Does postural experience influence when babies first roll over?

by

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A Thesis submitted to the Faculty of Graduate Studies of

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Abstract

Circumstantial evidence suggests that infants who spend little time on their stomachs while awake are likely to be delayed in motor milestones (Dudek-Shriber et al., 2007). The current study used an instructional manipulation to test this hypothesis with the rolling milestone. Parents of 2-to-3-month-olds were recruited and surveyed using the internet. Half were asked to place their infant on their stomachs for 30 minutes/day. Parents were sent on-line questionnaires about their infant's experiences and milestone acquisition until their baby was 6-months-old. Survival analysis revealed no differences in the age of first roll (AOR) between the groups. However, gestational age, infant health and SES were found to be predictors of rolling. Although the hypothesis was not supported, the experimental treatment may have been too short and not applied at an early enough age. The magnitude of gestational age on AOR was surprising and consistent with a maturational component in motor development.

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CHAPTER 1

INTRODUCTION

During the first few months of life, infants are quite limited in what they are able to do, as they spend the majority of their time eating and sleeping. Against such a background, one of the highlights for a parent is when their infant rolls for the first time. This is one of the first observable gross motor milestones a parent experiences and its appearance reassures them that their baby is growing and developing appropriately. Parents are excited by other motor milestones as well. They perceive these attainments to be the beginning of their infant's development, as they begin to see how their child is changing and adapting to the world around them. Parents are also interested in how their infant is developing in comparison to normative standards, because delays may signal developmental problems. Because of these concerns, the study of developmental variation in infant motor development is important for identifying those factors that influence rate, sequencing and quality of motor development in children. Better information on milestone variation not only benefits parents, but more generally leads to greater understanding and knowledge of how the motor skills of infants evolve.

Theories of Motor Development

Early theories of motor development attributed changes in gross motor skills during infancy to neurological maturation of the central nervous system (Piper & Darrah, 1994). This maturational theory held that all infants reach milestones in a common sequential order, with infants first gaining control of their head, upper limbs and, finally, lower limbs. Such a perspective assumes that motor abilities are in some fundamental ways represented in the brain and that motor skill development is primarily innate. Little

is said from this perspective about individual variation, apart from using age norms to identify when specific milestones should appear in infants. Variation within normal limits is not seen as particular interesting or informative from such a perspective. Although most infants follow a similar maturational progression, one criticism of the maturational theory is that it fails to adequately consider the importance of the variability that exists from one infant to another. By glossing over such variability, motor development seems more monolithic and uniform than it really is.

The maturational explanation of motor development has been replaced with a more contemporary approach, the dynamic systems theory, which focuses on individual variation (Thelen, 1995). The dynamic systems model proposes that a number of sequences of milestone development are possible when explaining the differences that exist among infants. This model focuses on factors within the child and environmental factors surrounding the child, such as body size, experience and the infant's environment (Adolph, Verijken, & Denny, 1998). From the dynamical perspective these variables are thought to play a considerable role in how and when infants develop motor skills like rolling, crawling and walking.

Factors that Influence Milestone Development

It is unquestionably clear that infants vary in a number of ways in reaching developmental milestones. For example, Piper and Darrah (1994) found in their sample of 2,200 infants that the onset of rolling prone to supine with rotation (when the infant rolls completely from stomach to back) ranged from four to ten months of age. Although the mean age of this attainment was 6 months, to say that infants roll at 6 months would drastically over-simplify the state of developmental affairs and ignore the development of

variability that characterizes the attainment of motor milestones.

Such variation is more than error of measurement, and a number of variables have been associated with when an infant reaches certain milestones. For example, demographic variables such as gestational age and birth weight of the infant (Sugar, 1977), family socioeconomic status (SES; Capute, Shapiro, Palmer, Ross & Wachtel, 1985), mother's age (Eaton, Bodnarchuk, McKeen & De Jaeger, 2007), and child's gender (Lejarraga et al., 2002) have, in various ways been linked to the timing of developmental milestones like rolling, crawling and walking. Other influences may be important as well. For example, some infants may reach these milestones sooner than others because they are more motivated to achieve mobility (Shirley, 1931), or the presence of parental encouragement of these motor behavior may lead to their earlier onset (Super, 1976). Body composition has also been considered to be influential in that thinner infants crawl and walk faster and sooner than their chubbier counter parts (Adolph et al., 1998; Shirley, 1931; Thelen & Smith, 1994). In addition, cultural differences have been found to have a large impact on how a child develops. The physical contact and handling parents and caregivers provide to their children may play a role in the onset of motor development, and these aspects of parenting have been shown to vary among cultures (Cratty, Cratty, & Cornell, 1986; Parks, Lenz, & Jenkins, 1992). Along the same lines, a lack of physical contact and emotional stimulation has been found to delay various aspects of development in infants (Dennis, 1938).

Environmental factors also contribute to variability in milestone attainment. For instance, Benson (1993) found that infants born in winter and spring months, crawled 3 weeks sooner than those born in the summer or fall months. Another environmental

factor thought to influence milestone attainment is that of experience and practice (Adolph et al., 1998). The learning and acquisition of a particular motor skill takes time and practice, similar to the learning of a particular sport. When an infant is given the opportunity to practice a particular skill or milestone, the onset is subsequently accelerated. In many ways parents are the providers of locomotor opportunities, and they play a substantial role in their infant's development.

CHAPTER II

LITERATURE REVIEW

A vast majority of the information parents obtain comes from family and friends who have had the experience of raising a child. In addition, the media also plays a critical role in distributing information to parents. One example of a childcare practice the media has encouraged was a published 1992 recommendation by the American Academy of Pediatrics (AAP) to have babies sleep on their backs to decrease the incidence of sudden infant death syndrome (SIDS). The effect of this publicity has had a very real impact, as described below.

Sudden Infant Death Syndrome

A panel assembled by the National Institute of Child Health and Human Development has defined SIDS as: "The sudden death of an infant under one year of age which remains unexplained after a thorough case investigation, including performance of a complete autopsy, examination of the death scene and, review of the clinical history" (Willinger, James, & Catz, 1991, p. 681). In 2002, SIDS was the third leading cause of infant death in the United States, (just behind congenital malformations, deformations and chromosomal abnormalities, and disorders related to gestation and low birth weight;

Anderson, Smith, & The National Center of Health Statistics, 2005). A number of risk factors have been identified as being associated with SIDS. Some maternal factors include: maternal age (with infants of younger mothers being at an increased risk; Gracey, 2001), low SES and education (Mitchell et al., 1997), maternal smoking (Schellscheidt, Øyen, & Jorch, 1997), and illegal drug use (Kandall, Gaines, Habel, Davidson, & Jessop, 1993). Other risk factors are: age (the greatest is risk between 2 and 4-months of age; Arnestad, Andersen, Vege, & Rognum, 2001), gender (males at higher risk; Brooke, Gibson, Tappin, & Brown, 1997), race and ethnic background (African American and American Indian infants are two to three times more likely to die compared to infant's of other races. (Mathews, Menacker, MacDorman, & Division of Vital Statistics, 2004), sleeping surfaces (older or soft mattresses and fluffy comforters or pillows have been found to be hazardous; Mitchell, Scragg, & Clements, 1996), and infant co-sleeping with parents or other siblings (Blair et al., 1999). Additional causes of SIDS have yet to be identified, as approximately 75% of infants who die from SIDS each year have no observable risk factor for the syndrome (Guntheroth, 1989).

One preventable risk factor, which has gained much attention is infant sleep position (American Academy of Pediatrics Task Force on Infant Sleep Position and Sudden Infant Death Syndrome, 2000). A case control study of 485 infant deaths caused by SIDS was investigated in New Zealand from 1987-1990 (Mitchell, Thach, Thompason & Williams, 1999). Autopsies and parental questioning revealed that 20% of these deaths were associated with lack of parental experience and knowledge about the prone sleep position. Subsequently, the AAP recommended that healthy infants should be placed in the supine or side position when put to sleep (American Academy of Pediatrics Task

Force on Infant Positioning and Sudden Infant Death Syndrome, 1992). This statement, as well as the 1994 national "Back-to-Sleep" educational campaign, has been associated with a decrease in the number of prone sleepers, down from 70% in 1992 to 20% in 2000 (American Academy of Pediatrics Task Force on Infant Sleep Position and Sudden Infant Death Syndrome, 2000). A number of other campaigns aside from "Back-to-sleep" have contributed to this decrease in prone sleepers.

Sleep Position and Milestone Development

Research has found that infants who regularly sleep in the supine position take longer to achieve a variety of milestones (i.e., rolling and crawling) compared to those infants who routinely sleep in the prone position (Davis, Moon, Jantz, Blosser, & Fruechting, 1998; Jantz, Blosser, & Fruechting, 1997; Vaivre-Douret, Santos, Charlemaine, & Cabrol, 2005). On average in the last 20 years, infants have been reaching the milestones of rolling (Capute et al., 1985; Nelson, Yu, Wong, Wong, & Yim, 2004) and crawling (Capute et al., 1985; WHO Multicentre Growth Reference Study Group, 2006) later than previously reported. A plausible explanation for this increase in age of attainment could be the changes that have been implemented in infant sleep position. Research on the effects of sleep positioning began in 1960, at a time where American babies were sleeping in the prone position. At that time Holt (1960) reported that American babies achieved certain milestones at an earlier age than infants from the United Kingdom who slept supine. In the 1970s and 80s there was only one reported study on infant sleep position. A small sample of supine and prone sleepers were compared on the Bayley Scale of Motor and Mental Development; however, no differences between the groups were observed (Modlin, Dawker, & Costello, 1973). With

the emergence of interest in SIDS and the campaign to reduce infant mortality, interest in the effects of sleep position once again emerged in the late 1990s.

In 1997, Jantz et al. (1997) investigated 343 full term infants using the Denver Developmental Screening Test (DDST). They found that infants who slept in the side or supine position were less likely to roll over by the age of 4 months than were infants who slept in the prone position. Using the same measure Dewey, Fleming, Golding, and ALSPAC Study Team (1998) reported similar results. They found that 6-months-olds who typically slept on their stomachs (prone) had higher scores on the gross motor scale compared to infants who typically slept on their backs (supine). They extended their study to determine if recommendations for infants to sleep supine would have adverse consequences on social skills. Indeed, prone sleepers had higher scores on the social skills total development scale as opposed to those infants who slept on their backs. Davis and collaborators (1998) continued to investigate motor milestones and sleep position; however, their study differed from previous investigations in that they asked parents to use a developmental log to track the acquisition of eight motor milestones rather than a standardized screening measure. Supine sleepers achieved *rolling prone-to-supine, tripod sitting, creeping, crawling,* and *pulling to a stance*, earlier compared to a group of infants sleeping prone. The results of this study, particularly the milestones of *creeping* and *crawling* have been emulated by other investigators using standardized assessments (Vaivre-Douret et al., 2005). The developmental log used to measure milestone attainment in Davis et al.'s study was beneficial in that it allowed the researchers to conclude that prone sleepers rolled over from *prone-to-supine* an average of 4 weeks sooner than infants sleeping in the supine position.

Children at-risk for developmental delays have also been studied in terms of sleep position and milestone attainment. In Ratliff-Schaub et al's study (2001), sleep position was questioned in regards to the motor development of premature infants, categorized on the basis of having a birth weight of less than 1750 grams and a gestational age of less than 34 weeks. Supine sleepers were less likely than prone sleepers to receive credit on the Bayley Scales of Infant Development II (BSID-II) for the milestone items of *maintaining head elevated to 45 degrees*, *head elevated to 90 degrees*, and *lowering with control*. This study again shows a relationship between early gross motor milestones and sleep position.

The most recent study on sleep position and gross motor development was investigated by Salls, Silverman, and Gatty (2002). In this study a comparison was made between a sample of infants tested in 1998 and a DDST normative group (assumed to have been placed on prone to sleep, as these norms were collected in 1988, when the majority of children were sleeping in the prone position). Salls et al. (2002) found differences between the groups of 2-month-old infants on three gross motor milestones: *head elevated at 45 degrees, head elevated at 90 degrees* and *sit-head steady*. The 1988 normative group was more advanced compared to the 1998 tested group on these measures.

Overall the results of these studies consistently show that the early development of infant's gross motor milestones may be related to sleep position for milestones that appear as early as 4 months of age (i.e., rolling; Jantz et al., 1997) to those that begin to develop around 7 or 8 months of age (i.e., pulling to a stand; Davis et al., 1998).

The impact sleep position may have on an infant's development can also be found

in early reports on cultural differences in sleep position. Asian countries for instance, have low rates of SIDS and have traditionally placed infants in the supine position to sleep (Lee, Chan, Davies, Lau & Yip, 1989). Yet, in these same regions, infants have been found to be delayed in gross motor milestones when compared to US norms (in this particular study the data were compiled prior to 1985 when North American infants were mainly sleeping in the prone position; Fung & Lau, 1985). North American infants tested on the DDST instrument in the mid 80s rolled over at an average age of 2.8 months, whereas in China, using the same measure, infants did not begin to roll, on average, until 5.4 months of age (Fung, & Lau, 1985). Of course there are many other possible sources of differences besides sleep position in such a comparison; however, data has consistently shown a link between sleep position and rate of milestone attainment.

Prone Awake Play

Since the AAP first expressed their recommendations for infants to sleep in the supine or side position in 1992, they have subsequently suggested that "a certain amount of 'tummy time' while the infant is awake and observed is recommended for developmental reasons and to help prevent flat spots on the [back of head]" (Task Force on Infant Positioning and SIDS, 2000, p. 654). This recommendation is often overlooked. Salls and colleagues have begun to question whether parents are misinterpreting the intent of the "Back-to-Sleep" campaign and are avoiding the prone position all together, for both infant sleep and play. Supervised awake time in the prone position is not considered a risk factor for SIDS and has been shown to be essential for normal infant development (Mildred, Beard, Dallwitz, & Unwin, 1995).

Prone positioning during waking hours has many benefits on an infant's

development. This position offsets some of the adverse effects of predominant supine positioning (i.e., head becoming misshaped). It also provides the infant with different sensory experiences and perspectives on the world, and promotes upper body development. Infants who are regularly placed in the prone position gain experience which helps the development of extensor muscle control and antigravity control (i.e., neck, shoulder and upper body muscles become stronger; Piper & Darrah, 1994; Ratliff-Schaub et al., 2001).

On the other hand, little or no time in the prone position can lead to the increased incidence of torticollis, where the neck becomes tight on one side (Raco, Raimondi, De Ponte, Brunelli, Bristot, & Bottinin 1999), or to an increased occurrence of plagiocephaly, the condition of a child's head becoming misshapen, often with a flat spots on the back of their skull (Persing, James, Swanson, Kattwinkel, Committee on Practice and Ambulatory Medicine, Section on Plastic Surgery, & Section on Neurological Surgery, 2003). In addition to the research demonstrating a connection between sleep position and the age of attainment of gross motor milestones, research has also been found to show that delays in gross motor milestones can be attributed to infants experiencing little or no time awake in the prone position (Davis et al., 1998; Jennings, Sarbaugh, & Payne, 2005; Monson, Deitz, & Kartin, 2003). Evidence of these delays have been documented in numerous cross-cultural investigations dating back to the 1940s. Literature on cultural rearing practices demonstrate the detrimental effects of being placed strictly in one postural position can have on an infants motor acquisition. Dennis and Dennis (1940) conducted a study on the Hopi tribe of Arizona, a group of Aboriginal people who bound their children to a heavy board, securely fastened with

strips of cloth. Infants in this culture were laid on their backs for all hours of the day for the first three months of life. Compared with infants not bound by this method and from other locations in the United States, the Hopi children were delayed in the acquisition of walking. Infants in other cultures have been found to exhibit similar delays due to cultural rearing practices. In Hong Kong infants tend to be heavily wrapped by their mothers, a possible contributing factor for their delay in gross motor milestones that has been observed during the first year of life (Fung & Lau, 1985). As well, in the Bambara culture of Mali, babies rarely crawl, as they are jounced in a sling by the mother's side, rarely put down in prone position (Bril & Sabatier, 1986). It has been found in cultures that promote upright postures, and minimal exposure to other prone and supine positions, infants crawl later or sometimes not at all (Bril, Zack, & Nkounkous-Hombessaet, 1989).

Prone Awake Play and Milestone Development

An intuitive explanation for this delay in the development of motor milestones is that infants are not receiving the exposure they need to the prone position. Therefore, they are not getting the opportunity to practice and learn the necessary skills (i.e., pushing up with their arms) needed for early mobility (Davis et al., 1998; Jantz et al. 1997; Schindler & Hausman, 2001). Practice has been shown to be beneficial for other motor skills, so regular exposure to various postural positions may influence continuous improvements relating to specific motor skills (Freedland & Bertenthal, 1994; Thelen & Smith, 1994). Zelazo (1998) found that infants who practiced their stepping for as little as 3 minutes a day, increased their precision and accuracy during three weeks of training. Stimulation of sitting was also investigated in this same study. Interestingly, 3 to 6 minutes of daily prompting in the sitting position led to a longer duration of sitting.

Zelazo (1998) concluded: "1) stimulation facilitates neuromotor development, 2) the effects are specific to the response trained, and 3) the effects of training on development appears to proceed from the specific to the general" (p. 454).

The benefits of practice in terms of crawling have been observed as well (Adolph et al., 1998). Adolph and colleagues (1998) found that the length of experience with an earlier form of crawling predicted the later speed and accuracy of other types of crawling. For instance, infants who first belly-crawled were more adept at crawling on their hands and knees compared to those infants who never belly-crawled, suggesting that experience not only influences early milestones like stepping and sitting but it also contributes to the development of later milestones like crawling (Adolph et al., 1998). The beneficial power that training and practice have on motor development has been seen in the Western Kenyan community, Kokwet. Approximately 80% of mothers teach their infants to sit, stand and walk (Super, 1976). Sitting is taught in a standardized way by situating a child into a special hole in the ground. Blankets are either snuggled around the child, or the hole is specially designed to support the child's back. This method to facilitate sitting occurs most days until the infant can sit well (Super, 1976). According to the normative data from the Bayley Scales of Infant Development (BSID), these infants were able to sit, stand and walk approximately 1 month earlier compared to American infants. Such a comparison is not definitive because the two groups differ on many variables, but the finding is consistent with the idea that specific practice accelerates motor development.

More conventional evidence has documented the importance of practice and experience in regards to prone positioning. Davis and colleagues found support for prone

playtime and motor milestone development in infants. After controlling for a number of variables (race, gender, number of older siblings, birth weight and mother's education) *pulling to a stand* was found to be significantly associated with prone awake time in infants. Monson et al. (2003) using the Alberta Infant Motor scale (AIMS) as a measure of motor development, studied 6-month old infants divided into two groups, a prone and non-prone group. These groups were based on the number of times per day an infant was placed in the prone position to play. The prone group scored higher on the total score and prone subscale (items included: *extended arm support, reaching from forearm support, pivoting, rolling from prone to supine*). In another study, which was unlike other studies supporting prone awake time, Vaivre-Douret and collaborators (2005) assessed infants placed in mixed positions (back and sitting) during the day. Babies who were placed in a variety of positions reached the *rolling-from-supine-to-side* milestone and the *rolling-from-supine-to-prone* milestone sooner, than those infants solely limited to the supine and prone position. Infants experiencing postural variety were more advanced at these milestones.

Recently, Dudek-Shriber and Zelazny (2007) investigated the effects of prone positioning on developmental motor milestones using the AIMS. A parent questionnaire was also used to gather information on the amount of time infants were spending in various positions throughout a typical day. Four-month-old infants who spent a considerable amount of time in the prone awake position, slightly more than an hour per day, reached seven prone milestones (milestones based in the stomach position), three supine milestones (milestones based in the back position) and three sitting milestones (milestones based in the sitting position), sooner than those infants who had limited

exposure in the prone position. According to the authors, providing infants with the opportunity to experience the prone position not only encourages the development of prone milestones, but allows the child to develop skills beneficial for movement and "weight-bearing patterns against gravity" (Dudek-Shriber & Zelazny, 2007, p. 54). Postural variety sets the ground work for milestones development in other positions as well. It must be emphasized that although babies experiencing awake prone time are developing milestones sooner than those who get little or no time in the prone position, the latter group of children should not be considered clinically delayed. Their milestone attainments are simply slower to appear.

In summary, experience in motor development has been implicated by considerable circumstantial evidence as playing an important causal role in the timing of milestone attainment. However, only one study to date has experimentally tested this idea through an instructional manipulation. Jennings and colleagues (2005) sought to determine effective communication techniques for educating parents about the benefits of an array of infant positions. In their study all parents were provided with verbal instruction of infant positioning information in the pediatrician's office, whereas some parents received an additional nurse visit, and/or a video, and/or a brochure. The percentage of infants who received prone placement increased with a nurse visit and increased even more so for those who received the informational brochure. The video was not found to enhance prone placement among parents. Jennings et al. (2005) concluded that 18-month-old infants' performance on the Peabody Developmental Motor Scales-II (PDMS-II) was related to the time they spent playing in the prone position before 6 months of age. Those placed in the prone position more than once a day

had higher locomotion scores compared to those babies who were rarely placed in the prone position (or spent less than one time a day in the position). One limitation of the Jennings et al. study was that there was no real no-treatment control group. All groups received at least one type of encouragement to use prone positioning. What varied across conditions was the intensity of the instructions. Thus, a study with a no-instruction control for prone position could better assess the causal role of prone positioning in facilitating motor development.

Present Study

As described above, consistent reports of circumstantial evidence support the premise that awake time in the prone position is beneficial for gross motor development in infants. The current study provided an experimental test of this idea by randomly assigning participants to either an instructional-encouragement condition or to a no-instruction control group. We expected the treatment to have an influence in the appearance of rolling over, which is one of the first milestones that could show a beneficial effect of prone awake time. This milestone was a sensible outcome to consider because prone awake time can only be controlled by the parent prior to the infant rolling over. Once the infant can roll over, the manipulation in the study (prone awake time) would be compromised because prone experience would be at least partially controlled by the infant. More importantly, when an infant begins to roll over, this is the start of the baby's physical independence. We hypothesized that the mean age for rolling attainment would be significantly younger for those infants receiving the prone awake time treatment than infants in the no-instruction group.

To measure milestone attainment we used a parent report in a longitudinal design,

which few studies in this area have used. Typically, one-time developmental assessments are used to assess milestone development in infants. Such assessments have many strengths, but their significant disadvantage is that they do not estimate the age when a milestone is reached. For the purpose of the current study, we used a daily diary parent report of milestone attainment, which has been found to be reliable and valid (Bodnarchuk & Eaton, 2004; Eaton, Bodnarchuk, McKeen & Davies, 2007). A daily diary enables the identification of the date of first appearance of a milestone, which should prove sensitive to the hypothesized experiential treatment effects.

If more prone awake time per day led to accelerated development, parents would be encouraged to place awake babies in the prone position without jeopardizing the campaign to fight SIDS. With this additional evidence suggesting the benefits of prone awake time, it would provide the strongest evidence to date that experience in the prone position accelerates the attainment of gross motor milestones.

CHAPTER III

METHODS AND MATERIALS

Internet based Research

Parents of infants were recruited and surveyed using a web-based protocol, which is not a common procedure in infancy research. In 2005, 61% of Canadian households (7.9 million homes) were connected to the internet (Statistics Canada, 2006). The Pew Internet and American Life Project (report based on Americans' use of the internet between March 2000 and September 2005) compared how women and men use the internet (Fallows, 2005). They found that 86% of women, 18-29 years of age (women in their child-bearing years), have access to the internet on a consistent basis. This statistic,

as well as other advantages of web-based data collection (popularity and feasibility of the internet) encouraged us to collect information from parents of young infants.

The first web-based data studies began in the mid 1990s (Birnbaum, 2004). Since then the advantages and disadvantages of internet data collection have become much clearer. As Birnbaum (2004) explains there are three predominant advantages of web research over lab research: 1) large sample sizes can be achieved, which makes statistical tests much more powerful; 2) web studies allow for better generalization to other populations and finally 3) specialized groups of participants who may be otherwise difficult to find can be recruited through the internet. Given these advantages and the numerous others reported (Reips, 2002), web research appears to be an effective and efficient way of collecting data.

Gosling, Vzire, Srivastava, and John (2004) discuss some common preconceptions about internet data collection (issues dealing with diversity, samples preconceived as being maladjusted, ungeneralizable data, unmotivated participants). They state that although internet data collection has some shortcomings, "lack of control over the participants' environment and the susceptibility to fake responses" (Gosling et al., 2004, p. 102), traditional methods of data collection are not free from weaknesses either (Gosling et al., 2004). After debating the strengths and weaknesses of each form of data collection, Gosling et al. (2004) concluded that data provided by the internet are as good in quality as those provided by traditional paper and pencil methods. With the increased use of the internet and numerous benefits of web-based data collection (i.e., availability of culturally and demographically diverse participants; cost saving benefits, etc., Reips, 2002), web-based report measures offered a

feasible tool for addressing our hypotheses, particularly as we relied on parents as our primary source of information.

Parents as Collaborators

The present study capitalized on parents' interest in observing their infant and their use of the internet at the same time. Large-sample studies that use observational evidence are valuable in developing our understanding of the variability that exists in infant milestone research. One way of achieving these studies, and advancing our knowledge in the field, is to use parents as collaborators.

In advancing our understanding of development, parents of infants have been found to be an eager and enthusiastic source of information (Bodnarchuk & Eaton, 2004). Parental measures provide an optimal means of data collection, as parents are able to recognize small changes in the developmental process of their infant. Parental reports have been examined in a variety of domains with respect to psychometric properties (Clarke-Stewart, Fitzpatrick, Allhusen, & Goldberg, 2000; O'Neill, 2007) and have been been found to be particularly advantageous in studying milestone acquisition (Bodnarchuk & Eaton, 2004; Davis et al., 1998). Parents are able to detect things in their child's development that may go unnoticed by others.

Researchers have expressed concern as to parental accuracy in the observation of developmental milestones. It could be the case that parents are biased in their observations, which raises questions about the accuracy and validity of parent diary data. To test the accuracy of parental report of milestone acquisition, Bodnarchuk and Eaton (2004) examined the validity of their daily checklist diary items by comparing parents' daily responses to home visitor assessments of the same milestones. After 95

home assessments, the agreement percentage between the parents' daily responses and the home visit pass-fail assessment ranged from 73% to 98%, which indicated that parents can provide dependable information about their infant's development if asked to focus on immediate, specific observable events. Consequently, we designed materials that emphasized such specific, observable events.

Participants

Participants were parents of 2-to 3-month old infants. This age criterion was selected for two reasons. First, the literature presented on the benefits of awake time in the prone position during infancy stresses the importance of beginning this activity early in the infant's development (Graham, 2006; Task Force on Infant Positioning, 2000). For some infants the prone position takes some getting used to, so the earlier parents begin with prone time, the faster the infant is able to adapt to this position. Second, because the milestone of rolling was the main variable of interest, we hoped to ensure that infants in the experimental group received at least one month of prone positioning prior to their instance of rolling over. Empirical data on the average age of rolling in infants seems to vary, especially in data gathered after 1990. The earliest mean instance of *prone-to-supine rolling* occurred at 4.9 months of age (Davis et al., 1998) and the latest at 7 months of age (Piper & Darrah, 1994). For *supine-to-prone rolling*, the earliest mean instance occurred at 5.0 months (Davis et al., 1998) and the latest at 6.8 months of age (Piper & Darrah, 1994). Overall, the earlier instance of rolling in the 1990s was found by Lim, Chan, and Yoong (1994) who investigated 2,194 infants in a Singapore population. They found that the average age of rolling was 4.3 months. (It should be noted that this study did not consider direction of rolling). Taken together the preceding

findings suggested that by recruiting parents of 2-month-olds, we would be able to obtain a sample of infants who have not rolled over at the start of the study.

Parents were recruited in a variety of ways. Our main source of recruitment which comprised 72% of our sample was the recruiting of parents via a short internet advertisement posted on popular parenting forums. Parenting forums have become quite common. They are usually open to anyone, and participation is free, however, most forums require a name and an email address to post a public message. Some of the larger parenting forums are further sub-classified into domains for those with more specific interests (i.e. breastfeeding, toddlers etc.). We used search engines to identify available forums and then registered as a member of those deemed appropriate. We then contacted the moderator of each forum (or, if available, a more specific sub-forum), explained who we were and our research, and requested permission to post a description of our study, with our web address on their board. Responses from moderators varied. They included: a) permission to post our information, b) refusal on the grounds that the forum did not allow advertising, c) offers to post a message on our behalf, or d) redirection to a particular forum dedicated to research postings. If we received no reply from the moderator after several days, we proceeded to post. If we were asked to remove such a post, we did so immediately. We successfully posted to 26 forums, some of which included multiple sub-forums. We also contacted one Facebook group and requested permission to post on their board. This request was granted. The forum posts read as follows:

> Hi everyone, I am part of a university research team interested in how infants develop. We have just put up a new research study for parents of 2-3 month olds.

> If you want to learn more about your infant, as well as how other infants around the world develop, please come check us out at: www.watch4milestones.org. We also have other studies for parents of 9-36 months olds too at www.milestonesresearch.org. Best wishes, Samantha

Our second main source of recruitment was posting our study's ad on parent blogs. A blog is a website that is kept up to date by an individual. They often include commentaries, graphics or videos. Parent blogs were searched using the search engines IceRocket and Blogspot. With use of these engines we were able to identify parents of infants in the appropriate age range. Once a parent blogger had been identified, we posted a brief response to a recent blog post that invited the parent to participate. The text of our post to parent's blogs read as follows:

> I was interested to read your blog. As a parent you may be interested in being part of a university study I'm involved with. It's about how infants and children develop. It wouldn't take much of your time, and it's a great way to contribute to knowledge by reporting on your own experiences. For more details go to the following address after copying it into your browser window, www.watch4milestones.org. Best wishes, Samantha

Blog posting had the advantage of finding parents of infants in the exact age range we were looking for. However, this means of recruiting participants was limited by the fact that it only reached one family at a time, as opposed to multiple families (as would be achieved by a forum post). We posted to a total of 262 blogs and 19% responded by completing the initial survey.

Participants were also recruited for the study through personal referrals. Emails

were sent to 27 of our friends and acquaintances who were either parents of children, or who we thought would know parents of children in the required age range. This type of recruitment made up 7% of the sample. An additional 2% were recruited through search engine results.

In the 25 days the initial questionnaire was available on-line there were a total of 914 visitors to the site. Of these 914 visitors, 447 left partial demographic information. Email address was a required field on the final page of the initial questionnaire, so if participants made it this far, we considered them to have taken the initial survey, and 223 got this far. The online nature of the study enabled parents from around the world to participate. While the majority of visitors to the site were from Canada, the United States and the United Kingdom, we also had participants from Australia, New Zealand, Argentina, South Africa, Singapore, Hong Kong, and Indonesia.

Materials & Procedure

By clicking the link in the ads, interested parents were directed to the Welcome page of the study's website. Once parents read some details about the study and consented to the conditions of participation, they were then asked their infant's birth date and questions regarding their family and child's health and demographic history. A number of questions on the survey were derived from the National Longitudinal Survey of Children (Statistics Canada, 1995) and included items on infant gestational age, birth weight, infant health (a 5-point scale rating of health was used), parental age and education as well as a subjective socioeconomic status question. See Appendix A for the initial questionnaire.

Typically a family income question is used to gauge socioeconomic status;

however, due to the web-based nature of the study an objective measure of social status (i.e., income) would have been difficult and impractical to measure. Instead, the MacArthur Scale of Subjective Social Status (Goodman, Adler, Kawachi, Frazier, Huang, & Colditz, 2001) was used to determine relative social class. This measure asked participants about their perceived position on a socioeconomic hierarchy. A vertical ladder with 10 levels (in the form of radio buttons) was presented to the participants, where the top level was labelled for those "best off" and the bottom step was for those "worst off". The parent was to select the circle on the ladder where they thought they stood at this time in their life.

Following the demographic questionnaire the parent was asked, with the use of pictures and descriptions whether they had or had not observed various milestones from their infant. The descriptions of the milestones were based on the AIMS (Piper & Darrah, 1994) and the DDST (Frankenburg & Doods, 1992). We developed specific wording of the items for clarity and simplicity. Determining which milestones an infant had reached was necessary to establish whether rolling had already occurred. Once parents completed this section, they were asked to watch for and record the date on which they first observed a milestone that had not previously been seen. To facilitate their recording, parents were asked to use the milestone recording sheet that was available for download from our site. The recording sheet included pictures, descriptions, and a space to enter a date for when the baby achieved each milestone listed (Appendix B).

Next we asked parents for their email address so that we could contact them periodically throughout the study to remind them to continue to 'watch 4 milestones', and to give them a few short questionnaires to gather additional information about their

infant's development experiences (i.e., sleep position, prone awake time, breastfeeding, etc.) and milestone development.

A randomly selected 50% of parents then received the treatment instruction. Parents were provided with instructions on performing a "fun activity" with their child. The "fun activity" described was prone awake time. Parents were asked to place their baby on his/her stomach for approximately 30 minutes of supervised prone awake time each day. The instructions stressed that the activity would not harm the infant in anyway, and may in fact prove to be beneficial for their infant's growth and development.

The current study encouraged parents in the experimental group to put their infant in the prone awake position for 30-minutes each day, taking into consideration the results of previous research. In the past decade, pediatricians have recommended supervised prone awake time to families; however, few studies have documented estimates of average infant awake time in the prone position. One of the studies compiled by Davis et al. asked parents of infants at a variety of ages (1 week – 6-months) to estimate the percentage of time that their infant spent in the prone position while awake. They reported that 2-month-old infants sleeping in the supine position spent approximately 54 minutes in the prone position while awake, whereas 4 and 6-month-olds spent 103 minutes and 156 minutes respectively. Drastically different estimates of awake time in the prone position have been reported by Majnemer and Barr (2005). Parents were asked to code 5-minute units every 2-3 hours, providing a full-day description of their infants' awake and sleep positioning. Using this method they found that 4-month-old infants were spending approximately 15-minutes in the prone awake position per day, while 6-month-old infants spent 27-minutes on their stomachs daily. These results were replicated by

Majnemer and Barr (2006) one year later. Again, 6-month-olds were spending approximately 27-minutes per day in the prone position.

The drastic differences in the estimates of prone awake time between Davis et al's and Majnemer and Barr's work (2005, 2006) could be due to the scale or intervals of time parents were asked to recall. Unlike Majnemer's studies, parents in Davis et al.'s study were not given set guidelines or intervals to follow, rather they were simply asked to estimate awake time in the prone position.

The advised 30-minutes of prone awake time was selected as a result of Majnemer et al.'s research. Because our instructions were designed to alter the amount of prone awake time 2-month-olds would be getting, we wanted to ensure there was enough difference between the amount of time a typical infant would get in the prone awake position, and an infant receiving the prone awake manipulation. Also, we did not want the length of time that we were asking parents to perform this activity to be unrealistic. Some infants do not like the prone position, so to help parents implement the treatment we provided them with suggestions for gradually introducing prone awake time (Appendix C).

The other 50% of participants made up the control condition and they did not receive instructions on prone awake time. No special activity was asked of this group of parents; however, we expected that infants in this group would receive some time in the prone position due to the encouragement that has been made regarding this position in the last decade.

When they began the initial survey, each participant was randomly assigned by our software to either group. Of course, not all who started the initial survey completed

it. Coupled with the complexities of random assignment, more participants who completed the initial questionnaire were in the control group (n = 122), than in the experimental group (n = 101).

An email reminding parents to 'watch 4 their infant's milestones' was sent to all parents during the second week enrolled in the study. The experimental group was also reminded to provide their infant with awake time in the prone position for 30 minutes per day. Apart from this one point reminder emails were identical (Appendix D).

Although 223 participants completed the initial questionnaire, this number dropped to 214 because of difficulties with email addresses and drop-out. Email reminders could not be sent to seven participants, as the email we sent to their addresses returned with unknown address/server messages. This could have been the result of a fake email address given at the start of the study, or spelling errors in the email address. In addition, two parents sent us an email notifying us that they would be dropping out of the study. One parent explained that they were dropping out because their infant hated tummy time. The other did not indicate why.

To identify the extent of variability in treatment duration, we emailed the parents four weeks into the study with a link to a brief questionnaire. To mask the primary intent of the study (i.e., the amount of awake time in the prone position that infants were receiving) this question was embedded among other questions about the infant's daily experiences (e.g., sleep position, awake time in the prone position, breastfeeding, etc.). The question we were particularly interested was phrased as follows: "*In what position did your infant spend time when awake? If more than one position, check all that apply: stomach, back, side.*" Parents were asked to answer this question based on their infant's

experiences over the past 24 hours. If the parent checked that their infant had played on their stomach, we proceeded to ask, *"Please estimate the amount of time your infant spent on their stomach when awake. (1-5 minutes, 6-10 minutes, 11-15 minutes, 16- 20 minutes...<90 minutes)"*. The purpose of this question was to see if the parents receiving the instruction of prone awake time were actually providing their infants with the time as advised. This question was also intended to gauge how much time the participants in the control group were getting in the prone position without encouragement or instructions to do so. These estimates were later computed into an estimate of awake time in the prone position prior to rolling (see creation of new variable section below). As part of this questionnaire, parents were asked to refer back to the milestone recording sheet they printed at the start of the study and to fill in the dates on which they saw their infant achieve the milestones. Parents had three options in answering each milestone item: 1) that the milestone had been observed and that they knew the date on which it occurred; 2) that they knew the milestone had occurred but that they were not sure of the date on which it happened; or 3) that the milestone had not yet occurred. If the parent had lost their original milestone recording sheet or had stopped recording for any reason, another sheet was available for them to download on the questionnaire website. By asking about the status of the infant's milestone achievement we were gathering information in case these parents were to drop out of the study at a later date.

All parents were sent a second follow-up questionnaire (similar to that of the first follow-up questionnaire) once their baby had been enrolled in the study for eight weeks. A final questionnaire was sent to parents when their infant was a week away from their 6-month birthday. Depending on the age of the baby, however, the number of follow-up

surveys varied. For instance, when the 8-week questionnaire was sent out, some of the older babies were already within a week of their 6-month birthday. Instead of sending these parents an 8-week questionnaire, we sent the final questionnaire to them. The final questionnaire included the same questions as the two previous questionnaires. On the last page however, a paragraph was included which thanked the parents for their participation in the study and provided them with the opportunity to comment and leave feedback to improve future studies (see Appendix E for follow-up questionnaire). If a parent had not completed one of the questionnaires after one week, a reminder email was sent out. This email included a sample graph of what the parent would receive if they continued to participate in the study (see Appendix F).

Once the parent completed their final questionnaire (at approximately 12-16 weeks into the study), we sent them a graph of their infant's progress based on the information provided to us by the parents throughout the study. From our perspective and from the feedback we received from parents, by participating in this study parents were made more aware of their infant's development and were happy to help contribute the information about their infant. See Table 1 for a complete time line of events in the study.

Table 1. Time line of when questionnaires and email reminders were made to parents.

Weeks from recruitment	Procedure of what occurred
0	Consent to the study, demographics questions, initial milestone assessment, assignment to condition
2	Email reminder (watch 4 milestones, or in the case of the experimental group, reminder to perform fun activity with baby)
4	4-week follow-up questionnaire sent

5	If parent had not yet completed the week 4 questionnaire, a reminder email was sent with a sample graph of what they would receive following completion of the last questionnaire
8	8-weeks follow-up questionnaire sent, depending on the age of the baby, the last survey (6 months) was sent out to some parents
9	If parent had not yet completed week 8 questionnaire, a reminder email was sent with a sample graph of what they would receive following completion of the last questionnaire
1 week before infant's 6-month birthday	Final questionnaire sent
Infant's 6-month birthday	If parent had not yet completed the final questionnaire, a reminder email was sent with a sample graph of what they would receive following completion of the last questionnaire

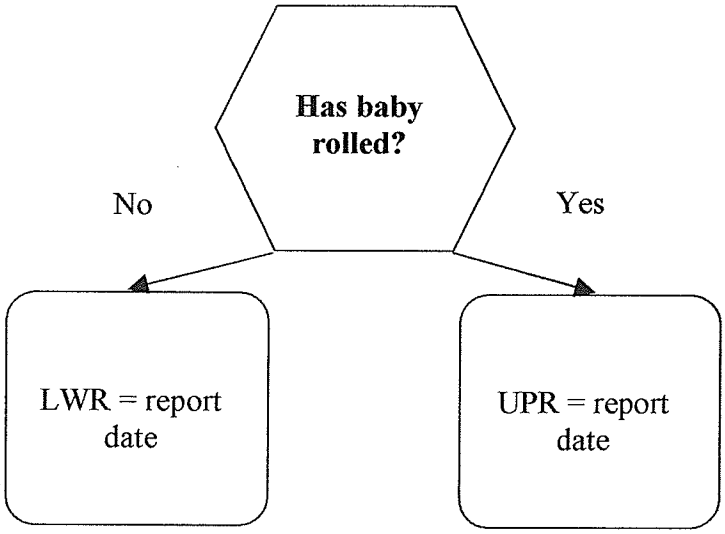
Rules for Analysis

Assignment rules for milestone acquisition were specified using procedures described below. In the initial questionnaire parents were only asked whether or not they had observed a milestone, and no date box was available for them complete. However, in the subsequent surveys parents could provide a date if they knew when the milestone had occurred. For example, for a given infant we might know that rolling had occurred but not know exactly when. For another infant we might know the exact date. In order to take these possibilities into consideration three new variables were created: a lower bound (LWR), an upper bound (UPR), and a date of first attainment (DOF). The LWR and UPR variables were later used for survival analysis. LWR was used in instances in which the milestone was reported as having not yet occurred and was defined as date of the report (i.e., the date the survey was completed). In other words, we knew that rolling could not

have occurred before this LWR date. The UPR was used in instances in which the milestone had already been observed but where the actual date of occurrence was not recorded. In these instances, the UPR was defined as the report date, and told us that rolling had occurred no later than the UPR date. When the parent reported that they knew the exact date of when a milestone occurred, the DOF was set to this date.

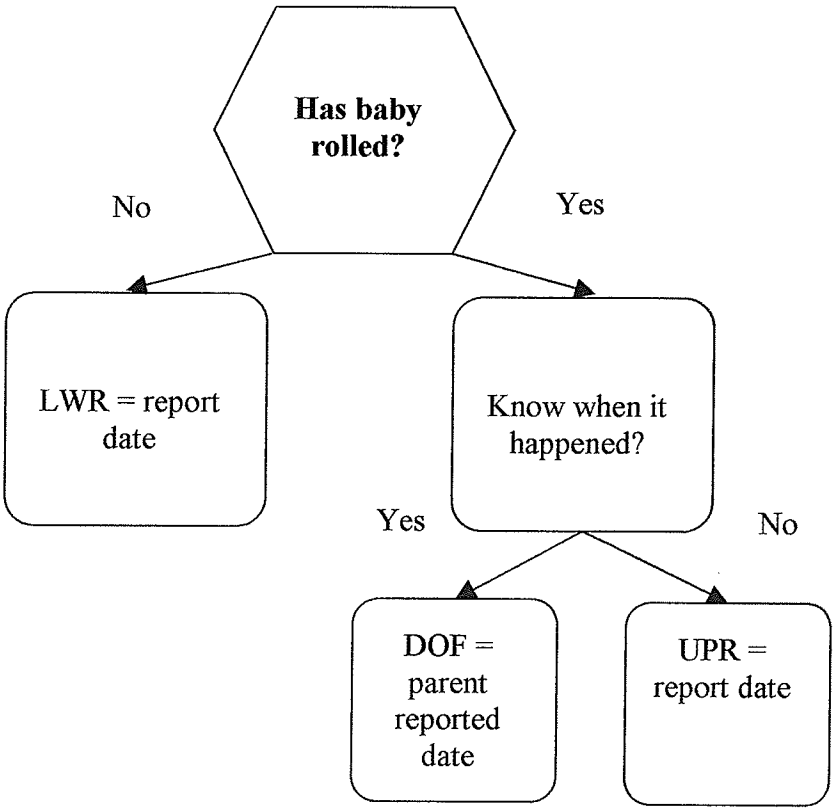
Using these new variables, rules for classifying parents' responses were created. Because the initial survey did not allow the parent to provide a date of attainment, the assignment rules are quite simple, as shown in Figure 1.

Figure 1. Possible parent responses on initial questionnaire.



Subsequent questionnaires required more complex rules for attainment because a date of attainment could have been reported by the parent (see Figure 2).

Figure 2. Possible parent responses on subsequent questionnaires.



Another possible scenario was that the parent reported on the initial questionnaire that rolling had occurred, but only reported the actual date on a subsequent survey. This situation would also arise if parents had looked back at a video or consulted with another person to determine the date. If the date the parents reported was before a previously established UPR then the DOF was set to the date the parents reported. In other words, the report of an actual date overrode a previously established UPR date.

One special case that should be noted was when a parent reported that a milestone had occurred and they knew the date of when it happened. However, the date the parent reported was earlier than a previously established LWR bound (and the UPR bound had not already been set). In this situation, an UPR bound was established and set to the

report date. In other words, there was a minor discrepancy as to when the actual event occurred. Because we had no contradictory evidence to suggest that rolling had not occurred, our scoring rule was based on our belief that rolling had occurred before the report date. If in any of these instances a DOF was established, the UPR and LWR bound dates were set to the DOF date.

Finally, we had to convert dates to ages, so we calculated three new variables: age of lower bound (ALWR), age of upper bound (AUPR), and age of first attainment (AOF) by subtracting the infants birth date from the LWR, UPR and DOF values and then dividing by 7 to get an age in weeks. In sum, ALWR is the age that represents the lowest (youngest) age when rolling cold have occurred; AUPR is the largest (oldest age) when rolling could have occurred. When the age of attainment is known ALWR=AOF=AUPR. Thus, even in cases where the date of rolling was not known, we had additional information that could be used by our analysis.

Creation of New Variables

We also needed to estimate how much experience each baby had in the prone position because we needed to check our experimental manipulation. In order to get an estimate of the amount of awake time infants were spending in the prone position during the day (prone awake time), we first had to convert the interval scale we used when questioning parents, into an average estimate of minutes in the prone position. For example, if a parent reported that their infant spent 0-5 minutes in the prone position during the past 24 hours (which was coded as 1 in the database), we multiplied 1 (the interval) by 5 (based on 5-minute intervals) and then subtracted 2, to get a median of that interval. In this case, the estimate would be 3 minutes. Next, to validate the manipulation

and to ensure that the experimental group was spending more awake time on their stomachs than the control group, we created a variable that calculated the average amount of time infants were spending in the prone position prior to the first instance of rolling over. For example, if the parent reported that their infant rolled (and it was the first time doing either type of rolling), then we would use the estimate of awake time in the prone position collected from the preceding follow-up questionnaire. By using the estimate from the earlier report we ensured that our estimate was based on the baby's experience prior to rolling.

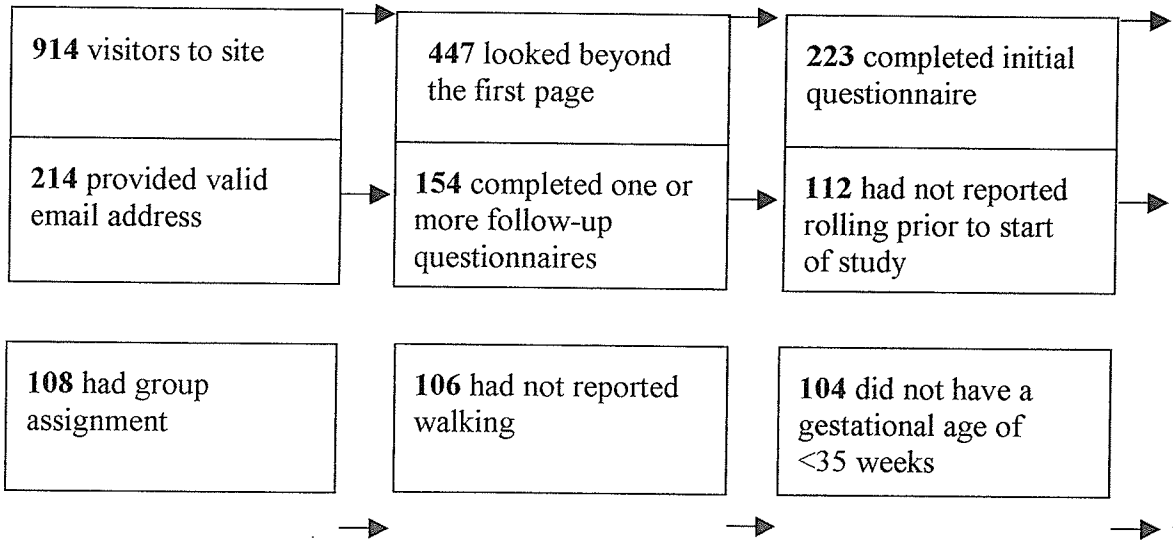
Another consideration was whether or not the baby had time to experience the manipulation, be it in the control or the experimental condition. A variable was created to take into account pre-rolling experience duration. We took the earliest date of rolling (either stomach-to-back rolling, or back-to-stomach rolling) and subtracted the date of the initial report date from it and divided by 7. Thus we had the number of weeks between the start of participation and when the baby first rolled over. No statistical difference was found between the groups. The decision was made not to exclude anyone based on treatment duration since both groups were receiving an equal amount of treatment time. Also, if we began to eliminate participants who had little treatment, it could have had an impact on our hypothesis. We predicted that treatment would have an impact and, as a result, infants would roll sooner; therefore, they would have a shorter duration of treatment.

Exclusions

Infants were excluded from the analysis for various reasons. We only included infants whose parents completed at least one follow-up questionnaire. One hundred and two of the 214 parents who started the study met this criteria. Although we sought only 2-

3 month olds, parents of other ages, mostly older, decided to participate. We then excluded infants whose parents reported that they had already rolled over at the initial visit (n = 42). Four other infants were excluded from the analysis because we were unsure of the group to which they had been assigned at the start of the study. These parents spent over 10 hours on the Welcome page during the initial questionnaire, which prevented the survey program from assigning them to a group. Two more participants were excluded because parents indicated that their infant was walking, which is implausible for a 2-3-month old (n = 2). In line with our goal of studying generally healthy infants, we excluded infants with a gestational age of less than 35 weeks. A child born less than 35 weeks of gestation would have a greater chance of being unhealthy due to complications associated with the premature birth (n = 2). Finally, two participants were excluded from the analysis because they had extreme outlier values of prone awake time (above 70 minutes prior to their first instance of rolling, which greatly exceeded the values reported by other participants). Following all of these exclusions, the sample comprised 102 infants; see Figure 3.

Figure 3. Participant flow: Drop-out and exclusions.



102 had no extreme prone awake time values (<70 mins)

Thus, our final sample available to test the hypothesis was 102.

CHAPTER IV:

RESULTS

Infant Demographics

The mean age at the initial questionnaire was 11.3 weeks, (range: 6.7- 17.1), and on average participants spent 12.5 weeks in the study. Tables 2 shows a summary of continuously distributed variables. Note that information on some variables was missing for some infants.

Table 2. Infant characteristics: Age and size.

Study Variables	N	Mean	SD	Minimum	Maximum
CA at the end of the study	102	23.9	3.4	11.8	27.4
Gestational age (weeks)	102	39.6	1.3	35.7	42.5
Rohrer Ponderal Index	93	2.5	0.4	1.7	4.1
Birth Weight (grams)	94	3472	497	1761	4943
Birth Length (cms)	101	51.7	3.3	43.2	60.9

Table 3 provides additional information.

Table 3. Infant characteristics: Gender, health and feeding.

Demographic variables	Percentage
Gender (n = 99)	
Female	47
Male	53
General Health (n = 101)	
Good	1
Very Good	27
Excellent	72
Feeding (n = 99)	
Formula	23
Breastfed without supplements	65
Breastfed with supplements	12

Note: General health was a subjective measure of infant health reported by parents at the start of the study.

Groups

Sixty-one infants were left in the control group and 41 were in the experimental group. Of the 102 infants, there were no significant differences between the groups on infant demographic variables, which indicates that the randomization successfully balanced the groups on background variables.

Parent and Family Circumstances

All parent participants in the study were the biological mothers of the infant on which they were reporting. Their ages ranged from 18 to 42 years, with a mean age of 30 years. All of them indicated that they spent seven days a week with their child, and 93%

of the sample reported being home with their child during the day. Some demographic characteristics are presented in Table 4.

Table 4. Education, marital status, and religion.

Demographic variables	Percentage
Education of parent reporting (n = 100)	
Some high school	2
High school graduate	6
Some college/university	42
Bachelor	28
Some graduate	6
Masters	13
Doctorate	3
Marital Status (n = 102)	
Married	87
Common-law	12
Never married	1
Religious Beliefs (n = 103)	
Christian	63
Jewish	4
Hindu	1
Secular, Agnostic, or Atheist	23
Other	9

There was considerable sample variability in self-perceived socioeconomic level as reported by parents in the study, and the country in which these participants reside (see

Figure 4 and 5).

Figure 4. Subjective socio-economic status as reported by parents.

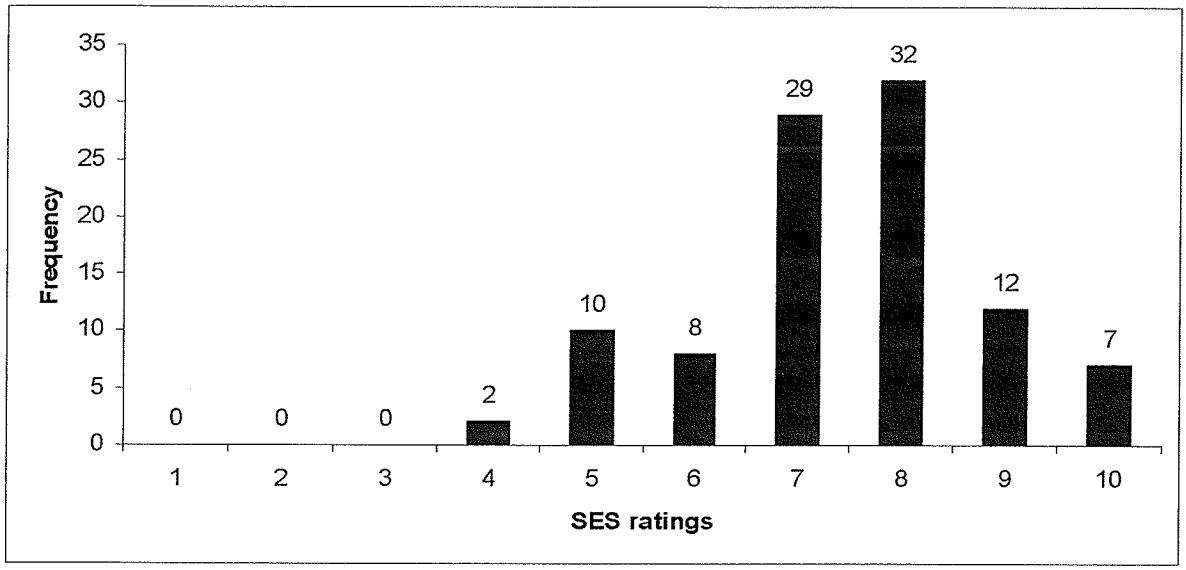
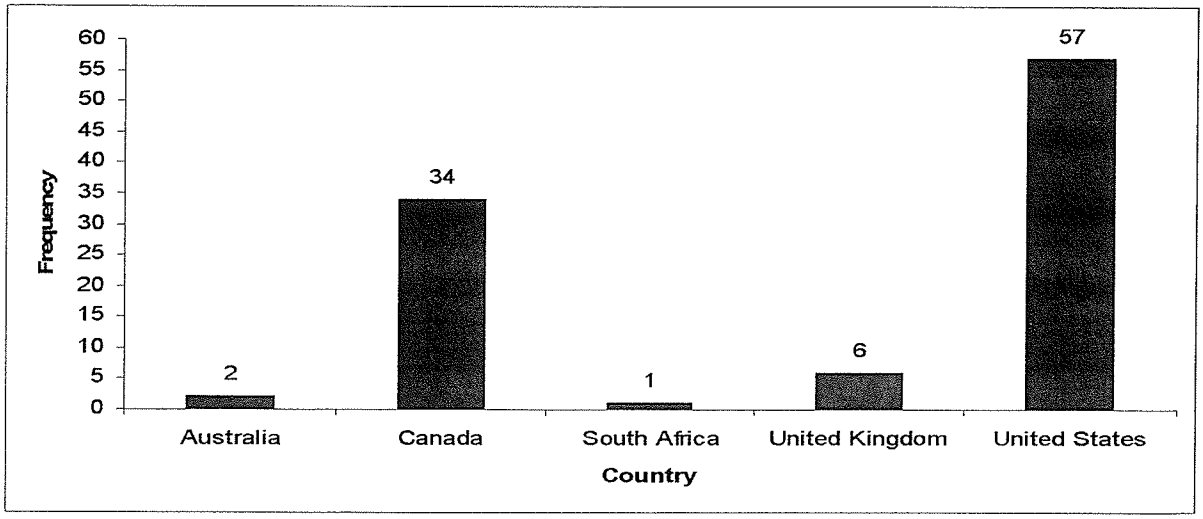


Figure 5. Participants' countries of residence.



The experimental and control group did not differ significantly on parent and family demographic variables described above.

Manipulation Check

To check whether the instructional manipulation had an effect on prone awake time, we compared the two groups on their reports of awake time in the prone position.

On average, the experimental group spent significantly more time in this position (22 mins) prior to their first instance of rolling, than the control group (11 mins), $t(62) = -3.7$, $p < .001$. Thus our instruction manipulation had an effect on parents placing their infants on their stomach when awake.

Survival Analysis

Our hypothesis was about developmental timing, rolling over, and the factors that influence it. The statistical procedure of choice for such a situation is survival analysis, also known as event-history analysis (Allison, 1984). This method was first developed by life insurers to predict how long a person would survive (Singer & Willett, 2003); however, it can be applied to be used for any time-situated event, such as the age of rolling. Instead of predicting whether or not an event occurs, survival analysis predicts when it happens. For the purpose of the current study, it allowed us to follow infants over time and observe at which point in time the milestone of rolling occurred. Although similar to multiple regression, survival analysis addresses some fundamental problems that arise if multiple regression analysis is applied to the prediction of time-related events. In longitudinal studies one recurring problem is that of missing data; participants often drop out of the study prior to its completion. In such a case a participant provides data up until a certain point (or certain milestones in the current study) but none thereafter. Thus, the timing of events that occur after dropping out is unknown to the researcher. Typically, when analyzing results with multiple regression these drop-out participants have to be completely excluded from the analysis because the event of interest has not yet occurred. Excluding such participants leads to a smaller sample size as well as a systematic bias, namely that participants with late attainments are more

likely to be excluded than those with early events. This bias leads to an underestimation of the timing of the event (an underestimate of the average age of attainment of a specific milestone). Unlike multiple regression analysis, survival analysis retains all information from dropouts. For example, if an infant leaves the study prematurely and before rolling for the first time, we still know the age which rolling occurred (if at all), and such knowledge is incorporated into survival analysis.

Event Definition

Our outcome variable, or event, was age of first roll (AOR) in weeks. Many studies assess rolling stomach- to-back and rolling back-to-stomach separately (Capute et al., 1985; Davis et al., 1998; Nelson et al., 2004; Piper & Darrah, 1994). We found in our sample that these two variables were highly correlated, $r = .60$.

Predictors

In addition to our primary predictor (experimental group membership) we included other possible predictors of AOR: gender, treatment by gender (whether there was a different treatment pattern for males and females), gestational age, child health, parent education, SES and feeding. Birth weight and length were not included in the model because they were highly correlated with gestational age ($r = .45$ and $r = .54$ respectively). However, we did use ponderal index at birth (a "chubbiness" index based on the ratio of birth weight and birth length; Scanlon, 1984) which had a much lower correlation with gestational age. The preceding predictors were included with group membership in a survival analysis to estimate when rolling over occurred (in weeks).

The statistical test of the influence for an individual predictor was assessed after the influences of all other predictors had been removed. The key predictor, group, was

entered into the model with the control group coded as 0 and the instruction group coded as 1. Other predictors were centered on 0 or referenced to it (e.g., females = 0, males = 1). In this way the effect of each covariate on the AOR could be assessed. Predictors that contributed to a lower (younger) age of attainment had negative significant coefficients.

Nine predictors were entered into the survival analysis (SAS Procedure Lifereg was used with the gamma distribution). The algorithm converged with a log likelihood of -19.19. Our group predictor did not have a significant influence on the AOR, which meant that our hypothesis that babies in the experimental group would roll over sooner was not confirmed, $X^2(1) = 0.00, p > .05$. Table 5 shows all the predictors and parameter estimates for AOR.

Table 5. Summary of survival analysis model and parameter estimates for rolling.

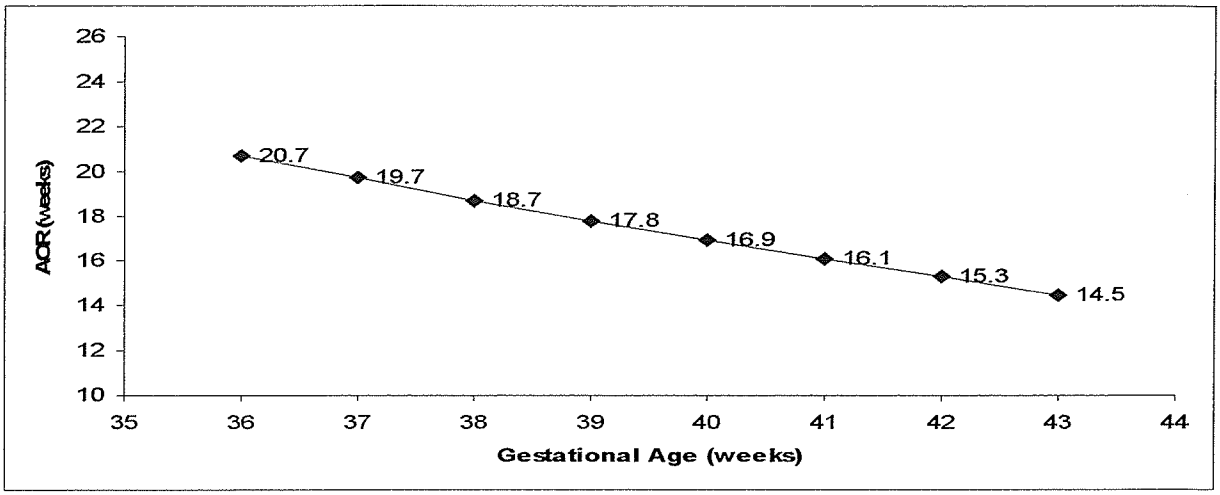
Predictors	Parameter Estimates
Group	-0.013
Gender	0.035
Treatment x Gender	-0.028
Gestational Age	-0.054 **
Ponderal Index	0.078
Child Health	-0.109 *
Education	-0.025
SES	0.046 *
Feeding	-0.011

* $p<.05$. ** $p<.01$.

However, three other predictors were significantly associated with AOR: gestational age, $X^2(1) = 7.4, p = .007$; child health, $X^2(1) = 4.3, p = .039$; and SES $X^2(1) =$

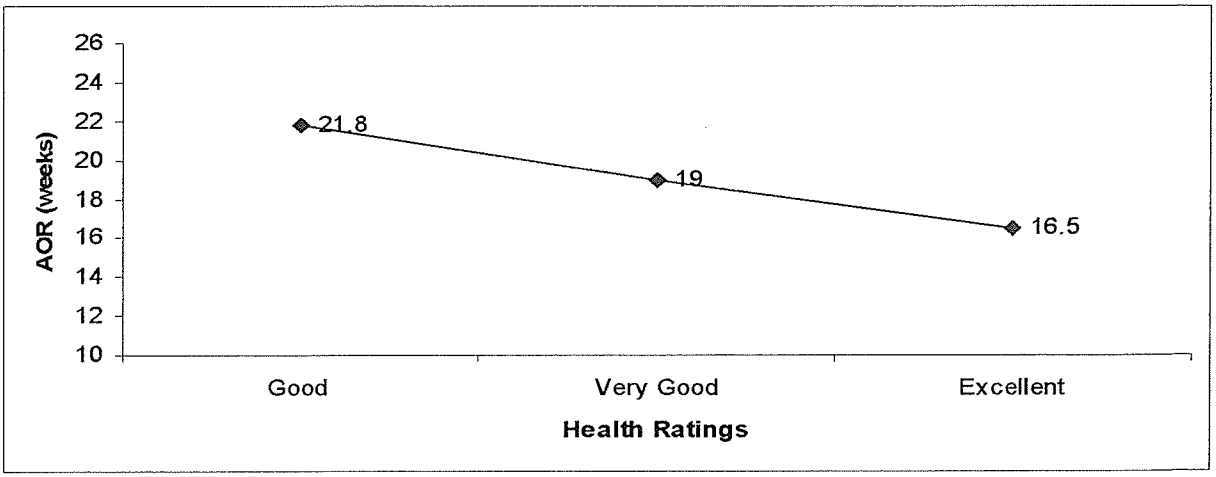
5.47, $p = 0.02$. Gestationally older babies were estimated to rolled earlier. For example, a baby born at 36 weeks gestation, was estimated to roll at 20.7 weeks, whereas, a baby born at 43 weeks gestation was estimated to first roll at 14.5 weeks; see Figure 6.

Figure 6. Estimated AOR by gestational age.



Babies reported to be in excellent health rolled earlier than those infants reported to be in good health; see Figure 7.

Figure 7. Estimated AOR for infants with good, very good and excellent health.



Higher family SES was associated with later attainment of AOR, however a small difference of approximately half a week was obtained. A parent marking a '4' on

the scale was estimated to have an infant who rolled at 16.9 weeks, while a parent indicating a social status of '10' would have an infant who rolled at 17.4 weeks.

CHAPTER V:

DISCUSSION

This study was developed to examine the idea that more awake time in the prone position would lead to accelerated development. Experience in motor development has been shown through circumstantial evidence to play a role in the timing of milestone development (Dudek-Shriber et al., 2007). Jennings and colleagues (2005) were the first to test this idea using a manipulation. The focus of their study however, was to determine effective communication techniques in educating parents about prone awake time. The present study took this idea one step further and implemented an instructional manipulation. We randomly created two groups of parent participants and asked one group to place their baby in the prone posture for 30-minutes each day, whereas the second group was not asked to do anything different. Our experimental instructional manipulation worked to some extent because the experimental group reported 22 minutes of awake time in the prone position per day, compared to 11 minutes for the control group. Infants in our experimental group were receiving approximately 11 minutes more time in the prone awake position (prior to first roll) compared to infants in the control group. However, this difference in prone awake experience did not appear to influence the attainment of rolling over because the two groups of babies did not differ in the age at which they rolled. It is possible that this was not a large enough difference to support the hypothesis.

Although circumstantial evidence has previously supported the premise that

awake time in the prone position is beneficial for gross motor development in infants, when looking at more specifically the milestone of rolling, mixed results have been found (Monson et al., 2003; Nelson et al., 2004; Vaivre-Douret et al., 2005).

One possibility is that the suggested hypothesis in the current study is inaccurate and that there is no, or perhaps a very weak, influence of prone awake time on rolling over. This statement is in line with research done by Nelson and colleagues (2004). They reported that prone awake time had no influence on the age an infant rolled. Perhaps the effects of prone awake time only arise from studies that use standardized assessment, where items are converted into subscales and are less stringent in their overall scoring (Majnemer & Barr, 2005; 2006; Monson et al., 2003; Vaivre-Douret et al., 2005). In these cases, certain milestones may more heavily be influenced by awake time in the prone position, and rolling may not be one of them. In other words, our reliance on the rolling milestone may have missed the broader influence of prone awake time.

In retrospect a variety of other factors may have played a role in our null result. First, when the study was being conceptualized it was difficult to determine exactly when to start infants in the study, as we wanted to ensure the majority of infants had not rolled over prior to the start of the study. Considerable variability exists for the average age at which an infant first rolls, so there was no clear start age. We used information from Piper and Darrah's research that suggested that 80% of infants at 2-months of age had not rolled for the first time, which seemed like a reasonable choice, however, in our sample, 42 infants had already rolled over prior to the start of the study and had to be eliminated from the analysis. Perhaps we missed the optimal developmental window for delivering the treatment.

Although the age of first roll in the current study was consistent with earlier reports (Lim et al., 1994), it is important to note that our sample of 2-3 month olds were all born in the months of December, January and February. It is possible season of birth hypothesis was playing a role. Season of birth has an influence on the onset of motor development (Benson, 1993). More specifically, Benson (1993) has reported winter and spring born babies as being more advanced in crawling. If this seasonal effect extends to rolling, our winter babies may have been advanced and affected our findings. Thus, more babies then originally anticipated, were excluded from the analysis due to their milestone ability.

Another possibility is that our treatment was too brief. It is likely that parents may be hesitant about giving their infants time in the prone awake position due to misconceptions about SIDS. This may have contributed to why infants in the experimental group were only received approximately 22-minutes of prone awake time prior to the first instance of rolling. In the initial questionnaire and 2-week reminder email we encouraged parents in the experimental group to provide their infant with 30 minutes of awake time in the prone position per day. This is not a new issue. Parents concern about prone positioning has been surveyed in the past. Mildred and colleagues (1995) asked parents and caregivers whether sleep position (being a risk factor for SIDS), influenced the positions they placed their infant for sleep and play. They found that 93% of respondents indicated that their knowledge of SIDS did in fact influence the position their infant was placed in when put down to sleep. Thirty-seven percent of parents and caregivers reported that their knowledge of SIDS influenced the position that their infants was placed in to play. Overall in Mildred et al.'s sample, 26% percent of these parents

never placed their infant down in the prone position for play. Mildred et al. (1995) suggested that clarification needs to be made about the actual risk factors of SIDS and the importance of supervised prone awake time through community education. Perhaps parents are still not familiar or being properly educated about the safest and most beneficial postures to use with their newborn babies. More information and emphasis needs to be put on the possible negative effects that lack of prone time can have on a child's physical development (i.e. head becoming misshaped, delays in motor milestone attainment).

Parent concern about prone positioning may also explain why there were more parents who did not return to the study after completing the initial questionnaire in the treatment group (35%) than in the control group (29%). This difference was not statistically significant, but it does raise some concern about the acceptability of the treatment to parents. Despite the findings not being in line with the hypothesis, the instructional manipulation was found to be promising.

Manipulation

Regardless of whether positioning instructions were given, parents made the ultimate decisions about the care and positioning of their children and whether they were or were not going to provide this experience to their infants. In addition to this, we had no control over whether parents provided their infant with prone awake time prior to the study. As indicated by Graham (2006), "infants who experience no periods of consistent tummy time become very distressed when placed in the prone position" (p. 120). We had limited information on the amount of time infants were getting in the prone position prior to the start of the study. In the initial questionnaire we did not ask for this information to

avoid drawing attention to the primary intent of the study. In retrospect, we should have tried to obtain more information on this issue at the start of the study. This information would have given us a more accurate description of whether parents were actually listening to the instructions we were giving to them regarding prone awake time.

In addressing this particular issue in more detail, the scale we used when we did ask about prone awake time on subsequent questionnaires, could be improved for future studies. We used an interval scale (e.g. 1-5 minutes, 6-10 minutes), which we later converted to get a median estimate of awake time in the prone position. One of the disadvantages of this scale was that it had a maximum of <90 minutes. A number of parents indicated on the final follow-up questionnaire that their infant was getting the maximum option of awake time in the prone position. A more fine-grained scale should be incorporated in the future to get a better estimate of the amount of awake time in the prone position.

Although we were encouraging prone awake time in early infancy, 2-to-3-months of age, the APA recommends that this activity should begin at an earlier age in order for the baby to become accustomed to this position (Task Force on Infant Positioning and SIDS, 2000). If parents were not providing their infant with time in this position prior at the start of the study and then were asked to try this activity with their infant, this may have been difficult for the infant to adapt to. In turn, it could have led to a shorter duration of prone awake time than advised. Jennings and colleagues (2005) found this to be a problem in their study. When parents did not start prone placement until 2-4 weeks after birth, many parents reported that if they tried to initiate prone awake time after this age, the baby would not tolerate the position and therefore the parent stopped trying.

There are a number of reasons why babies may not enjoy the prone awake position. First, the majority of an infant's time during the first few months is spent sleeping in the supine position. Because of this, they may prefer this position and be more accustomed to it, as opposed to the prone awake position. Another reason infants may not like this position could be that parents are putting their infant in this position at the wrong times of the day (i.e. when the baby is hungry or needs to be changed). We anticipated that some babies would not care for this position, but possibly underestimated the potential impact on the results. To compensate for infants who had little experience in the prone position prior to the study, we provided parents in the experimental group with a list of five steps to follow to help their infant gradually get used to, and over time lead strictly to, the prone awake position. We included this list of ideas to help parents ease their infant into this position if they were not accustomed to it before (Appendix C).

Had the difference in prone awake minutes been closer to 15 or 20, this additional 5 or 10 minutes may have had a greater impact on AOR. Future studies using instructional manipulations should pay special attention to ensure that the groups are receiving a large enough difference, perhaps more frequent reminders could be made to the experimental group about the manipulation, or more positive information could be sent out regarding the benefits of the manipulation. As well, non-intervention studies in the future could also provide a more tangible incentive to participate in a study, (i.e. having participant name put in a lottery draw for a gift once they complete the study). This could be incorporated to continue the experimental manipulation among the selected group (i.e. create a sense of obligation to participate) and at the same time maintain a reasonable sample size.

Other Considerations

Our follow-up questionnaires were designed to be simple and brief, and easy for the parents of young infants to complete. Because of the simplicity of the questionnaires, a number of predictors were not included that may have had an impact on AOR. For instance, asking parents about the types of equipment their infants were using (e.g. infant seats, exersaucers etc.) could have been beneficial. Abbott and Bartlett (2001), for example have found that equipment such as exersaucers, infant seats and high chairs are related to infant motor development. Infants who are not exposed to a lot of equipment have higher scores on motor development compared to those infants who are exposed to a lot of equipment use. The authors suggest that infants spending a large amount of time using infant equipment may not be receiving time on the floor which usually promotes the exploration of new motor milestones.

Another factor that was not taken into consideration and would have been useful to investigate was the infant's temperament when put in the prone awake position. We were concerned that such a question might draw too much attention to the primary intent of the study, which might have influenced the results, so we did not include a temperament measure. One parent in our study contacted us immediately after they were assigned to the treatment group to notify to us that they were dropping out of the study due to the fact their infant hated prone awake time. When given the opportunity on the final questionnaire to add a comment, another mother indicated that her baby did not like to be on her stomach for more than a few minutes at a time. She indicated that her baby had reflux and lots of gas which often led to spitting up when on her belly. Given that our sample was randomly assigned to experimental and control groups, temperament should

have been consistent for both; however, a strong infant response to prone awake time would have played more of a role for the experimental group.

Additional Contributions

To this point, we have emphasized complications and problems that arose in testing the central hypothesis. That emphasis should be balanced against the many other contributions this study has made, and it is to those contributions we turn next.

First, this was the first study to test the prone awake time hypothesis using an experimental instructional manipulation. Moreover, our study included infants from different backgrounds and geographic locations. In addition, the internet was used both for the purposes of collecting data as well as recruiting parents of young infants. While the current study made use of internet forums, which have been used in prior studies as recruitment method (Koo & Skinner, 2005) it also broached new mediums of internet delivery by using blog searching as part of its recruitment methodology. The potential and practicality of developmental internet data have been demonstrated. But can such internet-delivered data be trusted? We think so because the data we obtained is consistent with that obtained using other methods.

For instance, our mean age of first roll was found to be 16.8 weeks, which is consistent with a previous estimate reported by Lim et al. (1994). In their study infants rolled at 17.2 weeks. Second, we found that our control group parents reported similar amounts of prone awake time as those in Majnemer and Barr's study. In the current study infants reportedly received 11-minutes of prone awake time during the day, prior to their first instance of rolling over, which is in line with the data complied by Majnemer and Barr, in their report of 4-month old infants. These replications demonstrate that, online

methods of longitudinal data collection are as reliable as traditional means of collecting data, particularly in this type of developmental research.

Although experimental group membership was not a significant predictor of first roll, three other predictors were. First, higher gestational age predicted earlier AOR. When comparing infants born at 36 weeks of gestation to those who born at 43 weeks, the latter rolled significantly earlier. This general gestational effect has been reported numerous times before, (e.g. Peter, Viainder, & Livshits, 1999; Van Haastert, De Vries, Helders, & Jongmans, 2006); however, the potency of gestational age that we found has not. Gestational age was expected to have an influence, but its magnitude was surprising. We found a 6-week difference in rolling over when looking at a 7-week range of gestational age. This finding is consistent with the idea that there is a strong maturational element in early motor milestone development. In some ways a week-to-week match between gestational age and AOR implies that conceptual time is more important than post-natal experience, a strong claim that is left for a future study. Nonetheless our results emphasize the importance of assessing conceptual age (the sum of gestational age and chronological age) in research, particularly if a one week difference in gestational age can result in a one week shift in milestone attainment.

Parents who reported that their infant had excellent health at the start of the study reached the milestone of rolling earlier than those who reported their infant as having very good or good health. This finding was not unexpected but serves to remind us of the general effect that health has on a child's development. Infants who have more energy and are in better physical condition are lively, and more inclined to explore their surroundings, which eventually leads to milestone development. Our 5-category measure

of health was fairly crude, and it is plausible that stronger health effects might be evident if a finer and more in-depth measurement of infant health was used. A 5-week difference in the estimate of AOR was found between infants with excellent and good health. In the future intentionally recruiting a more diverse population of infants on health dimension would provide a better estimate of health influence on AOR.

Finally, although initially it may seem like a surprising finding, lower SES was associated with earlier AOR. Studies previously reporting on SES and milestone attainment have identified this same effect (McCarty, Vasudevan, & Hart, 2006; Neligan and Prudham, 1969). McCarty and colleagues (2006) found that children from low-income families had low cognitive scores and high gross motor skills. The relationship between lower SES and earlier milestone attainment may be explained by a child's autonomy and differences in the amount of parental supervision that exists in low and high SES families. It is possible that infants from higher SES have parents who are overprotective and restrict exploration and movement. That said, the significant SES effect was not large in its practical effect. There was a half a week difference in AOR for parents reporting a low SES (i.e. 4 on the scale) compared to those reporting a higher SES (i.e. 10). The magnitude of the effect seems small in practical terms.

Implications

Although the results of our study were not in line with the hypothesis, this research has a number of positive implications. Most interestingly, the finding of the difference in gestational age and AOR draws attention to the importance of the maturational theory of milestone development. Despite recent attention being drawn to the dynamic systems perspective, and the emphasis on individual variation, the older

theory of maturation cannot be forgotten. The idea that development is innate remains important in explaining milestone attainment. In addition, the magnitude of the gestational age effect on AOR indicates that in the assessment of early milestones, like rolling, should always include an evaluation of conceptual age. Health care providers need to emphasis to parents that for the first few years of life age should really be assessed conceptually. Comparing a child by year is not accurate in assessing growth and development for young children. For example a 2-year old child born in January 2006 will be quite different developmentally, compared to a child born in the same year but a different month (i.e. December). As to the degree to which the effects of gestational age persist to later developmental milestones (i.e. crawling and walking), or fades with age, is a question for future research.

Although the findings were not anticipated, this area of research warrants further investigation. Motor development was not accelerated in this study by prone awake time, but nonetheless the numerous benefits of the prone position need to be communicated to health care professionals and more specifically parents of young infants. The benefits of this position should be conveyed through pamphlets and brochures distributed during parenting classes and at time of birth in hospitals, to emphasize the importance of prone awake time. This type of communication has improved in recent years but much more should be done.

Other factors that were not assessed in the current study may also play a role in AOR. For example, infant temperament, infant motivation and infant equipment use are some variables that could have an impact on AOR. In future studies these variables should be addressed, which will require a larger sample of participants. This type of study

could be obtained using a methodology similar to that used here.

Conclusion

We found that 11 minutes of additional prone awake time per day had little effect on the age of attainment on the developmental milestone of rolling. These results add to previous research, as this study was the first to use an experimental instructional manipulation to test a circumstantial case for the value of prone awake time. The hypothesis was not supported, but the experimental treatment may have been too little and too late. A future study could test this hypothesis using a younger sample with more prone awake time. It would be beneficial to use the same methodology (an instructional manipulation) and also investigate milestone development for a longer duration of time. This would allow one to assess the effects treatment could have on later developing milestones (i.e. crawling), and possibly establish whether there are even long term effects (i.e. cognitive) that come from infant positioning.

This study was also the first longitudinal developmental study developed using internet recruitment and delivery. Internet research is a valuable and proficient way of collecting information from parents of young infants. Internet-based research proved to be a convenient way of gathering information from participants around the world. The data obtained by this method was also reliable in that it was in line with previous reports of developmental milestones (Lim et al., 1994; Majnemer & Barr, 2006). As well, the on-line recruitment methods used were functional in sampling parents of infants in the age criteria we required. With the growing body of research on the minimal differences in results between internet samples and traditional methods (Buchanan, 2003; Ritter, Lorig, Laurent, & Matthews, 2004), on-line recruitment is becoming a very attractive option for

researchers. Internet methodologies are promising for this type of research and would enable the necessary sample sizes to test complex, multi-variable models in real-world settings.

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Appendix A

Welcome

This study is for parents of infants who are between 2 and 3 months of age.

In this study you will be asked questions about your baby's birth and health, you and your family's social and financial circumstances, and your baby's motor milestones, like holding his or her head up.

We'll first ask you to review a list of milestones and to tell us if your baby has done them yet. We'll also ask you to print out a recording form where you can write down when your baby first reaches a new milestone. We may suggest an activity for you to do with your baby.

Later, when your baby is 6 months old, we will invite you to return to our website to record the dates of the milestones you've seen (we need your e-mail address for that). Between now and then we will also e-mail you several times to ask about how the recording is going.

Participation should take less than 15 minutes of your time for the first set of questions.

Continue [if selected, study continues]

Consent module

Before we can ask you any questions, you need complete the following section.

We take great care to protect your privacy and security, and the following statements describe your rights and our responsibilities. Please confirm that you have read and understood each of them:

* 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 understand I will receive several telephone calls from the MilestonesResearch.org team members.

* I understand that I will be invited back to the website again when by baby is about 6 months old.

* I may ask for additional information by calling the Milestones team at 204-474-9933.

* 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).

Yes, I wish to participate [if selected, study continues]

No, I do not wish to participate [If "No" is checked the following appears] Thank you for considering participation. If you would like to send us a comment, click here.

Referral source

We are interested in how you found out about our research. Please choose the following statement that best describes how you learned about us. /Traditional advertising, such as a newspaper ad, a poster, etc / Information on Facebook, MySpace, or similar site / Invitation from a friend, acquaintance, relative, etc / Posting to an online forum to which I belong / Result from a search engine listing / Online response to a posting on my blog / Other

About Child module

What is your child's gender? /Female / Male

We would like to know where in the world your child lives, so please enter the city, state province, and country of his/her normal residence. / City: / Province/State: / Country:/

When was your child born? Year: / 2007 / 2006 / etc. Month: / January / February / etc Day:/ 1 / 2 / 3 etc.

We have some questions about your child's birth size. Do you prefer to use metric or imperial measurements? /Metric / Imperial / [version used for weight & length will vary depending on]

What was his/her birth weight? / 450g to 6800g by 25g increments /

Was he/she born on, before, or after the due date? / On Due Date / Before /After /

[if not on due date] How many days before or after the due date was he/she born?

Was this a single or multiple birth? / Single birth / twins / triplets / more than triplets /

Was the delivery vaginal or caesarian? / Vaginal / Caesarian /

Was your child born head first? / Yes / No / Don't know /

Were birthing aids used? /None / Forceps / Cupping glass / Don't know

Did your child receive special medical care following his/her birth? / No / Intensive care Ventilation/Oxygen / Transferred to specialized hospital / Other / Don't Know /

[if care received] For how many days, in total, was this care received? ___ days

Baby feeding: /Formula / Solely breastfed (without supplements)/ Solely Breastfed with supplements

In what position does X sleep? If X sleeps in more that one position, check all that apply /On stomach / On back / On side

In what position does X spend time when awake? If in more that one position, check all that apply, /On stomach / On back / On side

Continue [if selected, study continues]

Child Health module

In general, would you say [your child]'s health is: / Excellent / Very good /Good / Fair / Poor / ?

Has a health professional diagnosed any of the following long-term conditions (expected to last 6 months or more) for X? [Yes /No for each] Food or digestive allergies? Respiratory allergies such as hay fever? Any other allergies? Bronchitis? Heart condition or disease? Epilepsy? Cerebral Palsy? Kidney condition or disease? Mental handicap? Learning disability? Attention deficit disorder (with or without hyperactivity)? Emotional, psychological or nervous difficulties? Any other long term condition? None

Continue [if selected, study continues]

About You Module

To better understand the results of this study, we need to know about those who participated. For this reason please answer the following questions.

What is your gender? / Female / Male /

What is your relationship to the child? / Biological Parent / Step Parent / Adoptive Parent / Legal Guardian / Other /

How many days per week do you spend in the same household with the child? / 0 /1 / 2 / 3.. /7

When were you born? / Year /

How much formal education have you completed? / Some high school or less / High school graduate / Some college or university / Associates (2-year) degree / Bachelors degree / Some graduate school / Master's degree / Doctorate

What is your current marital status? / Married / Living Common-Law / Separated / Divorced / Widowed / Never married /

Which best describes your religious beliefs? / Christian / Jewish / Muslim / Hindu / Buddhist / Chinese Traditional / African Traditional / Shamanist, Pagan, or Animist / Sikh / Secular, agnostic, or atheist / Other religious beliefs

Who cares for your baby during the day? / Parent at home with baby/ Other family member or babysitter at home with baby / Baby at family member or babysitter's home / Baby at daycare/ Other child care arrangement

Think of the ladder as representing where people stand in society. At the top of the ladder are those who are best off, at the bottom are those who are worst off. Click the rung where you think you stand at this time in your life. [10-rung ladder with "Best off" by top rung and "Worst off" by bottom rung]

Continue [if selected, study continues]

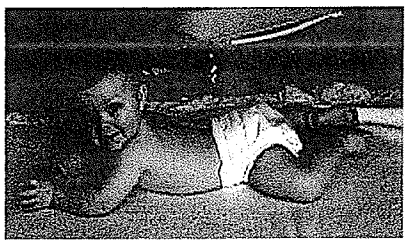
Baby Posture

Please tell us about the postures that your baby uses by reading each of the following descriptions. If you have seen your baby in a posture, select "Yes", otherwise select "No." Most babies of this age will not have shown many of these postures.

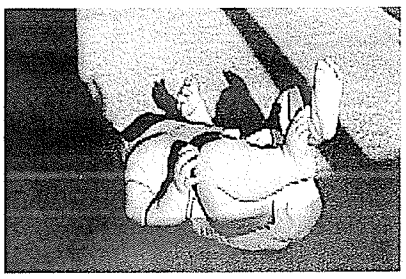
Stomach prop: Baby lies on stomach with elbows behind shoulders, and is able to raise head to 45 degrees. (Y/N)

Stomach mobility: Baby lies on stomach with weight shift onto one arm, head 90 degrees. (Y/N)

Forearm Support: Baby lies on stomach with weight on forearm and hands. Elbow in front of shoulders. (Y/N)



Hands to knees: Baby lies on back and with chin tucked, reaches hand or hands to knees. (Y/N)

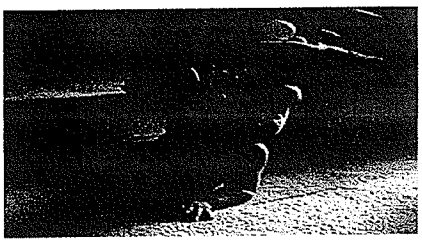


Extended arm support: Baby lies on stomach with arms extended and elbows in front of shoulders, chin tucked and chest elevated. (Y/N)

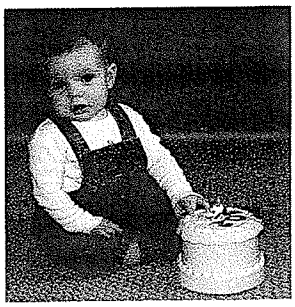
Hands to feet: Baby lies on back with chin tucked, reaches hand or hands to feet. (Y/N)

Sitting with arm support: Baby sits up alone for at least 30 seconds but uses own hands for support (is not propped with pillows or other supports). (Y/N)

Swimming: Baby lies with weight on stomach and raises head, arms or legs or both from surface. (Y/N)



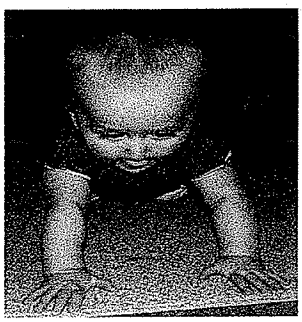
Reaching from forearm support: Baby lies on stomach and reaches forward without losing his or her balance. (Y/N)



Sitting without arm support: Sits up alone without hands for support for at least 30 seconds (is not propped with pillows or other supports). Back is straight. Baby often uses hands to play with a toy. (Y/N)

Rolls over: stomach to back: Baby rolls completely from stomach to back. (Y/N)

Rolls over: back to stomach: Baby rolls completely from back to stomach. (Y/N)



Rocks on hand and knees: Baby rests on hands and knees and rocks rhythmically back and forth. Count only if baby moves two or more times in each direction. (Y/N)

Crawling Baby can move forward across a room using only hands and knees for support without breaking stride or needing a long rest break. (Y/N)

Walks alone: Baby takes at least one step with each foot without your help and without holding onto furniture for support. (Y/N)

Continue [if selected, study continues]

Watch for New Postures

You've just seen the list of baby postures that we would like you to watch for until your infant is 6 months old. You will need to print a copy of a form we've prepared to help you. Simply watch your baby for those postures that you have not already seen. When you see Baby in a new posture, simply record the date in the appropriate spot. When completed, this sheet will make a great addition to a baby book, it is a good way of keeping track of your baby's progress.

The form you'll need to print out is called a pdf file. If you do not have an Adobe pdf reader on your computer, you can download one for free. Such files are widely used and quite safe.

Click here to open and print the recording form (see Appendix A)

We will contact you by e-mail when your baby is 6 months old and invite you to return to our website and tell us about what you saw. To do that we will need your email address to contact you.

Also, once you have filled out this information, we will send you a graph of your child's development.

To get some additional information about your child's development experiences, we will contact you a few times by phone to get this information, or if email is preferred please specify below. We will not use your email address or phone number for any other purposes besides these.

First name: (optional) / Last name: (optional)/ Email address: (required) /Phone number: optional)

Continue [if selected, study continues]

If assigned to treatment group, information was given here (see Appendix C)

Thank You!

We will contact you periodically during the next few months to gather some information about your baby's daily experiences. Remember to watch and record your infant's developmental milestones. When your baby is about six months old we will invite you to return to our site and tell us about when your baby reached milestones.

If you have any questions or concerns during the study please do not hesitate to call us at (204) 474-9933 or use the comment form.

Appendix B

Watch 4 Milestones Study

Here is a list of milestones to watch for. When you observe your infant performing one of these milestones for the first time, fill in the date that it occurs beside the milestone.

Stomach prop: Baby lies on stomach with elbows behind shoulders, and is able to raise head to 45 degrees

☐☐☐☐ ☐☐ ☐☐

YEAR MONTH DAY

Stomach mobility: Baby lies on stomach with weight shift onto one arm, head 90 degrees.

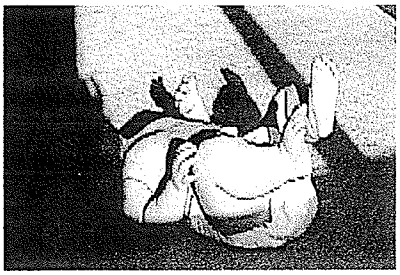
☐☐☐☐ ☐☐ ☐☐

YEAR MONTH DAY

Forearm Support: Baby lies on stomach with weight on forearm and hands. Elbow in front of shoulders.

☐☐☐☐ ☐☐ ☐☐

YEAR MONTH DAY



Hands to knees: Baby lies on back and with chin tucked, reaches hand or hands to knees

☐☐☐☐ ☐☐ ☐☐

YEAR MONTH DAY

Extended arm support: Baby lies on stomach with arms extended and elbows in front of shoulders, chin tucked and chest elevated

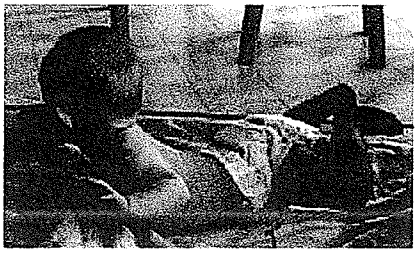
YEAR MONTH DAY

Hands to feet: Baby lies on back with chin tucked, reaches hand or hands to feet

YEAR MONTH DAY

Sitting with arm support: Baby sits up alone for at least 30 seconds but uses own hands for support (is not propped with pillows or other supports).

YEAR MONTH DAY

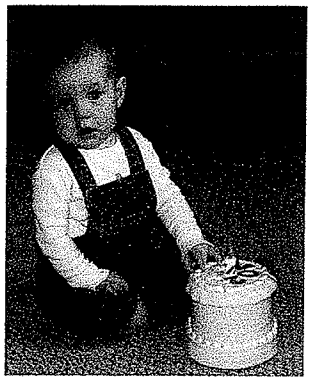


Swimming: Baby lies with weight on stomach and raises head, arms or legs or both from surface

YEAR MONTH DAY

Reaching from forearm support: Baby lies on stomach and reaches forward without losing his or her balance

YEAR MONTH DAY



Sitting without arm support: Sits up alone without hands for support for at least 30 seconds (is not propped with pillows or other supports). Back is straight. Baby often uses hands to play with a toy.

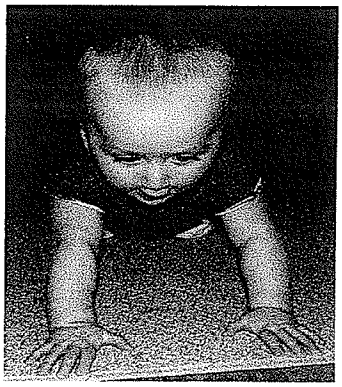
YEAR MONTH DAY

Rolls over: stomach to back:
Baby rolls completely from stomach to back

YEAR MONTH DAY

Rolls over: back to stomach:
Baby rolls completely from back to stomach

YEAR MONTH DAY



Rocks on hand and knees: Baby rests on hands and knees and rocks rhythmically back and forth. Count only if baby moves two or more times in each direction.

YEAR MONTH DAY

Crawling Baby can move forward across a room using only hands and knees for support without breaking stride or needing a long rest break

YEAR MONTH DAY

Walks alone: Baby takes at least one step with each foot without your help and without holding onto furniture for support.

YEAR MONTH DAY

Appendix C

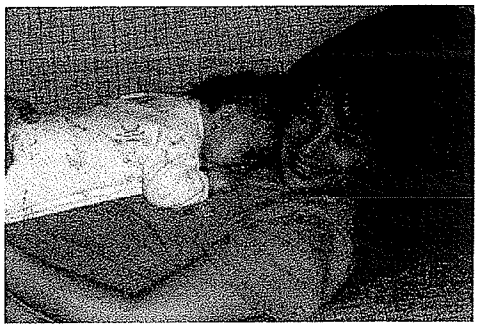
Tummy Time Exercise

Between now and when your baby rolls over or reaches 6 months of age, we would like you place your baby on his/her stomach for **30 minutes each day.** Only do this when your child is awake. This tummy time could take place all at once or could be divided into shorter intervals. This activity will in no way harm your child; it may in fact lead to benefits.

Here are some tips suggested by Laura Sobell, an infant development specialist:

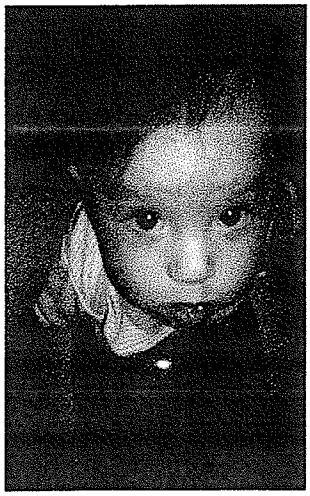
Some infants don't like to be on their tummies. If that is true for your baby, try the following five activities, which can help. Count these activities as part of the 30 minutes.

1. Start by holding her on your chest when you're lying down or in a reclined position



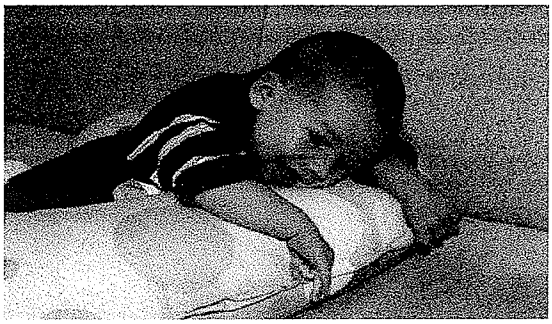
2. Carry or rock your baby while holding him in the "football" position: facedown, with his chest on your hand and his body supported by your arm

3. Lay her tummy-down across your lap or knees when you're sitting down



4. Place him tummy-down on top of a large athletic ball or beach ball and slowly rock him forward and back.

5. Place your baby tummy down on the floor with a rolled towel in order to support her chest.



Some other things to keep in mind during tummy time:

1. One way you can make tummy time more pleasant for your baby is by putting her on their stomach on the floor or bed and then lying on your stomach so that you are face to face with her.

2. Put a little unbreakable mirror in front of your infant so he can admire himself when he looks down.

3. Play a musical mobile, or have other toys out in front of your infant to encourage him to pull her head up.

4. Other things to keep in mind is to make sure your baby is not hungry or wet when attempting to have tummy time. Also, make sure her arms are not getting pinched or stuck under her body.

Appendix D

2-week Reminder Emails

Control Group:

Greetings from the Watch 4 Milestones Study,

Thank you for participating in our research. Remember to watch for your baby's milestones and record the date when you first see a new one appear. If you need another recording sheet, please email us, and we will e-mail another.

We appreciate your interest in this study, and we will contact you again in a few weeks.

Samantha and the Milestones Team

Experimental Group:

Greetings from the Watch 4 Milestones Study,

Thank you for participating in our research. Remember to watch for your baby's milestones and record the date when you first see a new one appear. If you need another recording sheet, please email us, and we will e-mail another.

Remember to place Baby on his/her stomach for 30 minutes each day. This tummy time could take place all at once or could be divided into shorter intervals. This activity will in no way harm your child; it may in fact lead to benefits.

We appreciate your interest in this study, and we will contact you again in a few weeks.

Samantha and the Milestones Team

Appendix E

Follow-up Email and Questionnaire

Email:

Greetings from the Watch 4 Milestones Study,

Thank you for participating in our research. Please click the link below, or copy the url address into a new browser and complete this short follow-up survey on your infant's daily experiences. It will take about 5 minutes to complete. To answer some of the questions you will need the milestone recording sheet we asked you to print out at the start of the study. If you have lost your sheet no need to worry, just do as much as you can.

xxxxxxxxxxxxxxxxxxxxxxxxx

To link your information to your previous entry please enter this 7-digit ID number when asked to do so: 1234567.

Thank you for your help.

Samantha and the Milestones Team

If you have comments or concerns please email: mileston@cc.umanitoba.ca or phone Dr. Warren Eaton at 204-474-9739.

Questionnaire:

To link this information to your previous entry please type in:

The 7-digit identification number specified in the email sent to you:

In the past month has your child had any serious health problems? Yes/No

[if parent answers yes] Has a health professional diagnosed any of the following long-term conditions (expected to last 6 months or more) for X? [Yes /No for each] Food or digestive allergies? Respiratory allergies such as hay fever? Any other allergies? Bronchitis? Heart condition or disease? Epilepsy? Cerebral Palsy? Kidney condition or disease? Mental handicap? Learning disability? Attention deficit disorder (with or without hyperactivity)? Emotional, psychological or nervous difficulties? Any other long term condition? None

Please answer the rest of the questions on this page, based on your infant's experiences over the past 24 hours:

In what position does X sleep? If X sleeps in more that one position, check all that apply /On stomach / On back / On side

Baby feeding: /Formula / Solely breastfed (without supplements)/ Solely Breastfed with supplements

In what position does X spend time when awake? If in more that one position, check all that apply, /On stomach / On back / On side

Please estimate the amount of time your infant spends on their stomach when awake? /1-5 minutes/6-10 minutes/11-15 minutes/16-20minutes.....<90minutes

Continue [if selected, study continues]

Baby Posture

Please tell us about the postures that your baby uses by reading each of the following descriptions. If you have seen your baby in a posture, select "Yes", otherwise select "No." Most babies of this age will not have shown many of these postures.

Stomach prop: Baby lies on stomach with elbows behind shoulders, and is able to raise head to 45 degrees. (Yes and I know when /Yes/No)

If answer: Yes and I know when:

Please enter the date when you saw this milestone from your infant. Select the date using the calendar tool or enter it manually using a Month/Day/Year format (e.g., 12/31/2007).

Stomach mobility: Baby lies on stomach with weight shift onto one arm, head 90 degrees. (Yes and I know when /Yes/No)

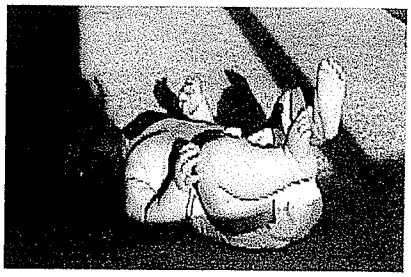
If answer: Yes and I know when:

Please enter the date when you saw this milestone from your infant. Select the date using the calendar tool or enter it manually using a Month/Day/Year format (e.g., 12/31/2007).

Forearm Support: Baby lies on stomach with weight on forearm and hands. Elbow in front of shoulders. (Yes and I know when /Yes/No)

If answer: Yes and I know when:

Please enter the date when you saw this milestone from your infant. Select the date using the calendar tool or enter it manually using a Month/Day/Year format (e.g., 12/31/2007).



Hands to knees: Baby lies on back and with chin tucked, reaches hand or hands to knees. (Yes and I know when /Yes/No)

If answer: Yes and I know when:

Please enter the date when you saw this milestone from your infant. Select the date using the calendar tool or enter it manually using a Month/Day/Year format (e.g., 12/31/2007).

Extended arm support: Baby lies on stomach with arms extended and elbows in front of shoulders, chin tucked and chest elevated. (Yes and I know when /Yes/No)

If answer: Yes and I know when:

Please enter the date when you saw this milestone from your infant. Select the date using the calendar tool or enter it manually using a Month/Day/Year format (e.g., 12/31/2007).

Hands to feet: Baby lies on back with chin tucked, reaches hand or hands to feet. (Yes and I know when /Yes/No)

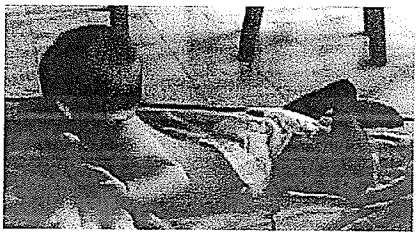
If answer: Yes and I know when:

Please enter the date when you saw this milestone from your infant. Select the date using the calendar tool or enter it manually using a Month/Day/Year format (e.g., 12/31/2007).

Sitting with arm support: Baby sits up alone for at least 30 seconds but uses own hands for support (is not propped with pillows or other supports). (Yes and I know when /Yes/No)

If answer: Yes and I know when:

Please enter the date when you saw this milestone from your infant. Select the date using the calendar tool or enter it manually using a Month/Day/Year format (e.g., 12/31/2007).



Swimming: Baby lies with weight on stomach and raises head, arms or legs or both from surface. (Yes and I know when /Yes/No)

If answer: Yes and I know when:

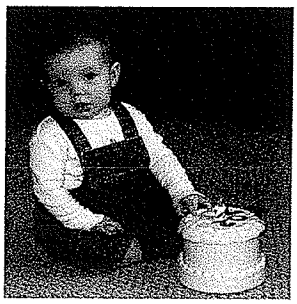
Please enter the date when you saw this milestone from your infant. Select the date using the calendar tool or enter it manually using a Month/Day/Year format (e.g., 12/31/2007).

Reaching from forearm support: Baby lies on stomach and reaches forward without losing his or her balance. (Yes and I know when /Yes/No)

If answer: Yes and I know when:

Please enter the date when you saw this milestone from your infant. Select the date using the calendar tool or enter it manually using a Month/Day/Year format (e.g., 12/31/2007).

Sitting without arm support: Sits up alone without hands for support for at least 30 seconds (is not propped with pillows or other supports). Back is straight. Baby often uses hands to play with a toy. (Yes and I know when /Yes/No)



If answer: Yes and I know when:

Please enter the date when you saw this milestone from your infant. Select the date using the calendar tool or enter it manually using a Month/Day/Year format (e.g., 12/31/2007).

Rolls over: stomach to back: Baby rolls completely from stomach to back. (Yes and I know when /Yes/No)

If answer: Yes and I know when:

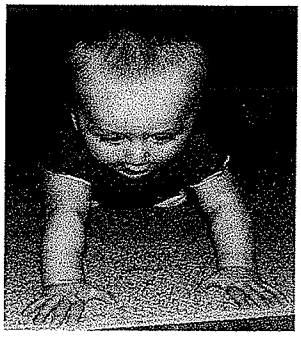
Please enter the date when you saw this milestone from your infant. Select the date using the calendar tool or enter it manually using a Month/Day/Year format (e.g., 12/31/2007).

Rolls over: back to stomach: Baby rolls completely from back to stomach. (Yes and I know when /Yes/No)

If answer: Yes and I know when:

Please enter the date when you saw this milestone from your infant. Select the date using the calendar tool or enter it manually using a Month/Day/Year format (e.g., 12/31/2007).

Rocks on hand and knees: Baby rests on hands and knees and rocks rhythmically back and forth. Count only if baby moves two or more times in each direction. (Yes and I know when /Yes/No)



If answer: Yes and I know when:

Please enter the date when you saw this milestone from your infant. Select the date using the calendar tool or enter it manually using a Month/Day/Year format (e.g., 12/31/2007).

Crawling Baby can move forward across a room using only hands and knees for support without breaking stride or needing a long rest break. (Yes and I know when /Yes/No)

If answer: Yes and I know when:

Please enter the date when you saw this milestone from your infant. Select the date using the calendar tool or enter it manually using a Month/Day/Year format (e.g., 12/31/2007).

Walks alone: Baby takes at least one step with each foot without your help and without holding onto furniture for support. (Yes and I know when /Yes/No)

If answer: Yes and I know when:

Please enter the date when you saw this milestone from your infant. Select the date using the calendar tool or enter it manually using a Month/Day/Year format (e.g., 12/31/2007).

Continue [if selected, study continues]

4 and 8 week questionnaire:

Thank you! Please continue to watch for and record your infant's developmental milestones. If you have any questions or concerns during the study please do not hesitate to call us at (204) 474-9739 or use the comment form.

Thank you for your continuing interest in this study.

6-month questionnaire:

Thank you for participating in our research. If you have provided us with dates of when your infant has reached various milestones, we will be emailing you a graph of your infant's progress.

To improve our studies and questionnaires for the future please leave any comments or suggestions.

When results of the study become available, we would gladly send you a summary of our findings. Would you like to receive a summary? (Y/N)

We may plan a future study based on what we learn from this one. Your email address could be used to connect what you have told us in this study to that future study, but we would only connect the two if you give us permission to do so. Would you would be willing to be contacted about future studies? (Y/N)

Appendix F

Example of Infant Development Graph sent to participants: a) when parent did not complete follow-up questionnaire after 1 week; b) upon completion of the study