Locomotor Restriction and Infant Walking: Does Mother Age Play A Role?

by

Amy De Jaeger

A Thesis submitted to the Faculty of Graduate Studies of

The University of Manitoba

in partial fulfilment of the requirements of the degree of

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Abstract

Maternal age is an understudied variable that is related to age of first walking: children of older mothers walk later. Walking age is also influenced by postural experiences and restrictions on physical exploration, so we tested the idea that the relation between maternal age and walking occurs because older mothers are more restrictive than younger ones. 803 mothers of 1- to 3-year-olds completed a newly created parent-report measure of restrictiveness. Factor analysis revealed five dimensions of restrictiveness that we entered into a mediational model to test our hypothesis. Maternal age remained predictive of walking age, but no relations were found between maternal age and restriction, or between restriction and walking. Although we did not find the expected influence of restrictiveness on walking age, we replicated the link between mother age and walking age. Other infant experiences related to mother age should be studied to clarify its role in development.

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CHAPTER I

INTRODUCTION

Locomotor Restriction and Infant Walking: Does Mother Age Play A Role?

The impact of maternal age on child development is of growing social relevance because of the widespread increase in childbearing age. As a result of societal changes (such as, high divorce rates, the number of women engaged in post secondary education/careers, advances in birth control methods (Bornstein, Putnick, Suwalsky, & Gini, 2006), many more women are having children well into their thirties and forties (Balen, 2004; Bornstein et al., 2006). This increase in average maternal age may have implications for the developmental trajectories of children in ways that have yet to be examined in the literature. Empirical evidence suggests that maternal age at the time of childbearing and variations in infant's daily experiences are linked to the developmental rate of offspring (Bornstein et al., 2006; Eaton, Bodnarchuk, & McKeen, 2006; Eaton, Bodnarchuk, & DeJaeger, 2007; Pan, Rowe, Spier, & Tamis-Lemonda, 2004; Pollock, 1993; Rosenthal-Rollins, 2003). As a result, maternal age is an important variable to consider when studying infant and toddler development. The overarching goal of this study was to explore maternal age in a meditational analysis by testing the relationship between daily experience and the timing at which offspring reach developmental milestones (tasks or skills that children achieve at certain ages).

Theoretical Framework

Infants vary considerably in their rate of motor development, and studying such variation should lead to a better understanding of the processes that influence developmental progress. Variation in developmental rate (or milestone attainment) is typically explained by two theories, maturational theory and Dynamic Systems theory.

The former, and older perspective, holds that motor changes during infancy and early childhood are related to maturational factors. On this account, motor changes: a) are related to an infant's neurological maturation, b) develop sequentially, and c) are reflexive in nature (Zelazo, 1998). Dynamic systems theory, conversely, posits that many environment and experiential factors contribute to the appearance of new milestones (e.g. independent walking). Under a systems perspective (where parents are a key influence on a child's daily experience), differences in the ways parents interact with their infants around motor behaviours should be important. Consequently if older mothers and younger mothers differ in their treatment of infants, such differences might influence infants' rates of development. The proposed research pursues this issue.

In concordance with a systems perspective of development, several factors have been linked to infants' rate of progress when considering motor skills. Motor milestones are an important area of study, as they can represent an infant's health and developmental status (Adolph, 1997; Eaton, 2008). Physical factors such as gestational age, birth size and body composition have all been linked to the onset of gross motor milestones such as crawling and walking. For example: infants who are smaller and leaner have been shown to walk earlier than larger, heavier infants (Eaton, 2008). Other variables associated with advances in developmental rate include, but are not limited to: gender (girls have a slight advantage over boys), nutrition (well nourished infants reach motor milestones sooner), culture, season of birth (infants born in the winter and spring walk earlier), and experience (experience in a prone position facilitates crawling; Adolph, 1997; Adolph, Vereijken, & Shrout, 2003; Eaton, 2008). The preceding factors are only a few of the many possible influences on milestones, and if we are to develop a comprehensive picture of developmental rate and its causes, we need to consider additional factors that are

plausibly related to differences in development. This study explored several factors that contribute to variation in a key gross motor milestone, walking.

CHAPTER II

LITERATURE REVIEW

Infant walking is an important motor skill to study for several reasons. First, the age of first independent walking provides an indication of overall health status and has been used to predict later developmental outcomes (Adolph et al., 2003; Adolph, & Berger, 2005). For example, a Finnish longitudinal birth-cohort study found that age of first walking was a significant predictor for outcomes in several cognitive domains such as categorization abilities and educational outcomes (Taanila, Murray, Jokelainen, Isohanni, & Rantakallio, 2005; Murray, Veijola, Moilanen, Miettunen, Glahn, et al., 2006). Specifically, Taanilia and colleagues (2005) reported that first standing and first walking were significantly related to positive educational outcomes during adolescence and adulthood such as increased school abilities at 16-years-old. Murray and colleagues (2006) also found that early walkers displayed better cognitive categorization abilities in adulthood than children who walked later. Such results do not demonstrate that variation in walking attainment caused later cognitive variation, but they highlight connections between motor development and other aspects of development. Moreover, bi-pedal locomotion is a uniquely human phenomenon, and the onset of infant walking is an easily observable and usually memorable event for parents. Certainly, the walking milestone provides researchers with an excellent yardstick with which to measure the rate of developmental change among infants.

Walking and Infant Experience

Our approach was to consider several daily experiences that have been identified to either facilitate or delay the rate at which infants begin to walk. First, we examined age at first walking and experience as they to parental restrictive/encouraging bahaviour. Several studies have demonstrated that infants begin to walk earlier when their daily experiences include postures requiring the use of large skeletal muscles (Adolph et al., 2003; Adolph, & Berger, 2005; Blank, 1964; Hopkins & Westra, 1988; Williams & Scott, 1953). Similarly, infants who spend more time in upright positions reach the walking milestone earlier than children who spend more time on their backs kicking (Adolph et al., 2003; Adolph, & Berger, 2005; Zelazo, Zelazo, & Kolb, 1972). Adolph and colleagues (2003) found that daily practice in postures that build strength and promote balance can facilitate earlier walking attainment. One such posture is an infant's freedom to explore the home environment. This type of unrestricted exploration provides infants with opportunities to explore and practice the skills required for walking, and has been directly linked to the advancement of walking (Adolph et al., 2003). Other benefits of physical exploration include: a) enhanced cognitive skills via a stimulating and ever-changing environment, b) varying perspectives of the world, and c) increased motivation for independent locomotion and further exploration.

The probable links between walking and motor experience are clearly of importance when considering milestone attainment. Early motor experience and infant walking is a difficult area to research, however, because it is necessary to study large numbers of infants who vary in their motor experiences. This will be feasible only if parent reports can be utilized, and no adequate parent-report measures of infant motor experience currently exist. Thus, there is a need for such a measure, and one major goal

of the current study was to develop one. More specifically, we created a parent-report questionnaire that was used to measure an infant's daily experiences and parent's restrictiveness of motor opportunities. The two aspects of motor experience considered were physical freedom and postural practice.

Physical freedom. The amount of time an infant spends exploring the physical environment (physical freedom) has been positively related to that infant's competence during the first few years of life (White, 1975). Following his longitudinal analysis of infant competence, White (1975) released several key recommendations for parents to promote healthy development. One of these recommendations included child-proofing homes to promote daily infant exploration. Blank (1964) also focused on the relation between exploration and developmental advance. Infants in Blank's study reached motor milestones later when their mothers were more protective and restrictive and less encouraging of independence. Similarly, comparisons between Brazilian and American infants indicated that Brazilian infants reached motor milestones later than their American counterparts when SES was controlled for (Santos, Gabbard, & Goncalves, 2001). Such differences were attributed to the increased protective and prolonged holding behaviours engaged in by Brazilian mothers (Santos et al., 2001). The relationships demonstrated between mothers' encouraging/restrictive behaviour and the developmental rates of children lend support for our idea that increased freedom to explore one's environment will have a positive influence on walking.

Postural Experience. Differences in the way infants are handled (postural experiences) have also linked to the onset of walking. Hopkins (1976; as cited in Hopkins & Westra, 1988) defined two types of handling practices known to facilitate motor development: formal handling practices, where the practices are ends in and of

themselves and the intent is educational, and informal handling, where practices are performed with the purpose of engaging in daily activities and interactions. Mothers who actively engaged in formal handling procedures reported that they did so because they believed these handling processes would assist their infants in sitting alone, and walking without help (Hopkins & Westra, 1988). Later findings from the same study confirmed that infants who experienced formal handling techniques actually did reach the sitting and standing milestones earlier than children who had different experiences (Hopkins & Westra, 1988). Additionally, some African cultures consider motor stimulation through handling to be 'good' parenting practices (Keller, Yovsi, & Voelker, 2002).When compared to German mothers (who valued mother sensitivity), African mothers reported that they hold children in an upright position because this type of holding is believed to lead to earlier self initiated locomotion (Keller et al., 2002). A longitudinal study with a North American sample also emphasized the importance of postural experience and cautioned against parental restriction (Blank, 1964). Blank found that children who were limited in experiences related to positioning tended to walk later than children whose movements were less limited. Because it was beyond the scope of this study to create to experimentally implement formal handling procedures, we examined naturally occurring variation in parental restrictiveness in a Western sample.

The relationship between an infant's rate of gross motor development and parental restrictive/encouraging behaviours is a key theme presented in the aforementioned literature. To capture levels of parental restrictiveness we examined parent reports of their provision (or restriction) of various locomotor experiences, and their reports of the age at which their child first walked independently. Specifically, we hypothesized that infants whose parents displayed high levels of restriction would walk later than infants

whose parents provided less restrictive experiences. To remain consistent with a dynamic systems approach, we felt it was important to look not only at restrictiveness in relation to walking, but also to examine other factors that might influence both restriction and walking.

Maternal Age as a Predictor for Restriction and Walking

Maternal age has traditionally been used as a demographic covariate to examine development on cognitive and linguistic domains (McClennan, Reece, & Harkless, 1996). Within this body of research, children display increased cognitive and linguistic skills in early childhood when their mothers were older than the average childbearing age of 27 (Pollock, 1993; Rosenthal-Rollins, 2003; Pan et al., 2004; Bornstein et al., 2006). Several studies have found that children with older mothers consistently scored higher on tests of vocabulary at 3, 5, and 10 years of age than peers with younger mothers (Pollock, 1993). Additionally, children with older mothers displayed higher levels of spontaneous speech at the age of two, and more advanced linguistic stills at the age of three (Pan et al., 2004). Thus, when considering language development, it seems that the children of older mothers are at an advantage. However, there is little research that examines why these mother-age-effects exist. It is possible the older mothers provide experiences that focus on cognitive and linguistic outcomes rather than motor ones. This assumption has not tested in the current literature and more research into the mother-age-effect is necessary if we are to understand the complexities of the relation between mother age and child outcomes.

Alternately, there are a few domains where younger mothers have an edge. Schum, McAuliffe, Simms, Walter, Lewis, and Pupp (2001) examined factors related to age of toilet training and found that younger (not older) maternal age displayed a positive

association with advances on toilet training (the younger the mother, the earlier the training). Adams, Jones, Esmail, and Mitchell (2004) found a similar trend by examining when children first begin to sleep through the night. Effects from this study indicated that infants with younger mothers slept through the night sooner than infants with mothers who were older. Similar unpublished work from our research lab has revealed a positive relationship between maternal age (at time of birth), and the rate of development for gross motor milestones such as crawling and walking (Eaton, Bodnarchuk, & McKeen, 2006; Eaton, Bodnarchuk, McKeen, & De Jaeger, 2007). This positive relation indicates that older motherhood is associated with later walking and earlier motherhood is associated with earlier walking. These preliminary findings are of particular relevance because walking was key milestone of interest in the present study.

Results from a large-scale observational study revealed positive relationships between maternal age and responsive/nurturing behaviours towards infants, or maternal sensitivity and structuring (the degree to which parents structure daily environments; Bornstein et al., 2006). Older mothers displayed more nurturing, sensitive, and structured behaviours towards their infants than younger mothers. Similarly, when maternal age was investigated relative to the number of objects and exploratory opportunities provided to children, Bornstein and colleagues (2006) found a 'U' shaped pattern in their results. These results imply that extremely young mothers and older-than average mothers provided few objects for exploration, while mothers of typical childbearing age presented a larger number of objects. Bornstein and colleagues note that this pattern was "unexpected at challenges further explanation" (p. 886). However, the evidence presented by Bornstein and colleagues, corroborates our belief that differences in the number of exploratory opportunities presented to children might also be related to maternal age.

The parent-infant interaction styles of older mothers as demonstrated by Bornstein and colleagues (2006) are similar to the interaction styles of mothers whose children reached motor milestones later as demonstrated by earlier studies. For example German mothers (Keller, et al., 2002), showed high levels of mother sensitivity and had infants who walked later than African mothers who encouraged motor stimulation. Similarly, Brazilian mothers who displayed protective daily environments (Santos et al., 2001) also had infants who reached motor milestones later than those whose mothers provided them with less structure. By examining maternal age in relation to interaction styles, the research by Bornstein and colleagues, highlights some patterns in the treatment provided by older and younger mothers. It is also important to consider the findings of Bornstein and colleagues in conjunction with the evidence provided by Santos (2001) and Keller (2002). If nurturance, protectiveness, sensitivity, and structure are relevant to motor development, then maternal age will likely play a role as well. Thus, our second hypothesis was that maternal age will be significantly related to degree of restrictiveness (via the number locomotor opportunities presented), such that older mothers display more restrictive behaviours (fewer opportunities for exploration) than younger mothers.

Taking the two previous hypotheses into consideration the following assumptions were made: a) Hypothesis One, daily experience influences the onset of walking (e.g. increased restrictiveness leads to later walking; Adolph et al., 2003; Blank, 1964; White, 1975), b) some of the variation in walking attainment is uniquely attributed to maternal age (Eaton et al., 2006, Eaton, Bodnarchuk, McKeen, & De Jaeger, 2007), and c) Hypothesis Two, mother age influences daily experience (Bornstein, 2006). It is with these assumptions in mind that we investigated the following mediational model: the relationship between mother age and age of walking is mediated by level of

restrictiveness. In other words, we expected that older-than-average mothers will engage in more restrictive behaviours, which would lead to an increase in infants' age of walking. Because research regarding older-than-average maternal age is rare, and because the links between maternal age, restrictiveness, and walking have yet to be studied, the current study makes a unique contribution.

Other Influential Variables

To adequately address the proposed model, we needed to consider other possible factors that could be tied to both mother age and age of walking. Following is a discussion of those variables we believe should be included in our analytical model.

Education. Older mothers tend to have higher levels of education, and it is possible that a maternal-age-effect is really education in disguise. Thus, it was important to include maternal education in the model. The educational advance exhibited by some mothers has prompted research into whether or not mothers with higher levels of education provide enriched environments for their children (Rosenkrantz-Aronson, & Huston, 2004; Bornstein et al., 2006). Higher levels of education might be linked to enriched environments for the development of cognitive domains. Most of the evidence we have presented so far suggests that for motor domains, the advantages of this enriched education-related environment are not relevant. Because of the ambiguity regarding the influence of maternal education, level of education is an important variable to include, but we held no a-priori expectations about the direction of the influence on walking attainment.

Socioeconomic status. Daily exploration of the physical world is associated with earlier attainment on various motor domains. Williams and Scott (1953) examined the parenting practices of African Americans participants from low and high socio economic

classes. Findings revealed significant relationships between SES and developmental rate. Participants from low SES families displayed less regimented or restrictive behaviours during daily routines than parents of higher SES. Furthermore, exploration into the differential treatment of infants in low and high SES families indicated that infants from low SES families were provided with more active, free, uninhibited play times throughout the day, and reached developmental milestones earlier, whereas children from high SES homes were

> "much more insulated from their environment by cribs, tenders, high chairs etc. These are not only used to sleep or feed the baby, as was their original purpose, but utilized for a large part of the day to set a barrier between the baby and the people and objects around him," (p. 118).

Older mothers tend to have higher levels of education and are often married (Bornstein et al., 2006). These two factors alone or together tend to result in higher SES households. Because SES seems to be related to two of the key variables in this study, it was crucial that we include SES as a covariate in our analysis. We expected SES to be positively related to age at first walking (higher SES will be associated with later walking).

Gestational age. Gestational age is another factor that is known to contribute to motor milestone attainment. Premature and gestationally younger infants tend to develop motor skills later than infants who are born on their expected due date (Eaton, 2008). Gestational age was considered as a covariate to control for the influence that age-at-birth might have on walking attainment.

Personality. Personality is defined as a group of traits that make up what people are like (Roccas, Sagiv, Schwartz, & Knafo, 2002), and maternal personality has been related to child outcomes (Champney, 1941; Kochanska, Clark, & Goldman, 1997).

Recent research has established that personality traits are not stable across the lifespan (as previously believed), but show significant changes in middle adulthood (Helson, Kwan, John, and Jones, 2002). Helson and colleagues (2002) reported that individual age is positively correlated with scores on traits such as conscientiousness and agreeableness. Other research confirmed that changes to personality occur with age; however, which aspects of personality show consistent changes over time are difficult to determine (Costa & McCrae, 1977; Costa & McCrae, 1988). We predicted that level of conscientiousness or neuroticism may influence the rate at which children begin to walk. Anxious mothers, who might score high on neuroticism, would be more likely, in our view, to restrict the movements of their baby. If that was the case we anticipated higher maternal neuroticism to be associated with later walking.

Conscientiousness is hypothesized to influence motor development through the use of safety-related maternal behaviours that would tend to restrict movement (e.g. the use of cribs, infant seats, etc). Our hypotheses about the role of maternal personality and maternal age are not theory driven, largely because no current theory explains the effects of maternal age on offspring development. However, evolutionary theory does have some relevant comments on maternal age. An evolutionary perspective suggests that older mothers allocate more resources to their children because they have few years for reproduction left (Buss, 1999). For example, older mothers may spend more time ensuring the safety of their children. Younger mothers, on the other hand, have many years in which they could have more children and are therefore less likely to allocate the same amount of energy into child rearing behaviours. Our expectation that older-than-average mothers will display high levels of conscientiousness towards their infants is consistent with this view.

Through this study we wanted to examine the influence of parental restrictiveness by creating a tool to measure the locomotor opportunities presented to pre-walking children. Furthermore, we wanted to test the relationship between mother age and walking when accounting for an important aspect of daily experience, locomotor opportunities. We predicted that locomotor opportunities would mediate the positive relation between maternal age and walking when all other covariates were held constant.

CHAPTER III

METHODS

Participants

To test the hypotheses in a correlational study, we needed heterogeneity on all important variables, so a large diverse sample of mothers and infants was required. Past research has indicated that parents are willing and reliable observers of their infants' motor development (Davis et al., 1998; Bodnarchuk & Eaton, 2004). Specifically, 95% of parents were able to accurately recall the age at which their child first started to walk, and these results were highly correlated with those of Health Visitor records (Donoghue & Shakespeare, 1967). Bodnarchuk and Eaton (2004) also found parent reports of infant milestones to be highly correlated with home-visit observations.

Mothers with 1 to 3-year-olds were recruited to participate in the present study. Because one of the study's main goals was to examine the relationship between maternal age and walking, we targeted children between 12 and 36 months to ensure that most participants in our sample would have reached the walking milestone prior to participation. We did however, include children in our final sample who were younger than 12 months if it was reported that they had started walking. The upper age limit of 36-

months was selected to help ensure the accuracy of parent's recall about walking attainment. Because we recruited 1 to 3-year-olds, some of the children in our sample were older than 36-months (e.g. parents of 3-and-a-half year olds completed our questionnaire). We included children up to 49-months-old in our final study sample to account for those children who were older than 3-years but had not passed 4-years (49 months) at the time that their parents completed the study. We felt that parents would still be able to accurately recall walking attainment during their child's third year. Finally, because it was important that the study sample represented typically developing children, we excluded from the analysis those participants whose children had illnesses that might delay age of walking (e.g., pre-mature infants).

Procedure

This study used a cross-sectional, self-report, internet questionnaire to address the outlined hypotheses. An internet questionnaire was the ideal mechanism for this particular study because it allowed us to easily access the large and heterogeneous sample we needed to assess the proposed study questions. Because we used the internet to administer the study questionnaire, we were able to recruit respondents from a variety of countries around the world. The majority of our sample consisted of parents from Canada, the United States and the United Kingdom, however we did have several participants from several other countries (Table 1 illustrates participants' countries of origin).

Table 1

Participants' countries of residence for the initial study sample (n=892)

Country of Residence	*n*	Initial Sample (%)
Canada	379	43
United States	176	20
United Kingdom	170	19
Australia	79	9
India	18	2
Ireland	10	1
Singapore	8	1
Other	48	5

Note: Other Countries include: China, Egypt, Indonesia, Israel, Japan, Malaysia, and South Africa. $n = 4$ missing.

Participants were asked to complete a one-time survey composed of several measures and titled 'The Baby Play Study'. The survey was created using an online software program called *Survey Gizmo* which allowed us to develop and launch our web-based questionnaire. Participants who clicked the "study participation" link located at the bottom of the study landing page were immediately transferred to our informed consent page (please see Appendix A for study landing page and consent information). Only those who provided their consent by selecting *'yes'* to the initial question were directed to begin the questionnaire. Participants who did not provide informed consent were directed back to the study landing page. All participants within the specified age-range were invited to take the study; however, only those who met the specific inclusion criteria were included

in the analysis. Participant inclusion and exclusion criteria are discussed in detail in the results section (Chapter Three).

All participant information was stored on a password protected, secure host server located in a secure location provided by Survey Gizmo. Participants who provided consent and visited the initial question page were automatically assigned a nine-digit participant ID number by the Survey Gizmo program. Participant information was tracked and referenced anonymously using the participant ID number. Email addresses were obtained from participants who indicated that they were interested in obtaining a copy of the study results or participating in future research. All participant information was written to the host server at the end of each study portion. Storing information at the end of each study portion ensured that no data was lost from participants who exited the study prior to completing every section. A summary of the aggregate study findings will be sent via email to study participants who have provided us with email addresses.

Recruitment

Mothers and infants were recruited using a variety of online and traditional methods. Table 2 contains a summary of our recruitment techniques and their success rates.

The main method of recruitment for this study was through postings made to popular online parenting forums. Parenting forums are becoming quite common among the various online communities in existence, and there are many forums specifically designed to target parents. Forums are generally free, and open to anyone. Most forums only request a username and valid email address to confirm membership, and allow users to post messages. We used search engines to find forums that target parents and then proceeded to join those forums using a standard email address/username created

specifically for the study. Prior to posting on the forums, we contacted the site moderator or administrators, if they were available, and requested their permission to post our advertisement and study link on the forum discussion boards (see Appendix B for a copy of the recruitment material). A series of three recruitment posts were used when posting to forum boards to ensure that we adhered to the forum guidelines.

The overall responses we received from moderators and administrators were positive, however, responses did vary from forum to forum. The responses we received can be categorized as follows: a) permission to post on the forum boards, b) permission to post our recruitment blurb, but only after a certain number of 'other' posts were made to build a rapport with participants of the forum, c) refusal because advertising is not allowed on the forum, d) refusal because research posts were restricted to the forum's country of origin, e) redirection to a research focused forum, or f) moderators posted the recruitment information on our behalf. If no response was received within seven days, we contacted the moderator/administrator a second time and waited an additional seven days. If we had no response at the end of the 14 days, or if no moderator/administrator could not be contacted, posted to the forum. If we were asked to remove our post we did so promptly and did not contact that forum again (four posts were removed in this manner). Posts were monitored for responses, and a second posting was made if the original message moved off the first page of forum discussion topics within a day or two.

We also joined and posted to several relevant parenting groups found on the social networking forum 'Facebook'. There are approximately 250 million registered Facebook users worldwide (Facebook, 2009). Because of its enormous popularity, we thought Facebook would be an ideal medium for promoting our research study. When posting to the Facebook parenting groups, we followed the same process we used for the parenting

forums. Group moderators were contacted for permission prior to posting, and a small recruitment blurb was posted when permission was received (please see Appendix B for recruitment material).

Facebook has strict rules and regulations regarding what types of messages are considered 'spam'. Spam, is a form of unsolicited internet advertisement and is considered to be poor practice among those in the internet community. Because we were posting several recruitment messages of a similar nature, we were unknowingly considered to be 'spam' by the Facebook administrators. To correct this oversight, we created our own Facebook 'group' for the Baby Play Study (see Appendix C for an image of the Facebook group for Baby Play). By creating our own group, we were able to create a virtual recruitment 'snowball'. We contacted the individuals in our contact list who would qualify as study participants, they contacted their list, and so on.

Participants were also recruited through personal referrals sent by email. We sent a personal invitation by email to friends, family, and acquaintances that had children within our specified age-range or who we thought might know individuals with children within our age-range.

Google Ad Words' were also used as a mechanism for online recruitment. A Google Ad is a two-line advertisement that appears on the side of the search results screen when potential participants made a 'Google-Search' using one of several predetermined key words (e.g., child developmental). We posted an ad that outlined the study and contained a link to the study web site.

Traditional recruitment methods were also used and included: posting advertisements at child day care centres, for local parenting, and child activity groups in the Winnipeg area. In addition to the posters, presentations were made to undergraduate

students in evening courses on child development offered at the University of Manitoba during the winter term.

Table 2

Recruitment methods, messages sent, percent of sample obtained

		Initial Sample[a]		Final Sample[b]	
Recruitment Method	Messages Sent	(n) [a]	(%)	(n)	(%)[b]
Parenting Forums	170	469	55	131	54
Facebook Parenting groups	62	124	14	42	17
Google Ad Words	n/a	60	7	11	5
Personal Invitation	66[c]	153	18	52	21
Traditional Methods, Other	140	41	6	6	3

[a] $n = 847$; $n = 44$ missing. [b] $n = 243$; $n = 1$ missing. [c] Refers to the number of initial emails sent by the researcher, email recipients were invited to pass the invitation along. This is only an estimate of those who received the invitation email. The actual number of invitations sent is likely to be larger than what is presented above. '*Final sample*' refers to individuals who had complete data on all variables and were included in the meditational analysis.

Measures

Study participants were asked to complete a web-based survey consisting of several sub-sections which are described next.

Baby Play Questionnaire (restrictiveness scale)

We developed the Baby Play Questionnaire to address the need for a new measure and to assess the degree of restrictiveness exhibited by parents. The Baby Play Questionnaire was created to capture maternal restrictiveness in an easily observable, concrete, and non-intrusive way. To achieve this goal we followed the model for scale

construction as outlined by Clark and Watson (1995).

Conceptualizing the constructs. On a conceptual level, the Baby Play Questionnaire was constructed upon evidence that linked the onset of walking to the provision (or restriction) of infants' experiences (Adolph, 1997; Adolph et al., 2003; Blank, 1964; White, 1975). We operationalized the key construct, restrictiveness, as the degree of parental interference with the child's physical movement through the limitation of various locomotor experiences (physical exploration and postural experience) that are known to facilitate the onset of walking. Next we defined subdomains to capture each aspect of the restrictiveness construct.

Subdomains. The Baby Play Questionnaire contained three subdomains believed to contribute to the overall construct of parental restrictiveness. Each was defined prior to item creation to ensure that subdomains (and subsequent question areas) would adequately contribute to a measurement of the overall construct. The conceptual definitions of each subdomain are outlined below:

1) *Physical Freedom/Exploration.* The number of opportunities for unrestricted movement available to the child within the home; the freedom allotted to the child to move around the home as his/her ability allows with or without the use of infant devices/accessories (e.g. infant walker, playpen, etc). Items related to physical freedom were designed to assess the availability for free movement provided within the child's home. The physical freedom/exploration subdomain consisted of varying levels of the availability of gross motor restriction: *Restricted movement*: little or no independent movement available (e.g. highchair), *Moderate movement*: some independent movement available (e.g. Jolly Jumper™, or jumping devices), and *Free*

movement: ample independent movement available (e.g. playing on the floor).

2) *Postural Experience.* The informal physical movement (or handling) of an infant by his/her parent on a daily basis (e.g. the way that infants are picked up, carried, put down, and physically positioned). *Neutral* handling positions (i.e. playing suspense games) were included to act as a balance for other more provocative positions (e.g. hanging upside down).

3) *Physical Arrangements: Home Safety.* The measures taken by parents to ensure the physical safety of infants within the home (e.g. electrical outlet covers). One of the ways mothers may encourage motor independence is through the provision of a safe environment. We anticipated that a balance would exist between encouraging independence through safety (e.g. providing a safe environment so that infants have the freedom to move around unrestricted) and safety as an indicator of restriction (e.g. providing an ultra-safe environment that restricts physical movement).

Creating the items. We expected that restrictive behaviour would be displayed by parents (particularly mothers) through various daily locomotor activities. Individual items were phrased in terms of an infant's daily patterns of play in order to: a) address concerns related to participants' negative bias towards questions discussing child 'restriction', b) minimize biases related to social desirability, and c) circumvent any feelings participants have that their parenting behaviours are being 'judged' by us. Independent play and infant/parent interactive styles of play are both characteristics of infants' daily experiences in many cultures. We felt that phrasing the study questions within the context of infant play would create a neutral context for parents when describing their daily behaviours.

As recommended by Clark and Watson (1995) a large number of items were created for each subdomain (a minimum of 14 in each) to ensure the initial pool of items contained questions that actually represented our conceptualized domains. Forced-choice and visual analog scales were used throughout the questionnaire. Participants were asked to refer to the time *before* their child began to walk independently when responding to each of the aforementioned sub-sections. From a causal perspective, it is these pre-walking experiences that should have influenced walking attainment. Participants were asked to refer to the conditions of their home/play behaviour during the time before walking occurred. Examples of questions included to represent each theoretical subdomain are outlined below.

Physical Freedom. Questions related to the types of infant accessories and toys used in the home were included to assess the level of physical exploration allowed. For example: a mother whose child has started walking was asked: "During a typical week did your child spend time in an exersaucer? Yes/No?" If 'yes' is selected, participants were asked "How many days a week?" with a scale from 1 to 7 (daily). We hoped to capture the degree to which parents display restrictiveness on each item by positioning each question in terms of the frequency of use for each accessory. For example: a child who spent more time in an exersaucer (e.g., 5 out of 7 days a week) would likely have had fewer opportunities for unrestricted movement throughout any given week than a child who spends less time in an exersaucer. A broad variety of toys and accessories were included in the questionnaire to get an accurate measure of infants' physical freedom. For a complete list of all toys and accessories included please refer to the Baby Play Questionnaire (Appendix D).

Postural Experience. Questions regarding the physically interactive games infants

play were included to assess the number of informal handling postures infants engage in on a day-to-day basis. For example, participants were asked: "During a typical week did you play tossing games (holding the child above one's head and toss them gently into the air)? Yes/No?" If 'yes' was selected, participants were asked "How many days a week?" with a scale from 1 to 7 (daily). We sought to assess the frequency with which parents engage in restrictive positioning by using each question to capture the number of positions parents engage in and the frequency of each game. For example, a child who spent less time playing games that facilitate large muscle growth (e.g., assisted walking) would have fewer opportunities to practice the motor skills required for walking. It was necessary to assess a broad variety of physically interactive games to accurately assess the provision of infant postural experiences. For a complete listing of the physically interactive games listed please refer to the Baby Play Questionnaire (Appendix D).

Home Safety. Questions regarding the use of home safety devices were included to assess the range of safety behaviours engaged in by parents within the home. For example: a mother whose child has started to walk was asked: "Did you use baby gates in your home? Yes/No?" Questions referred to participants' use of common safety devices such as baby gates and safety latches, as well as more obscure items such as window guards and protective body padding. Only Yes/No information was collected for each of the safety items. We also created an overall safety score by calculating the proportion of items used by the parent. We expected that the safety score would demonstrate a curvilinear prediction pattern indicating a "just right" or ideal level of home safety (some safety measures are provided, but infants are still allowed a reasonable level of physical freedom). For a complete listing of the safety devices listed please refer to the Baby Play Questionnaire (Appendix D).

Age of Walking

The major outcome variable for this study was age of first walking. Walking was defined in a similar manner to definitions developed by the World Health Organization (WHO) Multicentre Growth Reference Study (MGRS; Wijnhoven et al., 2004). Findings from the MGRS and other studies have found that parents/caregivers were able to correctly determine the onset of major gross motor milestones (such as walking) with great accuracy when using the definitions provided (Donoghue & Shakespeare, 1967; Bodnarchuk & Eaton, 2004). This is of importance for the present study because walking was assessed through online, retrospective parental reports. Age of first walking in this study was defined as the date on which the child takes one or more steps without holding onto furniture, and without help. Parents were also asked to report the means by which they remember when their child began to walk (e.g. baby book, video tape with date, memory, etc).

Mother age

Maternal age was assessed as part of an 'About You' questionnaire. Participants were asked to record the year of their birth. Infant year of birth was subtracted from mothers' year of birth to determine maternal childbearing-age and create the crucial *'mom age'* variable.

Covariates

When employing correlational models it is important to remember that any relationships between characteristics may also be attributed to other co-varying characteristics. It is then important to include all possible predicting characteristics into the initial model. The covariates included in this study are described below.

Subjective Socioeconomic Status. SES is not a universal construct; however, previous studies have found that SES related to both mother age and age of walking (Williams & Scott, 1953). Because SES was believed to be an important construct, a form of subjective social status was used in lieu of traditional measures of SES, which don't generalize well across countries and currencies. The MacAurthur Scale of Subjective Social Status was used to measure SES in this study (Goodman, Adler, Kawachi, Frazier, Huang, & Colditz, 2001; Operario, Adler, & Williams, 2004). For this measure, participants were asked to rank where they think they fall on a 10-rung ladder that represents status in their society. The MacAurthur Scale of Subjective Social Status has been demonstrated as a reliable and valid measure of income, education, and health outcomes (Goodman et al., 2001; Operario et al., 2004).

Education. Maternal education was measured using a five-item scale. Participants reported their most recently completed level of education. Options were presented in the form of a drop-down list and ranged from *"some high school"* to *"Doctorate"*.

Gestational age and ponderal index. Parents were asked to recall their child's expected due date. These dates were then used to calculate gestational age by subtracting the infant's date of birth from the parent's report of expected due date. Ponderal index is a measure of infant 'chubbiness' that is similar to an adult's Body Mass Index but allows for comparisons across individuals of different statures. Ponderal index is related to motor outcomes such that infants higher on ponderal index tend to reach these milestones later than leaner infants (Eaton, 2008). A "Ponderal Index (PI)" variable was calculated using the following formula: PI = 100 * (child weight in grams / child length in cm **3). Ponderal index captures an important feature of the infant's birth characteristic that is not highly correlated with gestational age, as birth weight and length typically are.

Neuroticism and Conscientiousness. Mother personality was measured using the Ten Item Personality Inventory (TIPI), developed by Gosling, Rentfrow, and Swann (2003). Questions for the abbreviated version were based on a combined list of unipolar and bipolar markers, and an adjective checklist of markers from the Big Five personality inventory (Goldberg, 1992, John, & Srivastava, 1999; as cited by Gosling et al., 2003). This set of questions provides an accurate measurement for each of the five personality domains included in the Five Factor Model (openness, agreeableness, conscientiousness, extraversion, and neuroticism), which is probably the dominant current model for personality. Participants were asked to rate themselves on each of ten descriptor-pairs (two for each of the five personality traits) using a 7-point scale.

Home ownership and type of dwelling. One of the goals of this study was to examine the various types of locomotor opportunities presented to infants on a daily basis. There were two aspects of the 'home' environment we expected to play a role in daily experience because they might influence locomotor experience. First, we included a measure of renting a home vs. owning a home. Participants were asked whether they rented or owned the home that they lived in before their baby could walk. We felt that owning versus renting might influence whether or not one installed certain safety devices and subsequently influence the number of safety devices used. We also expected that home size and style might influence physical freedom. For example large open rooms might allow for more space and freedom than smaller rooms. The 'dwelling type' question from Statistics Canada's (2006) public access census data was used as a measure of housing style. Participants were asked to select the housing style that best fit the house they lived in before their baby could walk. Six dwelling types were listed ranging from *'single detached house'* to *'apartment/condo with more than five stories'*.

Statistical Design

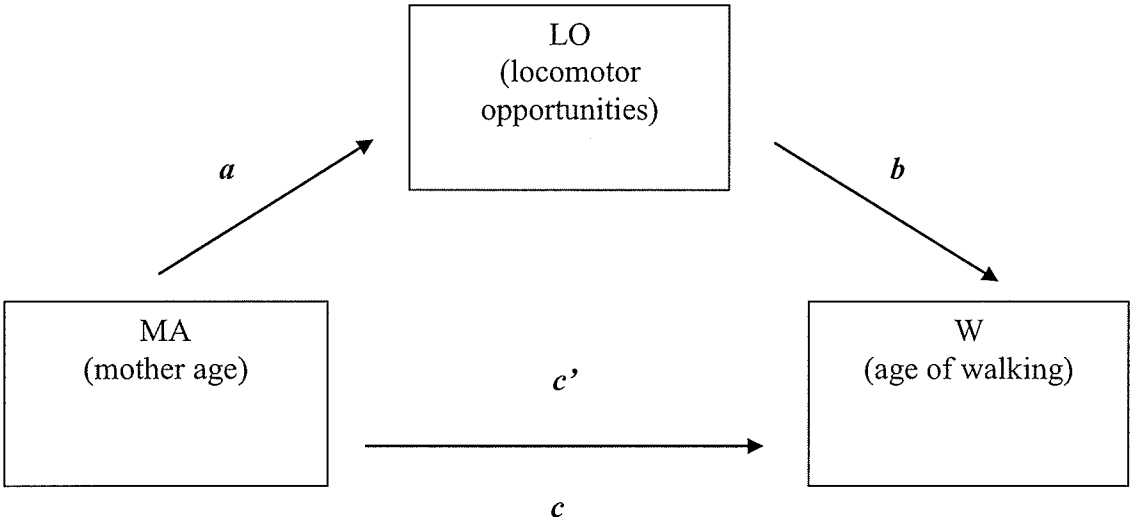
The overarching goal of this study was to examine the meditational hypothesis that locomotor opportunities (restrictiveness) mediate the relationship between mother age and age of first walking. In other words, we expected that maternal age would influence parental restrictiveness and this relationship would in turn influence the relationship between mother age and age of first walking.

The hypothesized mediation is presented in Figure 1. Figure 1 applies the hypotheses from this study to the standard mediation diagram presented by Kenny (2008) and allows for a visual illustration of the key variables as well as the anticipated relationships present in the mediation analysis. The main variables of interest; mother age, locomotor opportunities (restrictiveness), and age of first walking are represented with the letters MA, LO, and W respectively. The three main study hypotheses, as well as the relationship between mother age and age of walking are also illustrated. The relationship between MA and LO (hypothesis two) is represented by path *a*, the relationship between LO and W (hypothesis one) is represented by path *b*. The assumption that MA and W are positively related is illustrated by the direct relationship *c* and *c'* illustrates the relationship between MA and W when LO is taken into account.

Several steps are required to test a mediation hypothesis (Baron & Kenny, 1986; Judd & Kenny, 1981; Kenny, 2008). Specifically, a multiple regression analysis should be used to estimate paths *a, b and c* individually. Each path should result in a significant relationship before moving ahead with the mediation analysis. That is, MA should predict W, LO should predict W, and MA should predict LO. These prerequisite steps are consistent with our outlined hypotheses in that we predict: locomotor opportunities (restriction) will be related to age of walking; mother age will be positively related to

locomotor opportunities; and mother age will be positively related to age of walking. If these three assumptions were satisfied, we could conduct a test of the meditational hypothesis that locomotor opportunities mediate the relationship between mother age and walking. In other words, entering locomotor opportunities into the model should decrease the relationship between mother age and walking significantly or to zero.

Figure 1. Mediation Hypothesis



Traditionally Sobel's (1982) test for statistical significance of the mediated effect is conducted following the initial meditational analysis. The Sobel test for significance of relationships assumes that the paths between *a* and *b,* and *c* and *c'* are normally distributed (Preacher & Hayes, 2004). Because this is the main assumption of the Sobel test, it usually results in a very conservative test with low power. Preacher and Hayes (2004) have recommended alternative techniques that will test the significance of a mediated effect while maintaining statistical power. Preacher and Hayes suggest the use

of a macro that applies boostrapping to estimate a sampling distribution for the path *ab*. Thus, the Preacher and Hayes approach will

> "provide a bootstrap estimate of the indirect effect *ab*, an estimated standard error, and both 95% and 99% confidence intervals for population value of *ab*. The bootstrapping is accomplished by taking a large number of samples of size *n* (where *n* is the original sample size) from the data, *sampling with replacement*, and computing the indirect effect, *ab*, in each sample" (Preacher & Hayes, 2004; p. 722).

To circumvent the limitations attributed with assumptions of normality, we were prepared to use the SAS-macro as suggested by Preacher and Hayes (2004) and conduct both the bootstrapping and Sobel significance tests to test the hypotheses in this study.

CHAPTER IV

RESULTS

We had three goals for this study: First, we wanted to determine if parental restrictiveness was predictive of age of walking. To achieve this goal, we had to create and evaluate a scale aimed at capturing parental restrictiveness. Second, we wanted to see if maternal age predicted restrictiveness as measured by our scale. Finally, we wanted to know if restrictiveness mediated the hypothesized relation between mother age and age of walking. SAS version 9.1 was used to conduct all statistical analyses.

During the 3 months that we actively recruited for the Baby Play Study, we had 850 *'Dropouts'*, visitors who came to the study, but did not get past the consent page; 476 *'incomplete responses'* individuals who came to the study and answered at least one question before leaving the survey, and 582 *'complete responses'* individuals who

completed 95% of the survey questions, or made it to the email collection page. We considered those individuals who selected *'yes'* on the study consent page the initial study sample. This resulted in an initial sample size of 892 participants.

Exclusions

Although 892 parents completed the consent page of the questionnaire, once we applied our inclusion/exclusion criteria the samples, used to refine our restrictiveness measure and conduct the mediation analysis declined. Several children met one or more of our exclusion criteria and were eliminated from the study ($n = 89$). We recruited 1 to 3-year-olds, however, parents with children who were older and younger than our targeted age-range decided to participate. We excluded children who were younger than 5 months and older than 49 months on the basis that they were either too old or too young to participate. To predict walking in a typical population of infants, we only wanted to include infants who were typically healthy. We eliminated those who were born prematurely (i.e., those whose gestational age at birth was younger than 35 weeks), reported more than 6 general health issues, and whose parents reported that the child was in *'fair'* or *'poor'* health most of the time . Because age of walking is the outcome measure for this study, children were also excluded from the sample if parents reported an impossible first-steps date (e.g., the date of first steps was entered as a date that occurred before the child was born). Children who reportedly walked at an extremely young age (less than 7 months) were also eliminated as extreme outlier values. Finally, one child was deleted because the 'lie' item '*gout*' was selected as a health condition applicable to their child. Because children cannot suffer from *Gout* it was included as a commitment check for the questionnaire. For a complete description of participant flow, please see Table 3.

Table 3

Participant Flow, those that were retained, and eliminated

Progress	Retained (*n*)	Eliminated (*n*)	Total (*n*)
Answered '*yes*' to initial consent	892	855	1747
Completed locomotor opportunities items[a]	892	0	892
Met inclusion criteria	803	89	803
Completed all sections of the questionnaire[b]	568	324	568
Reported age of walking (AOW)	409	159	409
Complete information on all covariates and AOW[c]	243	166	243

[a]Respondents who completed the locomotor opportunities items were used to conduct the exploratory factor analysis for the equipment and interactive handling domains. [b]Respondents who completed the TIPI were considered to have competed all sections of the study questionnaire. [c]Those respondents that had complete information on all covariates and age of walking were included in the final regression sample.

Refining the Restrictiveness measure

This study consisted of one round of data collection ($n = 803$). Because we only had one sample to work with, we wanted to conduct our initial analysis of the items in the restrictiveness measure on one half of the sample (derivation sample). Creating two groups would leave us with one independent sample that we could use to check the reliability of our factor structure (generalizability sample). To split the sample into two independent groups, we created a new variable *'split'* which placed participants to either group one or group two using the participant ID assigned to them by the survey provider. Participants with an even participant ID were placed into the derivation sample *(split = 1; $n = 383$)* while those with an odd participant ID were placed into the generalizability sample *(split = 0; $n = 419$)*.

Once we had two independent samples, we were able to refine our restrictiveness measure. Our measure of locomotor opportunities was based on the continuous time-based question '*how many days per week did you use [name of equipment item inserted]?*' Parents answered this question for each of the 16 equipment related items or 14 handling techniques they used. We chose to use this number-of-days-per-week item for several reasons. First, number of days-per-week is a continuous variable which is an important prerequisite for conducting a factor analysis. Second, we felt that asking participants about the number of days-per-week they used an item would provide us with a reasonable estimate of usage duration for each specific item. Third, the number of days-per-week question was consistent across both of the domains we were interested in examining through our analysis, (equipment and interactive handling).

As an initial test of internal consistency among the raw days-per-week items, we intercorrelated the equipment-related variables and positioning items separately. None of these initial correlations were significant, and the estimated alpha reliability was well below .70 for both equipment and positioning sets of items. An exploratory factor analysis was then conducted on each of the question sets individually to further refine the survey questions. The resulting factor structures were used to create summary factor scores from the Baby Play Questionnaire that could be subsequently used to test the study hypotheses.

Exploratory Factor Analysis: Equipment

Responses to the 16 equipment related items were examined using an exploratory factor analysis with squared multiple correlations as the prior communality estimates. We chose the principle factor method to extract the initial factors. This strategy is the simplest method of extracting factors and is similar to a principle components analysis in that the

numbers of factors extracted equals the number of variables analyzed. Factors extracted using this method follow two basic assumptions: first, each subsequent factor is uncorrelated with all previously extracted factors at the time of extraction, and second, that each factor accounts for the maximum amount of variance available that has not already been accounted for by other factors (Hatcher, 1994).

We followed the decision-making-rules as suggested by Hatcher (1994) for determining the number of factors to retain, namely: 1) that a minimum of three variables had a significant loading on each factor, 2) that the retained factors seemed to make sense on a conceptual level, 3) that the variables loading on each of the different factors seemed to measure different characteristics, 4) that the items load highly on some factors and not others (i.e., factors have high loadings for some variables and not others), and 5) that the proportion of common variance accounted for by the eigenvales for each included factor totaled a minimum of 85%. Based on the previous criteria and results from a scree test, we retained three meaningful factors for the equipment domain.

We then applied a principle factor method with a varimax, orthogonal rotation to the newly created three-factor structure. We considered a variable to have loaded on a given factor when the rotated factor loading was greater than .30. Based on the aforementioned criteria, we found that five variables loaded onto the first factor, which we labeled *'Free Movement'*. Items in the *free movement* category allowed infants to move about freely as their ability allowed. Four variables were found to load onto the second factor, which we labeled *'Moderate Movement'*. Items in the *moderate movement* category were those items that somewhat restricted an infant's movements or limited infants to a specific type of movement (e.g., legs can only move in a 'jumping' motion while in a jolly jumper™). Five variables also loaded onto the third factor and were

labeled *'Restricted Movement'*. Items in the *restricted movement* category consisted of things that almost entirely restricted an infant's ability to move around or prevented exploration by restricting infants to one location a room. There were two variables that did not load above the .30 cut-off on any of the three outlined factors. These items were: the bumbo chair (a device that supports infants when sitting upright) and the baby carrier (sling or snuggly used for transporting infants). These two variables were then eliminated from the final factor structure and all further restricted related analyses. Table 4 contains each of the equipment related items and their factor loadings.

We then created three weighted factor-based scales for each of our three extracted factors. Our factor-based scales were created using the rotated factor loading for each variable and allowed us to calculate a participants' total score for each factor loading. Throughout the remaining analyses our newly created variables, *free movement, moderate movement,* and *restricted movement* were used to represent the various levels of parental restriction in relation to opportunities for physical exploration.

Table 4

Equipment items, corresponding factor loadings, and communality estimates rounded to two decimal places

	Factor Loading			
Questionnaire Item	1	2	3	h^2
	Free Movement			
How many days per week did you use push toys?	.53	-	-	.29
How many days per week did you use floor toys?	.45	-	-	.23

How many days per week did you use free floor play?	.38	-	-	.15
How many days per week did you use a bouncy chair?	.34	-	-	.17
How many days per week did you use play tables?	.31	-	-	.13
	Moderate Movement			
How many days per week did you use the exersaucer?	-	.59	-	.39
How many days per week did you use the infant swing?	-	.40	-	.22
How many days per week did you use the walker?	-	-.36	-	.27
How many days per week did you use the Jolly Jumper™?	-	.30	-	.13
	Restricted Movement			
How many days per week did you use the stroller between walks?	-	-	.49	.27
How many days per week did you use the car seat between car-rides?	-	-	.44	.22
How many days per week did you use the highchair between mealtimes?	-	-	.39	.32
How many days per week did you use the playpen between nap times?	-	-	.38	.15
How many days per week did you use the crib between nap times?	-	-	.30	.08

Note. Dashes indicate the variable was not found to load on the corresponding factor. h^2 represents the final communality estimates for each corresponding survey question. n = 383. [a]Rounded to two decimal places.

Scale Reliability: Equipment

To assess the reliability of our factor scores, we needed to ensure that our original variables were related to our underlying constructs as identified by our factor structure (degree of restriction), so we correlated each of our raw variables (equipment days used) with the corresponding factor scores (free, moderate and restricted movement) using the original derivation sample. If the correlations were relatively high (r = .40 or higher), we were confident that our original variables were representative of the underlying degrees of restrictiveness captured in our factor scores.

As previously mentioned we created the factor-based scales on the derivation sample only; therefore, it was also important that we also assess the reliability of our factor scores in relation to the generalizability sample. The same correlations were then conducted using the factor scores and the raw variables from our generalizability sample. Table 5 illustrates the reliability correlations between all of the raw variables and each of the three factor scores for both the derivation and generalizability samples. The significant correlations presented in Table 5 indicate reliability between the original variables and each factor-based scale respectively. Additionally, the alpha reliability estimates all exceeded .70 for both samples. Comparisons of the correlations drawn from the two samples indicate a high degree of concordance and replicability across samples, which speaks to the reliability of the factor structure.

Table 5

Correlations between equipment items and factor scores by sample

Equipment item	Derivation Sample (r) [a]	Generalizability Sample (r) [b]
	Free Movement (Factor 1)	
Push toys	.74	.75
Floor toys	.68	.62
Free floor play	.42	.36
Bouncy chair	.47	.55
Play tables	.52	.56
	Moderate Movement (Factor 2)	
Exersaucer	.84	.82
Infant swing	.67	.69
Jolly Jumper™	.48	.56
Walker	-.43	-.33
	Restricted Movement (Factor 3)	
Stroller (between walks)	.63	.61
Car seat (between car rides)	.68	.68
Playpen (between naps)	.53	.52
Crib (between naps)	.29	.33
Highchair (between meals)	.66	.73

Note. Items under the *Equipment item* category were drawn from the original question *'How many days per week did you used the _?'*. [a]*n's* vary from 225 to 235, [b]*n's* vary from 233 to 246. All Table 3 correlations are significant at $p < .01$.

Exploratory Factor Analysis: Interactive Handling

We used the same exploratory factor analysis techniques as described above for responses to 13 of the interactive handling related items in the derivation sample. Three items from this subdomain (suspense games, clapping games, and peek-a-boo games) were excluded because they were not related to infant positioning and were originally included as filler items. We used the principle factor method to extract the initial factors. We also followed the same decision-making rules when we determined the number of factors to retain. Two meaningful factors were retained from the initial analysis for the interactive handling subdomain.

The second exploratory factor analysis using the principle factor method with a varimax, orthogonal rotation was then conducted on the newly created two-factor structure. We used the same .30 loading to determine which variables loaded on each factor. Based on the .30 criteria, we found that seven variables loaded onto the first factor and were labeled *'Sitting/Stepping Movement'*. Items in the *sitting/stepping movement* category were games that required infants to engage movements related to sitting or stepping. Five variables were found to load onto the second factor, which we labeled *'Vestibular Movement'* because these activities engaged infants in movements that required the activation of the vestibular system (the system that controls one's sense of movement and balance). One variable (blanket rocking) was excluded from the final factor structure because it did not load above the .30 cut-off on either of the two outlined factors. Table 6 contains each of the interactive handling items and their factor loadings.

Table 6

Interactive handling items, corresponding factor loadings, and communality estimates rounded to two decimal places

Questionnaire Item	Factor Loading 1	Factor Loading 2	h^2
	Sitting/Stepping Movement		
How many days per week did you play riding games?	.58	-	.40
How many days per week did you play jumping games?	.55	-	.38
How many days per week did you play walking games?	.53	-	.30
How many days per week did you play rocking games?	.52	-	.28
How many days per week did you play piggy-back games?	.51	-	.29
How many days per week did you play walking-on-adults-feet games?	.47	-	.23
	Vestibular Movement		
How many days per week did you play hanging-upside-down games?	-	.86	.76
How many days per week did you play swinging-upside-down games?	-	.79	.65
How many days per week did you play hanging games?	-	.64	.49
How many days per week did you play swinging games?	-	.52	.47
How many days per week did you play tossing games?	-	.41	.39

Note. Dashes indicate the variable was not found to load on the corresponding factor. h^2 represents the final communality estimates for each corresponding survey question. $n = 383$.

We created two weighted-factor-based scales for each of the extracted factors. Throughout the remaining analyses, our newly created variables, *sitting/stepping movement* and *vestibular movement* were used to represent parental handling in relation to opportunities for movement in preparation for walking.

Scale Reliability: Interactive handling

We conducted a series of correlations between each of our raw variables (games-played-days) and the corresponding factor scores (sitting/stepping and vestibular movement) using the original derivation sample. If the correlations were relatively high (r = .40 or higher) we assumed that our original variables were representative of the underlying handling actions captured by our factor scores.

We followed the same strategy as before for assessing the reliability of our factor-based scales by comparing the correlations from the derivation and generalizability samples for the interactive handling items. Table 7 illustrates the reliability correlations between the raw interactive handling variables the factor scores for samples. Significant correlations as presented in Table 7 indicate reliability between the original variables and each respective factor score. The alpha reliability estimates all exceeded .70 in both samples.

Table 7

Correlations between interactive handling items and factor scores for the derivation and generalizability samples

Interactive Handling item	Derivation Sample (r)[a]	Generalizability Sample (r)[b]
	Sitting/Standing Movement (Factor 1)	
Ride-the-pony games	.70	.61

Riding games	.71	.65
Jumping games	.67	.63
Walking games	.63	.65
Rocking games	.62	.59
Piggy-back games	.59	.48
Walking-on-adults'-feet games	.54	.56
	Vestibular Movement (Factor 2)	
Hanging-upside-down games	.88	.85
Swinging-upside-down games	.84	.83
Hanging games	.78	.80
Swinging games	.72	.68
Tossing games	.67	.67

Note. Items under the *Interactive handling item* category were drawn from the original question *'How many days per week did you play ___?'*. [a]*n's* range from 282 to 303, [b]*n's* range from 287 to 311. All Table 5 correlations are significant at $p < .01$.

The Final Study Sample

As previously described, our initial sample was quite large ($n = 803$) and included all participants who provided consent and completed at least the first page of study questions. To test the study hypotheses, we wanted to consider only those individuals who completed all sections of the questionnaire ($n = 485$). The regression analysis required that we further trim our sample to only those individuals who provided us with complete data on all covariates and outcome variables ($n = 243$). This final sample was used for all remaining analyses.

Table 8 and Table 9 provide a summary of several infant variables for the final regression sample. Those variables that were retained and included as covariates in the regression analysis will be addressed in detail in a later section. Only those parent participants who were biological mothers of the child participants were included in the final study sample. Mothers ranged in age from 17 to 42 years, with a mean of 29 years (SD = 4.6). Further, 93% of the mothers in our sample reported that they lived in dual-adult households (married or common law). Table 10 provides a description of several parent characteristics.

Table 8

Infant age and birth characteristics

Age and Size Variables	Mean	SD	Minimum	Maximum
Child age at time of study (months)	22.9	7.8	9.9	46.6
Gestational Age (weeks)	39.9	1.3	36.0	42.6
Child length at birth (cm)	51.5	5.2	21.6	68.6
Child weight at birth (g)	3560	493	450	5227
Ponderal Index	3.1	3.9	0.3	39.5

Note. n = 243 for all variables.

Table 9

Infant health and home characteristics

Infant Variables	Percentage
Child gender	
Female	47
Male	53
General health	
Good	4
Very Good	21
Excellent	75
Childcare	
Child cared for in home	74
Child cared for outside home	26
Number of children in house	
Only child	42
One additional child	38
Two additional children	17
Three or more additional children	3

Note. $n = 243$ for all variables.

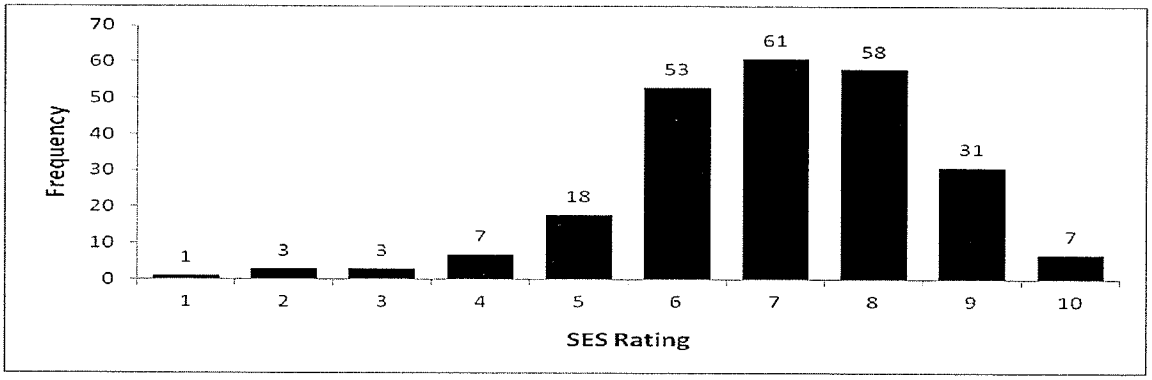
Table 10

Parent education and days spent with child

Parent Variables	Percentage
Education	
Some high school	2
High school graduate	12
Some college/university	33
Associate's degree	9
Bachelor's degree	25
Master's	15
Doctorate	4
Number of days per week spent with child	
Three or less	2
Four to six	5
Seven	93

Note. $n = 243$ for all variables.

Figure 2. Subjective Socio-Economic Status of Participants in Final Study Sample



Age of First Walking

Age of first walking was the criterion variable for our regression and subsequent mediation analyses. Parents were asked to report the age at which their child first walked (day, month, and year). The mean age for first walking was 11.8 months (SD = 2.3). When asked how they remembered the date: 77% of mothers said they '*remembered*', and 23% reported that they '*checked a diary or video recording*' they had kept.

Multicollinearity

When considering which covariates to include in the regression analysis it was important to identify and deal with the issue of multicollinearity (the situation when two predictor variables are strongly related, or redundant with each other). We considered a correlation that was greater than r = .30 to be a potential flag for collinearity and when two variables met that condition we deleted one of them from our final list of covariates. Most of the correlations between our chosen covariates were well below our r = .30 limit. In addition to correlational tests for collinearity we conducted tests for tolerance (tolerance > .80) and variable inflation (VIF < 2) to ensure that each of our covariates met our independence assumptions. Both the tolerance and VIF scores for our model respectively fell above and below our predetermined limits.

Covariates

We identified 19 covariates that were entered in the regression model. The details of each are described below.

Infant characteristics. The infant characteristics used in our model were: gestational age, ponderal index, gender, and number of other children in living in the house. Descriptive statistics for these and other infant related variables can be found in Tables 8 and 9. We did not find any large correlations between any of the infant-related

variables or any other covariates; therefore, each of the aforementioned variables was centred and entered into our model. Table 11 below outlines the final centering procedure for each variable.

Table 11

Centered, infant related covariates

Infant Variable	Centred Response
Gender	Female
Gestational age (weeks)	40
Ponderal Index	2.5
Number of other children living in the house	One other child

Parent Characteristics. The parent-related covariates we used were mother age, SES and education. These variables were each centred on the median response and entered into the regression model. SES was centred on 7 (just over the middle of the SES ladder), parent education was centred on *'some university'*, and mother age was centred on 28 years. It was unsurprising that both SES and education were positively correlated with one another ($r = .34$), and mother age ($r = .20$ and $r = .34$ respectively). That is, as SES increased so did the highest level of education (and vice versa). Moreover, as mother age increased so did SES and level of education. Regardless of these correlations, all three variables were included in the model. We decided to leave education as a covariate after examining the tolerance and variable inflation scores for the model. Because scores fell beyond the cut-off range we felt that the correlation between SES, education and mother age would not raise potential issues of collinearity.

Housing. Because several of our covariates were contingent upon the space available to infants, we asked parents two questions related to housing. First, parents were asked if they rented or owned the home they lived in before their infant could walk. Of the mothers in our sample, 68% reported that they owned their home and 32% reported renting. Second, parents were asked about the style of their home. Over half of the sample, 63%, said they lived in a single detached house before their infant started walking. We were not surprised to find that renting/owning was positively correlated with mother age ($r = .39, p < .01$). We also believed that renting or owning a home generally would not influence an infant's locomotor opportunities, and because of the correlation between renting/owning and mother age, we eliminated the rent-own variable from the model. Housing style was retained as a covariate and was centred on the median score, *'1 = single detached home'*.

Locomotor opportunities. Each of our factor-based-scales: free movement, moderate movement, restricted movement, sitting/walking movement, and vestibular movement were included in our model to represent an infant's locomotor opportunities (parental restriction). Free movement was positively correlated with sitting/walking movement, but because of the tolerance and variable inflation levels mentioned previously both were retained in the model. The proportion of safety items used was also included in the regression model. The percentage of safety items used was calculated (*pct_safety*) and subsequently centred on its median 55%.

Personality. The five personality traits as measured by the TIPI were also included as covariates (extraversion, emotional stability, agreeableness, conscientiousness, and openness). Each of the five TIPI variables were centred on the middle response-option *'5 – agree a little'*. None of the TIPI variables demonstrated

strong correlations with any of the other covariates, and all were included in our model. Interestingly, conscientiousness was positively correlated with *safey_pct* ($r = .23, p = < .01$) and openness was negatively correlation with restricted movement ($r = -.12, p < 01$).

Testing the Mediational Model

The causal steps approach to mediation as outlined by Baron and Kenny (1986; Kenny, 2008) was used to test the mediation hypothesis. The first step of this approach was to confirm the relationships between each of our core predictors (mother age and locomotor opportunities) and the criterion variable (age of walking). To establish these preliminary relationships, age of walking was regressed upon each of our newly created factor scores and retained covariates. The paths of our mediational model were outlined as follows: MA should predict W (path *c*); LO should predict W (path *b*), and MA should predict LO (path *a*; see Figure 1 for more detail). If paths *a, b,* and *c* each produced a significant relationship we planned to move ahead with the mediation analysis.

Maternal Age and Locomotor Opportunities (path a; hypothesis 2)

A second set of regressions were conducted to test the relationship between maternal age and the locomotor experiences presented to children (path a; see Figure 1). Specifically, we hypothesized that older mothers would provide more restrictive experiences than younger mothers. That is, mother age should be positively correlated to the more restrictive factor-based-scales (limited and moderate movement) and negatively correlated with the other scales. To remain consistent with the processes outlined by Kenny (2008) we conducted a set of regression analyses using each of the factor scores as the criterion and maternal age as well as several covariates as the predictors (please see Table 12 for a detailed description of these regressions). We did not find any significant

relationships between maternal age and any of our outlined locomotor opportunities (see Table 12).

Table 12

Locomotor opportunity factor scores as predicted by maternal age

		Maternal Age as a Predictor[a]			
Locomotor Opportunity Factor	*n*	Parameter Estimate	*SE*	*F*	*p*
Safety Percent	361	0.29	0.19	2.21	0.13
Free Movement	322	-0.07	0.04	3.03	0.08
Moderate Movement	331	0.02	0.04	0.51	0.47
Limited Movement	329	0.03	0.03	1.00	0.31
Sitting/Walking Movement	348	-0.09	0.06	1.83	0.17
Vestibular Movement	352	-0.03	0.07	0.24	0.62

Note. [a]Other predictors in regression include: gestational age, ponderal index, child gender, SES, mother education, number of children in the house, type of house, and mother personality. $^{*}p < .05$.

Maternal age and age at first walking (path c).

The direct relationship between mother age and age of first walking was tested by regressing age of walking on maternal age as well as our outlined covariates (path *c*; see Figure 1*)*. We entered mother age as well as our covariates to ensure that any variance in age of walking that was attributed to maternal age would be unique variance. Maternal age was found to be a significant predictor of age at first walking $F(13, 290) = 4.84, p = .02$. The relationship direction was positive, which meant children of older mothers walked later.

Complete Model: Locomotor Opportunities, Personality, and Mother Age Predict Age of Walking

The covariates and main predictor variables were conceptually placed into four groups (*demographics, locomotor opportunities, personality,* and *mother age*). Each group was then entered as a step in the regression model. A forward linear regression with four steps was used to examine each of the aforementioned relationships. Typically, a forward selection adds variables into the model until no remaining variables produce a significant *F* value. However, we forced each of the four variable sets to be included in the model regardless of significance. In other words, each of the covariates and predictors were retained through each step of the model. The model was not found to be statistically significant at the $p < .05$ significance level, $F(19, 223) = 1.42, p = .15$, and accounted for only 11% of the total variance in age of walking ($R^2 = .11$). The 11% of variance in age of walking that was accounted for by our predictors is outlined below in steps one through four. Please see Table 13 for a complete description of the results obtained from the complete regression model.

Step one: Demographic covariates and age at first walking. In step one of the model, we regressed age of walking on seven of our previously determined demographic covariates. None of the demographic variables appeared to have a significant relationship with age of first walking at the $p = .05$ level, $F(19, 223) = 0.53, p = .81$. Although we did not find a statistically significant relationship between the demographic variables and age of walking, the trends for these variables appeared to be in the hypothesized direction. For example, age of walking regressed negatively on gestational age, parent education, and ponderal index.

Step two: Locomotor opportunities and age of first walking (path b; hypothesis 1). The relationship between locomotor opportunities represented by our five factor-based-scales, and age of walking was tested in step two. Specifically we hypothesized that infants whose parents allowed them more experiences that facilitated and encouraged walking (e.g. the free movement, vestibular movement categories) would walk earlier than infants whose parents were more restrictive of their experiences. With the demographic variables held constant, age of walking was regressed on each of our factor scores and the percentage of safety devices used by parents. This study hypothesis and path *b* of the meditational model was not confirmed. No significant relationships between any of the outlined locomotor opportunities and age of walking were found $F(19, 223) = 1.45, p = .20$ (see Table 13 for more information).

Step three: Mothers' personality and age at first walking. The relationship between mothers' personality and age of first walking was tested in step three of the regression analysis. Each of the five personality traits as measured by the TIPI were entered as a group into the model. The five personality dimensions as a group were not significantly related to age of walking $F(19, 223) = 1.91, p = .09$. Openness, however, was found to be related to walking onset, $F(19,223) = -4.00, p = .04$. That is, as mothers' degree of openness increased infants' age of walking decreased.

Maternal Age, Restrictiveness and Walking (path c'; hypothesis 3)

After including each of the covariates, mother personality, and locomotor opportunities in the model we were left with the variable maternal age. We entered maternal age into the fourth step of our regression model (path *c'*; see Figure 1*)* as an informal test of *c'*. Mother age was entered into the fourth step to ensure that all possible covariates were accounted for prior to including mother age. Maternal age continued to be

a significant predictor of age at first walking $F(19, 223) = 7.75, p = .01$ above and beyond each of the locomotor opportunities factor score, and all of the study covariates. Again, a positive relationship was found between maternal age and age of walking. Please see Table 13 for a summary of the mother age/age of walking relationship in the complete model.

The goal of our meditational model was to test whether the maternal age and age of walking relationship was reduced when locomotor opportunities were entered into the model. However, each path of the model (see Figure 1) must be confirmed before testing the mediation (Baron & Kenny, 1986; Kenny, 2008). Because neither paths *a* or *b* were confirmed by our analyses, a formal test of the meditational hypothesis (path *c'*) was not conducted.

Table 13

Age at first walking predicted by locomotor opportunities, mother age, personality and demographic covariates (N = 243)

Variable	Parameter Estimate	*SE*	*F*
Intercept	54.50	2.96	338.84*
Step 1: Demographics & Age of Walking			0.53
Gestational age	-0.51	0.49	1.11
Ponderal Index	-0.05	0.16	0.11
Child Gender	0.58	1.29	0.20
SES	0.38	0.46	0.69
Mother Education	-0.47	0.42	1.30
Type of house	0.15	0.41	0.14

Number of other children in the house	-0.54	0.72	0.57
Step 2 (path b): Locomotor Opportunities & Age of Walking			1.45
Safety percent	-0.06	0.04	1.69
Free movement	0.23	0.23	0.90
Moderated movement	0.07	0.22	0.10
Limited movement	-0.20	0.25	0.66
Sitting/walking movement	0.25	0.15	2.92
Vestibular movement	0.01	0.12	0.01
Step 3: Personality & Age of Walking			1.91
Extraversion	-0.25	0.44	0.31
Emotional Stability	-0.66	0.58	1.30
Agreeableness	-0.06	0.68	0.01
Conscientiousness	1.06	0.63	2.82
Openness	-1.35	0.67	4.00*
Step 4 (path c): Mother Age & Age of Walking			7.75*
Mother Age	0.41	0.15	7.75*

Note. $R^2 = 0.11$. $^*p < .05$.

CHAPTER V

DISCUSSION

This study was designed to capture particular aspects of an infant's daily experience in relation to the gross-motor milestone, walking. Specifically, we sought to examine the possible mediating effects of locomotor opportunities on the relationship

between a mother's age and the age at which the infant first begins to walk independently. Dynamic systems theory suggests that several environmental and experiential factors contribute to the onset of walking and other developmental milestones (Adolph, 1997; Eaton, 2008). As parents are the greatest source of influence over an infant's daily experience, their influence (including how they interact with their infant), must be considered when examining gross-motor development.

One feature of the parent/infant interactions that appears to be an important influence on the age of onset of walking was handling (Blank, 1964; Hopkins & Westra, 1988; Keller et al., 2002). In addition, physical freedom and exploration have been circumstantially linked by previous research to other areas of gross motor development (Blank, 1964; Santos et al., 2001; White, 1975). In an attempt to better understand the nature of these hypothesized beneficial pre-walking experiences we created the Baby Play Questionnaire, which is designed to measure the amount of pre-walking exposure that infants experience in relation to equipment and positioning. This aspect of infant experience has not, to our knowledge, been measured previously. Parents with children who had already started walking were recruited to participate in this retrospective study. By recruiting a large number of parents, we sought to obtain a diverse sample that would capture the varieties of handling and equipment experiences that presumably exist. We did indeed find diversity, and the results of an exploratory factor analysis revealed five dimensions of movement experience (three related to equipment use, and two related to handling practices). The differences in infant experiences emerged from parent reports about the actual time (in days) a pre-walking infant spent in a particular piece of equipment, or body position. We also examined other characteristics of the infant's

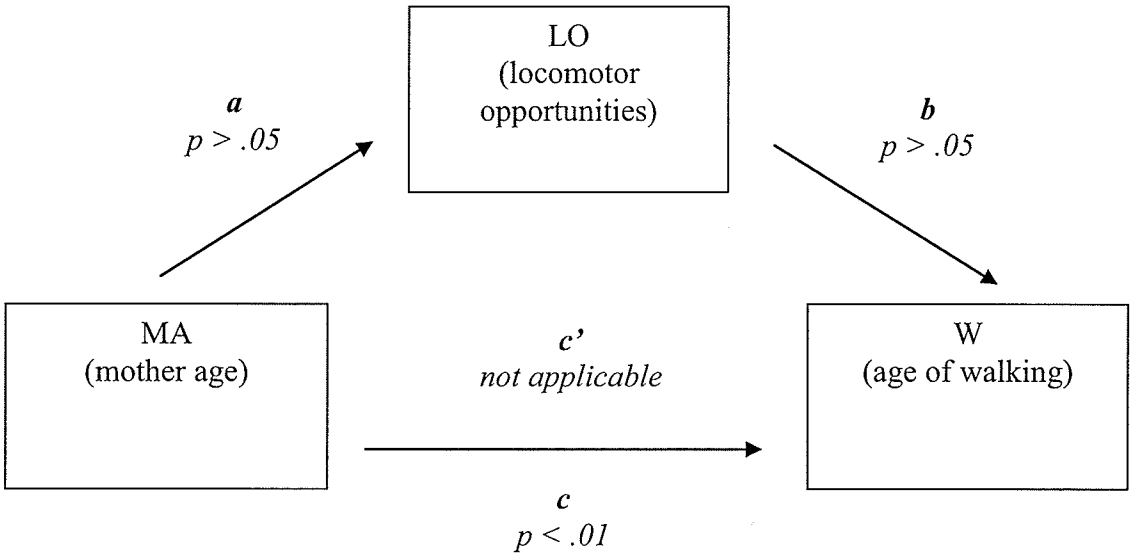
environment that may influence locomotor development and included them in an analysis to determine what predicts the timing of those first independent steps.

Maternal age has also been found to be a significant predictor for the age of first walking (Eaton, Bodnarchuk, & McKeen, 2006; Eaton, Bodnarchuk, McKeen, & De Jaeger, 2007). Specifically, and surprisingly, past research has found that older mothers have children who walk later. Although this finding is of great importance given the large number of older mothers present in today's society (Balen, 2004; Bornstein et al., 2006), the relationship between later mother age and child development is relatively unstudied. Some of these interaction styles have been linked to motor development (Keller, et al., 2002; Santos et al., 2001), yet we know of no evidence that clarifies the relationship between maternal age, interaction style, and motor development. We attempted to measure these interaction styles by capturing the aspects of daily experience we thought might be related to how much freedom and restriction infant's experienced as they developed their locomotor skills. Specifically, we wanted to determine whether maternal age was linked to the number of exploratory opportunities presented to children, and whether this relationship influenced the onset of walking.

Mediation Revisited

Because we believed locomotor experiences are an important predictor of walking, a meditational model was used to test the relationship between mother age and walking, where locomotor opportunities were accounted for as a mediating variable. Figure 3 revisits the visual illustration of our model with *p*-values entered to highlight those relationships found to be significant.

Figure 3. Mediation Outcomes



Locomotor Opportunities and Walking (b)

Contrary to our expectations, locomotor experience as measured by days-per-week did not predict the onset of walking in this study (Hypothesis One). Unfortunately for our expectations, the amount of time spent engaging in various locomotor opportunities was **not** a significant predictor of the walking milestone. It might be that the experiences identified in this study do not actually influence the onset of walking. We argue against this possibility, however, and suggest that our measure may be partially to blame for our unexpected results. In other words, the Baby Play Questionnaire may not have captured the most relevant aspects of these experiences when considering walking. Another possible limitation of this study could be that time, as measured in days-per-week, was not an accurate measure of equipment use or postural experiences, and infants' awake activity time. As a result, our time measure may not have allowed us to decipher

how these infant experiences contributed to the walking milestone.

Additionally, parents in this study were asked to recall specific events (e.g., '*How many days per week did you use _____?*') quite sometime after the events had occurred (more than a year and a half later in some cases). The intervening time may have introduced error into the recollections and rendered our measure inaccurate. It is possible that collecting retrospective data may not be the most effective technique for such specific events. Future research might consider constructing a more accurate measure of '*time-used*'. We advise future researchers to measure pre-walking handling and equipment experiences during the pre-walking period, and stop *after* the infant has taken his/her first steps, that is, to measure equipment, handling, and preliminary walking concurrently. Future research could also refine and expand the ways of measuring locomotor experience and broaden the criteria to include other milestones (e.g. rolling, pointing, sitting) as well as walking.

It has been suggested that some types of equipment do not allow infants the opportunity to practice the skills necessary for walking (e.g., falling forward and building momentum; Adolph, 2008). It seems reasonable to assume (as we did) that increased physical freedom would lead to less time spent in certain pieces of equipment. Unfortunately, our hypothesis was not confirmed. It is important to note that there was little variation in the free floor play variable (the key variable when considering physical freedom). That is, the majority of parents reported that they used free floor play on a daily basis. The relatively large amount of time infants spent freely exploring their surroundings might have countered any potential negative effects attributed to the use of restrictive equipment items. Furthermore, several of the equipment/handling items are likely used at one stage of development and abandoned at others (e.g., infant swings are

typically only used during the newborn stage). Because we were unable to account for specific age of use, it is possible that parents who used more restrictive equipment earlier on did not maintain this pattern of use through to walking. An additional factor that our measure did not capture was infant temperament. Some infants enjoy being held or spending time in particular pieces of equipment while others do not. Future studies examining experience in the equipment and handling domains should include a measure of infant temperament in conjunction with a more detailed account of duration of use.

Maternal Age and Walking (c)

The direct relationship between mother age and age of walking (path *c)* held true even after all other predictors were accounted for. According to our model the onset of walking is delayed by approximately 2.5 days (0.25 of a week) for every year of mother age. For example, a mother who is 33 years old when her child is born can expect that child to walk approximately 12.5 days later than a mother who is 5 years younger, and a 10-year mother age difference would predict nearly a month's difference in the timing of walking. Not only is the magnitude of this difference statistically significant, it is substantively quite important – at least in our view and, we suspect, in the view of most parents. Should this effect be replicated in future studies, it would represent an important stepping stone toward increasing our understanding of why babies differ in the ways that they do.

There are likely many other factors that influence age of walking, and some of these factors may also be related to mother age. Regardless, the results from this study lend further support for the importance of maternal age and the development of milestones. However, because of our mixed findings in relation to locomotor opportunities, other aspects of daily experience in relation to maternal age should be

included in future investigations of possible maternal-age-effects.

Of course, is it crucial to acknowledge that other non-experiential features of maternal age could be important. Research in human genetics has suggested that hormone levels during pregnancy are at the root of developmental differences observed in the children of older mothers (Bottini, Cosmi, Nicotra, Cosmi, & Bottini, 2005). This biological evidence should be interpreted with caution, however. The genetic research conducted thus far is speculative in nature, and biological causes have not been directly linked to differences in rates of development. Further exploration into the biological nature of development was beyond the scope of this study, but it could be playing an important role in the relationship between mother age and walking (Bottini et al., 2005). Additionally, the age at which mother's first walked independently might be predictive of infant age of walking. One way of partially controlling for genetic influences in future studies would be to include questions about the mother's and father's age of first walking. A genetic hypothesis would predict that age of parents' first steps would be a significant predictor of when their infant first walks. Should such a finding emerge, it would argue strongly for including more biological predictors in our explanatory models for rate of locomotor development.

Maternal Age and Locomotor Opportunities (a)

Although maternal age predicted age of walking, it did not predict the provision of locomotor opportunities (our hypothesis two). This could be due to any number of the previously mentioned drawbacks in relation to how our measure of locomotor opportunities captured the time of exposure for various activities. Alternatively, it is quite possible that older mothers do not differ from younger mothers in the handling, or equipment related experiences they present to their infants. To explore maternal age and

experience in greater detail, future research might examine the relationship between maternal age, opportunities related to time spent in specific pieces of equipment and positions, as well as various other demographic factors.

Interesting Finding: Openness and Walking

We found another surprising result when we examined mother personality in relation to walking. That is, children walked earlier when their mothers scored high on the openness dimension (individuals who are creative, have a wide variety of interests, and are open to new experiences). A possible explanation for this finding is that mothers who are open to new experiences might provide new and varied experiences for their children. To our knowledge, this is an idea not previously reported in the literature. The openness dimension variable, however, further supports the importance of daily experience in relation to advances in walking. It may also open up an interesting discussion about the balancing of freedom and safety. Although the percentage of safety items was not significantly related to walking or mother age, a more precise measure of safety items used, and the reasons behind their use, might reveal an interaction between safety measures and maternal personality. Maternal personality might be a potential mediating variable that can be used to clarify the relationship between maternal age and walking in future analyses.

Baron and Kenny (1986) and Kenny (2008) have stated that paths *a, b* and *c,* must be significant *before* a test of *c'* can be conducted. As demonstrated in Figure 3 and the preceding discussion, the relationships for paths *a* and *b* were not significant, and as a result, the mediation analysis was not conducted as planned. This is not to say that mediation does not exist, nor that a meditational model was not the best 'fit' for our data. We believe that infant experiences are important but that the meaningful aspects of these

experiences were not captured through our preliminary study. If our model is revisited with a refined measure and broader definition of experience, mediation analysis is a reasonable mechanism for exploring the relation between maternal age and developmental milestones.

Additional Contributions

Although we have discussed several drawbacks and problems with the study measures, and analysis, it is important to consider the contributions this study has made. The creation of a new self-report measure of locomotor opportunities is an important first step towards quantifying infant locomotor experiences. Variations of the Baby Play Questionnaire might be useful for many future analyses. Further refinement of our measure will allow us to examine the influence of early experience for other motor domains such as sitting, crawling, and mature walking -- just to name a few. Next, this study makes an important contribution to the literature regarding maternal age. Research in the area of older motherhood is just beginning, and there are few theories relating older mothering to later development. As the average age of motherhood continues to increase, an understanding of how maternal age influences developmental trajectories both in infancy and later childhood is necessary. Because the relationship between mother age and walking was confirmed by this study, it is reasonable to assume that the mother-age-effect exists for other domains as well. Finally, we have been the first to find evidence of a relationship between maternal personality and motor development in children. It is likely that this relationship is due to the indirect-acting-effects of maternal personality on the type of experiences mothers provide for their children. These preliminary findings will help to guide future research into the links between maternal personality, infant experiences, and developmental outcomes.

Implications

Various studies suggest that there are specific links between early development on motor domains, and later developmental outcomes (Eaton, Bodnarchuk, McKeen, & Lewycky, 2007; Murray et al., 2006; Taanila et al., 2005). Specifically, a longitudinal study conducted by Eaton, and colleagues (2007) found that age of sitting predicted cognitive abilities at 2-years of age. Many studies also suggest that later maternal age benefits development in cognitive domains. For example, the children of older mothers display increased cognitive and linguistic skills in early childhood when compared to children of younger mothers (Bornstein et al., 2006; Pan, Rowe, Spier, & Tamis-Lemonda, 2004; Pollock, 1993; Rosenthal-Rollins, 2003). As the current study has demonstrated, however, the benefits of older mothering in the cognitive and linguistic domains are not necessarily present in motor domains of development.

Future research examining the relationship between maternal age and development must investigate why maternal age is differentially related to cognitive and motor development. Despite the unanticipated findings from this study, daily experience likely remains to be one of the driving forces behind these mother-age-effects. Systems theories regarding development indicate that many aspects beyond biological maturation contribute to the variation observed in milestone attainment, and experience is one of these factors. If we can continue to clarify the relationship between mother age and motor development via daily experience, we will continue to contribute to a systems view of development.

Conclusion

This study was the first to measure pre-walking experiences as defined by actual time spent using various pieces of infant equipment and handling postures. Using the

Baby Play Questionnaire, a newly created measure, we found that mother age did not predict locomotor opportunities (as measured by number of days), and that the same locomotor experiences did not predict the onset of walking. Maternal age did, however, predict walking, and we confirmed our hypothesis that older mothers will tend to have children who walk later. Additionally we found that some aspects of maternal personality, particularly openness to experience, also predict walking. Future studies could refine our measurement of locomotor experience, account for additional aspects of infant experiences and even include a mediation analysis within a longitudinal methodology.

The goal of this study was to gain a better understanding of infant experiences in relation maternal age and the influence of these variables on development in early childhood, a relatively unexplored but important area of research. As variation in age of motherhood becomes more common, it is crucial to understand how such variation may influence developmental trajectories both in infancy and later childhood. Understanding these complex relationships will help researchers to develop tools for parents that stress the importance of parent/child interactions, and how these interactions can help children to reach their full potential. Furthermore, by continuing to explore, in detail, the relationship between maternal age and the timing at which offspring reach developmental milestones future research can make a significant contribution to the maternal-age literature. As the average age of motherhood continues to climb, it is important to study and communicate the influence delayed motherhood may have on both parents and children throughout the lifespan.

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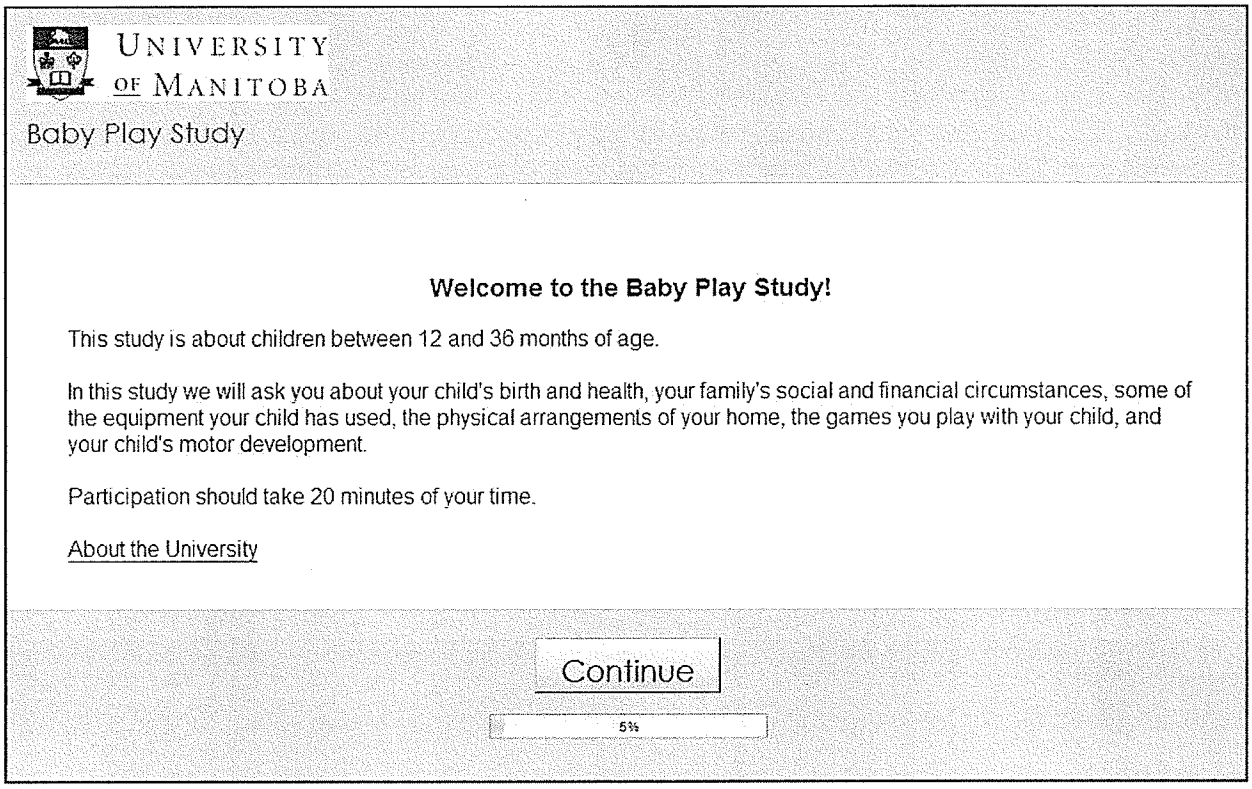
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Appendix A

Baby Play Study Landing Page



Consent

This study has been approved by the Research Ethics Board at the University of Manitoba. We take great care to protect your privacy and security, and the following statements describe your rights and our responsibilities.

This study has been approved by the Research Ethics Board at the University of Manitoba.

I am the parent or legal guardian of the child on which I am reporting.

I do not have to answer any question I do not want to.

My answers will be kept confidential, securely stored, and shared only with researchers on the Milestones team.

I may ask for additional information by calling the Milestones team at 204-474-9739.

My participation does not affect my legal rights.

My agreeing to participate does not release the researchers, sponsors, or involved institutions from their legal and professional obligations.

If I have concerns, I may contact Margaret Bowman at the Human Ethics Secretariat, University of Manitoba (phone: 204-474-7122; e-mail: margaret_bowman@umanitoba.ca).

Comments or questions about the study may be addressed to the principal investigator, Warren Eaton, Ph.D, Professor, University of Manitoba, Winnipeg, Canada, by clicking here.

Do you wish to continue?*

○ Yes ○ No

Back Continue

Appendix B

Permission Email as sent to forum and Facebook Group moderators

Dear Moderator,

My name is Amy (MomOfOneSon) and I am a member for the <<Insert Forum Name>> forum. I am also the mother of a six-year-old boy and a Master's student in child development. As both a parent and student I am fascinated by the ways children play and interact with others. My goal is to get a better understanding of the ways in which play influences development.

To achieve this goal I would like to combine hundreds of reports from parents, who are the experts on their child's development. That means I need to find a lot of parents who are willing to share!

Specifically I am looking for parents with children between 1 and 3-years-old who would be interested in completing an online questionnaire (about 20 minutes in length). With your permission I would like to post the following statement and study link for parents on your forum.

"Hi everyone, as parents you may be interested in being part of a university study I'm involved with. It's about how children play and develop. This study is designed for parents of 1 to 3-year-olds. It wouldn't take much of your time, and it's a great way to contribute to knowledge by reporting on your own experiences. If you want to learn more about your child, as well as how children from all walks of life develop, please come check us out at: www.babyplaystudy.org. Best wishes, Amy (MomOfOneSon)"

PLEASE NOTE: All of my activities are carried out through the University of Manitoba (located in Winnipeg, Canada). The University of Manitoba is a NOT FOR PROFIT organization. All of our surveys are conducted for educational purposes only.

This study has been reviewed for ethics and approved by our University. I will not share information I collect with any third party. I will not try to sell your members anything. I will keep information from your members in locked and password-protected locations.

If you would like more information about the University of Manitoba please click here http://umanitoba.ca

If you have any questions you can contact me (babyplaystudy@gmail.com) or my advisor Dr. Warren Eaton (eaton@cc.umanitoba.ca) anytime.

Thank you for your time,
Amy

Forum and Facebook Group Recruitment Messages 1-3

Message 1:
Hi everyone,
As parents you may be interested in being part of a university study I'm involved with. It's about how children play and develop. This study is designed for parents of 1 to 3-year-olds. It wouldn't take much of your time, and it's a great way to contribute to knowledge by reporting on your own experiences. If you want to learn more about your child, as well as how children from all walks of life develop, please come check us out at: http://www.babyplaystudy.org
Best wishes,
Amy

Message 2:
Hi everyone,
My name is Amy. I am the mother of a six-year-old boy and a Master's student in child development. As both a parent and student I am fascinated by the ways children play and interact with others. My goal is to get a better understanding of the ways in which play influences development. To achieve this goal I would like to combine hundreds of reports from parents, who are the experts on their child's development. That means I need to find a lot of parents who are willing to share! Specifically I am looking for parents with children between 1 and 3-years-old who would be interested in completing an online questionnaire (about 20 minutes in length).
The link is http://www.babyplaystudy.org If you personally know any parents that might be interested in these studies, and if you could forward this information on to them I would be very grateful.
Thank you for your time,
Amy

Message 3:
Hi there,
My name is Amy, and I'm e-mailing you from Winnipeg, Manitoba, Canada. I'm part of the Milestones Research team at the University of Manitoba, and we do non-commercial, internet based child development research with the help of parents from around the world. I am currently doing a study on play influences development, which involves parents of 1 to 3 year olds.
The address is http://www.babyplaystudy.org if you would like to come and check us out.
The website for our university is http://www.umanitoba.ca if you would like to review any of these sites to find out more about our research. If you personally know any parents that might be interested in these studies, and if you could forward this information on to them I would be very grateful.
Thank you very much for your time!
Amy

Appendix C

Facebook Group – Baby Play Study

facebook Home Profile Friends Inbox Milestones Eaton Settings Logout

Baby Play
Global



View Discussion Board
Message All Members
Promote Group with an Ad
Edit Group
Edit Members
Invite People to Join
Create Related Event
Leave Group

Share +

Basic Info

Type: Organizations - Academic Organizations

Description: Hi Everyone,

My name is Amy. I am the mother of a six-year-old boy and a Master's student in child development. As both a parent and student I am fascinated by the ways children play and interact with others. My goal is to get a better understanding of the ways in which play influences development.

To achieve this goal I would like to combine hundreds of reports from parents, who are the experts on their child's development. That means I need to find a lot of parents who are willing to share!

Specifically I am looking for parents with children between 1 and 3-years-old who would be interested in completing an online questionnaire (about 20 minutes in length).

The link is http://www.babyplaystudy.org

If you personally know any parents that might be interested in this study, and if you could forward this information on to them I would be grateful.

PLEASE NOTE: All of my activities are carried out through the University of Manitoba (located in Winnipeg, Canada). The University of Manitoba is a NOT FOR PROFIT organization. All of our surveys are conducted for educational purposes only.

If you have any questions you can contact me here or at babyplaystudy@gmail.com. Alternately you can contact my Advisor Dr. Warren Eaton (eaton@cc.umanitoba.ca) anytime.

Feel free to invite as many friends as you like to join this group!

Thank you for your time,
Amy

Group Type

This is an open group. Anyone can join and invite others to join.

Admins

- Milestones Eaton (creator)

Events

There are no events.
Create Events.

Contact Info

Email: babyplaystudy@gmail.com
Office: Milestones Study Centre
Location: University of Manitoba
Winnipeg, MB

Related Groups

Kendyl Lauzon - Artist
Entertainment & Arts - Fine Arts

Old St. Vital Crew
Common Interest - History

Kula Kips
Business - General

Unlike 99.99% of the Facebook population, I was born in the 70s.
Just for Fun - Totally Pointless

Glenlawn Collegiate
Student Groups - General

Recent News

Baby Play is now recruiting parents of 1 to 3-year-olds!

Please visit the study website at:

http://www.babyplaystudy.org

Members

Displaying 8 of 89 members See All


Darce-Lee Pyner


Samantha Lewycky


Sheryl Smith Schmid


Nicky Dawson


Amy DeJaeger


Jason Leboe


Dawn Barker


Melissa Nel

Discussion Board

Appendix D

Baby Play Study

Equipment Play

The following questions will ask about various types of equipment that your child may have used. Please remember that there are no right or wrong answers to these questions. The purpose of these questions is simply to explore different play environments.

The questions are about your baby's play behaviours ***before*** your baby walked without help

During a typical week did/does your child spend time in an infant car seat (between car rides)? /Yes / No /

If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

During a typical week did/does your child spend time in a highchair (between meals) /Yes / No /

If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

During a typical week did/does your child spend time in a bouncy chair /Yes / No /

If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

During a typical week did/does your child spend time in a baby swing /Yes / No /

If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

During a typical week did/does your child spend time in a stroller (between walks) /Yes / No /

If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

During a typical week did/does your child spend time in a Jolly Jumper™ /Yes / No /

If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

During a typical week did/does your child spend time in an infant walker /Yes / No /

If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

During a typical week did/does your child spend time in an exersaucer /Yes / No /

If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

During a typical week did/does your child spend time walking with push toys /Yes / No /

If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

During a typical week did/does your child spend time in a playpen (during non-nap times) /Yes / No /

If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

During a typical week did/does your child spend time in a crib (during non-nap times) /Yes / No/

If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

During a typical week did/does your child spend time at play tables /Yes / No /

If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

During a typical week did/does your child spend time playing with floor toys (e.g. kicking gyms, on activity blankets) /Yes / No /

If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

During a typical week did/does your child spend time playing on the floor with toys /Yes / No /

If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

Interactive Play

The following questions will ask about the ways that you may have played or interacted with your child. Please remember that there are no right or wrong answers to these questions. The purpose of these questions is simply to explore different aspects of parent/child play.

The questions are about games you played with your baby ***before*** your baby walked without help.

During a typical week did/do you play riding games (adult is on hands and knees, child sits or is held the back) /Yes / No /

If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

During a typical week did/do you play tossing games (holding the child above one's head and toss them gently into the air) /Yes / No /

If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

During a typical week did/do you play walking-on-an-adult's-feet-games (placing the child's feet on the tops of one's feet while holding the child's hands and walking) /Yes / No /

If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

During a typical week did/do you play Peek-a-Boo (Covering one's face and quickly uncovering it while saying 'peek-a-boo') /Yes / No /

If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

During a typical week did/do you play rocking games (holding the child close to one's body and rocking back and forth – perhaps accompanied with a poem or song) /Yes / No /

If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

During a typical week did/do you play hanging-upside-down-games(holding the child upside down by the ankles and slowly pulling the child up to a carrying position) /Yes / No /

If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

During a typical week did/do you play piggy back games (placing the child on one's back while standing or walking) /Yes / No /

If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

During a typical week did/do you play swinging games (holding child by the hands or under the arms and gently swinging them) /Yes / No /

If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

During a typical week did/do you play Pat-a-cake or other clapping games /Yes / No /

If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

During a typical week did/do you play blanket rocking games (holding the child in a blanket and rocking them back and forth) /Yes / No /

If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

During a typical week did/do you play hanging games (holding by the hands or wrists and then slowly pulling them up) /Yes / No /

If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

During a typical week did/do you play ride-the-pony games (seating the child over one's leg and bouncing the leg up and down) /Yes / No /

If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

During a typical week did/do you play jumping games (holding the child underneath his/her arms while alternately lifting and lowering the child) /Yes / No /

If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

During a typical week did/do you play suspense games, repeating a predictable series of actions (e.g. This Little Piggie...) /Yes / No /

If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

During a typical week did/do you play swinging-upside-down games (holding the child upside down by the ankles and swinging him/her back and forth) /Yes / No /

If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

During a typical week did/do you play walking games (holding the child's hands and walking) /Yes / No /

If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

During a typical week did/do you give your baby a massage? /Yes / No /

If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

Did you ever use a baby carrier (ex. snuggly, sling, etc.)? /Yes / No /
If Yes, then the following: How many days a week? [alternatives: 0 - 7 by 1]

Home Arrangements

The following questions ask about the physical arrangements in your home. Please remember that there are no right or wrong answers to these questions. A question about an arrangement does not mean that we endorse its use. The purpose of these questions is simply to understand how your home is arranged.

The questions are about your home arrangements as they were ***before*** your baby walked without help.

Did/do you use baby gates in your home? /Yes / No /

Did/do you use electrical outlet plug covers (something that you would use to block an electrical outlet)? /Yes / No /

Did/Do you use safety latches that prevent children from opening cupboards, drawers, toilets, etc.? /Yes / No /

Do you use power strip covers (a cover that prevents plugs from being removed)? /Yes / No /

Did/Do you use window guards, devices that are placed on the inside of a window to prevent your child from falling out the window? /Yes / No /

Did/Do you use protective doorknob covers (a device that covers the doorknob and requires adult strength to open)? /Yes / No /

Did/Do you use window-cord devices (keeps cords out of a child's reach)? /Yes / No /

Did/Do you have a fire extinguisher in your home? /Yes / No /

Did/Does your house have a working smoke detector? /Yes / No /

Did/Do you have a first aid kit in your home? /Yes / No /

Did/does your child wear protective equipment (i.e. knee pads, or a helmet) for non-medical reasons when playing in the home? /Yes / No /

Did/Do you have an area or room in your home where your child can play safely on his/her own? /Yes /

Did/Do you have a deadbolt or chain lock on the exterior doors of your home that is designed to prevent your child from leaving? /Yes / No /