	0.14	0.02
Exploration	-1.3	17.5	0.02	0.00
Adaptability	5.6	1.8	0.09	0.01

Unst. B = Unstandardized Loading; SE = standard error; St. B = Standardized Loading; ** $p < 0.05$

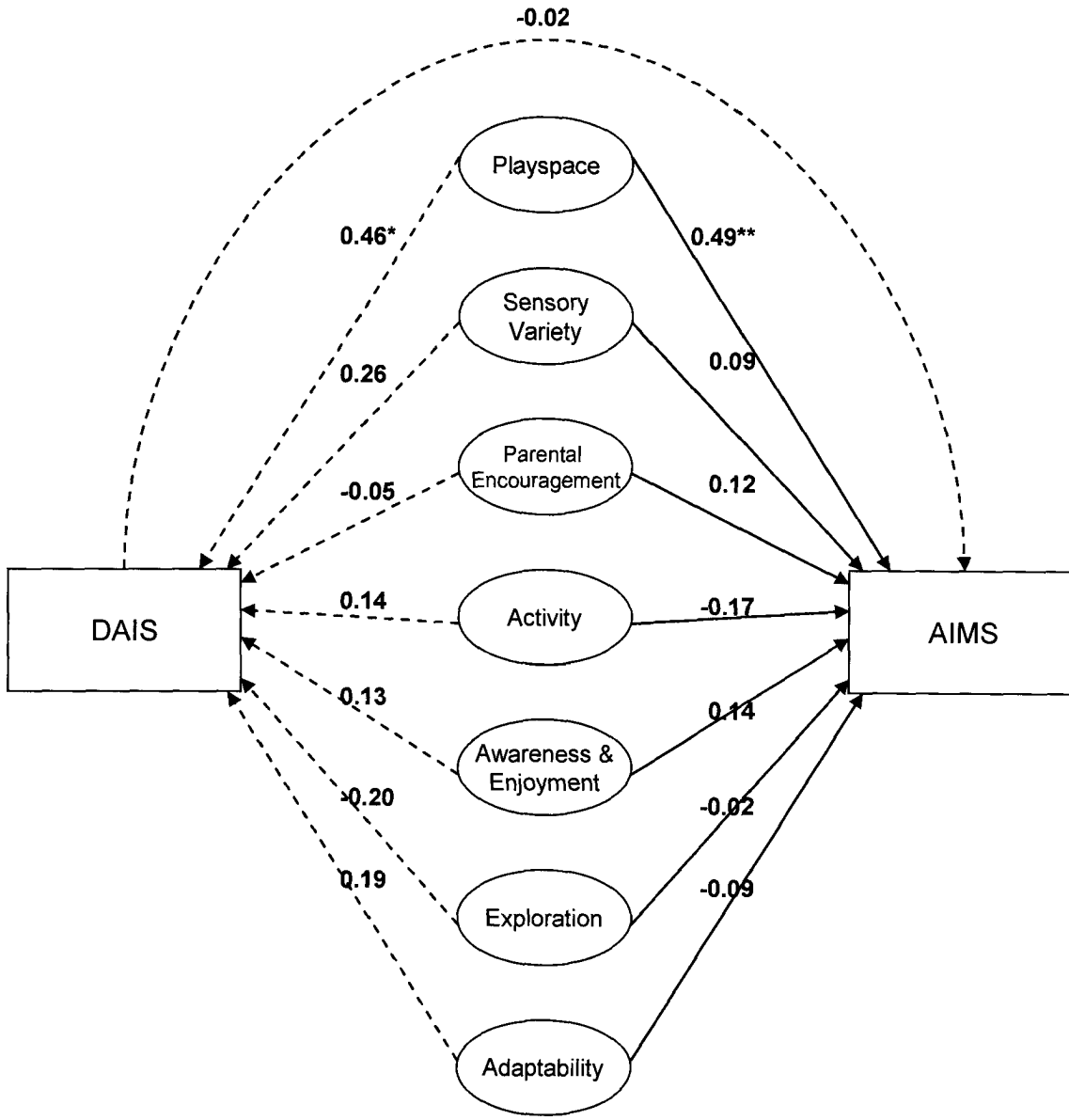

Figure 4-5. Standardized Regression Coefficients for the Conceptual Model. *The solid lines represent direct effects. The dashed lines represent indirect effects via the Daily Activities of Infants Scale as a mediator. The ellipses represent latent variables within the model. Asterisks represent statistical significance (** = less than 0.01 and * less than 0.05).*

Indirect Effects

Mediating effects were evaluated by looking at the total, direct, and indirect effects of the various latent constructs on the outcome of interest, which can be found in Table 4-9. Indirect effects represent the amount of variance accounted for by mediation. According to Baron and Kenny (1985), mediation requires a significant direct effect, which was only found for the *Playspace* factor. A bootstrapping procedure was chosen to calculate the significance for these effects. Overall, none of the factors are significantly mediated by the DAIS. The DAIS was not found to be a significant mediator for the *Playspace* factor once the direct effects were controlled for (Baron & Kenny, 1985).

Table 4-9. Total, Direct and Indirect Effects of the Various Factors on Motor Development. *All values are standardized.*

	Model Effects for Motor Development (SE)				
Factors	Total	Direct (AIMS)	Direct to DAIS	Indirect	P Value
Playspace	0.49 (0.34)	0.49 (0.40)	0.46 (0.30)	-0.01 (0.20)	0.836
Sensory Variety	0.09 (0.90)	0.09 (1.02)	0.26 (0.79)	-0.00 (0.41)	0.800
Parental Encouragement	0.12 (0.33)	0.12 (0.39)	-0.05 (0.31)	0.00 (0.18)	0.859
Activity	-0.17 (0.931)	-0.17 (1.28)	0.14 (0.97)	-0.00 (0.45)	0.768
Awareness & Enjoyment	0.14 (0.59)	0.14 (0.70)	0.13 (0.48)	-0.00 (0.30)	0.798
Exploration	-0.02 (0.67)	-0.02 (0.84)	-0.20 (0.61)	0.003 (0.39)	0.743
Adaptability	-0.09 (0.45)	-0.09 (0.51)	0.19 (0.37)	-0.00 (0.19)	0.747

DISCUSSION

The main purpose of this study was to investigate whether contextual factors have an effect on early motor developmental outcomes, and whether the DAIS can serve as a mediator between these contextual factors and development. Previous research has demonstrated that biology only explains a portion of the variance (5%) in developmental scores after a certain age (Lima et al., 2004), indicating much more needs to be understood about early motor development. Taken together with theoretical conceptions

proposed by the DST, it would appear that contextual factors have the potential to greatly influence early motor development. Nonetheless, the results of this study suggest that contextual factors might not play a significant role in influencing early motor developmental outcome in a population of full-term infants. The factors did explain a total variance of 32% of the variance observed in motor developmental scores, although the majority of this was contributed by the environmental factor, *Opportunities in the Playspace*. The small factor loadings for the other factors and high standard errors make interpretation of potential trends in the output limited.

The DAIS was hypothesized to be a mediator for both the environment and infant characteristics, but this hypothesis was not supported by these results. According to Baron and Kenny (1985), to determine the influence of a mediating or indirect effect, a significant direct effect must be present. This was only found with one factor and following an analysis of the indirect effects, this was not significant. In retrospect, perhaps it is not surprising that the DAIS did not mediate these contextual factors. Parental expectations and knowledge are theorized to play a part in caregiving practices (Hopkins & Westra, 1988; Lima et al., 2004), and the *Parental Encouragement* factor was found to explain only 2% of the variance in motor scores. The mean factor score (4.05) was high, although a frequent comment during interviews was that parents did not pay specific attention to their behaviours. This observation suggests that caregiving practices might not be so much of a focus among healthy full-term infants who largely develop on their own, without "intervention" from either parents or health care providers, but might have more of an impact with parents of infants who are not developing typically and require intervention. In this discussion, these unanticipated results will be considered with respect to the limitations of the study, clinical relevance and implications, and future research.

Limitations

The following discussion outlines the limitations of the current study and their potential impact on the results, with the key considerations being the match between the theoretical perspective and the analysis and design used, homogeneity of the sample, use of a cross-sectional approach to study developmental processes, the measures developed

for the study, including issues with parent report, violation of assumptions and sample size requirements of structural equation modeling, use of the same sample for both the exploratory and confirmatory factor analyses, and finally, the method of dealing with missing data.

One of the key limitations of this study is the degree of match between the theory surrounding early motor development and the method used to assess the key determinants. The DST emphasizes the role of inter- and intra-individual variability in early motor development. Moreover, development is considered a largely non-linear process, whereby changes from one time-point might not be highly correlated with performance at a later date. This inherent complexity begs the question of whether the linear method of analysis using structural equation modeling is ideal for investigating non-linear processes. Along these lines, developmental trajectories are inherently an individual phenomenon, which suggests that methods using group analyses might not be effective in capturing these effects, and that studying individual patterns of development within this context might be a more suitable alternative.

Sample composition is also an important consideration for generalizability of results. The sample used for this study consisted of a largely homogeneous sample of white mothers from a particular income bracket. Although considerations were implemented in the study design to avoid this, homogeneity further decreases the generalizability of the results. This relative homogeneity is problematic in that childrearing practices are known to vary among ethnocultural groups, which are not represented in the sample.

In terms of study design, the cross-sectional approach used here served the important purpose of ensuring efficiency in participant recruitment and assessment. With the limited time scale, using one time-point was deemed the most feasible. This trade-off in design is a limitation as it prevents analysis of change over time, which is essentially the variable of interest, and further, limits interpretations regarding causality. It was theorized that contextual factors effect motor development, but a likely option in the real-world of development is that both influence each other simultaneously, in a reciprocal, dynamic and complex relationship. SEM can deal with these more complex reciprocal processes, at least theoretically. Looking at changes in motor development scores over-

time, as well as changes in contextual factors, might provide clarification as to the real role of contextual factors in early development.

A lack of significance in this model might also be linked to the measurement tools. This work is exploratory and describes the initial stages of measurement development, which require further refinement and modifications. Developing measures also leads to the operationalization of abstract variables, such as exploration and adaptability. Thus, it is possible that the given structure of these contextual factors is not ultimately what is relevant to development, but that other items and indicators need to be considered. Given the early stage of measurement development, it is possible that modifications to the existing measurement tools might lead to changes in the results of the conceptual model. Refining the measures is a priority, and should occur prior to further testing.

Adding to this, a bias in parent-reporting is also likely to have serious consequences on the results. Developing a measurement manual that provides clarification to parents about how they should interpret given questionnaire items, fit with appropriate examples for a wide range of ages, would likely decrease bias. This suggestion stems from the observation that the *Opportunities in the Playspace* factor represents the least abstract factor on the measure.

Another key limitation is the violation of assumptions in SEM and the limited sample size in this study. SEM is a methodology requiring a host of assumptions, any of which, can bias the results and thus alter findings. In the present study, the assumptions were assessed and no serious violations were observed, although it is possible that slight deviations can shift results. On another note, SEM is a large-sample study, requiring sample sizes that demonstrate a subject-to-parameter ratio of 4:1 (Bentler & Chou, 1987). This study only had a medium-sized sample (Kline, 2005), which is also an important consideration when interpreting the results. Moreover, SEM is guided by numbers, but ultimately, is undertaken as a subjective analysis. Thus, it is possible that alternative designs are fit equally well and provide alternative explanations for the data. Alternative calculations of the latent and observed variable are also possible, such as collapsing factors in the EOQ and ICQ, or separating out the various subscales in the DAIS and the

AIMS. This study hypothesized about one model design, although testing of multiple models is possible.

Another concern with the current study, which has practical implications, is the use of the same sample for the exploratory and confirmatory factor analysis (EFA and CFA, respectively). Chapters two and three involved conducting EFA for the two measures and a preliminary analysis for this chapter consisted of conducting a CFA to evaluate factor fit. This common progression often involves using different samples for each analysis, to avoid capitalizing on the specific characteristics (correlation matrix and error variance) of a sample. Given this, the results of this study are limited to the sample described herein and further studies using other samples are necessary in order to ensure generalizability to the population of full-term infants as a whole.

Finally, another potential limitation of the analysis is that data were handled using listwise deletion. Only about 8% of the data were lost to this deletion method, which was found to be small and as such this method was felt to be sufficient, although research does suggest using more accurate procedures, such as Full Information Maximum Likelihood (FIML), when the percentage of missing data is significant.

Clinical Relevance and Implications

One of the key questions stemming from the motor development literature is the timing of early intervention. The DST introduces the concept of transition and highlights the malleability of behaviour during such times of instability (Thelen, 1995). Instability is marked by differences in behaviour, such as a reduction in certain observed movements or the introduction of new abilities into the movement repertoire (Darrah & Bartlett, 1985). This window of opportunity is markedly different between and within infants, and this inter- and intra-individual variability likely contributes to the difficulty in studying the determinants of motor outcomes.

Intervention planning occurs on a case-by-case basis and this consideration of individuals separately at the clinical level might be necessary as well in motor research. Moreover, if contextual factors were to have a demonstrated effect on developmental outcomes, it is likely that these effects would be subtle, alluding to the necessity of studying these effects in individuals as well as groups. Along these lines, Thelen (1990)

emphasized that the individual is the proper unit of analysis, the goal being to understand at what point the systems becomes unstable, is amenable to reorganization, and further, the specific factors that play a role in facilitating this change at that particular time. These nuances to development make it obvious that future understanding of development might stem from studying development at this individual level.

The malleability of development during this early time period is also linked to notions of vulnerability, which are not necessarily a consideration for healthy full-term infants, but are more important in populations of infants who are born preterm or are found to be at-risk. It is possible that the potential subtle effects of contextual factors—including childrearing practices—might play a more important role in this population, contributing to the existing ideas about environmental risk (Abbott & Bartlett, 1999).

Although the environmental variables outlined in this work, aside from the play space, were not found to explain the variability observed in development scores, it is still a potentially important modifiable variable. The *Playspace* factor contains items relating to opportunities for movement and making changes to the environment present feasible intervention options for parents and families. The infant characteristics did not show any relation to development, although given the links to other developmental outcomes, it is still an important research question for different populations of interest.

Ultimately, contextual factors might not be as clinically relevant to a population of full-term infants, with development potentially marked by a stochastic rather than deterministic process. An understanding of this might instead be of more benefit to a more vulnerable population of infants. Early motor development is a suggested marker for child well-being (Eikmann et al., 2003) and given the feasibility of using such factors in considerations for interventions, it still serves as an important research question.

Future Research

Although there are a host of limitations to this work, it serves as an informative springboard for developing future research questions. The key limitations of this study are the use of linear methods to assess non-linear processes, use of a large group to investigate unique individual developmental processes, the cross-sectional design, and weaknesses associated with the sample, such as homogeneity and use of only full-term

infants. The DST emphasizes the role of contextual factors and it is important to investigate alternate methodologies prior to assuming that these factors do not serve an important role in explaining the variability observed in early development. Using non-linear measurement tools and longitudinal study designs indicate a host of future research avenues. A simple and less complicated step involves replicating this study testing the measurement tools and conceptual model using different heterogeneous samples. Although this work did not provide evidence for a relationship between contextual factors and motor development, it is possible that other populations, such as using a population of infants born preterm, might lead to different conclusions. This suggestion is supported by recent work indicating links between the DAIS and the motor development of infants born preterm (unpublished data). Other necessary work involves further refining the EOQ and ICQ, and evaluating whether these measures are actually targeting the contextual factors of interest. It is possible that the measurement tools are not tapping into the key environmental or infant variables. In addition, future work in considering the DAIS as a mediating variable might consist of focus groups, in which parents are asked directly about why they feel they provide the opportunities that they do for their children.

Conclusions

There is much yet to be understood about early motor development. Although the results of this study did not detect an influence of the environment or infant factors on the motor development of infants 4 to 10 months of age, it does raise important questions about the methodologies currently used to assess these subtle changes and effects. Development progresses in a non-linear fashion and the large intra-individual variability suggests that more work investigating individual differences is needed. The DST embraces the complexity of motor development, and future work that capitalizes on this complexity and prioritizes individual differences has the potential to provide important information about developmental determinants.

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CHAPTER 5

CONCLUSION

Summary of Objectives

The overall objective of the present study was to address a gap in the motor development literature. A review of the literature identified a lack of information regarding the influence of contextual factors, including the home environment and infant characteristics, on the motor development of infants aged 4 to 10 months. This age range pertains to a period of time during which infants acquire voluntary motor abilities and become active participants in their environment. Given this transition, it also has the potential to provide a window of opportunity during which interventions can be successfully implemented, if an infant is not developing well.

Given the exploratory and foundational nature of this work, the sample of interest consisted primarily of full-term infants (97.6% greater than 36 weeks gestation). Prior to investigating the role that contextual factors play in a high-risk population, it is important to understand the extent to which these variables contribute to explaining the variability observed in a typical population of infants. As recommended by Campbell (1994), "working knowledge of motor development is the very basis of the practice of pediatric physical therapy" (p. 3).

The primary objective of this work was to test a conceptual model of early motor development comprised of the key contextual factors (ie. those associated with the infant and his or her environment) influencing the motor development of young infants. The Daily Activities of Infants Scale (DAIS, Bartlett & Fanning, 2004) is a measure used to assess the opportunities that parents provide for the development of antigravity postural control and movement exploration. An additional research question was the extent to which this measure acts as a mediator between the environment or infant characteristics and motor development. A survey of the literature for key contextual factors revealed a lack of appropriate tools designed to assess the contextual factors for this population. Given this, a secondary objective was to develop two new measures addressing the environment as well as infant characteristics in the specific context of early motor development. The goal was for these measures to be used by clinicians and researchers, as well as parents and families. Thus, developing quick and clinically feasible measures was a priority.

Summary of Study Results

Chapter two in this study describes the development of the Environmental Opportunities Questionnaire (EOQ). This measure addresses key aspects of the home environment and includes the factors *Opportunities in the Playspace*, *Sensory Variety*, and *Parental Encouragement*. The measure was developed from existing measures (Home Observation for Measurement of the Environment, Caldwell & Bradley, 1984; Affordances in the Home Environment for Motor Development, Rodrigues & Gabbard, 2005; Craig Hospital Inventory of Environmental Factors, Harrison & Mellick, 2000; Measure of Quality of the Environment, Fougeyrollas et al., 1999), and modified to deem the items relevant to motor development for the target age group of 4 to 10 months. Through a series of phases involving item generation, pilot testing and item reduction, factor analysis and further item reduction, and reliability analysis, a measure consisting of 21 items was developed. The measure had excellent test-retest reliability (0.92, CI 0.84 – 0.96) and acceptable internal consistency (0.79).

Similarly, chapter three describes the development of the Infant Characteristics Questionnaire (ICQ). This measure addresses key aspects of an infant's temperament that are theorized to be important for early motor development. These factors include *Activity*, *Motivation*, *Exploration*, and *Adaptability*. Developed from a limited set of existing measures (Carey Temperament Scale, Carey & McDevitt, 1977; Dimensions of Mastery Questionnaire, Morgan et al., 2005; Early Coping Inventory, Zeitlin et al., 1988), items were modified to be appropriate for the motor development of young infants. Measurement development proceeded through a set of phases identical to those in chapter two and resulted in a set of 27 items. The overall test-retest reliability was excellent (0.92, CI 0.83 – 0.96) and the internal consistency was also high (0.89).

Chapter four describes the testing of a conceptual model of early motor development. This parsimonious model is comprised of the EOQ, ICQ, DAIS, and the outcome of interest, early motor development, measured using the Alberta Infant Motor Scale (AIMS; Piper & Darrah, 1994). Prior to testing the model, confirmatory factor analyses were conducted on the EOQ and ICQ to ensure fit of the measurement tools. As stated earlier, an objective was to develop short and feasible measures, and items were

deleted based on theory and model fit. The result was a set of measures consisting of a set of factors, each with only four indicators. The measures had excellent fit indices (EOQ: $\chi^2 = 73.28$, df = 49, p = 0.014; IFI 0.969; TLI 0.958; CFI 0.969; RMSEA 0.051 and ICQ: $\chi^2 = 100.486$, df = 96, p = 0.357; IFI 0.993; TLI 0.991; CFI 0.993; RMSEA 0.016).

The conceptual model also had good fit indices ($\chi^2 = 473.1$, df = 368, $p < 0.01$; IFI 0.941; TLI 0.927; CFI 0.939; and RMSEA 0.039), indicating that the model did fit the data well. Overall, the factors explained 32% of the variance in AIMS scores. The factor *Playspace* from the EOQ was the only factor to carry a significant path coefficient and explained 24% of the variance in developmental scores; however, the DAIS was not found to be a significant mediator for any of the contextual factors in the model. Although not statistically significant, it is important to consider that small values might be practically meaningful, especially in more vulnerable infant populations.

The Dynamic Systems Theory and Linear Modeling

The results of this study are surprising in that the range contextual factors did not explain a significant portion of the variance observed in early motor developmental status at one point. Structural equation modeling (SEM) as an approach capitalizes on inter-individual variability, which is a widely-accepted characteristic of early motor development. The Dynamic Systems Theory (DST) emphasizes inter-individual variability, but more interestingly, introduces important conceptions regarding intra-individual variability. Early perspectives of variability viewed it as the result of errors (Stergiou et al., 2006). Current perspectives of the variability observed in motor repertoires are that it is normal (Hadders-Algra, 2002) and even adaptive for development, as infants have options for developing efficient movement repertoires (Touwen, 1993). The DST proposes that multiple subsystems interact to produce motor behaviour and moreover that, these systems develop asynchronously. These characteristics contribute to the large scale variability observed within infants. One of the difficulties of studying early motor development stems from its non-linear nature. Darrah and colleagues (1998) demonstrated that percentile ranks differed markedly from month to month in a large sample of full-term infants, with no systematic pattern of change.

Thus, this begs the question of whether linear tools are the best option for studying non-linear phenomena. Recent work conducted by Harbourne and Stergiou (2009) emphasized the use of non-linear methods to address movement variability and their potential utility in guiding practice and research. Moreover, earlier work suggested that encouraging complexity in motor behaviours has the potential to result in optimal motor outcomes (Stergiou et al., 2006).

Clinical Implications

The purpose of the EOQ and ICQ was to provide measurement tools of contextual factors that have the potential to inform parents, as well as provide a discriminative and predictive tool for use in clinical practice. The factor *Opportunities in the Playspace* was found to explain a significant portion of the variance (~25%) observed in motor development scores. This factor is comprised of items that relate to the layout of the playspace, such that movement is encouraged through the presence of opportunities in the surrounding environment. Given this, parents should make modifications to the play environment as needed in a manner that encourages movement. These changes will depend on the motor repertoire of the infant. The factors *Activity*, *Motivation*, and *Exploration* were significantly correlated with the *Playspace*, although these factors did not demonstrate significant relationships with motor development, when tested in the context of the entire model.

Although the infant characteristics were not found to be significantly related to motor outcome, early conceptions of affordances (Gibson, 1988) stress the important relationship between the infant and the environment. At this point, it is important not to rule out the potential utility of contextual factors in motor development. Other work has suggested that optimizing movement variability, which has been suggested to contribute to optimizing motor outcomes, can be facilitated by encouraging complex motor behaviour (Stergiou et al., 2006), which can be linked to a stimulating environment.

The large scale variability observed during infancy presents many challenges to clinicians invested in developing and administering interventions. The intra-individual instability in motor development has important implications for therapy, as it emphasizes

the need for measurement at multiple time points and also across multiple domains (Bartlett, 2000; Darrah et al., 2003). Thelen (1990) introduced the concept of "cluster analysis" that groups together individuals who share similar characteristics. This technique involves moving from the individual to the group level, and not vice versa, which is the method used in this study. Measuring contextual factors at multiple time-points might elucidate their impact on motor outcome by identifying when and how such variables change in conjunction with changes in motor development.

Study Strengths

A primary objective of this work was to address the gap in the motor development literature regarding contextual factors. Although the testing of the conceptual model only resulted in one significant relationship (between the *Playspace* and motor development), it does provide a foundation for understanding and questioning the means by which researchers should investigate the complex nature of development. The larger conceptual model was found to have good fit indices, indicating the proposed model does fit the data. Moreover, non-significant findings are important, as they encourage research questions and assist in directing future research.

An additional strength of this study is the variety of ages of participants and the balance between boys and girls. Recruitment also occurred at multiple locations in London, Ontario in attempt to stratify the sample across potentially different socioeconomic status groups. Moreover, given the cross-sectional design of the study and the fact that parents only needed to participate at one time-point, the majority of parents who were informed about the study agreed to participate.

The measurement development process, as outlined by Kirshner and Guyatt (1985), includes multiple phases to ensure the development of effective tools. These phases were followed to develop the EOQ and ICQ and details regarding item selection and deletion were well-documented. The two measures were also developed out of an existing group of measures to ensure that the measures shared qualities of current effective measurement tools. Each measure demonstrated excellent test-retest reliability and good internal consistency. The factor analysis, which was the final phase of chapters

two and three, demonstrated a sufficient sample size (Fabrigar et al., 1999; Tabachnick & Fidell, 2001).

Feasibility is an important consideration in the development of measurement tools. The initial pilot analyses included questionnaires regarding acceptability and feasibility of the two measures. In addition, two versions of the measures were tested to determine whether the measures would be best completed by the parent or an independent assessor. As a result, multiple avenues were undertaken to ensure that the measure would be appropriate for clinicians and parents.

The confirmatory factor analyses (CFA) of the EOQ and ICQ demonstrated excellent fit indices, suggesting that these proposed measurement tools fit the data. Moreover, the result of the CFAs are parsimonious factors consisting of four items each. An objective was to consider only the key factors influencing early motor development, and this work does only consider, according to the results of the modeling, the key factors. This simple structure is an important consideration for measures that are completed by clinicians, therapists, and parents.

Limitations and Directions for Future Research

As mentioned previously, one of the difficulties in studying early motor development is its non-linear nature and the large degree of intra-individual variability. This study used a cross-sectional design to ensure feasible participant recruitment, although a longitudinal design would provide the opportunity to investigate multiple time-points and the progression of motor abilities. Future work investigating the dynamic relationship between motor development and contextual factors using a longitudinal design with an emphasis on analysis at the individual level might clarify the effects between these variables.

Although it has been documented that parent-completed measures relating to motor development are accurate (Bodnarchuk & Eaton, 2004), one of the concerns of this work was the extent to which parents demonstrated biased reporting on the given Likert scale, especially with items on the ICQ. The scale was comprised of 5 options, and parents often had preconceived notions of their infant's performance. In subsequent

versions of the measures, examples were provided to clarify and inform parent choices, but developing a manual might be necessary. One of the trade-offs with developing a manual is measurement feasibility, as parents might not have time to review such a document. Moreover, a limited set of examples were provided for each question, which were not necessarily relevant to the entire applicable range of ages. Developing examples that are applicable across the age range of interest would be of benefit, but it is likely that the EOQ would still benefit from being administered via interview.

An important limitation of this study is the homogeneity of the sample of both the mothers and infants. The sample was obtained from multiple sites across London, Ontario, but consisted primarily of mothers (100%) who were Caucasian (89%) with an annual income greater than $60,000 (79%) and contained a large proportion of full-term infants. This limited demographic stratification reduces the inter-individual variability which is critical for SEM, and the ethnocultural diversity related to childrearing factors, which limits the external validity or generalizability of the results.

Another limitation of this work was the repeated use of the same sample for the exploratory and confirmatory factor analyses. Ideally, separate samples are used for these analyses to ensure that the results are not purely driven by the specific sample. One of the implications for using the same sample is the risk of getting results that are specific to the sample used. Future work must involve repeating this work with other samples of parents and infants. Moreover, it would be of benefit to consider a different population to ensure that the measures are applicable to a diverse population of parents and infants.

A common difficulty in human studies is the presence of missing data. In the present study, an original sample of 207 parents completed the study. This full sample was used for the factor analyses conducted in chapters two and three (pairwise deletion), although a final sample of 189 participants was used in the final SEM chapter due to missing data. In completing questionnaires, parents often overlooked questions or potentially refused to answer questions that they did not understand or found difficult. As mentioned before, providing a manual might reduce the possibility for such occurrences, as might a shorter measure. During the interviews, parents often mentioned completing the questionnaires while playing with their infants or doing other tasks, highlighting the distracted environment in which parents often fill out these questionnaires. This provides

further support for ensuring that measures are developed with feasibility for parents in mind.

The Daily Activities of Infants Scale (DAIS; Bartlett & Fanning, 2004) was used as a mediator in the testing of the conceptual model. As a measure of opportunities that parents provide their children, it was hypothesized that higher scores on the DAIS be associated with higher developmental scores. Recent work has shown links to full-term samples (Nijhuis-van der Sanden et al., 2008) and infants born preterm demonstrate different patterns than those born full-term (Doralp & Bartlett, 2008). The results of this study did not demonstrate this, and one of the concerns of the DAIS is that parents often find it difficult to complete so that there is error associated with completing this measure. Although time from each interview was spent on quickly reviewing the DAIS and asking parents if they had questions, it might still be of benefit to provide an additional information page or an example to parents on completing the DAIS. Moreover, it is essential to stress to parents that the number of items checked off needs to total a full day, which was often not the case. In addition, the weighted score on the DAIS was used to test the mediation of all contextual factors. The DAIS is comprised of 8 separate subcategories of activities, some of which might be more relevant than others. Future work might involve investigating how these separate categories are associated with motor development.

This study was completed using a sample of only full-term infants. Given the foundational purpose of this work, understanding the extent to which contextual factors explain the variability observed in motor development scores in a healthy and typical population is an important precursor to studies involving populations of at-risk or vulnerable infants, such as those preterm. Ultimately, the purpose of this work is to inform interventions for children that are not developing typically. Although this work was conducted with a full-term population, early research demonstrates that the majority of healthy infants develop typically and demonstrate resilience (Dennis & Najarian, 1957; McGraw 1939; 1946). It is possible that the development of infants born preterm is marked by a more deterministic process, which contrasts the malleable and stochastic nature of full-term development. Moreover, understanding these differences at the individual, rather than the group level, might provide clarification of these subtle

differences in development that are lost at the group level. Thus, future avenues should involve extending this work to such populations. Vulnerable populations of infants might be more susceptible to the influence of these contextual factors, and the notion of risk is very real phenomenon (Abbott & Bartlett, 1999).

The goal of this work was to identify key contextual factors influencing motor development. One of the inherent difficulties studying contextual factors is the operational definitions of such variables. What constitutes "exploration" or "adaptability" will likely vary and a limitation of this study is the potential limited scope of such factors. The questionnaires are limited to a set of factors and it is possible that other factors are equally important in influencing developmental outcome. As well, the questionnaire was developed from an initial set of items that were eventually classified into factors. It is possible that the results would be different if items were developed from an initial conception of important factors. Also, the specific wording of items within each factor will also have a great impact on parental response. Ultimately, these variables likely measure differences that are subtle between infants. Additionally, whether these factors vary considerably over time within a given infant is still under question. These unknowns make the study of contextual factors difficult and again, raise future research questions about longitudinal designs and conducting repeated analyses with different samples. Ultimately, the difficulty in defining such variables should not be a deterrent and initial setbacks can be used to refine and redirect future research designs.

Finally, this exploratory work does not provide information regarding causality and is only suggestive of relationships (or the lack of relationships) among variables. Determining the real impact of such contextual factors will require conducting longitudinal research, which seems to be a key limitation to this study.

Conclusion

There is much yet to be understood about the complexities of early motor development. The results presented here suggest that alternative strategies might be necessary to uncover the seemingly important relationship between contextual factors and early motor abilities. This exploratory work presents many questions about how one can

effectively capture the intra-individual variability that is present during this period. Thus, these results provide insight into questioning our existing methodologies for investigating these phenomena, and not our theories about the importance of such things as contextual factors in early motor development.

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APPENDICES

Appendix 2-A

Office of Research Ethics

The University of Western Ontario
Room 00045 Dental Sciences Building, London, ON, Canada N6A 5C1
Telephone: (519) 661-3036 Fax: (519) 850-2466 Email: ethics@uwo.ca
Website: www.uwo.ca/research/ethics

Use of Human Subjects - Ethics Approval Notice

Principal Investigator: Dr. D. Bartlett
Review Number: 12920E **Revision Number:** 2
Review Date: April 24, 2007 **Review Level:** Expedited
Protocol Title: Factors Influencing Early Motor Development: Pilot Testing Infant and Family Measures
Department and Institution: Family Medicine, University of Western Ontario
Sponsor:
Ethics Approval Date: April 24, 2007 **Expiry Date:** May 31, 2007
Documents Reviewed and Approved: Revised Study End Date
Documents Received for Information:

This is to notify you that The University of Western Ontario Research Ethics Board for Health Sciences Research Involving Human Subjects (HSREB) which is organized and operates according to the Tri-Council Policy Statement: Ethical Conduct of Research Involving Humans and the Health Canada/ICH Good Clinical Practice Practices: Consolidated Guidelines; and the applicable laws and regulations of Ontario has reviewed and granted approval to the above referenced revision(s) or amendment(s) on the approval date noted above. The membership of this REB also complies with the membership requirements for REB's as defined in Division 5 of the Food and Drug Regulations.

The ethics approval for this study shall remain valid until the expiry date noted above assuming timely and acceptable responses to the HSREB's periodic requests for surveillance and monitoring information. If you require an updated approval notice prior to that time you must request it using the UWO Updated Approval Request Form.

During the course of the research, no deviations from, or changes to, the protocol or consent form may be initiated without prior written approval from the HSREB except when necessary to eliminate immediate hazards to the subject or when the change(s) involve only logistical or administrative aspects of the study (e.g. change of monitor, telephone number). Expedited review of minor change(s) in ongoing studies will be considered. Subjects must receive a copy of the signed information/consent documentation.

Investigators must promptly also report to the HSREB:

a) changes increasing the risk to the participant(s) and/or affecting significantly the conduct of the study;
b) all adverse and unexpected experiences or events that are both serious and unexpected;
c) new information that may adversely affect the safety of the subjects or the conduct of the study.

If these changes/adverse events require a change to the information/consent documentation, and/or recruitment advertisement, the newly revised information/consent documentation, and/or advertisement, must be submitted to this office for approval.

Members of the HSREB who are named as investigators in research studies, or declare a conflict of interest, do not participate in discussion related to, nor vote on, such studies when they are presented to the HSREB.

[redacted]

Chair of HSREB: Dr. John W. McDonald
Deputy Chair: Susan Hoddinott

Ethics Officer to Contact for Further Information		
Jennifer McEwen [redacted]	Denise Grafton [redacted]	Ethics Officer [redacted]

cc: ORE File

This is an official document. Please retain the original in your files.

Appendix 2-B

Early Motor Development

Are you interested in your infant's early motor development?

Would you be interested in participating in a research project about early motor development?

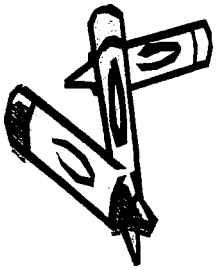
We are looking for parents who are willing to review two new measures of early motor development, fill out a questionnaire, and have a home visit!

Who? A PhD student in the Faculty of Health Sciences at the University of Western Ontario

What? A set of questionnaires and a home visit

Why? To learn more about early motor development

Will you be compensated for your time? Yes



If you are interested, please contact Samantha Doralp at [redacted] or (519) 661-2111 ext.

Appendix 2-C

Letter of Information

Factors Influencing Early Motor Development: Pilot Testing Infant and Family Measures

Principal Investigator: Doreen Bartlett (Associate Professor, Faculty of Health Sciences, University of Western Ontario) (519) 661-2111 [redacted]
Co-Investigator: Samantha Doralp (PhD Candidate, Rehabilitation Sciences, University of Western Ontario) (519) 661-2111 [redacted]

You are being invited to participate in this research project. This letter contains information to help you decide whether to participate in this pilot study with your infant.

Purpose of the Project: This pilot work is designed to give us information about how acceptable and feasible the Infant Characteristic Questionnaire (ICQ) and Environmental Opportunities Questionnaire (EOQ) are to parents and their infants, provide information on how long it will take to complete these measures, and to determine the best respondent for the EOQ. The goal is to develop measures that are tailored to parents and their infants that will eventually be used in a larger study investigating the infant and family environment factors influencing early motor development. For this work, we are inviting 20 parents to participate.

Research Involvement: You are eligible for this study if you are a parent with an infant (birth-12 months) attending the London-Fanshawe Ontario Early Years Centre for programs or services and are fluent in speaking and reading English. You are not eligible to participate if you are not fluent in reading and speaking English or your child is over the age of 12 months.

This project involves two components. First, you will be asked to review two new measures relating to infant motor development. The second portion involves a home visit. If you agree to take part in this pilot work, we will provide you with a package containing the Infant Characteristic Questionnaire, Environmental Opportunities Questionnaire, and a questionnaire about the acceptability and feasibility of these two measures, which you can complete at a time that is convenient to you. These questionnaires ask questions about you, your infant, and your home environment. We anticipate that you will be able to complete these questionnaires within an hour, but ask you to indicate the time you started and finished each questionnaire.

The home visit will be arranged with Samantha Doralp, a PhD student in the Faculty of Health Sciences at The University of Western Ontario. During this visit, she would like to observe a 20-30 minute play session of your infant. She will be completing the same two questionnaires (Infant Characteristic Questionnaire and the Environmental Opportunities Questionnaire) based on this observation session. At this home visit, the package containing the questionnaires will be collected. Attached to this letter is the consent form. All information you provide will be considered confidential. You will not be identified by name in any report or publication arising from the study.

Considerations: Participation in this study is voluntary. You may refuse to participate, refuse to answer any questions on the questionnaires, or withdraw from the study at any time with no effect on your relationship with the researchers or your service providers at the Ontario Early Years Centre.

Privacy: The opinions and ideas collected from the questionnaires will be stored in a secure location. If the results of the study are published, your name will not be used. No information that discloses your identity will be released or published.

Benefits: Through participation in this study, you are given the opportunity to share your opinions and experiences about the infant characteristics and aspects of the family environment that you feel influence early motor development. You will not benefit directly from participation in this research; however, the larger study does have the potential to improve future developmental care for infants. You will receive an honorarium in the form of a $25 Gift Card in recognition of your contribution to our work.

Risks: There are no known risks to participating in this study. You do not waive any legal rights by signing the consent form.

Other Pertinent Information: If you are participating in another study at this time, please inform a member of the research team to determine whether it is appropriate for you to participate in this study.

If you have any questions about the study, or would like additional information to assist you in reaching a decision about participating, please contact Doreen Bartlett at (519) 661-2111 [redacted] or Samantha Doralp at (519) 661-2111 [redacted]

If you have any questions about your rights as a research subject, you may contact:
Director of the Office of Research Ethics
University of Western Ontario
(519) 661-3036.

This letter is yours to keep for your future reference. If you agree to participate in this study, please sign the attached consent form, and provide a phone number and mailing address so we may contact you. Please return the consent form to us either in person at the Ontario Early Years Centre or in the provided stamped and addressed envelope.

Thank you in advance for your interest.

Yours Sincerely,

Doreen Bartlett Samantha Doralp

Consent Form

Factors Influencing Early Motor Development: Pilot Testing of Child and Family Measures

Investigators: Samantha Doralp, MSc, Doreen Bartlett, PhD, PT

I have read the accompanying letter of information, have had the nature of the study explained to me, and I agree to participate. All questions have been answered to my satisfaction.

_____	_____	_____
(Name; please print)	(Signature)	(Date)

_____	_____	_____
(Name of person obtaining informed consent)	(Signature of person obtaining informed consent)	(Date)

Contact Information

Name: _____

Address: _____
(street address, apartment number)

_____ Postal Code: __ __ __ __ __ __
(city)

Phone Number: (_____) _____

Email (optional): _____

APPENDIX 2-D

Environmental Opportunities Supporting Motor Development Questionnaire for Parents

Start time: _____ Age of your Infant:_____ Date: _____

In the following questionnaire you are asked 30 questions about your infant, your home, and the family environment. When completing these questions, please consider the usual surroundings and environment of your infant and how he or she usually plays and interacts with these surroundings. The questions address aspects of movement. ***Please make note of any questions that you find difficult to understand or that you simply do not like. Feel free to write on the questionnaire.*** *Please read each question carefully and select one of the response options (to a great extent, to a moderate extent, to a fair extent, to a small extent, not at all, or not applicable) to answer each of the questions. Thank you!*

To what extent—	to a great extent	to a moderate extent	to a fair extent	to a small extent	not at all	not applicable
1. Does your infant have the opportunity to interact with others during playtime?	○	○	○	○	○	○
2. Do you set aside a specific time to play with your infant?	○	○	○	○	○	○
3. Do you engage in spontaneous play with your infant?	○	○	○	○	○	○
4. Do you respond spontaneously to your infant in a positive way when he or she is trying a new or difficult movement?	○	○	○	○	○	○
5. Does communication between you and your infant involve an interactive component (such as eye contact or physical contact)?	○	○	○	○	○	○
6. Do you restrict your infant from engaging in new or different activities?	○	○	○	○	○	○
7. Are you very cautious when your infant engages in safe play or movement?	○	○	○	○	○	○
8. Do you encourage your infant to engage in play that involves movement and action?	○	○	○	○	○	○
9. Do you provide your infant with a *variety* of toys (both stationary and movement related)?	○	○	○	○	○	○
10. Do you encourage activities or play that will help your infant develop?	○	○	○	○	○	○
11. Do you alter your level of involvement to suit the developmental needs of your infant?	○	○	○	○	○	○
12. Do you have expectations of your infant when you provide a toy or engage in activities with your infant?	○	○	○	○	○	○
13. Do you introduce a toy to get your infant to perform a specific activity?	○	○	○	○	○	○
14. Does your infant have access to space that is well-suited to the level of movement he or she engages in?	○	○	○	○	○	○

To what extent—	to a great extent	to a moderate extent	to a fair extent	to a small extent	not at all	not applicable
15. Is your infant free to move in any space within the house, assuming that the space is safe?	○	○	○	○	○	○
16. Has the layout of your home made it difficult for your infant to move or engage in activity?	○	○	○	○	○	○
17. Does your infant have access to more than one type of floor texture (carpet, wood, tile, linoleum, and so on)?	○	○	○	○	○	○
18. Does your infant have access to furniture that can be held onto safely?	○	○	○	○	○	○
19. Does your infant have access to furniture for pulling up to a standing position?	○	○	○	○	○	○
20. Does your infant have access to furniture that permits stepping sideways while holding on?	○	○	○	○	○	○
21. Does your infant have access to furniture that is sufficiently far apart to facilitate walking movements?	○	○	○	○	○	○
22. Does your infant have access to furniture that permits climbing or stepping (such as sofas, small tables, chairs, and so on)?	○	○	○	○	○	○
23. Does your infant have access to space that supports the next stage of movement or development? (For example, sitting to standing, lying on his or her back to sitting).	○	○	○	○	○	○
24. Do you modify the play space to suit the needs of your infant?	○	○	○	○	○	○
25. Are the toys accessible to your infant so that he or she may choose when or with what to play?	○	○	○	○	○	○
26. Is there a *variety* of toys available to your infant during play times (both stationary and movement related)?	○	○	○	○	○	○
27. Do you encourage your infant to play with toys that challenge him or her to develop new motor skills? (For example, by attending to or providing specific toys).	○	○	○	○	○	○
28. Is your infant free to choose the toys or physical activities by him or herself?	○	○	○	○	○	○
29. Does your infant wear clothes that allow freedom to move and explore?	○	○	○	○	○	○
30. Is your infant barefoot in the house?	○	○	○	○	○	○

End time: _____

Thank you for taking the time to complete our questionnaire!

Appendix 2-E

Questionnaire about Acceptability/Feasibility

Factors Influencing Early Motor Development: Pilot Testing of Infant and Family Measures

Thank you for participating in this pilot work. We value your opinions and perspectives about the measures we are planning to use in a larger study. Please complete this final two-page questionnaire, and provide any additional comments on the back.

Infant Characteristic Questionnaire

1. Overall, was the measure acceptable? (By "acceptable", we mean that the content was not offensive to you in any way.)

yes ☐ no ☐ If not, please indicate why (and specific question numbers where possible)

_____
_____
_____

2. Overall, do you think this measure is feasible to complete? (By "feasible", we mean that the time invested to complete the measure is not overly unreasonable.)

yes ☐ no ☐ If not, please indicate why (and specific question numbers where possible)

_____
_____
_____

3. Were the questions clear and easy to understand?

yes ☐ no ☐ If not, please indicate why (and specific question numbers where possible)

_____
_____
_____

4. Did you find the format of the questionnaire easy to follow and friendly?

yes ☐ no ☐ If not, please indicate why

_____
_____
_____

5. In your opinion, did you feel that anything was missing in the questionnaire about important infant characteristics?

yes ☐ no ☐ If so, please provide some detail

_____
_____
_____
_____

Environmental Opportunities Questionnaire

1. Overall, was the measure acceptable? (By "acceptable", we mean that the content was not offensive to you in any way.)

yes ☐ no ☐ If not, please indicate why (and specific question numbers where possible)

2. Overall, do you think this measure is feasible to complete? (By "feasible", we mean that the time invested to complete the measure is not overly unreasonable.)

yes ☐ no ☐ If not, please indicate why (and specific question numbers where possible)

3. Were the questions clear and easy to understand?

yes ☐ no ☐ If not, please indicate why (and specific question numbers where possible)

4. Did you find the format of the questionnaire easy to follow and friendly?

yes ☐ no ☐ If not, please indicate why

5. In your opinion, did you feel that anything was missing in the questionnaire about important family environment characteristics?

yes ☐ no ☐ If so, please provide some detail

Thank you for taking the time to fill out this questionnaire!

Appendix 2-F

Office of Research Ethics
The University of Western Ontario
Room 4180 Support Services Building, London, ON, Canada N6A 5C1
Telephone: (519) 661-3036 Fax: (519) 850-2466 Email: ethics@uwo.ca
Website: www.uwo.ca/research/ethics

Western

Use of Human Subjects - Ethics Approval Notice

Principal Investigator: Dr. D. Bartlett
Review Number: 13370E **Revision Number:** 3
Review Date: December 22, 2008 **Review Level:** Expedited
Protocol Title: Attendances in Infant Motor Development: The onset of purposeful movement
Department and Institution: Physical Therapy, University of Western Ontario
Sponsor:
Ethics Approval Date: December 22, 2008 **Expiry Date:** March 31, 2009
Documents Reviewed and Approved: Revised study end date.
Documents Received for Information:

This is to notify you that The University of Western Ontario Research Ethics Board for Health Sciences Research Involving Human Subjects (HSREB) which is organized and operates according to the Tri-Council Policy Statement: Ethical Conduct of Research Involving Humans and the Health Canada/ICH Good Clinical Practice Practices: Consolidated Guidelines; and the applicable laws and regulations of Ontario has reviewed and granted approval to the above referenced revision(s) or amendment(s) on the approval date noted above. The membership of this REB also complies with the membership requirements for REB's as defined in Division 5 of the Food and Drug Regulations.

The ethics approval for this study shall remain valid until the expiry date noted above assuming timely and acceptable responses to the HSREB's periodic requests for surveillance and monitoring information. If you require an updated approval notice prior to that time you must request it using the UWO Updated Approval Request Form.

During the course of the research, no deviations from, or changes to, the protocol or consent form may be initiated without prior written approval from the HSREB except when necessary to eliminate immediate hazards to the subject or when the change(s) involve only logistical or administrative aspects of the study (e.g. change of monitor, telephone number). Expedited review of minor change(s) in ongoing studies will be considered. Subjects must receive a copy of the signed information/consent documentation.

Investigators must promptly also report to the HSREB:

a) changes increasing the risk to the participant(s) and/or affecting significantly the conduct of the study;
b) all adverse and unexpected experiences or events that are both serious and unexpected;
c) new information that may adversely affect the safety of the subjects or the conduct of the study.

If these changes/adverse events require a change to the information/consent documentation, and/or recruitment advertisement, the newly revised information/consent documentation, and/or advertisement, must be submitted to this office for approval.

Members of the HSREB who are named as investigators in research studies, or declare a conflict of interest, do not participate in discussion related to, nor vote on, such studies when they are presented to the HSREB.

[redacted]

Chair of HSREB: Dr. Joseph Gilbert

Ethics Officer to Contact for Further Information

☐ Janice Sutherland	☐ Elizabeth Wambolt	☑ Grace Kelly	☐ Denise Grafton
[redacted]	[redacted]	[redacted]	[redacted]

This is an official document. Please retain the original in your files.

cc: ORE File

Appendix 2-G

Early Motor Development

Are you interested in your infant's motor development?

Would you be interested in participating in a research project about early motor development?

We are looking for parents who are willing to complete questionnaires relating to early motor development and have their infant participate in a motor assessment!

If your infant is between birth and 10 months of age, you are eligible to participate in this study!

If you are interested, please contact **Samantha Doralp** at [redacted] or (519) 661-2111

The University of Western Ontario, Faculty of Health Sciences

Appendix 2-H

Letter of Information

Affordances in Infant Motor Development: The Onset of Purposeful Movement

Samantha Doralp (PhD Candidate, Rehabilitation Sciences, University of Western Ontario) (519) 661-2111 [redacted] and *Doreen Bartlett* (Associate Professor, Faculty of Health Sciences, University of Western Ontario) (519) 661-2111 [redacted]

You are being invited to participate in this research project which aims to recruit 300 infants and their families. This letter contains information to help you decide whether to participate in this study with your infant.

Purpose of the Project: The purpose of this study is to provide information about the relationship between the home environment, infant characteristics, and motor development. How these variables interact to influence the development of purposeful movement is still largely unknown. We hope to develop a model of early motor development that has the potential to account for this large degree of variation seen in infants between the ages of 4 and 10 months. Through a solid understanding of normal motor development, we seek to ultimately better inform early and effective therapeutic intervention for infants who are not acquiring independent functional movement.

Research Involvement: You are eligible for this study if you are a parent with an infant (birth - 10 months) attending an agency in the London area that provides programs or services for young children and families and are fluent in speaking and reading English. You are not eligible to participate if you are not fluent in reading and speaking English or your child is over the age of 10 months.

This project involves two components. First, you will be asked to complete a set of five questionnaires that ask information about you, your family and your infant. The second portion involves an interview and a motor assessment, which will take approximately 30-45 minutes and will take place at the Ontario Early Years Centre most convenient for you. If you agree to take part in this study, we will provide you with a package containing the questionnaires which you can complete at a time that is convenient to you. We anticipate that you will be able to complete these questionnaires within an hour.

The interview and assessment will be arranged with Samantha Doralp, a PhD candidate in the Faculty of Health Sciences at The University of Western Ontario. During this session, she will complete three questionnaires that ask questions about your infant's home environment and equipment use, as well as your baby's health status. She will also complete an observational motor development assessment. At this session, the package containing the questionnaires will be collected from you. Attached to this letter is the consent form. All information you provide will be considered confidential. You will not be identified by name in any report or publication arising from the study.

You might also be asked to participate in the testing of the reliability of the motor development assessment. If you agree to participate, the motor development assessment (20-30 minutes of the session) will be videotaped. This videotaping will occur at the Ontario Early Years Centre. You may choose to consent to the videotaping or refuse to participate in the videotaping component without withdrawing from the study. The videotapes are confidential and will only be viewed by one independent assessor. Following this, the video will be deleted. In addition, a sub sample of 30 families will be asked to participate in the test-retest reliability of two new measures relating to early motor development. An additional Infant Characteristic Questionnaire will be provided to you at the assessment and you will be asked to complete it 1 week following the assessment and mail it back to the investigator in the provided stamped and addressed envelope. Completion of the questionnaire will take 20 minutes and can be completed at a convenient time to you. A brief (10-15 minutes) phone interview will also be set up, during which time the investigator will complete the Environmental Opportunities Questionnaire with you on a second occasion.

Considerations: Participation in this study is voluntary. You may refuse to participate, refuse to answer any questions on the questionnaires, or withdraw from the study at any time with no effect on your relationship with the researchers or your service providers at the Ontario Early Years Centre.

Privacy: The opinions and ideas collected from the questionnaires will be stored in a secure location. If the results of the study are published, your name will not be used. No information that discloses your identity will be released or published. Representatives of The University of Western Ontario Health Sciences Research Ethics Board may contact you or require access to your study-related records to monitor the conduct of the research.

Benefits: Through participation in this study, you are given the opportunity to participate in an informative study about early motor development. You will not benefit directly from participation in this research; however, the larger study does have the potential to improve future developmental care for infants. You will receive a certificate upon completion of the study highlighting your child's successful completion of the study.

Risks: There are no known risks to participating in this study. You do not waive any legal rights by signing the consent form.

Other Pertinent Information: If you are participating in another study at this time, please inform a member of the research team to determine whether it is appropriate for you to participate in this study.

If you have any questions about the study, or would like additional information to assist you in reaching a decision about participating, please contact Doreen Bartlett at (519) 661-2111 [redacted] or Samantha Doralp at (519) 661-2111 [redacted]

If you have any questions about your rights as a research subject, you may contact:
Director of the Office of Research Ethics
University of Western Ontario
(519) 661-3036.
ethics@uwo.ca

This letter is yours to keep for your future reference. If you agree to participate in this study, please sign the attached consent form, and provide a phone number, email, and mailing address so we may contact you. Please return the consent form to us either in person at the Ontario Early Years Centre or in the provided stamped and addressed envelope.

Thank you in advance for your interest.

Yours Sincerely,
Samantha Doralp Doreen Bartlett

Consent Form

Affordances in Infant Motor Development: The Onset of Purposeful Movement
Investigators: Samantha Doralp, MSc, Doreen Bartlett, PT, PhD

I have read the accompanying letter of information, have had the nature of the study explained to me, and I agree to participate. All questions have been answered to my satisfaction.

_____	_____	_____
(Name; please print)	(Signature)	(Date)

Parent/ Primary Caregiver of _____
(Child's name)

_____	_____	_____
(Name of person obtaining informed consent)	(Signature of person obtaining informed consent)	(Date)

Contact Information

Name: _____

Address: _____
(street address, apartment number)

_____ Postal Code: _____
(city)

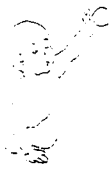
Phone Number: (_____) _____

Email (optional): _____

☐ I would like to participate in the reliability testing for the motor development assessment.

☐ I would like to participate in the test-retest reliability of the two new infant measures.

Appendix 2-I



Environmental Opportunities Supporting Motor Development Questionnaire

Start time: _____ Age of your Baby:_____ Date: _____

Pose the following questions to parents during an interview.

"During this interview, I am going to ask you questions about your home environment, your child's play space, and the things you do with your child. Please answer honestly. There is no right or wrong answers. If the question indicates something that you do with your child, before you answer, please think about how often it applies to you and your child. If you need some clarification or an example, please feel free to ask."

Each question should be rated as follows, using the description that best fits:

5 = to a great extent/ always	4 = to a moderate extent/ often	3 = to a fair extent/ sometimes	2 = to a small extent/ rarely	1 = not at all/ never	0 = not applicable

	5	4	3	2	1	0
1. Does your baby have the opportunity to interact with others during playtime?	○	○	○	○	○	○
2. Do you set aside a specific time to play with your baby?	○	○	○	○	○	○
3. Does it make you nervous when your baby engages in new or different activities?	○	○	○	○	○	○
4. Does your baby have access to a *variety* of stationary toys?	○	○	○	○	○	○
5. Does your baby have access to a *variety* of movement-related toys?	○	○	○	○	○	○
6. Do you encourage activities or play that will help your baby develop? • For example, encouraging play that involves movement and action.	○	○	○	○	○	○
7. Do you alter your level of involvement to suit the developmental needs of your baby? • For example, you help your baby or facilitate motor movement, such as helping your baby when they are having difficulty, or you may choose to help your baby in order to make things easier.	○	○	○	○	○	○
8. Do you have expectations of your baby when you provide a toy or engage in activities with your baby? • For example, introducing a toy to get your baby to perform a specific activity.	○	○	○	○	○	○
9. Do you encourage your baby to sit independently?	○	○	○	○	○	○
10. Does your baby have access to space that is well-suited to the level of movement he or she engages in? • For example, the layout of your home is set up to facilitate movement or	○	○	○	○	○	○

make movement easy or hard.						
11. Is your baby free to move in any space within the house, assuming that the space is safe?	○	○	○	○	○	○
12. Does your baby have access to more than one type of floor texture (carpet, wood, tile, linoleum, etc.)?	○	○	○	○	○	○
13. Does your baby have access to furniture for pulling up to a standing position?	○	○	○	○	○	○
14. Does your baby have access to furniture that permits stepping sideways while holding on?	○	○	○	○	○	○
15. Does your baby have access to furniture that is sufficiently far apart to facilitate walking movements?	○	○	○	○	○	○
16. Does your baby have access to furniture that permits climbing or stepping (such as sofas, small tables, chairs, etc.)?	○	○	○	○	○	○
17. Do you modify the play space to suit the needs of your baby?	○	○	○	○	○	○
18. Are the toys accessible to your baby so that he or she may choose when or with what to play?	○	○	○	○	○	○
19. Do you encourage your baby to play with toys that challenge him or her to develop new motor skills? (For example, by attending to or providing specific toys).	○	○	○	○	○	○
20. Overall, is your baby free to choose an activity by him or herself? • For example, the opposite would be that you prefer to select the activity.	○	○	○	○	○	○
21. Do your baby's clothes get in the way or interfere with movement? • For example, long pants dragging on the ground or socks coming off and making movement difficult.	○	○	○	○	○	○
22. Is your baby barefoot in the house?	○	○	○	○	○	○

"I just have two questions for you in addition to the questions above (using the same scale as above).

- Do you feel knowledgeable about your child's motor development? _____
- Are you aware of what your baby wants to do at a particular time? _____
  For example, although you are encouraging your baby to read, your baby wants to play with toys.
- If so, do you follow through with what your baby wants or do you adhere to what you were doing?" _____

"Thank you for taking the time to complete this questionnaire."

Appendix 2-J
Detailed listing of items generated during Phase I
for the Environmental Opportunities Questionnaire.

Existing Items	*New or Generated Items*
	Interaction with Others (6 items)
(HOME 19) Family has a pet (HOME 20) Child care, if used, is provided by one of three regular substitutes (HOME 35) Parent keeps child in visual range, looks at often (AHEMD 1) How many adults live in the family house? (AHEMD 21) Does your child play with other children as a usual and ordinary every day event? (AHEMD 22) During the day, do you or your husband/wife usually have a daily special time for playing with your child?	▪ Infant is surrounded by regular caregivers ▪ Family has a pet ▪ How many others live in the family house (include parents, siblings, family, and others that may regularly interact with the infant) ▪ Does your infant regularly interact with others during playtime? ▪ Do you have a special time for play with your child ▪ Do you choose to engage in play with your infant spontaneously?
	Communication with Others (2 items)
(HOME 2) Parent responds verbally to child's vocalizations or verbalizations (HOME 3) Parent tells child name of object or person during visit (HOME 4) Parent's speech is distinct, clear and audible (HOME 9) Parent's voice conveys positive feelings toward child	▪ Parent spontaneously vocalizes to child positively in response to movement ▪ Communication involves an interactive component with child (ie. eye contact or physical contact)
	Parental Regulation (2 items)
(HOME 7) Parent permits child to engage in 'messy' play (HOME 17) Parent does not interfere with or restrict child 3 times during visit (HOME 39) Parent structures child's play periods	▪ Parent does not restrict infant from engaging in new or different activity. ▪ Parent does not interfere with (safe) play/movement
	Parental Expectations/Involvement (7 items)
(AHEMD 27) Do you usually try to encourage your child to reach and grasp objects? (AHEMD 28) Do you usually try to engage your child in movements, games, or actions in order to each her/him parts of the body? (HOME 29) Parent provides toys for child to play with during visit (HOME 37) Parent consciously encourages developmental advance (HOME 38) Parent invests maturing toys with value via personal attention	▪ Do you encourage your child to move and engage in play that involves movement and action? ▪ Does the parent provides infant with toys (both static and movement related) ▪ Does child provide self with toys to play with? ▪ Parent consciously encourages developmental advance ▪ Do you alter your involvement to suit the developmental needs of your infant? ▪ Parent provides toy/engages in activity with expectation ▪ Parent introduces toy to get infant to perform specific activity

	Available Space (4 items)
(AHEMD 10) Inside your house, is there enough space for your child to play or move around freely? (AHEMD 38) How do you consider the living space inside your house? (AHEMD 35) On a typical day, how often is the child restrained to a specific space in the floor? (AHEMD 36) On a typical day, how often is the child free to move in any space of the house? (CHIEF 5) How often has the natural environment (temperature, terrain, climate) made it difficult for what your adolescent want or needs to do? (CHIEF 2) How often has the design and layout of your home made it difficult for what your adolescent wants or needs to do?	▪ The available space is conducive to the level of movement the infant engages in ▪ Is the infant free to move in any space of the house? ▪ How much time does the child spend in a specific space on the floor? ▪ How often has the layout of your home/space made it difficult for your infant to move or engage in activity?
	Layout of Space (8 items)
(AHEMD 11) Inside your house, is there more than one type of ground texture (carpet, wood, tile, linoleum, etc)? (AHEMD 13) Inside your house, is there any furniture or apparatus that your child can grasp and hang from safely? (AHEMD 14) Inside your house, is there any furniture or apparatus for your child to pull self up to a standing position? (AHEMD 15) Inside your house, is there any furniture or apparatus that permits child to pull-up and step sideway for at least three steps while holding? (AHEMD 16) Inside your house, are there any stairs? (AHEMD 17) Inside your house, is there any furniture or apparatus that permits your child to climb on/off and step or fall from (examples are sofas, small tables, chair, etc)?	▪ Is there more than one type of ground texture accessible to the infant (carpet, wood, tile, linoleum, etc)? ▪ Is there any furniture that your infant can grasp and hang onto safely? ▪ Is there any furniture for your child to pull up to a standing position? ▪ Is the any furniture that permits your infant to step sideways while holding on? ▪ Is there any furniture sufficiently far apart to facilitate walking movements? ▪ Is there any furniture that permits your infant to climb on/off and step or fall from (e.g. Sofas, small tables, chairs, etc)? ▪ Are there any stairs in the house? ▪ Does the space support the next level of independent purposeful movement (sitting to standing, supine to sitting)?
	Play Space (3 items)
(AHEMD 19) Inside your house, is there a playroom (compartment used only for kids to play? (AHEMD 37) How do you assess the lighting inside your house?	▪ Does the infant have a specific play space? ▪ How is the lighting inside the playspace? ▪ How often do you modify the play space (to suit the developmental needs of your infant)?
	Availability of Toys (3 items)
(HOME 24) Child has a special place for toys and treasures (AHEMD 20) Inside your house, is there a special place for toys that is accessible to the child so that s/he may choose when and with what to play (toy bins, drawers, or shelves)?	▪ The infant has a special place for toys and learning materials ▪ Are the toys accessible to the infant so that s/he may choose when and with what to play? ▪ How many toys are accessible/available during play time?

	Variety of Toys (2 items)
(HOME 26) Muscle activity toys or equipment (HOME 27) Push or pull toy (HOME 28) Stroller or walker, kiddie car, scooter or tricycle (HOME 30) Cuddly or role-playing toys (HOME 31) Learning facilitators – mobile, table and chair, high chair, play pen (HOME 32) Simple hand-eye coordination toys (HOME 33) Complex hand-eye coordination toys	▪ There are a variety of toys available to the infant during play times (both static and movement related, encourage the limits of stability) ▪ How often to you introduce a new toy to your infant?
	Challenge of Toys (3 items)
(HOME 40) Parent provides toys that challenge child to develop new skills	▪ How often do you introduce new and developmentally challenging toys? ▪ Parent attends to toys that challenge the infant to develop new skills ▪ Parent provides toys that challenge
	Opportunity for Exploration (3 items)
(AHEMD 24) When playing, is your child always allowed to choose the toys or physical activities by herself? (AHEMD 25) Does your child usually wear clothes that allow freedom to move and explore? (AHEMD 26) Is your child often barefoot in the house?	▪ Is your infant free to choose the toys or physical activities by herself? ▪ Does your child usually wear clothes that allow freedom to move and explore? ▪ Is your child often barefoot in the house?
	TOTAL: 43 items

Appendix 2-K
Items for First Draft of Environmental Opportunities Questionnaire from Phase I.

	Generated Item	*Source*	*Modifications made to original item*
1	Does your infant interact with others during playtime?	AHEMD 21	Modified to relate specifically to playtime
2	Do you set aside a specific time to play with your infant?	AHEMD 22	Slightly modified from original
3	Do you engage in spontaneous play with your infant?	NEW	Developed from observations of parents and their infants during a play session
4	Do you respond spontaneously to your infant in a positive way when he or she is trying a new or difficult movement?	HOME 9	Modified to reflect parental reactions towards actions of the child
5	Does communication between you and your infant involve an interactive component (such as eye contact or physical contact)?	NEW	Developed from observations of parents and their infants during a play session
6	Do you restrict your infant from engaging in new or different activities?	HOME 17	Modified to be more general and related to movement
7	Are you very cautious when your infant engages in safe play or movement?	NEW	Developed from observations of parents and ideas around opportunities for infants
8	Do you encourage your infant to engage in play that involves movement and action?	AHEMD 27	Modified to be less specific and relate to movement
9	Do you provide your infant with a variety of toys (both stationary and movement related)?	HOME 38 AHEMD 26-33	Modified to reflect variety of toys (not quantity or specific style)
10	Do you encourage activities or play that will help your infant develop?	HOME 37	Modified to fit scale of EOQ
11	Do you alter your level of involvement to suit the developmental needs of your infant?	NEW	Developed from observations of parents with their infants
12	Do you have expectations of your infant when you provide a toy or engage in activities?	NEW	Developed from interviews with parents during assessments of infants
13	Do you introduce a toy to get your infant to perform a specific activity?	AHEMD 28	Modified to relate to movement in a general way
14	Does your infant have access to space that is well-suited to the level of movement he or she engages in?	AHEMD 10	Modified to consider developmental level of infant
15	Is your infant free to move in any space within the house?	AHEMD 36	Modified slightly
16	Has the layout of your home made it difficult for your infant to move or engage in activity?	CHIEF 5	Modified for an infant
17	Does your infant have access to more than one type of floor texture (carpet, wood, tile, linoleum, etc)?	AHEMD 11	Modified to fit scale of EOQ
18	Does your infant have access to furniture that can be held onto safely?	AHEMD 13	Modified to fit scale of EOQ
19	Does your infant have access to furniture for pulling up to standing position?	AHEMD 14	Modified to fit scale of EOQ
20	Does your infant have access to furniture that permits stepping sideways while holding on?	AHEMD 15	Modified to fit scale of EOQ

21	Does your infant have access to furniture that is sufficiently far apart to facilitate walking movements?	NEW	Developed from observations of infants
22	Does your infant have access to furniture that permits climbing or stepping (eg. Sofas, small tables, chairs, etc)?	AHEMD 17	Modified to fit scale of EOQ
23	Does your infant have access to space that supports the next stage of movement/development? (sitting to standing, supping to sitting)?	NEW	Developed from a combination of items to consider developmental stage of infant
24	Do you modify the play space to suit the needs of your infant?	NEW	Developed from comments and ideas from parents during observations of infants
25	Are the toys accessible to your infant so that he/she may choose when or with what to play?	AHEMD 20	Modified to fit scale of EOQ
26	Is there a variety of toys available to your infant during play times (both stationary and movement related)?	AHEMD 26-33	Combination of items to reflect variety of toys
27	Do you encourage your infant to play with toys that challenge him or her to develop new motor skills? (ie. by attending to or providing specific toys)	HOME 40	Modified to fit scale of EOQ
28	Is your infant free to choose the toys or physical activities by him/herself?	AHEMD 24	Modified to fit scale of EOQ
29	Does your infant wear clothes that allow freedom to move and explore?	AHEMD 25	Modified to fit scale of EOQ
30	Is your infant barefoot in the house?	AHEMD 26	Modified to fit scale of EOQ

Appendix 2-L
Reasoning for Item Deletion and Modification (indicated in bold) following Phase II for the Environmental Opportunities Questionnaire

	Item Generated from Phase I	*Result of Phase II*	*Reasoning or Newly Modified Item*
1	Does your infant interact with others during playtime?	Modified wording	Does your **baby have the opportunity** to interact with others during playtime?
2	Do you set aside a specific time to play with your infant?	Modified wording	Do you set aside a specific time to play with **your baby**?
3	Do you engage in spontaneous play with your infant?	**Deleted**	Mean 4.63 is very high, all responded on high end of scale (range 3-5); Reduced internal consistency
4	Do you respond spontaneously to your infant in a positive way when he or she is trying a new or difficult movement?	**Deleted**	The majority of parents responded with a '5' indicating no discrimination; Mean 4.74 (range 4-5)
5	Does communication between you and your infant involve an interactive component (such as eye contact or physical contact)?	**Deleted**	The majority of parents responded with a '5' indicating no discrimination; Mean 4.89 (range 4-5)
6	Do you restrict your infant from engaging in new or different activities?	Modified wording	**Does it make you nervous when your baby** engages in new or different activities?
7	Are you very cautious when your infant engages in safe play or movement?	**Deleted**	Similar to item 6; Parents stated that they had difficulty judging this question
8	Do you encourage your infant to engage in play that involves movement and action?	**Deleted**	Reduced internal consistency; Mean of 4.74 is very high, all responded on the high end of scale (range 3-5); Highly correlated with item 10 (r = 0.90)
9	Do you provide your infant with a variety of toys (both stationary and movement related)?	Separated into two separate items	Does **your baby have access to** a variety of stationary toys? Does **your baby have access to** a variety of movement-related toys? (modified based on suggestions of external reviewer)
10	Do you encourage activities or play that will help your infant develop?	Modified wording	Do you encourage activities or play that will help **your baby** develop?
11	Do you alter your level of involvement to suit the developmental needs of your infant?	Modified wording	Do you alter your level of involvement to suit the developmental needs of **your baby**?
12	Do you have expectations of your infant when you provide a toy or engage in activities?	Modified wording	Do you have expectations of **your baby** when you provide a toy or engage in activities **with your baby**?
13	Do you introduce a toy to get your infant to perform a specific activity?	**Deleted**	Reduced internal consistency; Highly correlated with items 12 (r = 0.88) and 24 (r = 0.90)
14	Does your infant have access to space that is well-suited to the level of movement he or she engages in?	Modified wording	Does your **baby** have access to space that is well-suited to the level of movement he or she engages in?
15	Is your infant free to move in any space within the house?	Modified wording	Is your **baby** free to move in any space in the house, **assuming that the space is safe**? (modified based on comments by parents)

16	Has the layout of your home made it difficult for your infant to move or engage in activity?	**Deleted**	Opposite to item 14
17	Does your infant have access to more than one type of floor texture (carpet, wood, tile, linoleum, etc)?	Modified wording	Does your **baby** have access to more than one type of floor texture (carpet, wood tile, linoleum, etc.)?
18	Does your infant have access to furniture that can be held onto safely?	**Deleted**	Highly correlated with item 19 (r = 0.84); Mean 4.17 is moderately high
19	Does your infant have access to furniture for pulling up to standing position?	Modified wording	Does your **baby** have access to furniture for pulling up to a standing position?
20	Does your infant have access to furniture that permits stepping sideways while holding on?	Modified wording	Does your **baby** have access to furniture that permits stepping sideways while holding on?
21	Does your infant have access to furniture that is sufficiently far apart to facilitate walking movements?	Modified wording	Does your **baby** have access to furniture that is sufficiently far apart to facilitate walking movements?
22	Does your infant have access to furniture that permits climbing or stepping (eg. Sofas, small tables, chairs, etc)?	Modified wording	Does your **baby** have access to furniture that permits climbing or stepping (**such as** sofas, small tables, chairs, etc.)?
23	Does your infant have access to space that supports the next stage of movement/development? (sitting to standing, supping to sitting)?	**Deleted**	Highly correlated with item 14 (r = 0.87); Mean 4.33 is moderately high;
24	Do you modify the play space to suit the needs of your infant?	Modified wording	Do you modify the play space to suit the needs of your **baby**?
25	Are the toys accessible to your infant so that he/she may choose when or with what to play?	Modified wording	Are the toys accessible to your **baby** so that he **or** she may choose when or with what to play?
26	Is there a variety of toys available to your infant during play times (both stationary and movement related)?	**Deleted**	Similar to item 9; Mean 4.28 is moderately high
27	Do you encourage your infant to play with toys that challenge him or her to develop new motor skills? (ie. by attending to or providing specific toys)	Modified wording	Do you encourage your **baby** to play with toys that challenge him or her to develop new motor skills? (**For example**, by attending to or providing specific toys).
28	Is your infant free to choose the toys or physical activities by him/herself?	Modified wording	**Overall**, is your **baby** free to choose **an activity** by him **or** herself?
29	Does your infant wear clothes that allow freedom to move and explore?	Modified wording	**Do your baby's clothes get in the way or interfere with movement? (For example, long pants dragging on the ground or socks coming off and making movement difficult.)**
30	Is your infant barefoot in the house?	Modified wording	Is your **baby** barefoot in the house?
*	**NEW ITEM**: Do you encourage your baby to sit independently?	**Added**	Based on observations during pilot testing
*	**NEW ITEM**: Do you feel knowledgeable about your child's motor development?	**Added**	Based on comments from parents during pilot testing about their confidence level
*	**NEW ITEM**: Are you aware of what your baby wants to do at a particular time?	**Added**	Based on comments from parents during pilot testing

*	**NEW ITEM:** If so, do you do you follow through with what your baby wants to do or do you adhere to what you were doing?	**Added**	Based on observations of parents with their infants during pilot testing

Appendix 2-M

Environmental Opportunities Supporting Motor Development Questionnaire © Doralp and Bartlett, 2007 (revised)

Age of your Baby:_____ Date: _____

Pose the following questions to parents during an interview.

"During this interview, I am going to ask you questions about your home environment, your child's play space, and the things you do with your child. Please answer honestly. There is no right or wrong answers. If the question indicates something that you do with your child, before you answer, please think about how often it applies to you and your child. If you need some clarification or an example, please feel free to ask."

Each question should be rated as follows, using the description that best fits:

5 = to a great extent/ always	**4 = to a moderate extent/ often**	**3 = to a fair extent/ sometimes**	**2 = to a small extent/ rarely**	**1 = not at all/ never**	**0 = not applicable**

	5	**4**	**3**	**2**	**1**	**0**
2. Do you set aside a specific time to play with your baby?	o	o	o	o	o	o
3. Does it make you nervous when your baby engages in new or different activities?	o	o	o	o	o	o
4. Does your baby have access to a *variety* of stationary toys?	o	o	o	o	o	o
5. Does your baby have access to a *variety* of movement-related toys?	o	o	o	o	o	o
6. Do you encourage activities or play that will help your baby develop? a. For example, encouraging play that involves movement and action.	o	o	o	o	o	o
7. Do you alter your level of involvement to suit the developmental needs of your baby? a. For example, you help your baby or facilitate motor movement, such as helping your baby when they are having difficulty, or you may choose to help your baby in order to make things easier.	o	o	o	o	o	o
9. Do you encourage your baby to sit independently?	o	o	o	o	o	o
10. Does your baby have access to space that is well-suited to the level of movement he or she engages in? a. For example, the layout of your home is set up to facilitate movement or make movement easy or hard.	o	o	o	o	o	o

11. I s your baby free to move in any space within the house, assuming that the space is safe?	o	o	o	o	o	o
12. Doe s your baby have access to more than one type of floor texture (carpet, wood, tile, linoleum, etc.)?	o	o	o	o	o	o
13. Does your baby have access to furniture for pulling up to a standing position?	o	o	o	o	o	o
14. Does your baby have access to furniture that permits stepping sideways while holding on?	o	o	o	o	o	o
15. Does your baby have access to furniture that is sufficiently far apart to facilitate walking movements?	o	o	o	o	o	o
16. Does your baby have access to furniture that permits climbing or stepping (such as sofas, small tables, chairs, etc.)?	o	o	o	o	o	o
17. Do yo u modify the play space to suit the needs of your baby?	o	o	o	o	o	o
18. Are t he toys accessible to your baby so that he or she may choose when or with what to play?	o	o	o	o	o	o
19. Do yo u encourage your baby to play with toys that challenge him or her to develop new motor skills? (For example, by attending to or providing specific toys).	o	o	o	o	o	o
20. Overall, i s your baby free to choose an activity by him or herself? a. For example, the opposite would be that you prefer to select the activity.	o	o	o	o	o	o
21. D o your baby's clothes get in the way or interfere with movement? a. For example, long pants dragging on the ground or socks coming off and making movement difficult.	o	o	o	o	o	o
22. I s your baby barefoot in the house?	o	o	o	o	o	o
23. Do yo u feel knowledgeable about your child's motor development?	o	o	o	o	o	o
24. Are you aware of what your baby wants to do at a particular time?						

"Thank you for taking the time to complete this questionnaire."

Appendix 3-A

Infant Characteristics Supporting Motor Development Questionnaire for Parents

Start time: _____ Age of your Infant:_____ Date: _____

In the following questionnaire you are asked 75 questions about your infant, his or her social interactions, style of play, and level of activity. When completing these questions, please consider the typical behaviour of your child and how he or she usually plays and interacts with his or her surroundings. The questions address aspects of movement. ***Please make note of any questions that you find difficult to understand, or that you simply do not like. Feel free to write on the questionnaire.*** *Please read each question carefully and select one of the response options (to a great extent, to a moderate extent, to a fair extent, to a small extent, not at all, or not applicable) to answer each of the questions. Thank you!*

To what extent—	to a great extent	to a moderate extent	to a fair extent	to a small extent	not at all	not applicable
1. Is your infant active (for example, waving arms, legs, and so on.) while in one position (such as sitting, lying position, and so on)?	○	○	○	○	○	○
2. Does your infant test his or her limits of balance while in one position? (For example, reaching out to a far toy while sitting).	○	○	○	○	○	○
3. Does your infant test his or her limits of balance while trying to move from one position or place to another? (For example, rocking back and forth when in the crawling position).	○	○	○	○	○	○
4. Does your infant move around during 'quiet' play time? (For example, when you are reading to him or her).	○	○	○	○	○	○
5. Does your infant move around (such as bouncing, waving arms, and so on) during 'active' play time? (Where active play may involve playing games or playing with toys).	○	○	○	○	○	○
6. Does your infant move around (such as bouncing, waving arms, and so on) while playing alone?	○	○	○	○	○	○
7. Does your infant reach for objects within his or her reach?	○	○	○	○	○	○
8. Does your infant try to grasp objects that are out of reach?	○	○	○	○	○	○
9. Does your infant actively play with you?	○	○	○	○	○	○
10. Does your infant actively participate in situations, overall?	○	○	○	○	○	○
11. Does your infant actively play with others?	○	○	○	○	○	○
12. Does your infant vary his or her activity level according to the situation?	○	○	○	○	○	○

To what extent—	to a great extent	to a moderate extent	to a fair extent	to a small extent	not at all	not applicable
13. Does your infant complete activities that he or she has started? (For example, getting to a toy that he or she was interested in).	○	○	○	○	○	○
14. Does your infant seem to enjoy physical activity?	○	○	○	○	○	○
15. Does your infant seem to accept changes in place or position? (Such as not crying, and so on).	○	○	○	○	○	○
16. Is your infant's initial reaction to a new situation withdrawal?	○	○	○	○	○	○
17. Is your infant fretful for the first few minutes in a new place or situation?	○	○	○	○	○	○
18. Does your infant accept a change in place or situation within a few minutes?	○	○	○	○	○	○
19. Does your infant react appropriately to new situations or tasks as necessary? (For example, cautious if it is different or difficult, and comfortable if it is familiar and easy).	○	○	○	○	○	○
20. Does your infant try new ways of handling new or difficult situations?	○	○	○	○	○	○
21. Is your infant shy when meeting another person for the first time?	○	○	○	○	○	○
22. Is your infant's first reaction to a new person or stranger rejection (such as crying, clinging to you, and so on)?	○	○	○	○	○	○
23. Does your infant seem aware of changes in his or her surroundings? (For example, looking up when someone enters the room).	○	○	○	○	○	○
24. Does your infant inspect changes in her or her surroundings? (For example, looking around when in a new room).	○	○	○	○	○	○
25. Does your infant explore new objects?	○	○	○	○	○	○
26. Does your infant try new behaviours on his or her own?	○	○	○	○	○	○
27. Does your infant initiate exploration of his or her own body or objects using a variety of strategies? (For example, rolling a toy along the ground and also trying to bang it on the ground).	○	○	○	○	○	○
28. Does your infant respond to a variety of visual stimuli?	○	○	○	○	○	○
29. Does your infant use a variety of behaviours to respond to others?	○	○	○	○	○	○
30. Does your infant adapt his or her movements in response to specific situations?	○	○	○	○	○	○

To what extent—	to a great extent	to a moderate extent	to a fair extent	to a small extent	not at all	not applicable
31. Does your infant change behaviour when necessary to solve a problem or achieve a goal?	○	○	○	○	○	○
32. Does your infant tolerate being in a variety of positions (such as lying on his or her stomach, sitting, and so on)?	○	○	○	○	○	○
33. Does your infant seem to accept being moved by others?	○	○	○	○	○	○
34. Does your infant demonstrate an awareness that his or her own behaviour has an effect on people or objects?	○	○	○	○	○	○
35. Does your infant test his or her limitations of physical movement?	○	○	○	○	○	○
36. Does your infant anticipate events? (For example, reaching out to catch self if falling down when trying to walk).	○	○	○	○	○	○
37. Does your infant greet a *familiar* toy with eagerness?	○	○	○	○	○	○
38. Does your infant greet a *new* toy with eagerness?	○	○	○	○	○	○
39. Does your infant react mildly (such as quiet smiles or no response) to meeting unfamiliar people?	○	○	○	○	○	○
40. Is your infant pleasant when first arriving in an unfamiliar place? (By pleasant, we mean not crying or being fussy).	○	○	○	○	○	○
41. Does your infant make happy sounds and gestures while playing with toys?	○	○	○	○	○	○
42. Does your infant play quietly with toys?	○	○	○	○	○	○
43. Does your infant make happy sounds or gestures while playing with you or others?	○	○	○	○	○	○
44. Does your infant remain content following interruptions of playtime?	○	○	○	○	○	○
45. Does your infant try to get included when others are playing?	○	○	○	○	○	○
46. Does your infant try to start playing with others?	○	○	○	○	○	○
47. Does your infant smile broadly or show excitement after finishing something or making something happen?	○	○	○	○	○	○
48. Does your infant get excited when he or she figures something out?	○	○	○	○	○	○

To what extent—	to a great extent	to a moderate extent	to a fair extent	to a small extent	not at all	not applicable
49. Does your infant demonstrate pleasure (delight, happiness, enjoyment) in self-initiated body movement?	○	○	○	○	○	○
50. Does your infant demonstrate pleasure (delight, happiness, enjoyment) in sensory exploration? (By sensory exploration, we mean exploration by touching objects, moving around, looking around, and so on).	○	○	○	○	○	○
51. Does your infant get frustrated when he or she cannot do something?	○	○	○	○	○	○
52. Does your infant balance independent behaviour with necessary dependence on adults to accomplish tasks (such as walking, getting to a toy, and so on)?	○	○	○	○	○	○
53. Does your infant stay focused or engaged in tasks? (For example, while retrieving objects).	○	○	○	○	○	○
54. Does your infant stay focused on people or objects?	○	○	○	○	○	○
55. Does your infant ignore voices or other ordinary sounds when playing with a favourite toy?	○	○	○	○	○	○
56. Does your infant focus on a new toy, person or activity for less than a minute before looking elsewhere for another activity?	○	○	○	○	○	○
57. Does your infant stay continuously engaged or focused on a *new* toy or person or activity for 10 minutes or more?	○	○	○	○	○	○
58. Does your infant explore all parts of a *new* object or toy before doing something else?	○	○	○	○	○	○
59. Does your infant focus on a *familiar* toy or person or activity for under a minute and then look elsewhere for another activity?	○	○	○	○	○	○
60. Does your infant play continuously (more than 10 minutes) with a favourite toy?	○	○	○	○	○	○
61. Does your infant pay attention for only a minute to a familiar game with you?	○	○	○	○	○	○
62. When playing, does your infant stop play and watch when something in the environment changes? (For example, someone is walking by, door closing, noises, and so on).	○	○	○	○	○	○
63. Does your infant watch another toy when offered even though he or she is already holding one?	○	○	○	○	○	○
64. Is your infant persistent when trying a new activity or skill? (By persistent, we mean repeating a new skill).	○	○	○	○	○	○

To what extent—	to a great extent	to a moderate extent	to a fair extent	to a small extent	not at all	not applicable
65. Does your infant try to do things, even if it takes him or her a long time?	○	○	○	○	○	○
66. Does your infant try tasks even when they are difficult?	○	○	○	○	○	○
67. Does your infant give up if he or she cannot complete a physical task? (such as climb up stairs, crawl across the floor, pull up onto something, and so on).	○	○	○	○	○	○
68. Does your infant quickly recover after stressful situations?	○	○	○	○	○	○
69. Does your infant give up when reaching for a desired toy that is out of range?	○	○	○	○	○	○
70. Does your infant give up when attempting a difficult task or playing with a complex toy?	○	○	○	○	○	○
71. Does your infant give up on tasks when playing with or being assisted by adults?	○	○	○	○	○	○
72. Does your infant give up on tasks when playing alone?	○	○	○	○	○	○
73. Does your infant show frustration after failing at something that he or she has tried hard to do?	○	○	○	○	○	○
74. Does your infant attempt physical activities even when they are difficult?	○	○	○	○	○	○
75. Does your infant prefer difficult tasks over easy ones?	○	○	○	○	○	○

End time: _____ Thank you for taking the time to complete our questionnaire!

Appendix 3-B

INFANT CHARACTERISTICS SUPPORTING MOTOR DEVELOPMENT QUESTIONNAIRE

Dear Parent,

Thank you for taking the time to complete the following questionnaire. Your help is very valuable to us! At the end of this project, we hope to have a better understanding of the relationship between infant characteristics and early motor development. The following guidelines are to help you complete the questionnaire and ensure that you are answering as accurately as possible.

- Please fill out this questionnaire before your appointment, which is scheduled for

  _____ at _____ at the Ontario Early Years Centre.

- The questionnaire should take approximately 20 minutes to complete. You can complete it all at once, or at several different times, whatever is best for you.

- All of the questions are important. Each item begins with a question, followed in most cases by an example. We ask that you choose the answer that is the best fit.

- These questions are designed for infants aged 4 to 10 months of age. Not all questions will apply to your infant. If you feel the question does not apply, please answer '0' for not applicable.

- Please use the full range of the scale to answer questions. If your infant does a particular behaviour listed in a question, you can answer in the 1 -5 range, with an answer of '5' or 'to a great extent' meaning that your infant is the extreme of that case.

- The questions are **not** about the time spent, but more about the intensity or degree to which your infant acts or responds when he or she has the opportunity.

If you have any questions about this questionnaire, do not hesitate to contact Samantha before your scheduled appointment.

519-661-2111 ext. 87459 or sdoralp@uwo.ca

Infant Characteristics Supporting Motor Development Questionnaire
(ICQ)

Age of your infant: _____ months Date: _____

5 = to a great extent 4 = to a moderate extent 3 = to a fair extent 2 = to a small extent 1 = not at all 0 = not applicable

START TIME: _____

To what extent—	5	4	3	2	1	0
1. **Does your infant move around (for example, waving arms, kicking legs, shifting weight around, etc.) while in one position?** • This is a general question directed towards the degree of movement you observe in your infant while he or she is in any one position (sitting, lying on back, etc.), during any type of play.	○	○	○	○	○	○
2. **Does your infant test his or her limits of balance while in one position?** • Your infant is showing initiative to move, for example, by rocking while in the sitting or crawling position, or by extending body to roll over.	○	○	○	○	○	○
3. **Does your infant try to grasp objects that are out of reach?**	○	○	○	○	○	○
4. **Is your infant an <u>active</u> participant during play with you or others?** • As an <u>active</u> participant, your infant will initiate some or most of the physical interactions during play time. A less active participant would mostly respond to other's actions or participate by observation.	○	○	○	○	○	○
5. **Does your infant complete activities that he or she has started?** • For example, rolling or crawling to a toy that he or she was interested in, or reaching and grasping a toy that he or she is interested in.	○	○	○	○	○	○
6. **Does your infant seem to accept changes in place or position?** • By 'accept', we mean not fussing or getting frustrated and generally tolerating the transition. For example, your infant is content after being moved to another location.	○	○	○	○	○	○
7. **Is your infant's initial reaction to a new or unfamiliar <u>situation</u> reservation?** • A new situation might include being in a new and unfamiliar place. Strong reservation might include crying and/or clinging to you. Slight reservation might include quieting down and being very cautious. No reservation would be observed as your infant being entirely comfortable	○	○	○	○	○	○
8. **Is your infant shy or reserved when meeting a new <u>person</u> for the first time?** • Strong reservation would be crying and clinging to you, while no reservation would be that your infant is comfortable and friendly with new people.	○	○	○	○	○	○

5 = to a great extent 4 = to a moderate extent 3 = to a fair extent 2 = to a small extent 1 = not at all 0 = not applicable

To what extent—	5	4	3	2	1	0
9. **Does your infant <u>prefer</u> to explore new surroundings or toys physically?** • For example, your infant is eager to inspect and explore new surroundings by crawling around a room or playing with a toy. (Please do not make adjustments for developmental stage).	○	○	○	○	○	○
10. **Does your infant <u>prefer</u> to explore new objects or environments visually, rather than through movement?** • For example, when presented with a new toy, your infant will look at it for a while before attempting to play with it, or your infant will visually inspect a new environment before moving around in it.	○	○	○	○	○	○
11. **Does your infant try new behaviours on his or her own?** • For example, when given the opportunity, your infant will try to crawl or roll over on his or her own without your assistance or involvement.	○	○	○	○	○	○
12. **Does your infant explore his or her own body or objects using a <u>variety</u> of strategies?** • For example, your infant will roll a toy along the ground and also try to bang it on the ground, or your infant will put their toes in their mouth as well as bang their feet on the ground. Or does your infant prefer to play with a toy in mostly one way.	○	○	○	○	○	○
13. **Does your infant adapt his or her movements for different situations?** • For example, you notice that he or she is cautious in difficult situations and at ease and comfortable in familiar situations, or that he or she varies his or her activity level (waving arms, kicking legs, etc) depending on the activity (reading, playing, etc.).	○	○	○	○	○	○
14. **Does your infant change behaviour or try something new when necessary to solve a problem or achieve a goal?** • For example, when handling new or difficult situations, or for example, if your infant is playing with a certain toy, he or she will try something different if what he or she is doing is not working. Another example is if your infant is having difficulty climbing up a new set of stairs and tries a new way to get up them.	○	○	○	○	○	○
15. **Does your infant tolerate being in a variety of positions?** • For example, during play time, your infant is content being placed in several different positions, such as sitting, on all fours or lying on his or her back or stomach, or moves into various positions him or herself.	○	○	○	○	○	○
16. **Does your infant demonstrate awareness that his or her own behaviour has an effect on people or objects?** • For example, playing with the TV remote to change the channel, or doing a certain activity that he or she knows you encourage and looking over to you after he or she accomplishes it.	○	○	○	○	○	○

5 =	4 =	3 =	2 =	1 =	0 =
to a great extent	to a moderate extent	to a fair extent	to a small extent	not at all	not applicable

To what extent— 5 4 3 2 1 0

17. **Does your infant anticipate events?** • For example, your infant will reach out to catch him or herself if failing down when trying to walk.	○	○	○	○	○	○
18. **Does your infant greet a *new* toy with eagerness?**	○	○	○	○	○	○
19. **Does your infant tolerate interruptions of playtime, even if it isn't what he or she wants?**	○	○	○	○	○	○
20. **Does your infant try to get included when others are playing or initiate play with others?** • If your infant is too young, does your infant seem interested in the play of others, seen as your infant observing others play with interest.	○	○	○	○	○	○
21. **Does your infant get excited when he or she figures something out?** • For example, smiling broadly, laughing, or showing excitement after finishing something or making something happen.	○	○	○	○	○	○
22. **Does your infant express delight or happiness in self-initiated body movement?** • For example, laughing and giggling when he or she crawls, rolls over or walks across the room.	○	○	○	○	○	○
23. **Does your infant express delight or happiness in sensory exploration?** • Sensory exploration means touching or tasting objects, moving around, looking around, etc.	○	○	○	○	○	○
24. **Does your infant get frustrated or discouraged when he or she cannot do something?** • For example, when your infant is having difficulty climbing up stairs, or getting to a toy that he or she wants, or being unable to reach a toy that is just out of arm's reach.	○	○	○	○	○	○
25. **Does your infant balance independent behaviour with necessary dependence on adults to accomplish tasks?** • For example, your infant will try a behaviour on his or her own before looking to you for support (if necessary).	○	○	○	○	○	○
26. **Does your infant focus or engage in tasks only briefly?** • For example, your infant will play with a particular toy or game for only a minute before looking for another toy.	○	○	○	○	○	○
27. **Does your infant ignore voices or other ordinary sounds when playing with a favourite toy?** • Your infant does not pay attention to distracting sounds or events in the background while playing.	○	○	○	○	○	○

5 =	4 =	3 =	2 =	1 =	0 =
to a great extent	to a moderate extent	to a fair extent	to a small extent	not at all	not applicable

To what extent—	5	4	3	2	1	0
28. **Does your infant explore <u>all or most</u> parts of a *new* object or toy before *doing something else*?**	○	○	○	○	○	○

29. Is your infant persistent when trying a new activity or skill? • For example, once your infant starts to roll/crawl/walk, he or she will repeatedly do the activity.	○	○	○	○	○	○
30. Does your infant try tasks even when they are difficult? • For example, your infant will attempt to get to a toy that is high on a shelf or far away from him/her.	○	○	○	○	○	○
31. Does your infant give up if he or she cannot complete a physical task? • For example, if you were to move a toy that he or she is interested in farther away from him or her, would he or she give up on reaching for the toy and look for another closer toy, or would he or she continue reaching for the toy.	○	○	○	○	○	○
32. Does your infant quickly recover after stressful situations? • For example, if your infant falls or bumps his or her head while trying something new, does he or she remain calm or quiet down quickly, or does he or she get very upset and cry.	○	○	○	○	○	○
33. Does your infant give up on tasks when playing with or being assisted by adults? • For example, your infant is less likely to give up if being assisted by you.	○	○	○	○	○	○

END TIME: _____

Thank you for taking the time to complete our questionnaire! ☺

Appendix 3-C
Detailed listing of items generated during Phase I for the Infant Characteristics Questionnaire

Existing Items	*New or Generated Items*
	Level of Activity (6 items)
(RITQ 4) The infant sits still while watching TV or other nearby activity (RITQ 12) The infant lies quietly in the bath (RITQ 17) The infant moves about much (kicks, grabs, squirms) during diapering and dressing (RITQ 30) The infant sits still (little squirming) while traveling in car seat or stroller (RITQ 33) The infant moves much (squirms, bounces, kicks) while lying awake in crib (RITQ 86) The infant lies still during procedures like hair brushing or nail cutting (RITQ 51) The infant moves about much during feedings (squirms, kicks, grabs) (RITQ 64) The infant shows much body movements (kicks, waves arms) when crying (RITQ 55) The infant lies still when asleep and wakes up in the same place (RITQ 79) The infant lies still and moves little while playing with toys (RITQ 95) The infant moves much and for several minutes or more when playing by self (kicking, waving arms and bouncing) (ECI 15) Child has an energy level that is forceful and vigorous (eg. the child has the energy to participate in activities	▪ The infant is active(testing limits of stability, waving arms, legs) while in one position (sitting, prone position) ▪ The infant is active (testing limits of stability, waving arms, legs) while moving from one position or place to another ▪ The infant is active during 'quiet' play time (e.g. Reading) ▪ The infant is active during 'active' play time (e.g. Playing games, playing with toys) ▪ The infant is very active (bouncing, waving arms) while playing with toys ▪ The infant is very active while playing with self
	Active versus Passive (7 items)
(RITQ 43) The infant plays actively with parents – much movement of arms, legs, body (RITQ 71) The infant actively grasps or touches objects within his/her reach (hair, spoon, glasses, etc.) (ECI 14) Child actively participates in situations (IMQ 19) Likes to play actively with me or other adults (IMQ 16) Child varies activity level according to the situation (ECI 15) Child completes self-initiated activity (ECI 16) Likes physical activities and tries to do them well	▪ The infant actively grasps or touches objects within his/her reach ▪ The infant plays actively with parents ▪ The infant actively participates in situations ▪ Infant likes to play actively with others ▪ Infant varies activity level according to situation ▪ Child completes self-initiated activity ▪ Infant enjoys physical activities

	New Situations / People (8 items)
(RITQ 5) The infant accepts right away any change in place or position of feeding or person giving it (RITQ 24) The infant accepts new foods right away, swallowing them promptly (RITQ 66) The infant's initial reaction is withdrawal (turns head, spits out) when consistency, flavour, or temperature of solid foods is changed (RITQ 91) The infant's first reaction to any new procedure (first haircut, new medicine, etc.) is objection (RITQ 74) The infant appears bothered (cries, squirms) when first put down in a different sleeping place (ECI 13) Child enters new situations easily or cautiously as the occasion demands (RITQ 36) For the first few minutes in a new place or situation (new store or home) the infant is fretful (RITQ 62) The infant accepts within a few minutes a change in place of bath or person giving it (ECI 13) Child finds a way of handling a new or difficult situation (ECI 12) Child adapts to changes in the environment (ECI 4) Child demonstrates frustration tolerance in routine or new situations (RITQ 14) The infant is shy (turns away or clings to mother) on meeting another child for the first time (RITQ 31) The infant's initial reaction to a new babysitter is rejection (crying, clinging to mother, etc.) (RITQ 45) The infant's initial reaction at home to approach by strangers is acceptance (RITQ 82) The infant's initial reaction to seeing doctor is acceptance (smiles, coos)	▪ The infant accepts right away any change in place or position ▪ The infant's initial reaction to a new situation is withdrawal ▪ For the first few minutes in a new place or situation the infant is fretful ▪ The infant accepts within a few minutes a change in place or situation ▪ Infant enters new situations easily or cautiously as the situation demands ▪ Infant finds a new way of handling a new or difficult situation ▪ The infant is shy on meeting another person for the first time ▪ The infant's first reaction to a new person/stranger is rejection (crying, clinging to mother, etc.) is withdrawal
	Exploration (5 items)
(RITQ 37) The infant notices (looks carefully at) changes in the appearance or dress (hairdo, unfamiliar clothing) of the mother (IMQ 31) Explores all new objects (ECI 8) Child tries new behaviour on own (ECI 9) Child initiates exploration of own body or objects using a variety of strategies (ECI 10) Child applies a previously learned behaviour to a new situation	▪ The infant notices (looks carefully at) changes in his/her surroundings ▪ The infant inspects changes in her/her surroundings ▪ The infant explores all new objects ▪ Infant tries a new behaviour on own ▪ Infant initiates exploration of own body or objects using a variety of strategies

	Flexibility of Response (9 items)
(ECI 3) Child reacts to a variety of visual stimuli (eg. people, objects, range of patterns or colours) (ECI 10) Child organizes information from the different senses simultaneously for a response (eg. combines looking, listening, and touching in exploring a toy) (ECI 7) Child uses a variety of behaviours to respond to others (ECI 9) Child uses behaviour appropriate to the situation (ECI 12) Child changes behaviour when necessary to solve a problem or achieve a goal (ECI 7) Child tolerates being in a variety of positions (eg. lying on back, abdomen or side; being held upright; sitting; standing) (ECI 8) Child adapts to being moved by others during physical handling and caregiving (ECI 12) Child adapts movements to be responsive to specific situations (ECI 11) Child adapts to daily routines and limits set by caregiver	▪ The infant reacts or responds to a variety of visual stimuli ▪ Infant organizes information from the different senses simultaneously for a response ▪ Infant uses a variety of behaviours to respond to others ▪ Infant adapts movements to be responsive to specific situations ▪ Infant uses behaviour appropriate to the situation ▪ Infant changes behaviour when necessary to solve a problem or achieve a goal ▪ Infant tolerates being in a variety of positions ▪ Infant adapts to being moved by others during physical handling and caregiving ▪ Infant adapts to daily routines and limits set by caregiver
	Awareness (6 items)
(ECI 14) Child demonstrates ability to self-comfort (ECI 5) Child engages in reciprocal social interactions (eg. mutual give and take) (ECI 6) Child accepts help when necessary (ECI 8) Child demonstrates an awareness that own behaviour has an effect on people and objects (ECI 16) Child uses self-protective behaviours to control the impact of the environment (eg. withdraws from or stops the activity when over-stimulated; fusses when tired) (ECI 7) Child anticipates events	▪ Infant demonstrates ability to self-comfort ▪ Infant accepts help when necessary ▪ Infant demonstrates an awareness that own behaviour has an effect on people and objects ▪ Infant engages in reciprocal social interactions ▪ Infant uses self-protective behaviours to control the impact of the environment ▪ The infant anticipates events
	Familiar Places (2 items)
(RITQ 42) The infant greets a new toy with a loud voice and much expression of feeling (whether positive or negative) (RITQ 54) The infant displays much feeling (vigorous laugh or cry) during diapering or dressing (RITQ 23) The infant makes happy sounds (coos, smiles, laughs) when being diapered or dressed (RITQ 75) The infant reacts mildly to meeting familiar people (quiet smiles or no response)	▪ The infant greets a familiar toy with much positive expression and eagerness ▪ The infant greets familiar people with expression (positive or negative)
	Unfamiliar Places (3 items)
(RITQ 27) The infant is pleasant (smiles, laughs) when first arriving in unfamiliar places (friend's house, store, etc.)	▪ The infant greets a new toy with positive expression and eagerness ▪ The infant reacts mildly to meeting unfamiliar people (quiet smiles or no response) ▪ The infant is pleasant when first arriving in unfamiliar places

	Playtime (8 items)
(RITQ 84) The infant plays quietly and calmly with toys (little vocalization or other noise) (IMQ 21) While playing with a toy, he or she smiles or gets excited (RITQ 48) The infant cries when left to play alone (RITQ 61) The infant is content (smiles, coos) during interruptions of milk or solid feeding (RITQ 81) The infant remains pleasant or calm with minor injuries (bumps, pinches) (IMQ 32) Tries to get included when other children are playing (IMQ 35) Tries to start play with other kids	▪ The infant makes happy sounds and gestures while playing with toys ▪ The infant plays quietly and calmly with toys ▪ The infant makes happy sounds and gestures while playing with parents or others ▪ The infant cries when left alone to play ▪ The infant remains content following interruptions of playtime ▪ The infant remains calm following minor injuries during playtime ▪ The infant tries to get included when others are playing ▪ The infant tries to start play with others
	Accomplishment (5 items)
(IMQ 2) Smiles broadly after finishing something (IMQ 41) Smiles when he or she makes something happen (IMQ 43) Claps hands or shows excitement when he or she is successful (ECI 3) Child demonstrates pleasure after successfully accomplishing activities (IMQ 18) Gets excited when he or she figures something out (ECI 9) Child demonstrates pleasure in self-initiated body movement and sensory exploration (IMQ 11) Does not smile after he or she makes something happen (IMQ 34) Looks down or away when tries but cannot do something (IMQ 38) Gets frustrated when he or she does not do well at something (IMQ 44) Gets upset if he or she cannot do something after trying hard (ECI 16) Child balances independent behaviour with necessary dependence on adults	▪ The infant smiles broadly or shows excitement after finishing something or making something happen ▪ The infant gets excited when he/she figures something out ▪ The infant demonstrates pleasure in self-initiated body movement and sensory exploration ▪ The infant gets frustrated when he/she cannot do something ▪ The infant balances independent behaviour with necessary dependence on adults to accomplish tasks (e.g. Walking, getting to a toy)
	Engagement (4 items)
(IMQ 45) Gets involved trying to retrieve objects (ECI 4) Child maintains visual attention to people and objects (RITQ 22) The infant ignores voices or other ordinary sounds when playing with a favourite toy	▪ The infant is often focused or engaged in tasks ▪ The infant gets involved trying to retrieve objects ▪ The infant maintains visual attention to people and objects ▪ The infant ignores voices or other ordinary sounds when playing with a favourite toy

	New Situations (3 items)
(RITQ 3) The infant plays with a toy for under a minute and looks for another toy or activity (RITQ 25) The infant watches other children playing for under a minute and then looks elsewhere	▪ The infant is focused on a *new* toy/person/activity for under a minute then looks elsewhere for another activity ▪ The infant is continuously engaged/focused on new toy/person/activity for 10 minutes or more ▪ Explores all parts of a new object or toy with many parts before doing something else
	Familiar Situations (3 items)
(RITQ 8) The infant plays continuously for more than 10 minutes at a time with a favourite toy (RITQ 16) The infant amuses self for ½ hour or more in crib or playpen (looking at mobile, playing with toy) (RITQ 58) The infant watches television for more than 5 minutes at a time (RITQ 88) The infant pays attention to game with parent for only a minute or so (IMQ 17) Explores all parts of an object or toy with many parts before doing something else	▪ The infant is focused on a *familiar* toy/person/activity for under a minute and then looks elsewhere for another activity ▪ The infant plays continuously for more than 10 minutes at a time with a favourite toy ▪ The infant pays attention to a familiar game with parent for only a minute or so
	Attention (2 items)
(RITQ 87) The infant stops sucking and looks when he /she hears an unusual noise (telephone, door bell) when drinking milk (RITQ 21) The infant stops play and watches when someone walks by (RITQ 44) The infant watches another toy when offered even though already holding one	▪ The infant stops play and watches when something in surroundings change (someone walks by, door closes, noice, etc.) ▪ The infant watches another toy when offered even though already holding one
	Movement Accomplishment (6 items)
(RITQ 32) The infant keeps at it for many minutes when working on a new skill (rolling over, picking up object, etc.) (IMQ 1) Repeats a new skill until he or she can do it well (IMQ 36) Repeats motor skills in order to do them well (IMQ 26) Repeats skills related to moving around until he or she can do them well (IMQ 14) Tries to do things, even if it takes a long time (IMQ 23) Works for a long time trying to do something hard (ECI 11) Child demonstrates persistence during activities (IMQ 3) Gives up if he or she cannot do physical skills well (IMQ 5) Gives up easily if cannot do something (ECI 14) Child bounces back after stressful situations	▪ The infant keeps at it for many minutes when working on a new skill ▪ Repeats a new skill until he/she can do it ▪ Tries to do things, even if it takes a long time ▪ Works for a long time trying to do something hard ▪ Gives up if he/she cannot do physical skill ▪ Infant bounces back after stressful situations

	Toy / Task Accomplishment (4 items)
(RITQ 41) The infant keeps trying to get a desired toy, which is out of reach, for 2 minutes or more (IMQ 29) Will work for a long time trying to get something open or apart (IMQ 9) If a toy or task is hard to do, stops trying after a short time (IMQ 33) Gives up quickly when playing with adults	▪ The infant keeps trying to get a desired toy which is out of reach for 2 minutes or more ▪ If toy/task is hard to do, will stop trying after short time ▪ Gives up quickly when playing with adults ▪ Gives up quickly when playing alone
	Challenge (3 items)
(IMQ 7) Likes to try hard things instead of easy ones (IMQ 12) Tries to do well in physical activities even when they are hard (IMQ 28) Tries hard to touch other children when near them (IMQ 42) Cries or screams after failing at something he or she tried hard to do (IMQ 44) Gets upset if he or she cannot do something after trying hard	▪ Prefers hard tasks over easier ones ▪ Attempts physical activities even when they are difficult ▪ Cries or screams after failing at something that he/she tried hard to do
	TOTAL: 84 items

Appendix 3-D
Items for the First Draft of the Infant Characteristics Questionnaire from Phase I

	Generated Item	*Source*	*Modifications made to original*
1	Is your infant active (for example, waving arms, legs, and so on) while in one position (such as sitting, lying position, and so on)?	Ideas from RITQ 4, 17, 30	Modified to make it relevant to motor development
2	Does your infant test his or her limits of balance while in one position? (For example, reaching out to a far toy while sitting).	NEW	Developed from observations of parents with their children
3	Does your infant test his or her limits of balance while trying to move from one position or place to another? (For example, rocking back and forth when in the crawling position).	NEW	Developed from observations of parents with their children
4	Does your infant move around during 'quiet' play time? (For example, when you are reading to him or her).	Ideas from RITQ 33, 86, 51	Modified to relate to play time and motor development
5	Does your infant move around (such as bouncing, waving arms, and so on) during 'active' play time? (Where active play may involve playing games or playing with toys).	Ideas from RITQ 15	Modified wording to relate to motor development
6	Does your infant move around (such as bouncing, waving arms, and so on) while playing alone?	RITQ 95	Modified wording
7	Does your infant reach for objects within his or her reach?	RITQ 71	Slightly modified from original
8	Does your infant try to grasp objects that are out of reach?	NEW	Developed from ideas generated from item 7
9	Does your infant actively play with you?	RITQ 43	Slightly modified from original
10	Does your infant actively participate in situations, overall?	ECI 14	Slightly modified from original
11	Does your infant actively play with others?	IMQ 19	Slightly modified from original
12	Does your infant vary his or her activity level according to the situation?	IMQ 16	Slightly modified from original
13	Does your infant complete activities that he or she has started? (For example, getting to a toy that he or she was interested in).	ECI 15	Slightly modified from original
14	Does your infant seem to enjoy physical activity?	ECI 16	Modified to stress enjoyment not completion of task
15	Does your infant seem to accept changes in place or position? (Such as not crying, and so on).	RITQ 5	Modified to make relevant to motor development
16	Is your infant's initial reaction to a new situation withdrawal?	RITQ 66	Modified to make relevant to motor development
17	Is your infant fretful for the first few minutes in a new place or situation?	RITQ 36	Slightly modified from original
18	Does your infant accept a change in place or situation within a few minutes?	RITQ 5	Modified to make relevant to motor development
19	Does your infant react appropriately to new situations or tasks as necessary? (For example, cautious if it is different or difficult, and comfortable if it is familiar and easy).	ECI 13 SIB	Modified from original

20	Does your infant try new ways of handling new or difficult situations?	ECI 13 RB	Modified from original
21	Is your infant shy when meeting another person for the first time?	RITQ 14, 31	Modified from original
22	Is your infant's first reaction to a new person or stranger rejection (such as crying, clinging to you, and so on)?	RITQ 31	Modified from original
23	Does your infant seem aware of changes in his or her surroundings? (For example, looking around when in a new room).	RITQ 37	Modified to make relevant to motor development
24	Does your infant inspect changes in his or her surroundings? (For example, looking up when someone enters the room).	NEW	Developed from observations of infants
25	Does your infant explore new objects?	IMQ 31	Slightly modified to fit scaling
26	Does your infant try new behaviours on his or her own?	ECI 8 SIB	Slightly modified to fit scaling
27	Does your infant initiate exploration of his or her own body or objects using a variety of strategies? (For example, rolling a toy along the ground and also trying to band it on the ground).	ECI 9 SIB	Slightly modified to fit scaling
28	Does your infant respond to a variety of visual stimuli?	ECI 3 SO	Modified wording
29	Does your infant use a variety of behaviours to respond to others?	ECI 7 RB	Slightly modified to fit scaling
30	Does your infant adapt his or her movements in response to specific situations?	ECI 12 SO	Slightly modified to fit scaling
31	Does your infant change behaviour when necessary to solve a problem or achieve a goal?	ECI 12 SIB	Slightly modified to fit scaling
32	Does your infant tolerate being in a variety of positions (such as lying on his or her stomach, sitting, and so on).	ECI 7 SO	Slightly modified to fit scaling
33	Does your infant seem to accept being moved by others?	ECI 8 SO	Modified wording
34	Does your infant demonstrate an awareness that his or her own behaviour has an effect on people or objects?	ECI 8 RB	Slightly modified to fit scaling
35	Does your infant test his or her limitations of physical movement?	NEW	Developed from observations of infants
36	Does your infant anticipate events? (For example, reaching out to catch self if falling down when trying to walk).	ECI 7 SIB	Slightly modified to fit scaling
37	Does your infant greet a familiar toy with eagerness?	NEW	Developed from observations of infants
38	Does your infant greet a new toy with eagerness?	RITQ 42	Modified wording
39	Does your infant react mildly (such as quiet smiles or no response) to meeting unfamiliar people?	RITQ 27	Modified to focus on unfamiliar person
40	Is your infant pleasant when first arriving in an unfamiliar place? (By pleasant, we mean not crying or being fussy).	RITQ 27	Modified wording

41	Does your infant make happy sounds and gestures while playing with toys?	IMQ 21	Modified wording
42	Does your infant play quietly with toys?	RITQ 84	Slightly modified wording
43	Does your infant make happy sounds or gestures while playing with you or others?	NEW	Developed from observations of infants
44	Does your infant remain content following interruptions of playtime?	RITQ 61	Modified to make relevant to motor development
45	Does your infant try to get included when others are playing?	IMQ 32	Slightly modified to fit scaling
46	Does your infant try to start playing with others?	IMQ 35	Slightly modified to fit scaling
47	Does your infant smile broadly or show excitement after finishing something or making something happen?	IMQ 2, 41	Slightly modified to fit scaling
48	Does your infant get excited when he or she figures something out?	IMQ 18	Slightly modified to fit scaling
49	Does your infant demonstrate pleasure (delight, happiness, enjoyment) in self-initiated body movement?	ECI 9 SO	Slightly modified to fit scaling
50	Does your infant demonstrate pleasure (delight, happiness, enjoyment) in sensory exploration? (By sensory exploration, we mean exploration by touching objects, moving around, looking around, and so on).	ECI 9 SO	Slightly modified to fit scaling
51	Does your infant get frustrated when he or she cannot do something?	IMQ 38	Modified wording to eliminate 'doing something *well*'
52	Does your infant balance independent behaviour with necessary dependence on adults to accomplish tasks (such as walking, getting to a toy, and so on)?	ECI 16 SIB	Slightly modified to fit scaling
53	Does your infant stay focused or engaged in tasks? (For example, while retrieving objects).	IMQ 45	Modified wording
54	Does your infant stay focused on people or objects?	ECI 4 SO	Slightly modified to fit scaling
55	Does your infant ignore voices or other ordinary sounds when playing with a favourite toy?	RITQ 22	Slightly modified to fit scaling
56	Does your infant focus on a new toy, person, or activity for less than a minute before looking elsewhere for another activity?	RITQ 3	Slightly modified to fit scaling
57	Does your infant stay continuously engaged or focused on a new toy or person or activity for 10 minutes or more?	RITQ 8	Modified to focus on a *new* toy
58	Does your infant explore all parts of a new object or toy before doing something else?	IMQ 17	Slightly modified to fit scaling
59	Does your infant focus on a familiar toy or person or activity for under a minute and then look elsewhere for another activity?	RITQ 3	Slightly modified to fit scaling (same as 56)
60	Does your infant play continuously (more than 10 minutes) with a favourite toy?	RITQ 8	Slightly modified to fit scaling
61	Does your infant pay attention for only a minute to a familiar game with you?	RITQ 88	Slightly modified to fit scaling

62	When playing, does your infant stop play and watch when something in the environment changes? (For example, someone is walking by, door closing, noises, and so on).	RITQ 27, 81	Modified wording
63	Does your infant watch another toy when offered even though he or she is already holding one?	RITQ 44	Slightly modified to fit scaling
64	Is your infant persistent when trying a new activity or skill? (By persistent, we mean repeating a new skill).	RITQ 32	Modified wording
65	Does your infant try to do things, even if it takes him or her a long time?	IMQ 14	Slightly modified to fit scaling
66	Does your infant try tasks even when they are difficult?	IMQ 23	Modified wording
67	Does your infant give up if he or she cannot complete a physical task? (such as climb up stairs, crawl across the floor, pull up onto something, and so on).	IMQ 3	Modified to focus on completion and not whether it was done well or not
68	Does your infant quickly recover after stressful situations?	ECI 14 RB	Slightly modified to fit scaling
69	Does your infant give up when reaching for a desired toy that is out of range?	RITQ 41	Modified wording to eliminate time component
70	Does your infant give up when attempting a difficult task or playing with a complex toy?	IMQ 9	Modified wording
71	Does your infant give up on tasks when playing with or being assisted by adults?	IMQ 33	Modified wording
72	Does your infant give up on tasks when playing alone?	NEW	Developed from extension of item 71
73	Does your infant show frustration after failing at something that he or she has tried hard to do?	IMQ 44	Modified wording
74	Does your infant attempt physical activities even when they are difficult?	IMQ 12	Modified to fit scaling
75	Does your infant prefer difficult tasks over easy ones?	IMQ 7	Modified to fit scaling

Appendix 3-E
Reasoning for Item Deletion and Modification following Phase II for Infant Characteristics Questionnaire

	Item Generated from Phase I	*Results of Phase II*	*Reasoning or Newly Modified Item*
1	Is your infant active (for example, waving arms, legs, and so on) while in one position (such as sitting, lying position, and so on)?	Modified wording	**Does** your infant **move around** (for example, waving arms, kicking legs, shifting weight around, etc.) while in one position? Examples were added
2	Does your infant test his or her limits of balance while in one position? (For example, reaching out to a far toy while sitting).	Maintained	Wording of question was maintained; Examples were added
3	Does your infant test his or her limits of balance while trying to move from one position or place to another? (For example, rocking back and forth when in the crawling position).	**Deleted**	Highly correlated with item 2 (r = 0.84); Mean 4.21 is moderately high; Movement naturally requires shifts in balance—parents had difficulty with question
4	Does your infant move around during 'quiet' play time? (For example, when you are reading to him or her).	**Deleted**	Item was removed due to interest in 'active' play times, not times during which the infant might be encouraged to be quiet
5	Does your infant move around (such as bouncing, waving arms, and so on) during 'active' play time? (Where active play may involve playing games or playing with toys).	**Deleted**	Mean 4.74 (range 4-5) shows poor discrimination
6	Does your infant move around (such as bouncing, waving arms, and so on) while playing alone?	**Deleted**	Mean 4.53 (range 3-5) shows poor discrimination
7	Does your infant reach for objects within his or her reach?	**Deleted**	Highly correlated with item 8 (r = 0.86); Mean 4.78 is very high and indicates poor discrimination
8	Does your infant try to grasp objects that are out of reach?	Maintained	Wording of question was maintained; Examples were added
9	Does your infant actively play with you?	**Deleted**	Mean 4.42 (range 2-5); Also, item 11 considers how infant plays with others (theorized that it does not matter with whom the child interacts with necessarily)
10	Does your infant actively participate in situations, overall?	**Deleted**	Mean 4.21 (range 2-5); Activity is considered elsewhere
11	Does your infant actively play with others?	Modified wording	**Is** your infant **an active participant during** play with **you or** others?
12	Does your infant vary his or her activity level according to the situation?	**Deleted**	Similar to item 30 (wording incorporated into another similar item)
13	Does your infant complete activities that he or she has started? (For example, getting to a toy that he or she was interested in).	Maintained	Wording of question was maintained; Examples were added

14	Does your infant seem to enjoy physical activity?	**Deleted**	Mean 4.89 (range 4-5) is very high and shows poor discrimination; Parents made comments that few children would not enjoy activity
15	Does your infant seem to accept changes in place or position? (such as not crying, and so on).	Maintained	Wording of question was maintained; Examples were added
16	Is your infant's initial reaction to a new situation withdrawal?	Modified wording	Is your infant's initial reaction to a new **or unfamiliar** situation **reservation**? Examples were added
17	Is your infant fretful for the first few minutes in a new place or situation?	**Deleted**	Similar to item 16; Parents stated that it was similar to another question
18	Does your infant accept a change in place or situation within a few minutes?	**Deleted**	Mean 4.42 (range 3-5); Reduces internal consistency
19	Does your infant react appropriately to new situations or tasks as necessary? (For example, cautious if it is different or difficult, and comfortable if it is familiar and easy).	**Deleted**	Reduces internal consistency; Was used as an example for another item 30
20	Does your infant try new ways of handling new or difficult situations?	**Deleted**	Correlated with item 13 ($r = 0.82$); Parents had difficulty answering this question
21	Is your infant shy when meeting another person for the first time?	Maintained	Wording of question was maintained; Examples were added
22	Is your infant's first reaction to a new person or stranger rejection (such as crying, clinging to you, and so on)?	**Deleted**	Correlated with item 21 ($r = 0.87$); Parents felt the examples were strong and might be better of considering this question for it's distractive quality
23	Does your infant seem aware of changes in his or her surroundings? (For example, looking around when in a new room).	**Deleted**	Reduces internal consistency; Mean 4.42 (range 3-5)
24	Does your infant inspect changes in his or her surroundings? (For example, looking up when someone enters the room).	**Deleted**	Reduces internal consistency; Mean 4.58 (range 3-5)
25	Does your infant explore new objects?	Separated into two questions	Does your infant **prefer to** explore new objects **or environments visually, rather than through movement**? **Does your infant prefer to explore new surroundings or toys physically?** Examples were added to each
26	Does your infant try new behaviours on his or her own?	Maintained	Wording of question was maintained; Examples were added
27	Does your infant initiate exploration of his or her own body or objects using a variety of strategies? (For example, rolling a toy along the ground and also trying to band it on the ground).	Modified wording	Does your infant **explore** his or her own body or objects using a variety of strategies?

28	Does your infant respond to a variety of visual stimuli?	**Deleted**	Mean 4.47 (range 3-5); Reduces internal consistency
29	Does your infant use a variety of behaviours to respond to others?	**Deleted**	Reduces internal consistency; Parents had took longer to answer this question and found it difficult
30	Does your infant adapt his or her movements in response to specific situations?	Modified wording	Does your infant adapt his or her movements **for different situations**? Examples were added
31	Does your infant change behaviour when necessary to solve a problem or achieve a goal?	Modified wording	Does your infant change behaviour **or try something new** when necessary to solve a problem or achieve a goal? Examples were added
32	Does your infant tolerate being in a variety of positions (such as lying on his or her stomach, sitting, and so on).	Maintained	Wording of question was maintained; Examples were added
33	Does your infant seem to accept being moved by others?	**Deleted**	Mean 4.11 (range 3-5); Reduces internal consistency
34	Does your infant demonstrate an awareness that his or her own behaviour has an effect on people or objects?	Modified wording	Does your infant demonstrate **awareness** that his or her own behaviour has an effect on people or objects? Examples were added
35	Does your infant test his or her limitations of physical movement?	**Deleted**	Correlated with items 2 ($r = 0.86$) and 8 (0.85); Mean 4.11 (range 2-5) is moderately high
36	Does your infant anticipate events? (For example, reaching out to catch self if falling down when trying to walk).	Maintained	Wording of question was maintained; Examples were modified
37	Does your infant greet a familiar toy with eagerness?	**Deleted**	Reduces internal consistency
38	Does your infant greet a new toy with eagerness?	Maintained	Wording of question was maintained
39	Does your infant react mildly (such as quiet smiles or no response) to meeting unfamiliar people?	**Deleted**	Removed due to irrelevance to motor development
40	Is your infant pleasant when first arriving in an unfamiliar place? (By pleasant, we mean not crying or being fussy).	**Deleted**	Mean 4.42 (range 3-5); reduces internal consistency
41	Does your infant make happy sounds and gestures while playing with toys?	**Deleted**	Mean 4.63 (range 3-5)
42	Does your infant play quietly with toys?	**Deleted**	Reduces internal consistency
43	Does your infant make happy sounds or gestures while playing with you or others?	**Deleted**	Mean 4.79 (range 4-5) is very high and does not show discrimination
44	Does your infant remain content following interruptions of playtime?	Modified wording	Does your infant **tolerate** interruptions of playtime, **even if it isn't what he or she wants**?
45	Does your infant try to get included when others are playing?	Modified wording	Does your infant try to get included when others are playing **or initiate play with others**? Examples were added
46	Does your infant try to start playing with others?	**Deleted**	Incorporated into item 45

47	Does your infant smile broadly or show excitement after finishing something or making something happen?	**Deleted**	Correlated with item 48 (r = 0.87);
48	Does your infant get excited when he or she figures something out?	Maintained	Wording of question was maintained
49	Does your infant demonstrate pleasure (delight, happiness, enjoyment) in self-initiated body movement?	Modified wording	Does your infant **express delight or happiness** in self-initiated body movement? Examples were added
50	Does your infant demonstrate pleasure (delight, happiness, enjoyment) in sensory exploration? (By sensory exploration, we mean exploration by touching objects, moving around, looking around, and so on).	Modified wording	Does your infant **express delight or happiness** in sensory exploration?
51	Does your infant get frustrated when he or she cannot do something?	Modified wording	Does your infant get frustrated **or discouraged** when he or she cannot do something? Examples were added
52	Does your infant balance independent behaviour with necessary dependence on adults to accomplish tasks (such as walking, getting to a toy, and so on)?	Maintained	Wording of question was maintained; Examples were added
53	Does your infant stay focused or engaged in tasks? (For example, while retrieving objects).	Modified wording	Does your infant **focus or engage in tasks only briefly**? Examples were added
54	Does your infant stay focused on people or objects?	**Deleted**	Correlated to item 53 (r = 0.91); Mean 4.16 (range 3-5); Reduces internal consistency
55	Does your infant ignore voices or other ordinary sounds when playing with a favourite toy?	Maintained	Wording of question was maintained
56	Does your infant focus on a new toy, person, or activity for less than a minute before looking elsewhere for another activity?	**Deleted**	Reduces internal consistency; Similar to item 53; Parents found difficult to answer
57	Does your infant stay continuously engaged or focused on a new toy or person or activity for 10 minutes or more?	**Deleted**	Reduces internal consistency; Similar to item 53; Parents found time component limiting
58	Does your infant explore all parts of a new object or toy before doing something else?	Modified wording	Does your infant explore all **or most** parts of a new object or toy before doing something else?
59	Does your infant focus on a familiar toy or person or activity for under a minute and then look elsewhere for another activity?	**Deleted**	Similar to item 54
60	Does your infant play continuously (more than 10 minutes) with a favourite toy?	**Deleted**	Opposite to item 54
61	Does your infant pay attention for only a minute to a familiar game with you?	**Deleted**	Similar to item 54 and 59

62	When playing, does your infant stop play and watch when something in the environment changes? (For example, someone is walking by, door closing, noises, and so on).	**Deleted**	Mean 4.26 (range 2-5) is moderately high; Reduces internal consistency
63	Does your infant watch another toy when offered even though he or she is already holding one?	**Deleted**	Parents found this to vary depending on child's mood; Found it difficult to answer
64	Is your infant persistent when trying a new activity or skill? (By persistent, we mean repeating a new skill).	Maintained	Wording of question was maintained; Examples were added
65	Does your infant try to do things, even if it takes him or her a long time?	**Deleted**	Correlated to item 66 (r = 0.92) and item 13 (r = 0.84)
66	Does your infant try tasks even when they are difficult?	Maintained	Wording of question was maintained; Examples were added
67	Does your infant give up if he or she cannot complete a physical task? (such as climb up stairs, crawl across the floor, pull up onto something, and so on).	Maintained	Wording of question was maintained; Examples were added
68	Does your infant quickly recover after stressful situations?	Maintained	Wording of question was maintained; Examples were added
69	Does your infant give up when reaching for a desired toy that is out of range?	**Deleted**	Reduces internal consistency
70	Does your infant give up when attempting a difficult task or playing with a complex toy?	**Deleted**	Reduces internal consistency
71	Does your infant give up on tasks when playing with or being assisted by adults?	Maintained	Wording of question was maintained; Examples were added
72	Does your infant give up on tasks when playing alone?	**Deleted**	Reduces internal consistency
73	Does your infant show frustration after failing at something that he or she has tried hard to do?	**Deleted**	Reduces internal consistency
74	Does your infant attempt physical activities even when they are difficult?	**Deleted**	Correlated to item 66 (r = 0.82) and 13 (r = 0.87)
75	Does your infant prefer difficult tasks over easy ones?	**Deleted**	Parents had difficulty judging what was a hard task

Appendix 3-F

Infant Characteristics Supporting Motor Development Questionnaire

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Age of your infant: _____ months Date: _____

5 = to a great extent	4 = to a moderate extent	3 = to a fair extent	2 = to a small extent	1 = not at all	0 = not applicable

To what extent—	5	4	3	2	1	0
1. Does your infant move around (for example, waving arms, kicking legs, shifting weight around, etc.) while in one position? ▪ This is a general question directed towards the degree of movement you observe in your infant while he or she is in any one position (sitting, lying on back, etc.), during any type of play.	o	o	o	o	o	o
2. Does your infant test his or her limits of balance while in one position? ▪ Your infant is showing initiative to move, for example, by rocking while in the sitting or crawling position, or by extending body to roll over.	o	o	o	o	o	o
3. Does your infant try to grasp objects that are out of reach?	o	o	o	o	o	o
4. Is your infant an <u>active</u> participant during play with you or others? ▪ As an <u>active</u> participant, your infant will initiate some or most of the physical interactions during play time. A less active participant would mostly respond to other's actions or participate by observation.	o	o	o	o	o	o
5. Does your infant complete activities that he or she has started? ▪ For example, rolling or crawling to a toy that he or she was interested in, or reaching and grasping a toy that he or she is interested in.	o	o	o	o	o	o
6. Does your infant seem to accept changes in place or position? ▪ By 'accept', we mean not fussing or getting frustrated and generally tolerating the transition. For example, your infant is content after being moved to another location.	o	o	o	o	o	o
7. Is your infant's initial reaction to a new or unfamiliar <u>situation</u> reservation? ▪ A new situation might include being in a new and unfamiliar place. Strong reservation might include crying and/or clinging to you. Slight reservation might include quieting down and being very cautious. No reservation would be observed as your infant being entirely comfortable.	o	o	o	o	o	o
9. Does your infant <u>prefer</u> to explore new surroundings or toys physically? ▪ For example, your infant is eager to inspect and explore new surroundings by crawling around a room or playing with a toy. (Please do not make adjustments for developmental stage).	o	o	o	o	o	o

11. Does your infant try new behaviours on his or her own? ○ ○ ○ ○ ○ ○
- For example, when given the opportunity, your infant will try to crawl or roll over on his or her own without your assistance or involvement.

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12. Does your infant explore his or her own body or objects using a variety of strategies? ○ ○ ○ ○ ○ ○
- For example, your infant will roll a toy along the ground and also try to bang it on the ground, or your infant will put their toes in their mouth as well as bang their feet on the ground. Or does your infant prefer to play with a toy in mostly one way.

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13. Does your infant adapt his or her movements for different situations? ○ ○ ○ ○ ○ ○
- For example, you notice that he or she is cautious in difficult situations and at ease and comfortable in familiar situations, or that he or she varies his or her activity level (waving arms, kicking legs, etc) depending on the activity (reading, playing, etc.).

---

14. Does your infant change behaviour or try something new when necessary to solve a problem or achieve a goal? ○ ○ ○ ○ ○ ○
- For example, when handling new or difficult situations, or for example, if your infant is playing with a certain toy, he or she will try something different if what he or she is doing is not working. Another example is if your infant is having difficulty climbing up a new set of stairs and tries a new way to get up them.

---

15. Does your infant tolerate being in a variety of positions? ○ ○ ○ ○ ○ ○
- For example, during play time, your infant is content being placed in several different positions, such as sitting, on all fours or lying on his or her back or stomach, or moves into various positions him or herself.

---

16. Does your infant demonstrate awareness that his or her own behaviour has an effect on people or objects? ○ ○ ○ ○ ○ ○
- For example, playing with the TV remote to change the channel, or doing a certain activity that he or she knows you encourage and looking over to you after he or she accomplishes it.

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17. Does your infant anticipate events? ○ ○ ○ ○ ○ ○
- For example, your infant will reach out to catch him or herself if falling down when trying to walk.

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18. Does your infant greet a *new* toy with eagerness? ○ ○ ○ ○ ○ ○

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20. Does your infant try to get included when others are playing or initiate play with others? ○ ○ ○ ○ ○ ○
- If your infant is too young, does your infant seem interested in the play of others, seen as your infant observing others play with interest.

---

21. Does your infant get excited when he or she figures something out? ○ ○ ○ ○ ○ ○
- For example, smiling broadly, laughing, or showing excitement after finishing something or making something happen.

---

22. Does your infant express delight or happiness in self-initiated body movement? ○ ○ ○ ○ ○ ○
- For example, laughing and giggling when he or she crawls, rolls over or walks across the room.

23. Does your infant express delight or happiness in sensory exploration? ○ ○ ○ ○ ○ ○
- Sensory exploration means touching or tasting objects, moving around, looking around, etc.

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24. Does your infant get frustrated or discouraged when he or she cannot do something? ○ ○ ○ ○ ○ ○
- For example, when your infant is having difficulty climbing up stairs, or getting to a toy that he or she wants, or being unable to reach a toy that is just out of arm's reach.

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25. Does your infant balance independent behaviour with necessary dependence on adults to accomplish tasks? ○ ○ ○ ○ ○ ○
- For example, your infant will try a behaviour on his or her own before looking to you for support (if necessary).

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27. Does your infant ignore voices or other ordinary sounds when playing with a favourite toy? ○ ○ ○ ○ ○ ○
- Your infant does not pay attention to distracting sounds or events in the background while playing.

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28. Does your infant explore <u>all or most</u> parts of a *new* object or toy before doing something else? ○ ○ ○ ○ ○ ○

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29. Is your infant persistent when trying a new activity or skill? ○ ○ ○ ○ ○ ○
- For example, once your infant starts to roll/crawl/walk, he or she will repeatedly do the activity.

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30. Does your infant try tasks even when they are difficult? ○ ○ ○ ○ ○ ○
- For example, your infant will <u>attempt</u> to get to a toy that is high on a shelf or far away from him/her.

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32. Does your infant quickly recover after stressful situations? ○ ○ ○ ○ ○ ○
- For example, if your infant falls or bumps his or her head while trying something new, does he or she remain calm or quiet down quickly, or does he or she get very upset and cry.

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33. Does your infant give up on tasks when playing with or being assisted by adults? ○ ○ ○ ○ ○ ○
- For example, your infant is less likely to give up if being assisted by you.

Thank you for taking the time to complete our questionnaire! ☺