AN INVESTIGATION OF THE INFLUENCE OF A WAKEFUL PRONE AND VESTIBULAR ACTIVITY PROGRAM ON EARLY INFANT MOTOR DEVELOPMENT

by

Brenda Jane Lovell

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DECLARATION

I, Brenda Jane Lovell, declare that the PhD thesis entitled An Investigation of the Influence of a Wakeful Prone and Vestibular Activity Program on Early Infancy Motor Development is no more than 100,000 words in length, including quotes and exclusive of tables, figures, appendices, bibliography, references, and footnotes. This thesis contains no material that has been submitted previously, in whole or in part, for the award of any other academic degree or diploma. Except where otherwise indicated, this thesis is my own work.

I have conducted my research in alignment with the Australian Code for the Responsible Conduct of Research and Victoria University's Higher Degree by Research Policy and Procedures.

Signature:

[redacted]

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to follow my passion. You are a source of inspiration, admiration and strength to me. Thank you and love from my heart.

ABSTRACT

Critical elements of early infant motor development can be observed when very young babies spontaneously kick and wave their arms. This initial movement phase progresses through various motor milestones from engaging the inhibition of the primitive reflexes through to rudimentary movements, fundamental motor skills, and finally to engaging in specialised sports activities in the early primary school age years (Gabbard, 2012; Goodway, Ozmun, & Gallahue, 2019). Even though infants have the propensity to naturally move through these rudimentary motor milestones, time spent in awake prone positions is central to achieving to achieving these skills (Ohman, Nilsson, Lagerkvist, & Beckung, 2009). Prone positioning is commonly referred to as tummy time, which has been described as a practice whereby an infant is placed on their stomach during awake play times (Hewitt, Stanley, & Okely, 2017). This tummy time positioning encourages head, neck and arm strength supporting timely rudimentary rolling and crawling skills (Dudek-Shriber & Zelazny, 2007; Jennings, Sarbaugh, & Payne, 2009; Lobo & Galloway, 2012; Majnemer & Snider, 2005), and also reducing the risk of deformational plagiocephaly or flat head syndrome (Kennedy, Majnemer, Farmer, Barr, & Platt, 2009).

Researchers have proposed that motor development and motor milestones in infants may be affected or in some cases delayed, following the introduction of sleeping babies on their backs as a result of the SIDS (Sudden Infant Death Syndrome) campaign of the 1990s (Davis, Moon, Sachs, & Ottolini, 1998; Speltz et al., 2010). As a consequence of this campaign the incidence of SIDs declined worldwide in the following years although it was reported that parents tended to avoid placing their infants on their stomach during awake times, subsequently affecting motor milestones, head shape and core strength (Davis et al., 1998; Robertson, 2011). This doctoral research centres on the Baby Activity Chart-Program

(BAC-Program) that was devised and created to support families and to provide a variety of fun, tummy time and vestibular focused actions for infants from 6 weeks post birth. Families are encouraged to interact with BAC-Program's four milestone focused divisions of 34 activities, and culminating when the infant is mobile, feasibly crawling on hands and knees.

The doctoral research incorporated the concept and activities within the BAC-Program, and subsequently undertook two separate but inter-linked research studies. Study one involves the evaluation of the BAC-Program through an 'experts' response questionnaire' (ERQ) presented to sixteen experts in the early childhood and the allied health professions. The questionnaire consisted of five sections covering all aspects of the BAC Program's design, layout, diagrams, text and contents. The Experts were instructed to rate all milestone divisions within the BAC-Program within the questionnaire's five sections and to also include comments and suggestions according to each expert's professional expertise. Overall, this first study produced a very positive result with the BAC-Program being effectively recommended by 93% of the experts. Consequently, a BAC-Program/2 (BAC-P/2) was created as the Expert's recommendations were carefully analysed and those considered significant and theory based to enhance the activities were incorporated into the newly produced infant activity program-edition two.

The positive endorsement and results achieved in Study one enabled the newly created BAC-P/2 to be investigated in a further study within this doctoral research. Study two investigated whether an experimental group of twenty nine infants that commenced participation in the BAC-Program/2 at 10 weeks of age, were more advanced in their motor skills (prone, supine, sitting, standing) when compared to a control group of thirty four infants also observed at 7-9 months post birth. The control group had not participated in the BAC-P/2 but were presented with the program at the completion of the testing procedure.

The overall results defined that the total percentage mean score on the Alberta Infant Motor Scale (AIMS) of the experimental group was significantly higher (the difference was significant at **.**023 alpha level) than the control group's mean score based on all sixty three infant's AIMS' motor development scores. The interpretation at a practical level suggests that the participation by parents and carers in the activities within the BAC-P/2 have contributed to the overall differences in the recorded scores when comparing the means between the sample groups using the SPSS independent sample *t*-test.

Study two also examined the differences in overall motor development between groups in relation to time spent daily in tummy time and in vestibular stimulating activities. The experimental group spent greater time daily in both activity categories (tummy time and vestibular) and recorded a higher total percentage mean AIMS score when compared to the control group, however, the differences were not statistically significant. The data revealed that the association between the two study group's AIMS scores may be influenced by the varying amount of both daily tummy time and daily vestibular time. Interestingly, both study groups reported higher total mean percentage scores in relation to greater amounts of time spent in both tummy time and vestibular activities. The overall conclusion to this study was reinforced by the result that when participating in the BAC-Program/2 from 10 weeks to 7-9 months, involving specifically modified infant movement activities, the twenty nine experimental group infants were significantly advanced in their motor development. There are also recognisable benefits (e.g. improved head control, core strength, response to gravity, spatial and body awareness) for infants to spend significant time in tummy and vestibular focused movements in regard to achieving their motor milestones.

Author: Bren Lovell

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ABBREVIATIONS

AIMS- Alberta Infant Motor Scale

BAC-Program -Baby Activity Chart Program

BAC-P/2 – Baby Activity Chart Program/Two

MCHN- Maternal and Child health Nurse

ERQ- Experts Response Questionnaire

PIIQ- Parent and Infant Information Questionnaire

Primary(primitive) Infant Reflexes

Moro- Moro Infant Reflex

ATNR- Asymmetrical Tonic neck Reflex

TLR- Tonic Labyrinth Reflex

SIDS- Sudden Infant Death Syndrome

W Of M- Word of Mouth

CHAPTER 1: INTRODUCTION

Background

"If you can't fly then run, if you can't run then walk, if you can't walk then crawl, but whatever you do you have to keep moving forward"

- Martin Luther King Jr

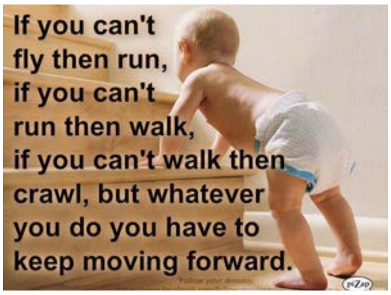


Figure 1.1 Infant crawling up the stairs (sourced: Quotemaster.org: piZap)

Most children have the potential to experience and journey through rudimentary motor milestones and subsequently learn a variety of fundamental movement patterns and skills (Nitsos, Estrada, & Messias, 2017). The development of motor skills depends on a combination of influences including a functional central nervous system, sensory motor system, environmental and cultural factors (Murray, Jones, Kuh, & Richards, 2007; Taanila, Murray, Jokelainen, Isohanni, & Rantakallio, 2005). Previous research has consistently reported that the normal progression of an infant's motor milestone development may also be an important contributor to a child's subsequent cognitive and behavioural developmental status (Ghassabian et al., 2016; Hitzert, Roze, Van Braeckel, & Bos, 2014).

Existing studies have presented findings that reinforce the specific importance of daily tummy time for infants younger than six months to promote the development of normal infant milestones and motor functioning (Dudek-Shriber & Zelazny, 2007; Guidetti, Wells, Worsdall, & Metz, 2017; Kuo, Liao, Chen, Hsieh, & Hwang, 2008; Lee & Galloway, 2012; Majnemer & Barr, 2006; Russell, Kriel, Joubert, & Goosen, 2009). Since the ‘Back to Sleep and Tummy to Play’ (SIDS) campaign of the 1990’s and the more recently 2016 ‘Safe Infant Sleeping Environment’ campaign (Moon, 2016), researchers continue to present evidence that a lack of awake prone positioning correlates with delays and/or non-achievement of major motor milestones (Nitsos, Estrada, & Messias, 2017).

A growing awareness and encouragement for the need for infants to spend more time in the prone position led to documents such as the 24-Hour Movement Guidelines for the Early Years -Birth to 5 years (Australian Government, 2017a). This document recommended a minimum of 30 minutes or more daily for infants to spend in tummy time or prone positions. Despite this encouragement evidence indicates a reluctance of parents and carers to undertake the desired awake supervised tummy time (Nitsos et al., 2017). Ricard and Metz (2014) and Vladescu, Schnell, and Day-Watkins (2020) reported that parents were uncomfortable when placing their infants in tummy time positions, particularly when infants exhibited frustration and crying behaviours.

Problem statement

As outlined, there have been strong recommendations that propose sleeping infants in supine positions to reduce the risk of SIDS (Moon, 2016). However, research continues to present evidence that the lack of awake prone positioning correlates with delay and lack of infants achieving major motor milestones (Guidetti et al., 2017; Majnemer & Barr, 2006; Ricard & Metz, 2014). Parents are encouraged to place their infants in ‘tummy time’ positions but ideas, programs and specific recommendations are not readily available to provide the necessary confidence and knowledge regarding suitable and enjoyable ‘prone’ activities (Hewitt et al., 2017; Koren, Reece, Kahn-D'angelo, & Medeiros, 2010; Zachry & Kitzmann, 2011).

A gap appears to exist relating to research of relevant factors such as sensorimotor systems underpinning the achievement of infant motor milestones (Cascio, 2010). There also appears to be gap in research regarding the impact of parents and carers interacting with infants participating in daily prone and daily vestibular activities to achieve motor milestones (Cohn, 2001) . Research studies have primarily centred on infant prone positioning intervention programs, resulting in improved infant motor development outcomes (Hewson, 2011; Jennings et al., 2009; Lee & Galloway, 2012; Lobo & Galloway, 2012). It is not typical for infant motor development studies to emphasize specific vestibular (response to gravity) activities.

Purpose and justification of the study.

The purpose of this doctoral study is to impart knowledge and increase confidence with parents and carers to undertake daily prone and vestibular activities with their infants. This focus led to the creation of the BAC-Program booklet. This program is outlined in a detailed infant prone and vestibular activities booklet, consisting of thirty four illustrated and described actions presented within four identified milestone sections. Hewson (2011) suggests that without a suitable (prone) movement program to support parents and carers, the achievement of the daily (30 minutes) tummy time for infants is challenging. The BAC - Program booklet is novel in that it offers a greater variety of tummy time and vestibular actions, presented in a format that is readable with clear prone sketched actions. Additionally, the BAC-Program offers age appropriate tummy and vestibular time with explanatory text to allow parents and carers to understand the ‘why’ reasoning behind each activity. The text plus the diagrams intend to increase parent knowledge and to encourage families to interact with their infant utilizing the guidance of the activities outlined in the booklet.

Specifically, promoting daily vestibular time is noteworthy for parents and carers to understand and to further assist in the development of their infant's motor skills (Schreiber-Nordblum, 1995). Families would benefit from guidance to become aware and confident with the purposeful vestibular and postural activities that support the infant's early head lifting, head control and later balance (Lee & Galloway, 2012). The BAC-P/2 includes a diversity of response to gravity activities that aim to accommodate the infants form 8 weeks to 9-10 months post birth, gently increasing to more exploratory vestibular sensory responses over this period.

Research aims and Research Question

The aim of this doctoral thesis is to create a family friendly wakeful prone and vestibular activity program that will assist parents and carers in providing valuable daily activities to facilitate infant motor milestone development. This can be achieved through research that theoretically selects, evaluates and supports the selected movement activities and secondly, demonstrates that participation in the prone and vestibular activities can positively impact on achievement of infant motor milestones and overall motor development.

The initial stage of this thesis was the creation and design of the BAC-Program. It was created to be visually presentable and easily understood, allowing families to confidently select prone/tummy and vestibular time activities to enhance their infants motor milestone skills. The activities were grouped on the basis of theoretical interrogation into the four rudimentary (non and prone locomotive) stages including body awareness and head control; rolling over, commando crawling and hands and knees crawling (Kuo et al., 2008; Nitsos et al., 2017; Zachry & Kitzmann, 2011).

The design of the BAC-Program will then be validated in Study one. This study aims to determine the BAC-Program's face and content validity and practical relevance. To achieve this aim, the booklet will be evaluated by a panel of selected Expects within the Early Childhood and Allied Health professions. All comments will be analysed, and appropriate changes integrated within a revised version, the Baby Activity Chart-Program/edition two (BAC-P/2). Knowledgeable validation of the BAC-Program is essential as professionals can advise, provide input, techniques and ideas relative to their particular expertise or proficiency in the context of their professions relating to infant movement development (Hewson, 2011; Schell & Schell, 2008).

The aim of Study two will be to investigate the influence of the wakeful prone and vestibular activity program on early infancy motor development. To achieve this outcome, the BAC-P/2 will be undertaken by an experimental group of twenty nine 10-12 week old infants. With the active involvement of parents, the focus will be on infants interacting with core strength, tummy time and vestibular time activities to be undertaken on a daily basis. Utilizing the Alberta Infant Motor Scale (AIMS) to assess the motor skill development at 6-9 months of age, the scores of the experimental group will be compared to the scores of a control group at the same age, not exposed to the BAC-Program. This comparison will determine the movement program's influence on infant's motor development.

In addition, the amount of time spent (in the 3-7 months categories) in daily tummy time and vestibular time activities (independent variables) and the variance between the two study groups- experimental and control will be evaluated. The dependent variable is the AIMS total percentage mean score. An inferential contrast approach will be adopted to identify patterns and the relationship of the predictors (daily tummy and vestibular time) as the independent variables.

Contribution to Knowledge and Significance of the Study

The importance of infant prone positioning from a young age to has been highlighted to assist in motor development, through strengthening muscles (neck, core and limbs) needed in the attainment of infant milestones and reducing the possibility of deformational plagiocephaly (Guidetti et al., 2017; Hewitt, Kerr, Stanley, & Okely, 2020; Hewson, 2011; Russell et al., 2009; Zachry & Kitzmann, 2011). There appears a lack of validated activities and programs to support parents to undertake the daily recommended tummy time of 30 minutes with research indicating that only a third of four month old infants were achieving this recommendation (Hesketh et al., 2017). Hewitt et al. (2017) outlined that ideas and strategies to inform and support parents regarding the importance of tummy time are invaluable. Mendres-Smith et al. (2020) suggest increased parent knowledge regarding tummy time is important although increasing infant tolerance to this prone positioning may also impact on daily tummy time uptake. The initial BAC-Program booklet idea arose as means of enabling parents to undertake a variety of tummy time activities especially if their infant was unsettled when placed on the floor .The booklet presents a range of prone position activities (away from the floor) together with vestibular movements to meet individual infants' tolerance and enjoyment levels. Several infant activity programs (Guidetti et al., 2017; Hewson, 2011; Lee & Galloway, 2012; Lobo & Galloway, 2012) present a limited number of prone and response to gravity activities for quite young infants with few intervention programs focusing beyond four months of age post birth. To share with families a significant variety of daily tummy time and infant positioning movements through to later rudimentary motor skills, the simply written text and clear sketches became the catalyst for the creation of the BAC-Program .

The significance of this doctoral study became the validation of a prone and vestibular activity focused program booklet. This visual guide was then central to an investigation to ascertain the input tummy time actions and responses to gravity activities may have on infant motor development (Khan & Chang, 2013; Vladescu et al., 2020).

Thesis Structure and Chapter Organisation

Chapter One: *Introduction*. This chapter provides an overview and background to the study with a brief consideration of the literature. The purpose of the study is described and a short explanation on the contribution to knowledge expected from this thesis.

Chapter Two: *The Literature Review.* This chapter undertakes a comprehensive review of the literature on infant motor development and an overview of the infant motor milestones. The review initially provides an explanation of the terms tummy time and vestibular time. Important components of the relationship of the central nervous system and the sensory motor component impacting on infant motor development are reviewed and discussed. Finally, an overview of researched prone and vestibular focused infant motor programs are presented.

Chapter Three: *The Theoretical Context for the BAC-Program Activities***.** In this chapter, the doctoral thesis focuses on the creation and design of the individual sections of the BAC-Program. An important theoretical overview concentrates on the justification for selection of each activity within the program's four milestone sections.

Chapter Four: *Experts' Evaluation of an Infant Wakeful Prone and Vestibular Activity Program (Study one)*. Study one focuses on the sixteen Experts' evaluation of the BAC-program and their opinions on the program's propensity to impact on and to inform parents regarding early infancy motor development. The chapter aims to substantiate the initial face and content validity of the BAC-Program through the extensive review of opinions and comments from early years experts in the field. The outcome of this review will be the formation of a second edition BAC-P/2.

Chapter Five :*An investigation of the influence of a wakeful prone and vestibular activity program on early infancy motor development (Study Two)*. In Study two the intent is to examine the influence of the prone and vestibular activity program on infant motor development. This investigation will determine the effect of the modified BAC-P/2 applied to an experimental sample compared to a non-participating control sample of young infants.

There will be two sub aims within Study Two:

1: Review the amount of time infants and parents in both sample groups participate in 'tummy time' (prone) activities in relation to milestone development.

2: Review the amount of time infants and parents in both sample groups participate in 'vestibular time' activities in relation to milestone development.

Chapter Six: *General Discussion*. This chapter focuses on the results and conclusions revealed from the results of Study one and Study two. The efficacy of the diagrams and text of the BAC-Program to support parents, and the sequential order of the rudimentary infant motor milestones will be discussed in relation to overall motor development. Reflection on the effect of daily prone and vestibular time on infant motor scores will be considered, as well as the efficacy of the BAC-P/2 to increase the knowledge and confidence of parents and carers.

Recommendations for practice and implications for future research will also be provided in this chapter.

Chapter Seven: *Conclusion*. This final chapter will present closing summaries and overall conclusions of the research relating to the influence of a wakeful prone and vestibular activity program on early infancy motor development.

CHAPTER TWO: LITERATURE REVIEW

Motor development

Motor development is primarily expressed as progression through which an infant and child explore motor patterns and motor skills (Malina, 2004). The neuromuscular maturation occurs within the confines of both physical and sociocultural environments within cultures specific to the infant (Pin, Eldridge, & Galea, 2007). Clark and Whitall (1989) suggest that there was controversy over whether motor development was defined as a ‘product’ or a ‘process’. These authors outline the motor development product as changing over time with the focus on the motor performance: for example, an infant rolling over or crawling. Interestingly they define the process aspect of motor development with the emphasis on the underlying mechanism of this change. It appears obvious that both definitions still apply as it is important to study and understand the overall processes including the central nervous system to facilitate infant motor development and to also appreciate that there are many stages that constitute the ongoing progression that is motor development over perhaps a lifetime. Gallahue and Ozman (2005) present the term motor development as a discipline linking motor learning and motor control within the overall motor behaviour field, whereas other researchers see these three areas as disciplines in their own domains (Schmidt, Lee, Winstein, Wulf, & Zelaznik, 2018). Adolph and Berger (2006) suggest that the term motor development, when interestingly defined within the area of developmental psychology is referred to as motor skill acquisition and perceptual motor development. There appears an acceptance that infant motor development is best understood through approaches that include the nervous system and goal directed actions linking together both maturational, dynamic and environmental considerations (Lopes, de Lima, & Tudella, 2009). Kamm, Thelen, and Jensen (1990) depicted the process of motor development as more phase shifts that include the dissolving of primitive reflexes that then allow infants to explore more stable and flexible motor solutions within each subsequent subsystem that develop very individually.

To develop a movement program for young infants the researcher requires an understanding and definition of motor development with an initial focus on the evolving infant nervous system. To better understand the body's physical communication system, Horak (1991) outlines a fundamental assumption linking how the brain controls movement. This overall approach unpacks the physiological aspect of sensory input and motor output, early infant reflexes, the development of the brain stem through to the cortex, integrating with the psychological systems model of the dynamic task and goals concept. Researchers typically need to examine this dependence of motor development according to the infant's intent to pursue the task and then opportunity within the environment, particularly in the context of recent research that underlies the effect that infant prone awake time can have on early motor milestones.

There have been debates and discussions over the past thirty years as to whether motor development is found within the models of Maturation or the Dynamic theories. The early maturation or neuromotor system researchers included Gesell (1939) and McGraw (1943) who looked at infant motor skill acquisition through the biology lens. These researchers presented motor development as strongly linked to the maturation of the central nervous system. More specifically Gesell (1939) framed that behavioural maturation was dependent on neural maturation. This model brought together the reflex (primitive) based repertoire of the very young infant within the nervous system thus influencing behaviours. Similarly, the McGraw (1943) approach applied a more neuromaturation explanation researching infant motor development as establishing an association between the maturation of neural tissue and the development of motor behaviours. In contrast the Dynamic Systems

Theory (DST) focuses more on the relationship between internal subsystems (including the nervous system and musculoskeletal system), environmental factors and the demands of the task (Colombo-Dougovito, 2017; Parker, 2016). Thelen (1995) presented the dynamic approach to motor development as a continuum of developmental change, incorporating the unification of perception, action and cognition. These factors together with the role of exploration and selection combined to influence new behaviours. As previously mentioned the nervous system is significant within the dynamic model but a core assumption is that no one sub-system has ‘logical priority’ for determining the behaviour of the entire system (Kamm et al., 1990). The term motor development appears principal to this dynamic model approach although other terms including perceptual and cognitive development together with social development appeared to also feature prominently.

When investigating infant motor development, it is assumed that the relevant and central components of several existing theories and models are incorporated to guide the researcher. The relationship of the infant’s developing brain to the central nervous system also needs researching to determine the link between the early primitive reflexes and particular motor responses. Williams and Shellenberger (1996) present a Pyramid of Learning model (maturation theory approach) that links the central nervous system with the sensory motor and the primitive reflexes together with other domains of infant and childhood stages (perceptual motor and attention function) that culminate in cognitive development. When viewing the dynamic theory approach, Kamm et al. (1990) consider that early primitive reflexes are not necessarily ‘hard wired’ but contend that a particular motor response is exhibited under certain circumstances. Hadders-Algra (2018) emphasizes the importance of the nervous system although terms these early foetal motor actions as spontaneous neural activity networks that are centred in the infant’s brainstem and the spinal cord, being regulated by above the spinal cord actions. This motor behaviour may not necessarily be termed reflexive, because even at the foetal stage the cortex may be modulating behaviour (Forma, Anderson, Goffinet, & Barbu-Roth, 2018). Although the dynamic theory is accepted widely as an explanation of motor development, there are differing views as to how this approach fully informs research or focuses consistently on early motor delay intervention (Colombo-Dougovito, 2017).

Research aligned with the maturation approach and incorporating a distinct emphasis on primitive reflexes, investigated that these natural reflex reactions play a developmental role in assisting the infant in the early months to initially react and respond to gravity, gradually integrating to allow voluntary movements (Gieysztor, Choińska, & Paprocka-Borowicz, 2018). In relation to neural sensorimotor brain function pre-birth and the association to later infant motor skills, Thomason et al. (2018) present observations of increased connectivity between motor and prefrontal cortex areas, reviewing the effect that a positive functioning neural system can have on maturing infant motor functions. Perhaps Gerber, Wilks, and Erdie-Lalena (2010) portray an important overview of the often conflicting approaches to motor development when stating that ‘Developmental theory has, itself, developed as clinicians have tried to grapple with which influence is more predominant’ pp 267. Thus, a relevant perspective common to both approaches is the assumption that researchers in this motor development field share a common resolve to ensure that infants and children importantly reach independent movement, albeit on their own unique terms.

Overview of motor milestones in infant development.

Examination of the predictable motor patterns or milestones occurring from birth to approximately one year of age enables the researcher to understand infant motor development in more depth. Infant milestones can be considered as indicators of developmental progress and ages of achievement seen as markers of this development (Dudek-Shriber & Zelazny, 2007; Kimura-Ohba et al., 2011; Piper & Darrah, 1994). It is typically agreed that developmental milestones generally occur in a predictable order or sequence over time although there is individual variability in the appearance and progression (Flensborg-Madsen & Mortensen, 2017; Sauve & Bartlett, 2010). The journey that infants and children take to acquire independent movement begins with early motor responses within utero. This foetal behavior appears in the framework of reflexes and reactions, that are present at birth and gradually weaken or are inhibited in the months following birth (Malina, 2004). The non-appearance or even persistence of these primary reflexes may be indicative of neuromuscular concerns or may affect the attainment of motor milestones (Capute, Accardo, Vining, Rubenstein & Harryman, 1978; Goddard 2005; McPhillips & Jordon, 2007). Researchers in the Dynamic realm contend that certain involuntary actions or reflexes may actually resemble later voluntary movements presenting a different approach to motor milestone acquisition (Adolph & Berger, 2006; Kamm et al., 1990; Thelen, 1995). Paralleling these early primary re-actions are the infants attempts to overcome gravity by attaining sufficient strength to lift the head, support the body's shape and size and to balance the body in various positions (Kimura-Ohba et al., 2011). This development enables the rolling over milestone, generally from prone to supine and then from supine to prone with Capute, Shapiro, Palmer, Ross, and Wachtel (1985) presenting these actions as distinctly separate milestones, appearing often at different times. There are various motor development screening scales available with suggested standard ages for infant attainment of motor skills (Bayley, 1993; Frankenburg, Dodds, Archer, Shapiro, & Bresnick, 1992; Piper & Darrah, 1994). Interestingly, WHO Multicentre Growth Reference Study Group and de Onis (2006) through focusing on the variability in infant development, present the term 'windows of attainment' with specific scales reflecting a greater range of normal milestone development. It is important to note that the wide variation in ages of achieving various motor stages may also complicate the identification of infants with motor developmental delay, a domain for which motor milestones are reliably accepted (Colombo-Dougovito, 2017; Flensborg-Madsen & Mortensen, 2017).

The general progression following the rolling over milestone in the prone continuum is observed as the commando (or belly) crawling action, creeping (crawling) on hands and knees, sitting unassisted and then pulling self to stand (Hadders-Algra, 2018; Kuo et al., 2008; Lopes et al., 2009; Malina, 2004; Nitsos et al., 2017; Touwen, 1975). In relation to the more efficient mode of infant locomotion, Patrick (2012) poses that the commonly observed hands and knees crawling infants utilized a systematic and rhythmic interlimb ipsilateral coordination action, followed generally by contralateral. This author continues that this action was both supported and limited by the developing nervous system, with Adolph and Robinson (2013) suggesting that while many infants do the iconic crawl, many infants may 'bear' crawl on hands and feet. These two specific milestones are not only important as benchmarks of infant motor development but are seen as definitively and uniquely enabling motor skill progression (Soska, Robinson, & Adolph, 2015). As a natural progression through the locomotion milestones infants who explored the commando crawl milestone in varied postures then progressed to noticeably more efficient hands and knees crawling behaviours (Adolph, Bertenthal, Boker, Goldfield, & Gibson, 1997; Yamamoto, Lee, Matsumura, & Tsurusaki, 2021). The milestone journey through the first year post birth is frequently referred to as the rudimentary stage of development that is then followed by the childhood fundamental motor stage (Goodway et al., 2019).

Both pre and postnatal factors are associated with the ages that infants reach milestones with gestational age, prematurity and birth weight as key determinants

(Flensborg-Madsen & Mortensen, 2017). Neonatal complications and 'poor' parent infant relationships are also identified as influences that can affect motor development (Baumann, Tresilian, Heinonen, Räikkönen, & Wolke, 2019). Perhaps the slower timing of these milestones or non-achievement may impact on overall infant development. Recent research supports the assumption that motor development and motor milestones have been slower to develop since the recommendation of sleeping babies on their backs in 1992 (Majnemer & Barr, 2006; Monson, Dietz & Kartin, 2003; Vaivre-Douret, Dos Santos, Charlemaine, & Cabrol, 2005). Parents show reluctance to place their babies in awake prone position due to fear of sudden infant death syndrome -SIDS (Davis & Moon, 1998; Majnemer & Barr, 2005) with Salls, Silverman and Gatty (2002) reporting that infants infrequently placed in prone position showed significant lack of head control when compared to the prone placed infants. Delayed early infant milestones may affect future coordination, balance, speed and strength in subsequent years (Gerber, Wilks & Erdie-Lalena, 2010) and cognition and behavioural performance by early school age (Hitzert et al., 2014). Some researchers even suggest that the younger age of attainment of motor developmental milestones can predict cognitive outcomes or higher educational levels in adults (Flensborg-Madsen & Mortensen, 2017; Taanila et al., 2005).

Parental knowledge regarding motor milestones post the SIDS recommendations

Researchers aligning with the Dynamic Systems Theory present various multiply sub-systems within the task, individual and the environment to support infants to achieve the important motor behaviours or motor milestones (Smith & Thelen, 2003; Smith et al., 2017). A major influence is the interaction of 'individual' or parent and carer as facilitators of infant motor learning and development (Baumann et al., 2019). Parent's confidence and knowledge of motor milestone development when interacting with their young term born infants is an area not readily researched and supported. Investigations generally focused on the premature or low birth weight infants with the emphasis on implementation of a relationship, family centred intervention program that produced improved motor outcomes (Koldewijn et al., 2010). Nordhov et al. (2010) introduced a sensitized parental intervention program to families with preterm infants in relation to affecting motor and cognitive outcomes. This relationship program addressed aspects including infant reflexes, self-regulation and behaviour interactions to relax parents and infants to ultimately show beneficial effects mainly on cognitive rather than motor outcomes at five years of age. These studies albeit with premature infants, endorse the importance of the parent-infant relationships in developing infant motor skills and the emphasis on ensuring parents confidence and knowledge to provide opportunities to support their infant's motor development.

Hewitt et al. (2017) highlight that with the emphasis on parents to initiate the recommended daily thirty minutes or more of prone activities with their infants, there is lack of research to identify factors that actually influence and encourage parents to follow the guidelines. Generally, there is reluctance by parents to meet these recommendations due to factors including infant intolerance to the positioning (Davis et al., 1998; Dudek-Shriber & Zelazny, 2007; Guidetti et al., 2017; Majnemer & Barr, 2006; Salls, Silverman, & Gatty, 2002). There appeared the lack of relevant information received by parents in relation to the importance of placing their infants in a prone position (Koren et al., 2010). More recently, there have been studies that have focused on supporting parent and carers confidence with specific programs and pamphlet ideas, aimed at increasing self-assurance with simple suggestions to encourage daily prone or tummy time positioning (Hewson, 2011; Jennings et al., 2009; Lobo & Galloway, 2012).

As facilitators of infant motor learning, parent and carers also need to be supported in acquiring knowledge as to the importance of interacting with their infants to promote the acquisition of motor milestones. As previously discussed, each distinct motor milestone can enable and assist further skill progression through this rudimentary motor stage of development. Various studies (Jennings et al., 2009; Koren et al., 2010) have focused on providing uniform and readable material on the importance of tummy time activities to promote the skills and strength required to achieve motor milestones. Interestingly Ricard and Metz (2014) concluded that although parents and carers were receiving various prone positioning information from a variety of sources, it was often lacking in specific details and guidelines. Further research has acknowledged that specialized and knowledgeable service providers were needed to increase awareness regarding the consequence of participating daily prone positioning to offset the delay in major milestones (Majnemer & Barr, 2006).

Define the term 'Tummy Time'.

The phrase 'Tummy Time' is a more accepted and parent/carer friendly expression than the academic 'Prone time' term although Hewitt et al (2019) define tummy time as an awake time in the prone position. The prone position refers to positioning infants on their stomach with the supine positioning denotes placing the infant on their back (Piper & Darrah, 1994). In the prone position young infants begin to acquire and utilize neck righting responses to contend with antigravity movements and to generate stabilizing postural connections (Lopes, 2009). The awake infant prone positioning is a vital procedure to be recognized by parents as a natural process for the infant to strengthen their head, arms and upper body muscles (Nitsos et al., 2017). Additionally, spending time on their tummies ensures the back of infant's heads receive fewer constant pressures to specific areas helping to offset the possibility of head moulding leading to plagiocephaly (Guidetti et al., 2017; Hewitt, Kerr, et al., 2020; Kordestani, Patel, Bard, Gurwitch, & Panchal, 2006; van Vlimmeren et al., 2007). Head and neck strengthening becomes critical for a range of early motor (trunk and arm strength, oral motor control) and visual behaviours with a stable head supporting the vision function (Lee & Galloway, 2012). As the infant gains strength, the daily time in this awake supervised posture is encouraged by health professional to gradually increase over various sessions to equate to a minimum of thirty minutes each day (Hewitt, 2017). Several studies exhibit a positive link between time in prone and infant motor development (Dudek-Shriber & Zelazny, 2007; Monson, Deitz, & Kartin, 2003; Russell et al., 2009) enabling the movement actions of rolling over, commando crawling and hands and knees crawling. Factors hindering infants spending the suggested daily awake tummy time include limited knowledge and choice of different prone postures available to parents and carers. Other factors include parent's confidence as a result of the SIDS supine sleeping directives, parents ages and education, maternal anxieties, age to start prone and early poor initial head and neck strength (Feldman, Greenbaum, Mayes, & Erlich, 1997; Hewitt et al., 2017; Majnemer & Barr, 2006; van Vlimmeren et al., 2007).

Define the term 'Vestibular Time'.

The term vestibular refers to placing the awake infant in a position where the vestibular sensory system responds to the pull of gravity (Nandi & Luxon, 2008). The phrase vestibular time is not as acknowledged by parents and carers or encouraged to be undertake daily by early years professionals as is the tummy time expression (Schreiber-Nordblum, 1995). Importantly, Le Gall et al. (2019) emphasize the input that vestibular sensory perception generates to the early stages of infants sensorimotor development. The vestibular sensory system (predominately located in the inner ear) is stimulated by rocking, swaying and tipping motions providing the brain with information about movement and stillness, head position and spatial orientation (De Kegel, Maes, Baetens, Dhooge, & Van Waelvelde, 2012; Khan & Chang, 2013; Le Gall et al., 2019; Nandi & Luxon, 2008; O'Reilly, Grindle, Zwicky,

& Morlet, 2011). Development of postural control including head and neck strength enables the infant to gain mechanical support assisting the body to resist the forces of gravity (de Graaf-Peters et al., 2007; Massion, 1998). Several researchers deem that this vestibular sensory action together with the visual system, functions as a strong contributor to infant balance and physical development (Fong, Tsang, & Ng, 2012; Gioacchini, Alicandri-Ciufelli, Kaleci, Magliulo, & Re, 2014; Nandi & Luxon, 2008). Sandler and Coren (1981) succinctly describe that vestibular positioning 'provided through rocking, spinning, or other movement experiences has been shown to have a significant influence upon arousal level, visual alertness, visual tracking behaviour, motor development, and reflex development': p. 48.

The vestibular system consists of a peripheral section namely the lateral (horizontal), anterior and posterior semicircular canals, and the otoliths known as saccule and utricle that interacts with a central ocular and spinal responses, critical for postural control, balance and gaze stabilisation (Rine, 2009). The semi-circular canals respond to angular (rotational) acceleration with the otoliths interestingly reacting to linear (head tilting) acceleration. Overall, the vestibular sensory system is part of other multisensory inputs including proprioceptive and visual systems that are integrated within the infant's central nervous system to promote balance and postural development (Wiener-Vacher, Hamilton, & Wiener, 2013). Consequently, the infant's responses to interact and react with gravity are assisted and stimulated by gentle but active circular and linear movements that allow displacements of the centre of gravity of the neck, shoulders, trunk and hips creating a reaction to imbalance (Dieterich & Brandt, 2019; Hylton, 1997). The vestibular sensory system is particularly sensitive to gravity forces and together with vision and neck muscles, assists to maintain the steady position of the head in relation to the trunk (Massion, 1998).

The Central Nervous System, Infant Motor Development and Motor Milestones.

Infant Brain Structure and Early Growth Patterns

It is foremost in this literature review to investigate the relationships of the observable and significant central nervous system brain structures that include the brainstem, sensory and motor cortexes and cerebellum to the observable but less apparent motor components including the primitive infant reflexes and sensory systems. An overall deliberation supports an understanding of the impact of these developments within the infant's brain structures to early infant motor movements. This understanding will contribute to the selection of movement activities to form a wakeful, prone vestibular program to assist parents and carers to provide stimulation for their young infants.

The human brain consists of the cerebrum (front of brain consisting of right and left hemispheres), the brainstem (medulla, pons, midbrain), and the cerebellum (back of head structure engaged with voluntary muscle movement, posture, balance and equilibrium (Joseph, 2000; Shumway-Cook & Woollacott, 2007). The brain development during the first two years post birth in infants is very vibrant. The brain reaches 80-90% of adult volume by two years of age including the proliferation of new synapses. This corresponds with the overall volume of 'grey matter' reaching the full quota at end of the second year (Groeschel, Vollmer, King, & Connelly, 2010). Myelination of axons also reaches a peak around age two although this procedure continues at a slower speed into adulthood. Perhaps the most important phase occurs in the early months post birth. After conducting a structural MRI studies of 98 infants, Knickmeyer et al. (2008) concluded that total brain volume increased 101% in the twelve months post birth and 15% in the second year. It is important to note that concurrent with this profound structural brain development is the equally strong development of both cognitive and motor functions (Kagan, Herschkowitz, Snarey, & Ousley, 2005).

As the structure of the infant's brain is created genetically before birth, the continued development is dependent on the process called plasticity, including both neuron and synaptic plasticity (Mateos-Aparicio & Rodríguez-Moreno, 2019). This process is a response to stimuli (intrinsic or extrinsic) evoking the constant changing of neuron and synaptic connections as the brain's structure, functions and connections are reorganised (Kolb, Mychasiuk, Muhammad, & Gibb, 2013). Brain plasticity is noticeably effective after the completion of neuronal migration pre and post-natal as dendrite outgrowth and synaptic formation are highly active (Blauw-Hospers & Hadders-Algra, 2005; Kolb & Gibb, 2011). This high plasticity has been suggested to occur 2-3 months prior to and 6-8 months post birth (Hadders-Algra, 2018). Bell and Fox (1996) present research outlining an initial increase in the production of synapses in the expectation or onset of crawling in eight month old infants, with pruning of 'over abundant connections' occurring once the motor action (crawling) becomes a learned response. In the first year post birth, the cerebellum volume also increases 240% with the lateral ventricle- subcortical structures increasing 280% compared with a greatly reduced increase in the second year. This significant increase in the total brain volume in first year post birth reinforces that this is a critical time for the infant's cognitive and motor development and thus avoidance of developmental disruption and support of sensory and motor exploration is key (Knickmeyer et al., 2008; Kolb & Gibb, 2011).

Brainstem:

Medulla, Pons, Midbrain.

Joseph (2000) outlines that the human brainstem develops in the early weeks of gestation and matures structurally to form the medulla, pons, and midbrain components. This configuration contains various nerve nuclei and links the brain and the spinal cord (Sciacca, Lynch, Davagnanam, & Barker, 2019). The brainstem's vestibular nuclei together with several cerebellum sections consist of central vestibular processes linking up to the peripheral vestibular apparatus within the inner ear.

The medulla (also known as the medulla oblongata) is situated closer to the spinal cord and controls arousal, breathing, heart rate, and larger movements of the body and head. The functions of the medulla proceed those of the pons, and the midbrain (Caminero & Cascella, 2019). The brainstem of 2-9 month old infants studied by Tang, Machaalani, and Waters (2010) showed most expression (nerve growth responses) within the medulla and pons areas with less activity in the midbrain, together with action observed in the vestibular nucleus within the central brainstem structure when compared with activity within adult brainstems.

The pons structure is located above the medulla and connects the pathways of the fore brain to the laterally situated cerebellum and also contains the vestibulocochlear nucleus. The pons is later to mature than the medulla, and also has roles in arousal, body movements, and vestibular and vibroacoustic perception (Joseph, 2000; Sciacca et al., 2019). The smaller and most cranial of the brainstem structures is the midbrain connecting to the upper pons and predominately involved with consciousness and sleep and links the cerebellum with the forebrain.

This midbrain configuration also mediates auditory discriminations, head turning and eye movements and performs a necessary role through ascending pathways and descending systems that carry either motor or sensory information (Caminero & Cascella, 2019; Joseph, 2000). An important function of the infant's brainstem is the corticospinal tract (vital for movement skills) that descends along a motor pathway beginning in the upper brain's cerebral cortex, crosses the midline in the pyramids of the lower medulla and descends along the trunk and limbs (Jen et al., 2004; Martin, 2005). This corticospinal tract within the brain's system is also linked to motor control and sensory input (Jen et al., 2004) with the somatosensory tract and visual receptors guiding axons to particular locations in the specific lower brain centres (medulla and midbrain) and also enables axons to cross the midline (Woods, 2004).

Cerebellum

The cerebellum structure in sensory motor terms appears to be the link between the brainstem structure and the cortex responses in early infant development. Diamond (2000) outlines that the cerebellum shares similar functions to the prefrontal cortex (being motor and cognitive processes), reaching maturity later than the other structures within the brainstem. The cerebellum or 'little brain' is located anterior to the brainstem and can be defined by its sensory-motor processing function (Buckner, 2013). This structure features input channels, with connections from the synapses within the pons, crossing to separate cerebellum sections where an output channel forms deep in the cerebellar nuclei, and via the thalamus (and basil ganglia) sending responses to the cerebral cortex (Buckner, 2013; Koziol, Budding, & Chidekel, 2011).

Cognitive tasks involving the prefrontal (dorsolateral) cortex are also supported by responses from the neocerebellum, for example when comparing movement intention and performance, suggesting that motor development and cognitive development may be fundamentally interrelated (Diamond, 2000). This relationship reassures early infant researchers to continue to encourage infants to achieve early movement patterns to assist early motor and cognitive development. Middleton and Strick (1998) suggest that the cerebellum contributes a role in motor control, motor learning and also in brain cognition, with Barmack (2003) and Koziol et al. (2011) proposing a further link to the vestibular sensory system and the role of postural regulation.

The vestibular nuclei (cranial nuclei for the vestibular nerve) connect to the vestibular apparatus within the inner ear and are grouped in the lower pons and the upper medulla of the brainstem and ascends to the cerebellum region known as vestibulocerebellum. This cerebellar region has a function to assist with the stability of the head on the body through stimulation of the infant's neck muscles. The vestibulocerebellum receives vestibular and visual information and is linked to the vestibular reflexes and is deemed to be the only sector to be fully operational at the time of birth (Koziol et al., 2011). Pereira, Valentini, and Saccani (2016) outline that the cerebellum has a circular relationship through the activation of motor tasks and a reactive co-activation in cognitive tasks with a similar co-dependence observed in the pre-frontal cortex, with this co-dependency highlighting the important on an enriching movement environment for infants.

Primitive Reflexes

Further research details that the lower brain centres of the brainstem facilitate the reactions observed with the primitive reflexes and slower integration or retainment of these reflexes may affect desirable maturation of specific brain regions and shape motor development (Berne, 2006; Bilbilaj, Aranit, & Fatlinda, 2017; Chandradasa & Rathnayake, 2020; Gieysztor et al., 2018; McPhillips & Jordan-Black, 2007). Essentially primitive reflexes are present at birth and are assumed to assist in the birth process, to be strengthened by the actual birth and also to provide responses to assist with the infant's survival (Berne, 2006; Pecuch et al., 2020). Zafeiriou (2004) and Sohn, Ahn, and Lee (2011) outline that primitive reflexes are brainstem mediated, typically elicited during the first six months post birth and are observed as highly stereotypical patterns in response to specific sensory stimuli.

Primitive reflexes prepare the neonate to respond to gravity and to process sensory information (Gieysztor et al., 2018). They support and facilitate the infant birth process (Pecuch et al., 2020) and prepare the infant to react to stimuli within the environment to assist with survival (Melillo, 2011). The more common studied primitive reflexes include the Moro, the Asymmetrical Tonic Neck Reflex (ATNR), the Tonic Labyrinth Reflex (TLR), Symmetrical Tonic Neck Reflex (STNR) and the Spinal Galant (Capute et al., 1984; Gerber et al., 2010; Gieysztor et al., 2018; Goddard Blythe, 2002).

The less studied crawling reflex is described as the newborn's capacity to propel themselves when prone (Forma et al., 2019), with Hym et al. (2021) suggesting that the survival crawling reflexive action is a reflex that propels the newborn towards the scent of mother's milk soon after birth. Rather than group as a primitive reflex, this newborn crawling action has been interestingly categorized as a 'locomotive reflex' as the response is perhaps not as essential when determining the infant's general neurological status (Gabbard, 2012). Katona (1989) outlines a distinction between primitive reflexes and elementary neuromotor patterns that accordingly includes the very young infant crawl action. These neuromotor patterns are a repeating sequence of involved movements in response to a particular activating pose as opposed to the primitive reflexes which elicit responses of shorter duration with more rapid, singular responses to a stimuli (Kuiper et al., 2018). There is a suggestion that the basal ganglia is required to support the brain stem during the more complex neuromotor patterns.

In reference to this summation, this doctoral study will define the term as a 'crawling reflex', deeming the action as a general indictor of the neurological status. This approach maintains continuity between the other selected stereotypical reflex patterns that also respond to specific sensory stimuli. The action of this crawling reflex produces a response when pressure is applied to the ball of the infant's foot when placed prone, thus propelling the infant forward (Sekulić et al., 2009). Recent research indicates that in certain conditions the legs only (bipedalism) crawling motion may in fact be coordinated with the arms if the infant's head (and chest) is raised freeing up the arms to support the legs to propel forwards (Forma et al., 2019; Hym et al., 2021).

Primitive reflexes, observed during early infancy, periodically recede due to cerebral cortex inhibition and brainstem activity as voluntary motor actions including rolling over and commando (belly) crawling become more cortically controlled (Gieysztor et al., 2018; Hobo et al., 2014; Sohn et al., 2011). Touwen (1975) and Touwen (1990) describe a variability of infant's reflexes specifically the Moro, ATNR and Spinal Galant reflexes as indicators of a functioning central nervous system for both premature and term infants. Specifically, the Moro reflex is located in the lower brainstem in the pons and medulla regions (Futagi, Toribe, & Suzuki, 2012) and is elicited with head backwards movements (Bilbilaj et al., 2017). A retained Moro in older children can present as poor balance and sensory overload (Pecuch et al., 2020). The ATNR is initiated when the infant's head turns to the side influencing the arm and leg on that same side to extend whilst limbs on the contra side both flex (Lange-Küttner, 2018). A retained ATNR may produce difficulties crossing the body's midline with both eyes and limbs and result in poor eye tracking (Gieysztor et al., 2018). The TLR has similar responses to the Moro reflex, as a backward head movement initiates the body arching backwards. A forward head movements instigates the entire body curling forwards. When retained in childhood, the TLR also produces poor balance, difficulty with ball tracking above the head and perhaps tippy toe walking (Goddard Blythe, 2002; Pecuch et al., 2020). Most of the early infant primitive reflexes are inhibited between six to twelve months post birth.

Interestingly, several postural reactions including righting, equilibrium and protective responses, assist with early head control, allowing postural and balance mechanisms to respond if infants' centre of gravity is disturbed (Haley, 1986). The later emerging postural reactions including the Symmetrical Tonic Neck Reflex-STNR, assist with the more sophisticated voluntary movements and response to gravity reactions, often weakening as the crawling on hands and knees action begins. The postural reactions inhibit into the nervous system around 9-12 months post birth (Goddard Blythe, 2002).

The continued persisting of earlier primitive reflexes can interfere with gravity responses and voluntary motor actions, impacting on sensory motor development and motor milestone attainment (Pecuch et al., 2020; Sigafoos, Roche, O'Reilly, & Lancioni, 2021). Melillo (2011) specifically identifies that persistence of primitive reflexes may constitute a maturational delay in areas of the brain involved with feedback within the frontal lobes. This author expands that all primitive reflexes never fully disappear but appear to come under the control of the frontal lobes, perhaps surfacing during injury or older age. Available evidence suggests that the interaction between the infant's nervous system and exposure to sensory stimulation and motion actions within the environment, including the lessening of the impact of the early reflexes, forms the basis for rudimentary rolling, and crawling movements (Gabbard, 2012). Reflex inhibition and sensory action over the infant's first twelve months, excites the activation from the more primal brain areas (lower brainstem) to progress to the more mature and developed anterior areas of the upper brainstem and the cortex (Berne, 2006; Melillo, 2011; Sohn et al., 2011). Primitive reflexes require external stimuli to elicit responses and to ultimately inhibit. The introduction of specific activities undertaken with infants that closely reproduce or mirror these reflex motor sequences can support the reflex inhibition process. Melillo (2011) highlights that encouraging infants to utilize and elicit the primitive reflexes with carefully selected actions increases sensory stimulation, producing feedback to the central nervous system, supporting the inhibition journey towards cortical maturity. In summary, primitive reflexes and postural reactions are a common tool used to assess the brainstem, spinal cord and central nervous system integrity of infants and young children (Capute et al., 1985; Swaiman & Phillips, 2017; Zafeiriou, 2004). Additional research should seek to clarify that the persistence of primitive reflexes may negatively impact motor development and learning (Sigafoos, Roche, O'Reilly, & Lancioni, 2021).

Sensory Motor System:

Vestibular Sensory System.

Newborns begin their development through a connection and interaction between the sensory and motor systems (Chorna, Solomon, Slaughter, Stark, & Maitre, 2014; Le Gall et al., 2019). Interestingly, the mode of the sensory input (being either vestibular, tactile, proprioceptive, sound or light) that elicits a reflexive response in very young infants, markedly influences the scale of the motor response (Flanagan, Schoen, & Miller, 2019; Kaga, Suzuki, & Marsh, 1981). The sensory motor scheme becomes a coordination between different sensory inputs resulting in varied and modified movements as the infant begins to encounter gravity, sounds and sights after a fluid uterine environment (Dusing, 2016; Le Gall et al., 2019; Nandi & Luxon, 2008). Wiener-Vacher et al. (2013) specifically describe how vestibular sensory signals are evoked from the infants head movements (generally a Moro reflex response), producing an awareness of the body parts, both to each other (body awareness) and to their position within the environment (space awareness).

Examination of the multi-faceted vestibular sensory system begins with the peripheral organs, consisting of three pairs of semicircular canals and the two otoliths within the inner ear providing information on the direction of gravitational force dependent on head movements and motion accelerations (Wiener-Vacher et al., 2013). In particular, the semi-circular canals (lateral, anterior and posterior) respond to angular acceleration whereas the otoliths (saccule and utricle) are involved in detecting linear acceleration (Cronin, Arshad, & Seemungal, 2017; Nandi & Luxon, 2008). This peripheral vestibular system connects via the 8^{th} cranial nerve (shared with the auditory apparatus) to centres within the developing brainstem, cerebellum, thalamus and cerebral cortex regions where integration from all vestibular receptors ensues the expansion of the balance responses and orientation of the body in its environment (Dieterich & Brandt, 2019; Khan & Chang, 2013). The thalamus has been regularly termed a passive transit structure relaying information from sensory organs and the subcortex through to the cortex. Interestingly, Hwang, Bertolero, Liu, and D'esposito (2017) present the thalamus as a more vital multisensory system and cognitive hub, integrating both vestibular components of spatial and motion perception across multiple cortical networks.

In humans the peripheral vestibular sensory system is the first sensory system to develop in utero (Nandi & Luxon, 2008), credibly to prepare for the birth process (Roizen, 2009) and post birth, to respond to changing body positioning and motion responses in relation to gravity (Le Gall et al., 2019). Van Hecke et al. (2019) outline that vestibular dysfunction occurring at birth or early in infant development becomes more impeding to subsequent movement development than if transpiring in adulthood. Infants and young children with vestibular issues may experience common motor milestone delays, with excessive compensation occurring through visual and somatosensory (tactile/proprioceptors), thus hindering an initial ‘under functioning’ vestibular diagnosis (Nandi & Luxon, 2008; Rine, 2018). More recently, awareness and evidence has focused on early acquired or underdeveloped vestibular problems may considerably influence development of various infant motor tasks and the maintenance of postural stability (Van Hecke et al., 2019). Research has also reported links between vestibular function and motor performance (Maes, De Kegel, Van Waelvelde, & Dhooge, 2014) with vestibular dysfunction presenting a reduced balance performance and a delayed acquisition of early motor milestones including head stabilisation, core strength and independent walking (Martens et al., 2019).

Studies of children presenting with neurodevelopmental disorders (NDD) reported issues with both the peripheral and central vestibular systems that can result in distorted motor coordination, postural instability and poor balance symptoms (Medeiros et al., 2005; Van Hecke et al., 2019). In relation to post birth infants, there is an observable endeavour to master head and neck control, explore the locomotion motor milestones, and progress to an upright balance stance over the first 18 months. The vestibular sensory system is principal to enabling the infant to realize these motor skills through interacting with the pull of gravity, and also requiring the collaboration of the vision, tactile and proprioception sensory systems to achieve neuro motor maturity (Kushiro, 2012; Rine, 2018).

Research also indicates that the auditory and peripheral vestibular sensory systems are closely linked as depicted in the structure's adjacent anatomic inner ear positioning. Interestingly, vestibular dysfunction can be observed as a comorbidity of sensorineural hearing loss with audibly affected children often displaying balance and motor deficits (Cushing, Papsin, Rutka, James, & Gordon, 2008; De Kegel et al., 2012; Inoue et al., 2013; Martens et al., 2019). Similarly, children with autism spectrum disorders (ASD) may exhibit atypical sensorimotor behaviours particular in relation to the vestibular ocular reflex (VOR- located in the brainstem) particularly affecting eye movement responses in relation to head rotation (Jou, Minshew, Melhem, Keshavan, & Hardan, 2009). Carson et al. (2017) contribute further support with research indicating that this ASD population may possibly lack cerebellar inhibition to the brain stem vestibular nuclei as the sensorimotor system labours to maintain stable vision during head movement. Research into children with neurodevelopmental disorders (NDD: of which autism is a sub-category) indicates that there appears to be more difficulties, in comparison with typically developing children, in both static and dynamic balance and postural stability (balance, gross and fine motor disturbances) reinforcing the connection for vestibular dysfunction in this population (Balatsouras et al., 2007; Coleman, 2011; Fong et al., 2012; O'Reilly et al., 2011; Van Hecke et al., 2019). A range of investigations also found that during early infancy increasing vestibular activity both assists in the inhibition of the primitive reflexes and also supports head and postural control as the motor rudimentary milestones begin with rolling over around from three to six months post birth (Blayney, 1997; Gerber et al., 2010; Swaiman, 1999). The maturity of the vestibular system appears very responsive between 6 to 12 months (post birth) during the emergence of commando and hands and knees crawling milestones, demonstrating the infants' effect or impact over gravity (Nandi & Luxon, 2008). These early locomotive behaviours of early infancy evolve in relation to the input of the maturing vestibular system influencing the neural descending pathways to the spinal cord (Dewolf, Sylos-Labini, Ivanenko, & Lacquaniti, 2021). Le Gall et al. (2019) summarise the vestibular systems as a cornerstone of the infant's multisensory cortex with links to the hippocampus' relationship to spatial awareness, hypothesising the importance in relation to both sensorimotor and cognitive functions with particular focus on the otolith's vital role of perceiving gravity.

Sensory System: Proprioceptive, Tactile, Visual, Auditory Systems.

In the infant development domain, the term sensory systems implies the input of each of the senses and resultant responses occurring in the nervous system, with the term sensory integration referring to the converging from more than one sensory domain of information into the brain (Miller, Nielsen, Schoen, & Brett-Green, 2009). Both terms will be inter merged in this literature review as the impact of the processing and organizing of sensations from various sensory domains is analysed in relation to infant motor development (Cheung & Siu, 2009). In addition to the vestibular structure, the proprioceptive, tactile, visual and auditory sensory systems, present as an interconnected sensory scheme. The less well understood proprioception sense can be defined as a perception of muscle force, effort, joint position and movement relayed from sensory signals located in the skin, muscles and joints (Taylor, 2009).

Collectively the impact of the overall sensory system on all areas of development (including motor development) within the infant's first year is determined by the input of the varied and crucial sensory information (Dusing, 2016). Similarly, the infant's vestibular, tactile, proprioceptive, visual and auditory sensory systems are inexplicitly linked and become integrated during early development (Graven & Browne, 2008). Nelson et al. (2001) utilised a multisensory (auditory-tactile-visual-vestibular) ATVV intervention program to stimulate the development of premature infants who were considered a high risk for neurodevelopmental disorders. Additional research indicates certain variations of sensory systems combinations, with Riemann and Lephart (2002) presenting the concept that somatosensory (tactile sensations and proprioceptive inputs), visual and vestibular inputs are integrated to achieve motor control, with a particular emphasis on proprioceptive inputs when focusing on functional joint stability. Dusing (2016) and Marcus, Lejeune, Berne-Audéoud, Gentaz, and Debillon (2012) report research that new-born (term age) infant appears to adjust and modify various motor responses in reaction to the tactile stimulus particularly finger grasping and hand shape perceptions, with Khan and Chang (2013) and Rosander and von Hofsten (2000) highlighting that vestibular inputs appear to connect and link to various sensory signals from proprioception, vision and motor directives, particularly stabilising infant gaze during head movements. Overall the multisensory processing occurring concurrently within the above mentioned sensory modalities appear to be interdependent with all modalities emerging to contribute to support the infant's motor development within the first twelve months post birth. The structure and function of the infant's developing brain is influenced by stimulation of and from the sensory organs which in turn provide for healthy neurodevelopment within an accommodating environment (Dusing, 2016; Koziol et al., 2011; Lackner & DiZio, 2005; Miles, 2018; Sweeney, Heriza, Blanchard, & Dusing, 2010).

Lateral Development and Bilateral Relationship to the Midline

The environment has a large impact on shaping brain function dramatically during early life as neural circuits develop revealing profound plasticity (Takesian & Hensch, 2013). Hemispheric asymmetries and typical laterization are the brain's major early organizational principles (Berretza, Wolf, Güntürküna, & Ocklenburg, 2020) with normal development outcomes centred on stabilizing these neural networks that can be shaped by both genetics and experiences (Brandler & Paracchini, 2014; Takesian & Hensch, 2013). The brain's structure is commonly described as having cerebral asymmetry with each hemisphere of the brain controlling and receiving sensory inputs from the opposite side of the body (Vulliemoz, Raineteau, & Jabaudon, 2005). Each hemisphere is composed of different neuronal networks that allow for diverse specialized function with each hemisphere developing both functional (language laterality) and structural (behavioural and handedness laterality) asymmetries (Doyen, Lambert, Dumas, & Carlier, 2017; Ocklenburg, Korte, Peterburs, Wolf, & Güntürküna, 2016).

Lateralization commonly refers to the location of function of neural or cognitive processes to be specialized on one side of the brain in preference to the other, with the example of language generally located in left hemisphere for right handers (Doyen et al., 2017). This lateralization is unique to each infant and child as every human brain develops differently (Halpern, Güntürkün, Hopkins, & Rogers, 2005). Thus, evolutionary brain structure is acknowledged to explain a link between motor and cognitive behaviour with the brain's left-hemispheric networks highlighted for various language processes (including syntactic and grammatical processing) and the right-hemispheric network relevant more for the tune and rhythm of speech and the contribution these features have to meaning (Berretza et al., 2020). There appears symbolism of human nature with the left brain linked to controlling manual actions, specialized for handedness and also denoted as the analytical centre, with the right side of the brain depicted as more intuitive and creative and responsible for processing location and spatial relationships (MacNeilage, Rogers, & Vallortigara, 2009). The types and directions of structural or behavioural asymmetry are referred to as typical lateralization when there are similarities in the population as observed in the majority of the population being right-handed (Papadatou-Pastou et al., 2019).

Both of the brain's hemispheres are connected predominately through the corpus callosum. Cell axon fibres cross the midline at several sites in the brain stem and at the spinal cord, with visual fibres crossing at the optic chasm, auditory at the pons with various sensory fibres also crossing at the lower medulla or within the spinal cord (Vulliemoz et al., 2005). The axons provide signals from the neuronal cell body via synapses to other target neurons, thus creating neuronal circuits within the brain. Consequently, within the nervous system, the negotiation of the midline requires the axons to become reliant on the attraction of molecules known as netrins, subsequently guiding the relevant axons to their correct location (Woods, 2004). If appropriate crossing does not occur when 'scheduled' or appropriately stimulated by various cues as in infancy, the developing axon with the sensory receptive growth cone may miss the opportunity to find its target, restricting the infant in both perceiving and responding to the stimuli (Dusing, 2016; Seeger & Beattie, 1999). Bilateral movement actions (coordinated use of two sides of the body) can assist infant's arms and legs to flex and extend as they cooperate to meet in the infant's body midline. This contralateral or opposite action also can impact on the neural connections during important infant growth phases (Liddle & Yorke, 2004). In summary, laterality within the motor cortex, is principally the essential component of brain organisation with motor and sensory fibres crossing the midline to affect movement, handedness, speech production, literacy, visual tracking (Carlier, Doyen, & Lamard, 2006 ; Doyen et al., 2017; Ocklenburg et al., 2016; Whitehead & Banihani, 2014).

Infant Sensorimotor Interaction and the Resultant Handedness.

Takesian and Hensch (2013) and Leeles et al. (2012) support the rationale for sensory stimulation during critical periods on cortical projections (inhibitory) across brain zones and the susceptibility when reduced or overlooked in early life experiences. The responses within the cortical cells to the degree of lateral (right or left side) reactions including images, sounds and body movement are further impacted by interhemispheric connections through the midline (corpus callosum) (Le Gall et al., 2019). All infant sensory modalities are located in both hemispheres with the vestibular, vision and auditory system in particular, bilaterally organised although one hemisphere may react in a more sensory dominant role. The vestibular sense is typified by a hemispheric ascendancy (dominance) and is interestingly generally located in the right hemisphere (temporo-parietal) in right handers (Dieterich et al., 2003).

Research proposes that hand preference in right handers in located in the brain's left hemisphere and consistent dominance does not usually appear until between 2-7 years of age (Scharoun & Bryden, 2014). This timing is somewhat challenged by earlier discourse relating to infant's evolvement of handedness and midline crossing presented by Butterworth and Hopkins (1993). These authors indicate evidence of the in-utero foetus showing right handed thumb sucking; consistent and aimed infant hand reaching at three weeks (if head supported); intermittent hand preference shown with hand/arm reaching observed at three months and finally consistent right handedness emerging at 11-14 months-including reaching across the midline. Ramsay (1985) linked early communication (babbling) with periods of observed right handedness intermittently from 6-9 months of age with Scharoun and Bryden (2014) recounting that language is lateralized in the left hemisphere in around 90% of the population with the majority identifying as right handers, although agreeing that controversy remains on an agreed age that handedness is fully developed.

It is interesting to note that localization of handedness and vestibular dominance are found in opposite brain hemispheres denoting left and right hemispheres respectively. Brandt and Dieterich (2015) discuss that laterization of handedness may synchronize with the opposing lateralization of vestibular function and propose that these developments could be slowly establishing to function and optimize in parallel during movement exploration in infancy. There appears an added dimension to brain lateralization and handedness that highlights vestibular lateralization or dominance (perhaps occurring at the earliest in 6 month old infant) that may influence attainment of handedness or perhaps handedness may affect vestibular dominance (Brandt & Dieterich, 2015). These authors discuss that the vestibular system may be more influential due to early phases occurring within infant gestation although conclude that the vestibular cortex dominance focus is more appropriately directed to the multisensory integration of visual (spatial) and peripheral vestibular inputs supporting infants to physically negotiate their environment. Finally, individual differences exist in attaining handedness and both genetic and environmental factors contribute with research from Corbetta, Williams, and Snapp-Childs (2006) and Fagard (2013) indicating that handedness may be directly sensitive to sensorimotor inputs.

Defining the Rudimentary Stage of Infant Motor Development.

Developmental motor milestones in infants occurring in the first 12 months post birth are presented as early rudimentary movement abilities including the large body locomotion of rolling over, commando crawling and hands and knees crawling (creeping) actions (Gabbard, 2012; Gallahue, Ozmun, & Goodway, 2012; Goodway et al., 2019). These propulsion actions together with the manipulative skills of reaching, grasping and the releasing of objects, and the stability skills of sitting and standing are classed together as rudimentary motor milestones (Goodway et al., 2019). The larger body physical propulsion movements generally begin with the inhibition of the early infant's reflexes and reactions in parallel to the infant gaining control of the head and the upper body, overcoming gravity to support and become aware of the body's shape and size (Gabbard, 2012; Kimura-Ohba et al., 2011). There are suggestions that infant head control is the first major milestone although early examinations of this posture are more often conducted as a part of a general overall neuromotor evaluation with the evaluation of milestones (presence or absence) often precludes discussions regarding an infant's developing or impaired head control (Lee & Galloway, 2012).

The period referred to as the rudimentary locomotion stage of motor development emerges with the rolling over milestone, usually prone to supine, supine to prone although this sequence is often dependent on the amount of daily time in the prone position (Jantz, Blosser, & Fruechting, 1997; Salls et al., 2002). This milestone development progression continues from daily prone time to prone circular pivoting, proceeding to the achievement of the commando (i.e., belly) crawling action (Shumway-Cook & Woollacott, 2007). This locomotion milestone may begin with the infant initially pushing only with the arms when in prone and consequently moving backwards (Piper & Darrah, 1994). As legs start to coordinate with the arms and hands, the infant locomotes forward with the movement initiating as an ipsilateral (same sided) action and then maturing to the contralateral command crawling motion (Goodway et al., 2019; Lenke, 2003). An alternative term 'reciprocal crawling' describes the infant moving in a synchronized right hand/forearm with opposite left leg/knee/toes showing a mature reciprocal (bilateral) commando crawling pattern (Bartlett & Fanning, 2003).

The next action commonly appears as crawling (creeping) on hands and knees, then sitting unassisted, an important positioning stage within this current doctoral study in relation to the BAC-P/2, and then pulling self to stand, cruising then walking unaided (Adolph, 2008; Hadders-Algra, 2018; Kuo et al., 2008; Lopes et al., 2009; Malina, 2004; Nitsos et al., 2017; Touwen, 1975). Adolph and Robinson (2013) outline that the infants who commando crawl prior to hands and knees crawling locomote with greatly increased skill regarding the action and speed of their movements in this hands and knees action. Early attempts at crawling are often observed with the infant rocking in the four point kneeling pose, progressing to moving one limb at a time, maturing into the contralateral right hand left knee action (Goodway et al., 2019; Piper & Darrah, 1994). The novice onset of hands and knees crawling increases the stimulation and production of brain synapse connections with the more mature crawling action instrumental in the pruning of the less required cortico-cortical connections (Bell & Fox, 1996). Crawling on hands and knees can prepare the infant for upright walking together with contributing to the development of motor planning, eye-hand coordination and visual perception (Visser & Franzsen, 2010).

McEwan, Dihoff, and Brosvic (1991) outline the importance of crawling in the development of the sensory (vestibular, tactile, proprioceptive) and motor systems and the contribution of this early milestone to motor skill development including eye-hand coordination, spatial awareness and social maturation. As previously acknowledged, these rudimentary developmental milestones can predictably occur in sequence although there is individual infant variability in both occurrence and progression (Adolph, Hoch, & Cole, 2018; Flensborg-Madsen & Mortensen, 2017; Sauve & Bartlett, 2010). Milestone attainment data can be utilized in many early childhood settings to ascertain typical infant development, assist in collating infant motor program activities and also to investigate infant impediments including possible delayed motor development (Liddle & Yorke, 2004; Størvold, Aarethun, & Bratberg, 2013).

The Infant Sitting Milestones and the Crawling Milestones.

There are disparities in the order that rudimentary milestones may appear with various researchers and commentators suggesting that the sitting supported stance actually precedes the commando crawling phase (Gerber et al., 2010; Kimura-Ohba et al., 2011; Robertson, 2011; Senju et al., 2018; Soska et al., 2015; WHO Multicentre Growth Reference Study Group & de Onis, 2006). These two pertinent milestones actually focus on different physical requirements and outcomes, with sitting enabling the reaching and exploration of objects, and commando crawling requiring the coordination of the four limbs and trunk for stability, and to enable more efficient forward propulsion (Soska et al., 2015). This infant milestone appearance discrepancy can be viewed as a result of the sitting action being more adult led and determined e.g. prop sitting, with the occurrence of supported sitting often recorded between 4-6 months (Davis et al., 1998). The more independent infant sitting mode appears around 6-8 months post birth (Thelen, 1995; von Hofsten, 2004). Karasik, Tamis-LeMonda, Adolph, and Bornstein (2015) revealed in their study that parents and carers made the decision to sit the five month old infants as none of the infants could transition independently from a prone or supine position into sitting posture. These authors contend that cross cultural practices can contribute to individuality in sitting variability and outline that parent-led supported sitting situations include the infant being placed on the floor, often supported with cushions or the mother's hand, to the infant being nursed, or placed inside infant furniture (e.g., prams and highchairs).

Generally, infants can independently place themselves into the sitting stance post creeping on hands and knees as the requirement of the arm and leg strength to push off the prone tummy position is necessary for the independent sitting stance (Soska et al., 2015). Interestingly, the parallel occurrence of sitting concurrently with the hands and knees crawling action is commonly observed although each action serves different functions and involves different muscle groups for the execution of differing movements (Adolph, Berger, & Leo, 2011). Several studies have outlined that advanced levels of prone and supine skill and control, including rolling over and prone lying, influence the progression to hands and knees propulsion, and precede the onset of independent sitting (Green, Mulcahy, & Pountney, 1995; Lee & Galloway, 2012). Once the infant has the strength and responsiveness for the hands and knees posture (around 6-9 months) then moving onto the bottom for sitting only requires a trunk twist (Gerber et al., 2010). When moving in reverse from sitting back to hands and knees posture, Soska et al. (2015) discussed that the body orientation and control required for this transition differed if the sitting stance pursued was 'legs out sitting' as opposed to 'knee sitting'.

This current doctoral study research is focusing on activities to support early motor milestone development with the focus on locomotion movements with the emphasis addressing milestones equated with propulsion. The milestone sequence will therefore follow the rolling over, commando crawl and hands and knees crawling motions as all these actions develop arm, leg and trunk muscle tone, muscle control and strength. Research supports the functional transition from commando (belly) to hands and knees crawling as this practical continuity presents motor similarities including the developmental timing and structure together with the cross patterned action for both forms of locomotion (Adolph et al., 2011). Prone positioning emerges as the essential nucleus for supporting infant motor development as the inability for a young infant to maintain an extended arm prone position has been linked to delays in later motor maturity (Senju et al., 2018). Therefore, this doctoral study will align with research outlining that independent sitting action will naturally develop due to newly acquired arm, leg and trunk strength as a result of the hands and knees crawling milestone. This sequence can evolve with the two action systems both requiring balance, core and limb strength (Soska et al., 2015). Adolph et al, (1998) outline that infants can smoothly transition from the crawling phase to sitting and vice versa around 7-8 months once both skills are achieved. The hands and knees crawling action in comparison to the sitting stance becomes an anatomically efficient form of locomotion, providing opportunities for spatial learning, supporting optic near and far vision as the eyes connect closely with the hands and then to objects in the distance (Soska et al., 2015; Visser & Franzsen, 2010). Kimura-Ohba et al. (2011) highlight that the infant achievements of crawling and sitting are similarly significant with crawling being the 'key' element in locomotion and sitting the basis for achieving fine motor function. It should be noted that individual infant's exhibit variability (sequence and occurrence) in achieving each rudimentary milestone (Flensborg-Madsen & Mortensen, 2017)

Factors that Induce the 'Bottom shuffling' locomotion action

The inference of the sitting milestone as a locomotion milestone can be observed when the infant primarily moves whilst sitting, commonly referred to as 'bottom shuffle' or 'scooting' (Fox, Palmer, & Davies, 2002; Kretch & Adolph, 2013). It is acknowledged that this form of pushing, pulling and scooting forwards generally only involved legs working together with occasional support and propulsion from one hand (Harbournea, Lobo, Karst, &

Galloway, 2013; Patrick, Noah, & Yang, 2012). Harbournea et al. (2013) also suggest that the infant's reaching action can both drive the development of sitting and also disturb the sitting posture due to the reliant on arms to support the trunk and prevent falling in early sitting stances. Importantly, independent locomotion is an infant's pivotal achievement (Anderson et al., 2013) and early introduction and over reliance on sitting may interfere with the progression to locomotion on hands and knees.

The actual locomotion bottom shuffling action occurs somewhat infrequently with figures of 9-10% of infants (Fox et al., 2002; Patrick et al., 2012). This figure may increase to 30% when calculated according to a specific sample of children who presented with delayed walking (Robson, 1970). Robson also reported that the infant bottom shufflers achieved the actual independent sitting stance later than the controls and had also previously exhibited difficulties in the prone stature at 4-6 months and walked late (average 19.4 months). Okai et al. (2021) report that infants who bottom shuffle may have over-protective or indecisive parents in relation to encouraging prone play or the infants may have experienced trunk hypotonia or decreased muscle tone. These findings were also confirmed by Bottos et al. (1989) with a further suggestion that asymmetry (hemi-syndrome: weakness on one side of the body) and the difficulty with weight bearing on arms and legs may have induced or provoked infants to become bottom shufflers. In summary, infants who experience low muscle tone and low postural reaction may find the progression to the hands and knees position challenging, and thus remain on their bottoms (Fox et al., 2002; Hadders-Algra, 2018; Monson et al., 2003; Touwen, 1975).

Not all infants pass through the crawling (hands and knees) stage as supported in the WHO Multicentre Growth Reference Study Group and de Onis (2006). The Who study revealed that although almost all of the 816 infants in their study achieved the motor milestones of sitting, standing (with assistance and alone) and walking (with assistance and alone). This study also outlined that the hands and knees crawl milestone recorded a non-achievement of 4.3% of the assessed population. Infants may move straight from prone positioning to walking or may sit/shuffle prior to standing. The non-crawling phase may be due to the lack of prone experiences due to discomfort when lying on the tummy, poor muscle tone and control and lack of rhythmic cross patterned movements (Howard, 2007).

Postural control required in both crawling and sitting milestones is influenced and shaped by sensory feedbacks including vestibular, vision, tactile and proprioceptive inputs (Chen, Metcalfe, Jeka, & Clark, 2007). Anderson et al. (2013) outline that the action of locomotive crawling utilises and functionalises both the proprioceptive and visual sensory systems for added postural stability Thus, the encouragement of prone play together with sensory experiences in early infancy can impact on achieving the sequential development of prone specific milestones (rolling, commando and hand and knees crawling) (Kuo et al., 2008). Kimura-Ohba et al. (2011) present data that infants who were ‘later’ to achieve these early postural and locomotion milestones (including the sitting milestone) were affected in their motor skills development particularly presenting with delayed independent walking.

A Review of Wakeful Prone and Vestibular Infant Movement Programs

The purpose of this section is to review the wakeful prone and vestibular activity programs in relation to infant handling for infants under 12 months of age. This review will investigate programs that outline prone and vestibular based activities with the aim to promote infant motor development. Lee and Galloway (2012) propose that daily movement experiences including prone and response to gravity actions are critical for the emergence of infant head control which in turn affects limb, trunk, sensory-perceptual and cognitive development. Due to the major growth changes occurring within the infant’s brain structure in the first twelve months post birth, and in view of infant brain plasticity, research has shown that infant movement programs should begin early in an infant's development. (Dudek-Shriber & Zelazny, 2007; Guidetti et al., 2017; Kuo et al., 2008; Lee & Galloway, 2012; Majnemer & Barr, 2006; Russell et al., 2009). These research programs authors focus particularly on infants younger than six months with the aim to promote postural and movement exploration. The early months of life can be a period of developmental vulnerability where planned and also therapeutic activities can have a very positive effect on movement development (Knickmeyer et al., 2008; Le Gall et al., 2019). The vestibular system is a well-developed sensory system at birth and with increased reactivity and motion during infancy, postural control can be nurtured and achieved together with head lift, balance and motor skills (Nandi & Luxon, 2008).

Generally, the focus of infant motor programs is on the prone handling activities that have been planned to support families to undertake the recommended support guidelines of 30 minutes or more of daily tummy time (Australian Government, 2017a) and to enhance infant movement skills (Hewson, 2011; Jennings et al., 2009; Lobo & Galloway, 2012). Specifically, tummy (prone) time can be defined as an infant being placed on their stomach whilst they are awake and observed (Guidetti et al., 2017; Russell et al., 2009).

Prone and Tummy Time Focused Infant Motor Research Programs.

The following section examines research principally addressing prone activities or actual prone programs, together with essentially prone programs that include various vestibular activities. From a review of the 'support', 'encouragement' or 'intervention' activity programs outlined in recent research involving infant prone (tummy time) positioning, several mainly prone studies were identified including Jennings et al. (2009), Guidetti et al. (2017) and Hewitt, Kerr, et al. (2020). The Jennings et al. (2009) study involved thirty four participating families of 4-8 week old infants who received the research team's tested and visually outlined prone activities brochure. This handout includes optimal prone positions including a tummy time activity requiring a rolled towel placed under the chest to support more fussy 'intolerant' infants. The research study's results concluded that the prone program together with a nurse home visit had increased the daily time spent by the infant participants in tummy positions. These subjects also produced higher movement locomotion score (including head control, reaching in prone, rolling over) when compared to the control group at 6 months of age.

Guidetti et al. (2017) studied the effect of also using a rolled towel, together with a more commercial 'Boppy' prone support device offered to thirty two 10-14 week old infants over three home visits. Both additions were found to increase the amount of daily tummy time tolerance in the study's participants. These authors also outlined that the generic Pathways Awareness Tummy Time brochure (Pathways.org, 2006) was used to educate caregivers on the importance of supervised, wakeful play.

Hewitt, Stephens, Spencer, Stanley, and Okely (2020) offered small intervention groups comprised of a total of sixteen mothers, (nineteen in control group) four weekly physiotherapist led tummy time practiced classes for their 5-6 week old infants. This research study investigated the feasibility and acceptance of mothers to increasing the daily home prone time with their infants. The goals were to encourage families to set aside specific daily prone times, to organize a specific space with any required equipment ready, with the tummy time activities being practised weekly together at a venue, with a trained nurse. Positively, the results showed the intervention mothers found goal planning significantly useful and the participating infants more closely met the daily 30 minutes tummy time guidelines. No actual take home program was created although the Early Childhood Health Nurses (ECHN) 24-h

Movement Guideline information handout was proposed as warranting incorporation in future programs.

Several researchers have conducted infant prone positioning studies with predominately specific tummy time activities but also included several vestibular actions (Hewson, 2011; Lee & Galloway, 2012; Lobo & Galloway, 2012). The Hewson (2011) program was titled 'Infant Postural Control Programme' (ICCP) and was offered to thirteen 8 week old infant participants with a control group of seventeen infants. The participating infants and families interacted with the monthly activities for four months, with new actions introduced each month by trained nurses at their infant health clinics. The ICCP activities had been viewed previously by allied health profession experts together with the author of this 2011 study and the validated program activities were made available to each family. The initial take-home photo sheets consisted of six prone movements including prone head lifts, rugby hold and infant prone positional lying across parents legs. Other prone activities offered included infants positioned along parents legs and lifted up into the air; infants prone held whilst taking weight on arms/hands and then prone floor lying whilst tummy pivoting. It should be noted that the program ideas continued monthly until the infants were 6 months of age. The two vestibular actions firstly included the infant held prone in the parent's arms and then horizontally swayed side to side, and secondly the infant was placed prone, lying along parents legs as parents leg lifted the infant up and down. Interestingly, the term 'vestibular' was not mentioned in this study as the emphasis appears to be predominately on prone positioning, coupled with a swaying action. The study's results that were recorded 5-6 months post the program's commencement, produced a significant difference on the Peabody Developmental Motor Scales when comparing the total motor development between groups. The intervention group recorded higher scores in reflex integration, locomotion, grasping and visual motor integration.

Lee and Galloway (2012) also introduced a specialized prone postural intervention program including vestibular type activities for eleven 4 week old participants (with eleven control group infants). The movement training research aimed specifically to increase head control in very young infants through the presentation of prone positioning and infant reaching shoulder strengthening actions. The researchers presented the twenty minute program at the infant's home over four weeks and also offered action photo sheets and information regarding all activities. The prone focused actions centred on infant tummy floor time using a toy to visually track and prone time on parents chest to encourage head lifts. The vestibular focused activities included prone lifting up and down (baby fly) and rocking sideways, forwards and backwards and diagonally whilst infant is fully supported (adult hands at chest/waist) in an upright posture. These two vestibular focused actions (although not identified as vestibular) were encouraged to be practised daily for a total of 6 minutes out of the 20 minute program. The results recorded over various testing sessions displayed the participating infants exhibited greater head control, more advanced postural control and higher overall general motor development.

The final example reviewed relating to prone positioning with vestibular linked activities is the study by Lobo and Galloway (2012). This investigation supported parents and caregivers to specifically handle and position 8 week old infants in a variety of predominately prone positions and explored how these actions can influence infant motor development. The twelve week intervention provided 14 participating infants (14 control infants) with prone experiences formatted in an illustrated manual and presented over the three weekly visits by a physical therapist. Encouragement and discussions regarding the manual's activities were offered to provide the infants with 15 minutes daily (not necessarily concurrent) over these initial weeks. The therapist continued to visit three additional times over the remaining nine weeks of the study. The research then continued up to a total of 60 weeks or until infant was walking. Prone activities included prone lying on parents chest and prone positioning on the floor whilst encouraging infants to push and arm extend. Vestibular actions (again no reference to term vestibular) involved supporting infant in either sitting and standing positions whilst swaying in different directions to both weight bear and to re-orientate with respect to gravity. Results at both the three and five month testing showed the intervention infants scored higher on the AIMS prone subscale score. Also, at 5 months the participating infants produced advanced head righting and midline hand movement abilities. Interestingly, hands and knees crawling, cruising and walking milestones were achieved at an earlier age by the experimental group when tested at completion of the 60 weeks study.

All studies reviewed in this section included examples of infant prone positioning to encourage tummy time activities. The studies all resulted in positive outcomes although the variety of the introduced infant prone positions was limited. Hewson (2010) produced the most variation regarding prone activities with six different poses enabling more varied tummy time experiences. Lee and Galloway (2012) included three specific prone actions and Lobo and Galloway (2012) cited two. The exact prone activities offered in the Jennings et al. (2009) brochure were not provided in the research article or as supplements. Given that the Hewitt, Stephens, et al. (2020) research focused more on parent feasibility and acceptability of additional weekly physiotherapist delivered tummy time sessions, there was also little information of the actual practiced prone activities.

In addition, a recent observational study acknowledged that parent-led tummy time sessions produced more favourable infant responses including infant head elevation compared with researcher-led sessions (Mendres-Smith et al., 2020). This result poses further discussion as the majority of the above studies reviewed featured researcher-led interactions. Perhaps the creation of progressively planned take home prone programs or brochures as offered by Hewson (2011) will empower parents and caregivers of young infants with more confidence and 'know-how' to undertake a recommended minimum of 30 minutes daily tummy time to foster their infant's motor development. Infant programs that more specifically select and refer to sensorimotor and vestibular terms and activities will be reviewed in the following section.

Vestibular and Sensory Focused Infant Motor Research Programs.

It has been challenging to find research studies regarding infant vestibular stimulation programs that detail and promote the development of the vestibular sensory system in term infants. Only two investigations have been located, albeit quite long-standing research including Clark, Kreutzberg, and Chee (1977) and Korner and Thoman (1972) that outline primarily vestibular activities to support term-born infant's motor development. Interestingly, researchers report that it is challenging to detect vestibular loss of function or hypofunction in both premature and term infants at or shortly after birth (Neel et al., 2019; O'Reilly et al., 2011). Generally vestibular intolerances are observed as avoidance or negative responses to a vestibular tipping or swaying activity.

Generally, vestibular testing and consequent programs that have been explored in motor development research appear to focus on older infants with hearing impairment or loss (Inoue et al., 2013; Rine et al., 2004). Research appears to focus on older children who are exhibiting vestibular issues (Coleman, 2011; Gioacchini et al., 2014; Medeiros et al., 2005), and on premature and very premature infants (de Jesus, de Oliveira, & de Oliveira Azevedo, 2018; Kanagasabai, Mohan, Lewis, Kamath, & Bhamini, 2013; Keller, Arbel, Merlob, & Davidson, 2003; Medoff-Cooper, Rankin, Li, Liu, & White-Traut, 2015; Neel et al., 2019; Rice, 1977; White-Traut et al., 2002).

The focus of this doctoral thesis pertains to a prone and vestibular activity program for term born 10-12 week old infants. The premise centres on the basis that motor development in all infants is dependent both on core strength and the function of the inner ear balance (vestibular) organ and central vestibular structures, therefore impacting on balance and locomotion skills (Adolph & Berger, 2006; Goddard Blythe, 2005). The limited amount of recent vestibular focused research programs concerning term infants may be the result of low recognition regarding the influential continuing growth and development of the infant's vestibular sensory system-post birth (Nandi & Luxon, 2008).

The infant research programs that situate on recreating multisensory (including vestibular) stimulation environments to effect neuromotor development for premature infant require reviewing (Kanagasabai et al., 2013; Neel et al., 2019). It appears valuable to investigate the relevant vestibular and sensory based (premature and term) infant research programs to determine the impact of these systems on overall infant motor development.

Sensory motor based programs offered to predominately preterm infants incorporate vestibular activities together with other sensory modules, to stimulate infant postural development and consequently can vary in their combined components. When devising infant stimulation programs, the vestibular system is generally combined with other sensory systems, particularly in reference to the ATVV -auditory, tactile, vestibular, vision multisensory intervention program approach (Kanagasabai et al., 2013; Medoff-Cooper et al., 2015; Nelson et al., 2001; White-Traut et al., 2002). The ATVV program approach evolved from early research by Rice (1977) with the RISS (Rice Infant Sensorimotor Stimulation) technique including tactile, vestibular, auditory, visual.

Within the ATVV approach, the sensory combination includes the auditory component of a soothing female voice, the visual involves infant/adult eye contact as the infant receives a tactile massage for approximately 10 minutes. This action is followed by 5 minutes of vestibular horizontal rocking generally undertaken by the researcher and involving the parents wherever possible (Nelson et al., 2001; White-Traut et al., 2002). Generally, the ATVV program (10/5 minute breakdown) was conducted twice daily, both morning and afternoon. The programs were continued over varying time periods relating to the length of the premature infants' hospital stay. Nelson et al. (2001) discussed positive results depicting greater motor and cognitive performances (particularly at 12 months- corrected age) for the nine 33 week gestational age participating infants who similarly undertook the ATVV program and then continued at home post hospital discharge.

A slight variation of the ATVV approach was adopted by Kanagasabai et al. (2013) as the program duration totalled 12 minutes and was evenly distributed between all four sensory systems. The vestibular component included adults supporting infants in both horizontal and vertical rocking action positions, covering a smaller daily total of 3 minutes compared to the previous studies. Interestingly, the intent of the research undertaken by these researchers centred on an investigation of the effect of multisensory stimulation specifically on neuromotor development in twenty five 33-36 week gestational age infants. They found that the intervention infants exhibited an increased neuromotor score (compared to twenty five control infants). This finding, particularly regarding tonal maturation, allowed the authors to highlight the positive effect of the 3 minute daily vestibular input although no difference occurred between groups in primitive reflex (ATNR, TLR) maturation.

Conversely, these results were similarly reported by Mohamed, Abdelazeim, Elshafey, and Nasef (2018) who utilized a longer daily multisensory daily (40-45 minutes) two weeks program with twenty intervention and twenty non-participating control infants, all at 33-34 weeks gestational age. They concluded that the intervention infants also recorded increased tone and motor patterns together with now improved primitive reflex strength and higher total behavior responses post the program. This developmentally appropriate sensory program is similar to the ATVV approach but also included kinaesthetic and oral components. The researchers indicated that the tonal improvements may be attributed to the now 5 minute daily vestibular stimulation involving hammock supine rocking with slight upper body forward elevation to elicit head righting responses. This improvement is also accredited to the additional 5 minutes of kinesthetic limb flexion and extension actions. The multisensory approach also included a total of 30 minutes of tactile massaging, plus oral stimulation activities together with mothers voice stimulation. Mohamed et al. (2018) concluded that the inclusion of the multisensory stimulation procedure can support head and trunk control, postural alignment and increase limb movement in pre-term infants.

Several focused vestibular, tactile and prone based programs for preterm infants also centred on ‘hammock positioning’ stimulation. Keller et al. (2003) provided a supine positional hammock swing apparatus placed within the infant’s incubator for the ten (31 week gestational age) intervention infants. An additional prolonged prone ‘nesting’ position to maintain infant body forward flexion stimulating the intrauterine mothers space was also provided for all of the study’s twenty participants, including the ten control infants. The ‘nesting’ apparatus also provides tactile stimulation as the infant is fully contained within soft cotton materials. The control infants maintained the prone positioning all day for 10 days of this study with the intervention group interacting with the hammock swing for the increased time of 3 hours daily.

This overall daily vestibular stimulation was noticeably higher than offered in all the previous reported studies and the remaining intervention time placed all the infants in the encouraging prone positioning. The vestibular intervention hammock infants recorded higher neuromuscular maturity test scores together with a more ‘relaxed’ demeanor depicting lower heart and respiratory rates. Interestingly, the Keller et al. (2003) findings support the premise that although prone positioning is very important for future development with all newborn infants, the added vestibular component, albeit in the supine position, appeared to contribute to additional improvement particularly to the premature infant’s neuromuscular maturity.

Another ‘hammock positioning’ stimulation was presented in more recent vestibular and tactile study from de Jesus et al. (2018). These researchers studied twenty eight participating 28-36 week gestational age infants (no control infant group) interacting with daily one hour long hammock (vestibular supine rocking) and then also transferred to prone nesting positions. The results showed results of reduced stress levels and greater induced sleep patterns, (recorded over 20 minute intervals during hammock time). These recent findings produced similar infant behavioral status to the Keller et al. (2003) research and also recorded more relaxed intervention participants post the vestibular and tactile stimulation program.

An early study by Rice (1977) concentrated on tactile and vestibular stimulation (simultaneously with auditory and visual input) adopting the RISS technique for one hour daily (10 minutes tactile massage and 5 minutes vestibular cradled rocking- 4 times per day) once the preterm infants were released from hospital. The fifteen preterm (37 weeks gestational age) infants post the 4 week parent sensory home program, recorded more enhanced neurological development (fewer retained primitive reflexes) at the four months (post birth) testing point compared to the control group. The experimental group also showed a more positive trend towards higher motor scores on the Bayley scale of infant neurological development. The author suggests that the stimulation of an infant’s nerve pathways in the skin and within the vestibular nerve cells, as a result of the sensory program can contribute to the acceleration of the premature infant's growth and development. It is noteworthy that compared to the other vestibular and sensory based research programs, the Rice (1977) research program was undertaken by parents originally trained by hospital staff but undertaken in the infants home environment.

The study by Korner and Thoman (1972) involving twenty 2-4 day old 'term' (39-40 week gestational age) infants, undertook research involving a six day vestibular, proprioceptive and tactile (contact) program. The research consisted of six (30 second) activities including five vestibular/proprioceptive activities (vertical swaying, horizontal and inclined rocking) and one tactile (cuddling) component. Those activities reported by the researchers to exhibit the peak soothing effect on crying times were the vestibular, proprioceptive stimulations, focusing specifically on swaying and rocking actions. The Korner and Thoman study outlines the soothing input of vestibular motions for young infants although there was little reporting or examination on the participant's muscle tone and gravity reactions, post the intervention program.

A vestibular stimulation program for term infants was undertaken by Clark et al. (1977) with 13 participants (13 control) aged from 3-13 months (mean age 7 months). Each infant was involved through 16 sessions of 10 clockwise and anti-clockwise chair spins (adult supported) to stimulate the semi-circular canals. The study's post-treatment results showed the participating infants scoring significant outcomes compared to the control group on both the reflex test and the motor skills test. This vestibular focused intervention research may be difficult to replicate in the home environment as the postures of the held infants, chair spin speed and calculated rotations were undertaken and controlled by experienced therapist researchers.

From this comprehensive review of the predominately preterm infant sensory research and vestibular component studies, only two vestibular focused research studies were undertaken with term infants and these researches were interestingly conducted over 40 years ago (Clark et al., 1977; Korner & Thoman, 1972). There was variance in the mode of vestibular activities included in all research studies outlined and variability in the amount of daily vestibular time proffered. The studies reviewed suggested vestibular time to total between three to five minutes daily for premature infants, although the vestibular based hammock studies offered between one to three hours daily as the infants were gently rocked whilst placed in their incubator. The daily vestibular stimulation offered to term infants in the Korner and Thoman (1972) study was outlined to equate to three minutes daily, although it was difficult to determine the exact length of daily vestibular chair rotation action offered by Clark et al. (1977). In conclusion, a typical functioning vestibular system is considered to be critical in an infant's development with a vestibular dysfunction linked to motor, cognitive and later psychosocial issues (Van Hecke et al., 2019).

The Alberta Infant Motor Scale in Comparison to other Infant Assessment Tools.

Infant motor assessment tools record a variety of developmental skills that can be observed particularly in the infant's first year post birth, sharing motor capacity as the common focus. Current infant evaluations include the Alberta Infant Motor Scale (AIMS); the Bayley Scales of Infant and Toddler Development-Total Motor Quotient Edition III (BSITD-III); the Peabody Developmental Motor Scales, Editions I and II; and the Test of Infant Motor Performance (TIMP). These tools all involve observations and interpretations of infant motor development skills and are undertaken by a skilled and trained assessor (Majnemer & Snider, 2005).

The Alberta Infant Motor Scale: (AIMS)

The AIMS (Piper & Darrah, 1994) is an observational instrument that is norms tested and designed to assess the motor development of infants from birth to eighteen months. The assessment can be completed within 20 minutes with minimal handling of infants (Saccani, Valentini, & Pereira, 2016). The motor scale has four positions or subscales: prone (21), supine (9), sitting (12) and standing (16) with subscales scoring each ability as either 'observed' (one point) or 'not observed' (0 points) (Hewitt, Kerr, et al., 2020). This reliable and valid assessment tool observes infant weight bearing, posture and antigravity movements within each of the four positions (Blanchard, Neilan, Busanich, Garavuso, & Klimas, 2004; Charitou, Asonitou, & Koutsouki, 2010; Kennedy et al., 2009; Syrengelas, Vassiliki, Paraskev, Konstantinou, & Siahanidou, 2014). A raw score (0-58 points) is calculated from the sum of the subscales and then converted into percentiles that is compared to age match other infants percentile rankings (Piper & Darrah, 1994; Saccani et al., 2016). Lopes et al. (2009) detail that the selection of AIMS for their study involving 0-6 month old Brazilian infants was centred on the AIMS test taking into account the actual infant's sequence of motor development through the four subscale positions. Syrengelas et al. (2016) outline that the AIMS is an effective observational tool that evaluates infant gross motor maturation over time, with Liao and Campbell (2004) indicating that this measure also determines infant motor ability most effectively from ages 3-9 months of age.

The Bayley Scales of Infant and Toddler Development

The Bayley Scales of Infant and Toddler Development - (BSID-III) (2005) is an infant assessment tool that is composed of five major domains with motor: gross and fine motor being a component within these domains. The specific gross motor subtest contains 72 items of which four are new in the 2005-edition three. The norm-referenced individual motor assessments are designed to measure infants movements of the limbs and torso between the ages of one and forty two months (Bayley, 2007). BSID-III provides separate raw and scaled scores rather than overall total motor scores. The tool also provides composite scores and percentage ranks for each scale. Finally, the motor development of the infant is classified on one of seven levels from extremely low, borderline, low average, average, high average, superior or very superior (Bayley, 2007; Madasch, Mecca, Macedo, & Paula, 2016).

Interestingly, the gross motor subtest of BSID-III and the AIMS were not highly correlated (Jackson, Needelman, Roberts, Willet, & McMorris, 2012). The BSID-III was developed more as a screening device for infants with possible motor delays thus influencing the more specific item assessment selection. Whereas the AIMS generates information for general motor diagnosis together with clearer distinctions between motor behaviours that provide planning ideas for infant motor programs (Jackson et al., 2012). In terms of concurrent validity, Blanchard et al. (2004) comment that between the ages of birth and 13 months, the AIMS and Bailey Scales together with the Peabody Developmental Motor Scales-2 (see below) show high validity.

The Peabody Developmental Motor Scales

The Peabody Developmental Motor Scales-second edition (PDMS-2) is an independently standardized assessment tool covering both gross and fine motor development for children from 0 – 6 years of age (Folio & Fewell, 2000). Along with assessing infant developmental progress, the PDMS-2 is widely used to detect motor restrictions of children with disabilities and support clinical and educational interventions planning and follow-ups (Zanella, Valentini, Copetti, & Nobre, 2021). The assessment procedure involves collating a maximum score on three consecutive tasks in sequence until a zero or non-completion of task occurs, and the subscale testing is then concluded. Evaluations of gross motor areas can be divided into 0-11 months, and 12-23 months categories, with four more age divisions created up to 71 months of age (almost 6 years). The youngest category (0-11 months) includes the specific subscales tests of various stationary, locomotion and infant reflex movements (Folio & Fewell, 2000). The duration of the test procedure per participant can take between 40-60 minutes.

Connolly, McClune, and Gatlin (2012) reported a high or robust current validity correlation of a = .83 between the PDMS-2 Gross Motor quotient and the Bayley-III for infants aged between 6-12 months. Inquiringly, Fetters and Tronick (2000) observed that the AIMS tool produced more accurate sensitivity and specificity scores when infants were assessed at 7 months than the Peabody GMS, with Campbell and Kolobe (2000) reporting that the Pearson product moment correlation between the AIMS and the PDGM-2 was 0.99. Interestingly, the same correlation between the AIMS and BSID-III was 0.97.

Test of Infant Motor Performance

Test of Infant Motor Performance- TIMP is a criterion referenced measure designed to assess motor control and the organization of posture and movement for functional movements of both premature and term infants, up to age 4 months post birth (Majnemer & Snider, 2005). The TIMP is a sensitive, valid and also a predictive assessment tool that is used to assess typical motor development of younger infants and to predict future impairments, particularly those items that relate to and evaluate head control (Lee & Galloway, 2012). This tool measures 27 ‘spontaneous’ and 25 ‘elicited‘ items that are scored either present or absent (Majnemer & Snider, 2005). Campbell and Kolobe (2000) contend that the TIMP shows concurrent validity of r = .64 at 3 months adjusted age with the AIMS assessment program. These authors further commented that although both tests assess for postural control in young infants, the item content of each share little commonality due to

TIMP presenting infants with tasks to respond to whereas the AIMS items involve observing the infants spontaneous behaviour.

All four of these infant assessment tests are highly regarded by researchers and share both similarities and differences in the assessment of infant motor performances. They predominately involve observations although individual testing time varied from 20 minutes to almost one hour. TIMP is linked to appraising very young infants, with PDMS-2 evaluating infants motor development up to almost 6 years of age. The AIMS appears to share most consistent concurrent validity with these other widely used motor tests, particularly with BSID-III and PDGMS-2 and emerges as less strong with TIMP (Campbell & Kolobe, 2000).

CHAPTER 3: THEORETICAL CONTEXT FOR THE BAC-PROGRAM ACTIVITIES

The Baby Activity Chart-Program (BAC-Program) (see program attachment A to this PDF thesis) was created to support families by providing a variety of fun, tummy time and vestibular focused activities for infants from 6 weeks post term birth. Families are encouraged to interact with the four milestone focused divisions of thirty four activities, culminating when the infant is mobile, feasibly crawling on hands and knees.

The Design and Layout of the BAC-Program Format.

The BAC-Program format is designed to include a short Introduction and four subsequent milestone Sections. The Introduction section of the BAC-Program is depicted to inform parents and carers of the program's intentions and principles, outlining the natural progression of an infant's motor milestones. The specific movement sections within the booklet are selected according to the milestone progressions occurring over the infant's first 12 months, although there are varied views on the sequence order over this period. The following four progressions were selected to define the BAC-Program's sections: 1: Body awareness, head control and tummy time; 2: Rolling over 3; Commando (tummy) crawling 4: Hands and knees crawling (creeping). This selection of progressions was based on research studies that provide evidence to support this milestone sequence (Adolph, 2008; Gerber et al., 2010; Hadders-Algra, 2018; Kuo et al., 2008; Lopes et al., 2009; Malina, 2004; Nitsos et al., 2017; Touwen, 1975; Zachry & Kitzmann, 2011).

The BAC-Program focuses predominately on prone (tummy time) and vestibular activities and comparable infant motor programs were reviewed in the Literature Review (Chapter Two). An investigation of these similar prone and vestibular focused programs reveals a positive impact movement activities can have on early infant motor development (Hewson, 2011; Lee & Galloway, 2012; Lobo & Galloway, 2012). Parents and carers appear to vary in their awareness of the need to offer their infants daily tummy time, and a lack of confidence, knowledge and available activities may be influencing the often low recorded daily tummy time overall percentages (Ricard & Metz, 2014). In addition, parents and early childhood health professionals appear to be unfamiliar of the benefits of daily infant vestibular participation and the connection to develop infant responses to gravity, post birth head control and later balance and stability reactions (Phillips & Backous, 2002; Schreiber-Nordblum, 1995; Wiener-Vacher, Hamilton, & Wiener, 2013). The overall design and layout format selected for the BAC-Program is focused on simplicity of relevant motor information to support parent's knowledge and confidence to undertake movement activities with their infants to facilitate achievement of motor milestone development.

Introduction Section of BAC-Program

The Introduction section of the BAC-Program includes information for parents and carers to engage in age appropriate, selected activities and to be actively and confidently involved in their infant's motor development. Written text conveys information that infants are being presented with the opportunity/possibility to explore and reach the early movement milestones thus creating the foundation for physical, neurological and social development (Mendres-Smith et al., 2020). The Introduction also provides facts about the infant's brain development (Gerber et al., 2010) in relation to the prone rudimentary motor development stages including rolling over, commando crawling and crawling on hands and knees. Neurological terms including the brainstem, medulla, pons and midbrain are appropriately interspersed with more recognizable motor milestone expressions to provide additional background knowledge (Gerber et al., 2010). Parents and carers are reassured that it is not necessarily when or how quickly an infant reaches each milestone but more the general importance of experiencing these milestones (Hadders-Algra, 2018). The emphasis is to provide varied and fun activities to encourage and support the infant's natural individual progression through the rudimentary milestones. The BAC-Program was initially printed as an A3 chart (hence the word chart in the name) that could be hung above the infant's nappy (diaper) changing table. This was to remind and encourage parents to follow the activities during the frequent nappy changes with various movement actions becoming a daily occurrence. At a later stage, an A4 size booklet format was adopted to allow parents ease of carrying to different suitable places to undertake the activities. The Introduction also encourages parents to take the chart or booklet onto the infant's play floor spaces so that the specific floor activities could be readily practiced.

The Layout and Headings of the BAC-Program's Four Milestone Sections

The chart was designed to include 4 individually coloured milestone sections (BAC-Program copy attached to the Thesis):

- Section One: Body awareness; head control and tummy time is blue consisting of twelve activities.
- Section Two: Aware of my body and preparing to roll (over) is green consisting of nine activities.
- Section Three: Arms and legs are preparing to push/pull across the floor is purple consisting of ten activities.
- Section Four: Preparing to crawl on hands and knees across the floor is red consisting of eight activities.

Each section of the BAC-Program includes activities pertaining to the section's specific milestone theme with several activities appearing again in subsequent sections. The decision to reinclude certain activities relates to these actions having on-going important developmental contributions to the next motor milestone. Of the thirty four individual activities, five actions are repeated in subsequent sections of the program with a final total of thirty nine activities overall.

The BAC-Program has an initial milestone Section one (blue) that precedes actual locomotive prone milestones and is referred to as ‘body awareness, head control and tummy time’. Lee and Galloway (2012) suggest that head control is the first major non locomotive milestone emerging in the first few months of postnatal life with this development also crucial for subsequent later motor behaviours. Section one (blue) is designed for infants from six weeks to four months post term and includes relevant information regarding infants displaying important birthing and post birth primitive reflexes. Additional text placed next to this section’s headings, outlines how the Program’s activities can support the engaging and releasing (inhibition) of early reflexes, together with fun tummy time actions to encourage infant head control and body extension. Additionally, early infancy reactions including head righting, equilibrium and protective responses that are also observed post birth (Gerber et al., 2010; Haley, 1986) are acknowledged within BAC-Program activities. Specific activities were chosen to provide postural support for these infant head aligned reactions.

The primitive reflexes that are the main focus within the BAC-Program include the Crawling reflex, the Moro reflex, the Asymmetrical Tonic Neck Reflex (ATNR) and the Tonic Labyrinth Reflex (TLR). The newborn crawling reflex can also be grouped under ‘locomotive reflexes’ (Gabbard, 2012) as well as within the primitive/survival reflexes category. Forma et al. (2019) and Hym et al. (2021) suggest that this early crawling action is not only spinally-mediated but may also be controlled via supra spinal control (input from brain/brainstem to process the stimuli) that initially drives the newborn towards the smell (olfactory stimuli) of mother’s breast milk at birth.

Generally, the primitive reflexes that are the focus within the BAC-Program are beginning their decline in intensity beginning around three months post term birth (Malina, 2004). Voluntary motor actions and early milestones begin to emerge around three to six months of age starting with rolling over from prone to supine position or from supine to prone (Monson et al., 2003). This action features in Section two (green) of the BAC-Program.

Section two (green) of the BAC-Program is targeted at infants from approximately four to seven months of age and focuses on the first voluntary milestone: rolling over. Many of the emerging voluntary motor movements have large variation of appearance within the first 18 months post birth (WHO Multicentre Growth Reference Study Group & de Onis, 2006) with attainment being very specific to each infant. The actual acquisition of each motor milestone consists of a course of movement sequences with these patterns generally uniform in appearance (Adolph et al., 1997; Malina, 2004). The sequences begin initially as a ‘first change’ as the infant experiments with each new milestone action. Over time the action becomes more practised and the skill reaches a ‘final change of a milestone’s response’ (Touwen, 1975). Thus, there is a time frame discrepancy between the appearance of a specific movement milestone and the final skill acquisition, both between individual infants and within the movement milestone. The implication is that a previous milestone lays down the foundations for subsequent motor skills (Hadders-Algra, 2018; Touwen, 1975; Yamamoto et al., 2021).

The remaining sections of the BAC-Program include Section three (purple) focusing on commando crawling, and progressing to the Section four (red), namely hands and knees crawling. Hadders-Algra (2018) summarizes that developing infants may switch forward and back between commando and hands and knees crawling, indicating that this progression is an expression of individual infant milestone variation.

The BAC-Program includes thirty-four original activities within the four milestone developmental sections. Each of these activities consists of visual, professionally drawn sketches or diagrams of infants performing the particular actions, accompanied by a step-by-step written instruction of how to prompt or perform the action with an infant. There is also a detailed explanation under the additional heading ‘Why’, outlining in simple wording the neurological principle behind each action.

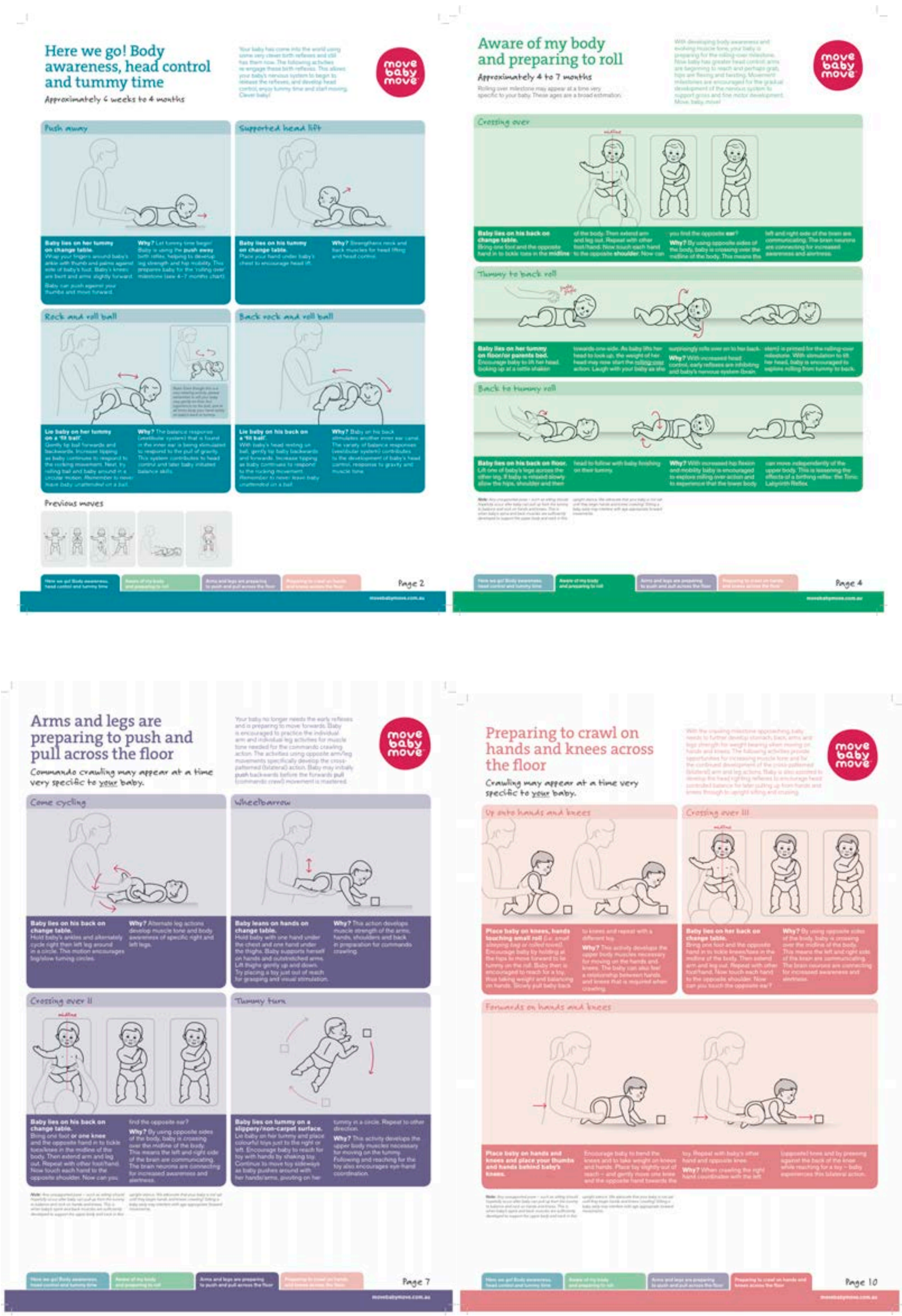


Figure 3. 1 Examples of sketches of specific activities from each of the four coloured sections within the BAC-Program.

This design was chosen to meet the aims of the BAC-Program where parents and carers are firstly introduced through diagrams or sketches to various fun tummy and vestibular activities to encourage infant motor milestone progressions. Secondly, the information text snippets were included to provide parents and carers with knowledge regarding the infant's nervous system responses within each of the thirty four actions. Studies have shown that parents of infants in the first 12 months are often sleep deprived, anxious to parent correctly, adapting to new life routines and managing differing infant dispositions (Feldman, Greenbaum, Mayes, & Erlich, 1997; Kennedy, Gardiner, Gay, & Lee, 2007). Therefore, the BAC-Program format presents clear sketches, with well-defined action descriptions together with short neurological explanations (Why) to cater for the parents of young infants.

Theoretical Structure Underpinning Selection of the Movement Activities

Each of the thirty-four activities was analyzed before selection according to the prone and vestibular emphasis of the BAC-Program. An overall theoretical structure and configuration was created before printing the program on the assumption that early brain experiences are fundamentally linked with the infant's motor development (Als et al., 2004; Hadders-Algra, 2018; Horak, 1991). A comprehensive approach encompasses the consequence of sensory input and motor output, vital early infant reflexes, the brainstem activity through to the cortex growth together with the integration of the 'systems model' including the task and goals of the motor skills within the infant's environment (Adolph & Franchak, 2017; Gieysztor et al., 2018; Thomason et al., 2018). In support of this approach, the Pyramid of Learning model (Williams & Shellenberger, 1996) (see Figure 3.2), provides a comprehensive visual interpretation. This model outlines the relationship between the central nervous system together with the specifically focused sensory systems, sensory motor development, reflex maturity (maturity and elimination of the primitive reflexes) and bilateral body awareness stages.

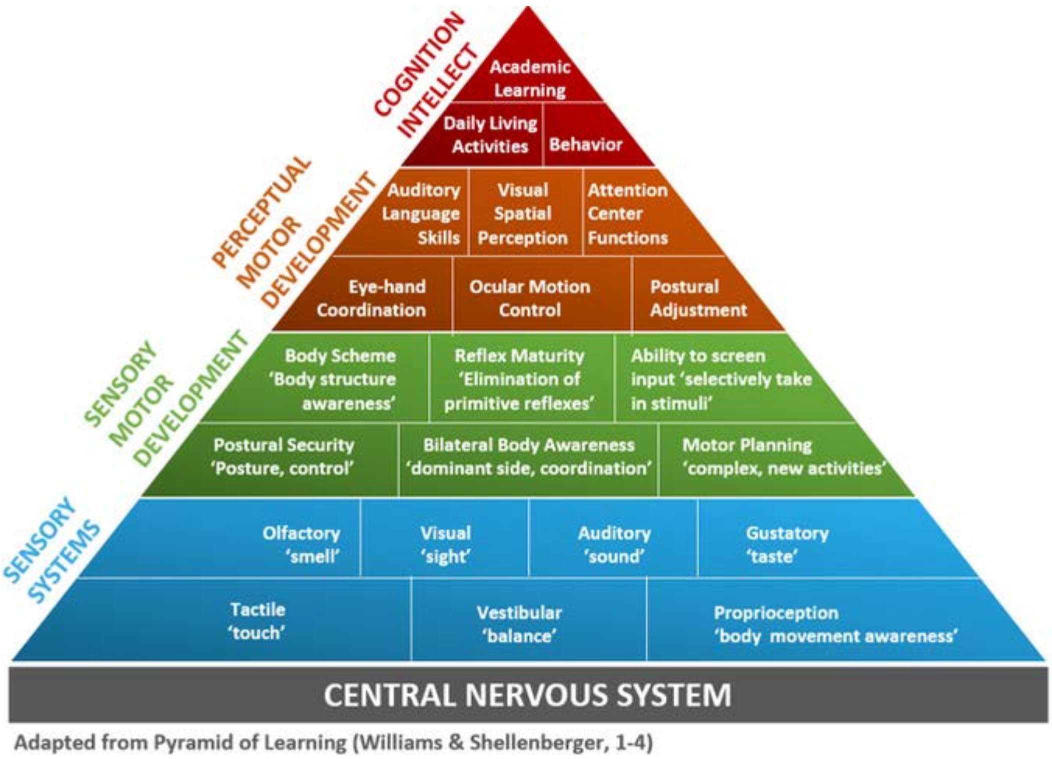


Figure 3. 3 Adapted from Pyramid of Learning (Williams & Shellenberger, 1996)

Cascio (2010) outlines that the content within the Williams and Shellenberger pyramid presents a theoretical developmental hierarchy for the sensory structures providing a schema to integrate the sensory, cognitive and behavioral systems that are appropriate for sensory integration programs. Kurniawati, Mustaji, and Setyowati (2018) comment on the importance of the specific connection required within each stage of the Williams and Shellenberger pyramid model, emphasizing the sensory, motor and gross (perceptual) motor stages that link to support the infants' central nervous system journey towards cognitive development.

Consequently, the BAC-Program structure was shaped by the Williams and Shellenberger pyramid, with this doctoral infant movement program's overall objectives focusing on *infant core muscle and neurological response classifications or elements* that are essential to milestone acquisition. Therefore, the following four central elements of the 'infant core muscle and neurological responses' (a-d) were adopted and scrutinized to ensure that each of the four BAC-Program sections included activities focusing on these elements and consequently meeting the aims of the program: These elements include:

a: Prone actions (tummy time) including head control, muscle tone/core strength, muscle flexion and stretch in supine positions

b: Sensory: vestibular, tactile, proprioceptive, visual systems.

c: Primitive reflexes: maturity and inhibition: (Crawling, Moro, ATNR, TLR).

d: Bilateral actions: crossing the midline of the body.

Malina (2004) supports a corresponding connection between the four central elements and outlines that the infant's central nervous system evolves in parallel development between the brain, the spinal cord, and the sensory systems, underpinning infant motor development. Table 1 presents each of the four BAC-Program sections that are cross checked against the four 'infant core muscle and neurological responses' central elements.

Table 3.1:
The four BAC-Program Milestone Sections with corresponding numbered activities

Central Elements: ***'infant core muscle and neurological responses'***	**Section one** **(blue)** 'Body awareness Head control Tummy time' *Numbers specific to 12 overall activities within first BAC-P section*	**Section two** **(green)** 'Aware of my body Preparing to roll' *Numbers specific to 9 overall activities within second BAC-P section*	**Section three** **(purple)** 'Push and pull across the floor' *Numbers specific to 10 overall activities within third BAC-P section*	**Section four** **(red)** 'Preparing to crawl on hands and knees' *Numbers specific to 8 overall activities within fourth BAC-P section*
a: ***Postural control***				
a1: Prone/tummy time	5, 6, 7, 11, 12	2, 4, 7	2, 4, 5, 8	1, 4, 6
a2: Head control	5, 6, 7, 11, 12	2, 5, 6, 7, 8	4, 6, 7	4, 8
a3: Muscle tone and core strength	5, 6, 12	3, 5, 8	1, 2, 4, 6, 8, 9	1, 3, 4, 6, 8
a4: Supine Flexion/stretch	1, 2, 3	1, 3, 6	1, 3, 7	2
b: ***Sensory systems***				
Vestibular	7, 7a, 8, 9, 10	4, 5, 6, 7,	7, 8, 9, 10	4, 5, 6, 8
Proprioceptive	1, 2, 3, 5, 6	1, 3, 6, 8	2, 6, 7, 8, 9	3, 4, 6, 8
Tactile	4, 7, 8, 10	2, 3, 4, 5, 6, 9	3, 4, 5, 7, 8, 9, 10	1, 2, 3, 6, 7
Visual	8, 9	4, 5, 6, 7, 8	2, 4, 6, 7, 9, 10	1, 3, 4, 6, 7, 8
c: ***Primitive reflexes***				
Crawling motion	5	6	7, 8, 9	0-reflex usually weakened
Moro	8, 9,	5, 6, 8	7, 9, 10	0-reflex usually weakened

Asymmetrical Tonic Neck (ATNR)	1, 2	1, 2, 3,	3, 4	0-reflex usually weakened
Tonic Labyrinth (TLR)	6, 7, 8, 9,	4, 5, 6	7, 8, 9, 10	4 TLR- forwards usually weakened TLR - backwards still responding
d: ***Bilateral actions***				
Crossing across the midline of the body	2	1	1, 5, 3, 10	2, 3 2

Part 1: The BAC-Program Section One Correlating to the Central Elements:

BAC-Program's Section one blue (discussed below) presents a theoretical analysis of each of the twelve selected activities. This breakdown reinforces the overall developmental and neurological theory (Williams & Shellenberger, 1996) in relation to the 'four central elements' (a-d) within **infant core muscle and neurological responses** (column one in Table 3.1): These elements are **a:** ***prone actions:*** **b:** ***sensory systems:*** **c:** ***primitive reflexes:*** **d:** ***bilateral actions.***

Consequently, within the subsequent chapter headings concerning the remaining three BAC-Program Sections namely 2, 3 and 4, only the activities specific to the actual motor rudimentary milestones (rolling over, push/pull commando crawl, hands and knees crawl) will be described and analyzed in detail. This is to prevent duplication as many movement similarities are included across all four program sections and dissected in detail in the Section one blue analysis below. These similarities occur as many of the neurological development underpinnings still apply in varying degrees to infant development over the first twelve months. The BAC-Program caters for infants from 6 weeks post birth and journeys through to the hands and knees milestone generally achieved at any age from six to eleven months and beyond. As the infant grows in physical size, strength and brain maturity over this period, the similar activities within the BAC-Program are clarified, modified and adapted to cater for these major changes. Prone activities and primitive reflex inhibition are largely the focus in Section one (blue) and two (green), with additional muscle strengthening, bilateral and body awareness focusing in Sections three (purple) and Section four (red). The sensory systems category features strongly within all four milestone sections with vestibular, proprioceptive, tactile and visual activities prominent throughout. The visual system is more clearly featured in Sections two, three and four due to the developing infants' visual ability to track, focus and to grasp toys within the varying movement activities.

Section One (blue): 'Body Awareness, Head Control and Tummy Time'.

Section one (blue) of the BAC-Program contains twelve activities (see Table 3.1). It includes greater concentration in the prone/tummy time and head control elements in comparison to designated activities with the other three BAC-Program sections. This outcome is due to the more specific focus within this section on activities to promote tummy/prone time for very young infants. The Section one (blue) also focuses on sensory systems vestibular actions and primitive reflex stimulation and inhibition, with only one bilateral and midline movement. Specifically, this section correlates to infants aged from six weeks to approximately four months of age post term birth. Several prone and postural research programs have recruited infants participants aged from 4- 8 weeks post term reinforcing the support for introducing infants to prone positions at very young ages (Hewson, 2011; Lee & Galloway, 2012; Lobo & Galloway, 2012).

At six weeks post term birth, the infant is beginning to experience slightly longer awake times with the infant's body continuing to produce General Movements (GMs) that originated in utero and less time in whole body flexion (Hadders-Algra, Van den Nieuwendijk, Maitijn, & van Eykern, 1997). These GMs occur when the infant is placed in supine positions, vary in sequence and complexity and are generally rapidly occurring. They involve arm, leg, trunk and neck movements and evolve into slower, smaller fidgety GM's around 9 weeks post term (Snider, Majnemer, Mazer, Campbell, & Bos, 2008). Both GMs and fidgety GMs differ in observation from infant primitive reflexes as the nature of these former supine actions are more spontaneous, varied, whole body motions and with more complexity when compared to the more specifically survival stereo-typical, sensory elicited prone primitive reflex patterns (Zafeiriou, 2004). Selected BAC-Program primitive reflex activities focus more specifically on adopting inhibiting (integrating) mirror actions of these reflexes thus preparing and facilitating the infant during the first months to respond to and move against gravity. The resultant overall reflex integration actions encourages the nervous system to proceed from stem reflex to cortically controlled responses ensuring the progression to voluntary movements (Gieysztor et al., 2018).

Recent studies have produced important findings that an infant's progression to voluntary milestone movements is also very dependent on experiencing awake time in the prone position (Guidetti et al., 2017; Hewitt, Kerr, et al., 2020; Kordestani et al., 2006; van Vlimmeren et al., 2007). This positioning allows strengthening to head, arm and upper body muscles encouraging inhibition of the primitive reflexes, exploration towards the rolling over milestone and offsets the risk of plagiocephaly (van Vlimmeren et al., 2007).

To clarify the specific analysis of each of the BAC-Program's thirty four activities, a numbering system is included. This system for example 1/1 or 4/3, denotes that the first number refers to one of the sections of the BAC-Program's four sections. The second number refers to the actual activity's numerical placement within that section's pages. For example, 1/1 refers to 'open shut them' located in Section one blue and is activity one.

a: Postural control: Prone actions

Section one (blue) of the BAC-program has five prone/tummy time and head control activities with muscle tone and core strength of similar numbers. The selection of the following prone actions is to provide parents with fun tummy time activities that infants respond positively and willingly to and find less challenging thus supporting the parents to undertake daily tummy/prone actions. The first prone activity appears on page two of the program with the 'push away' activity 1/5. This action incorporates placing the infant in a more traditional or commonly accepted tummy time, on the floor pose. The text accompanying the diagram outlines the parent placing their thumbs to the sole of the infant's foot whilst baby's knees are bent and arms slightly positioned forward. This action stimulates a naturally occuring crawling reflex with the infant reflexively pushing against the force and moving forward. The aim of this activity is to activate the infant's 'crawling reflex/action' as the effort produces leg flexion and extension (Forma et al., 2019) and allows the repositioning of the infant's feet in a flexed pose with toes pushing when in contact with a firm surface (Hym et al., 2021). The adjacent 'why' explains that the 'push away' reflex action can assist the infant to develop leg strength and hip mobility. The reflex action is outlined in more detail in the primitive reflex section (3.3.1.c). This first prone activity is quite detailed so the following four prone/tummy time activities appear more simple and basic aiming to further support parents and carers confidence to undertake tummy time actions with very young infants. The text for 'supported head lift' 1/6 proposes that the parent place their hands under the infant's chest supporting and encouraging the infant to lift their head. The 'why' section outlines that this action strengthens the infants neck and back muscles for head and neck control (Lopes, 2009). Prone ‘rock and roll ball’ activity 1/7 places the infant in the tummy time position but on a soft ‘fit ball’, allowing the gentle tipping/rocking action to perhaps distract the less tummy time keen infant, whilst enabling small head and neck lifts.

The ‘why’ mainly summarizes the vestibular influence but also includes the ‘prone’ linking words: head control. Activity 1/11 diagram describes the head and neck support that the infant receives in this prone position whilst the parent holds and carries in the ‘rugby ball hold’ pose. The accompanying text outlines that this prone postion can be modified according to the infant’s confidence and subsequent neck strength. The ‘why’ describes the terms: head control and body extension in the endeavour to develop parent’s prone positioning knowledge and to foster motivation to continue to experience new tummy time actions. The prone ‘up and down feeling’ activity 1/12 again allows varying support for the infants chest whist this time lying across parent’s legs. This jiggling up and down action again distracts the infant thus increasing tummy time enjoyment with the ’why’ reiterating with the terms: strengthens neck and back muscles.

Finally, within this first central category of the ‘infant core muscle and neurological responses’ namely a: postural control is the inclusion of the three *supine flexion and stretching actions*. These include ‘open shut them’-1/1,’meet in the middle’-1/2 and ‘knees up’ 1/3 are important additions to Section one (blue) as they allow the very young infant to experience extension and stretching of both upper and lower limbs after experiencing the flexion positon prebirth (Cameron, Maehle, & Reid, 2005). The three activities will be outlined in more detail below in the ‘infant core muscle and neurological responses’ elements: proprioceptive sensory system, primitive reflex- ATNR and the bilateral actions.

b: Sensory Systems.

Newborn infants' sensory and motor systems are dependent on interpreting the incoming sensory information as they journey towards postural control and motor milestones (Dusing, 2016). Newly acquired movements are modified by sensory input and Graven and Browne (2008) suggest that the sensory systems develop in close association with critical sensory stimulation and motor experiences both contributing to enhance infant neurosensory development. Several sensory systems work together to achieve the proficient processing of sensory information with Miller et al. (2009) highlighting that pooled sensory stimuli assist in attaining and maintaining responses to complement motor development including vestibular, proprioceptive, tactile and visual activities. Celik, Elbasan, Gucuyener, Kayihan, and Huri (2017) similarly collate the proximal sensory systems (vestibular, proprioceptive and tactile) as instrumental in the development of infant postural control and movement coordination. Furthermore, Mauer (1999) outlined that these particular senses are essential to add meaning to sensations and purpose to movement. The visual sensory system is particularly involved with stabilising infant gaze during head movements and is a critical component due to its complementary collaboration with the proximal senses namely vestibular, tactile and proprioceptive to support the body to achieve upright balance (Kushiro, 2012; Miles, 2018; Rosander & von Hofsten, 2000). There is reasoning to focus on these four targeted sensory systems in the selection of BAC-Program activities. Consequently, the program's section one blue presents five vestibular determined activities, four movements have a tactile emphasis, five movement emphasize the proprioceptive sense and three have a visual emphasis.

Vestibular Sensory System

This sensory system is one of the main focuses of the BAC-Program being a critical but not highly understood purveyor to an infant's motor development (Chorna et al., 2014;

Schreiber-Nordblum, 1995). Le Gall et al. (2019) outline that vestibular sensory perception contributes crucially to sensorimotor function in the early stages of development. The peripheral vestibular organ consists of three dimensional semi-circular canals namely lateral (horizontal), anteria and posteria which respond to angular acceleration thus detecting rotational movement in their specific plane located, and all organs located within each ear (Khan & Chang, 2013; Wiener-Vacher et al., 2013).

Accordingly, the otolith organs (saccule and utricle) are also located within each ear and react to linear acceleration. This linear term refers to changing head position or head tilt in reponse to gravity with the saccule sensitive to upright head tilt and the utricle sensitive to horizontal (lying down) head tilt (Khan & Chang, 2013). Both of these inner structures link up via a vestibular nerve to the brain stem and the cerebellar pathways with the thalamus relaying this multi modal information to the cortical network (Cronin et al., 2017; Dieterich et al., 2003; Hwang et al., 2017). The vestibular organ is mature four months post conception and is functional at birth (Cronin et al., 2017; Le Gall et al., 2019). It is also integral in the process of the birthing infant being positioned head first in the birth canal thus preparing for the delivery process (Roizen, 2009). Consequently, the newborn, previously cushioned within the intrauterine fluid medium now relies on the responses of the vestibular sensory receptors to adapt to the effect of gravity (Nandi & Luxon, 2008).

As this vestibular organ has five functioning structures with each detecting different movements whether rotational, lateral/anteria/posteria accelerations or linear vertical/horizontal responses to gravity, there is an emphasis in the BAC-Program to select vestibular actions to cover all divergent factors. In Section one (blue) of the program, the first vestibular action does not begin until page two with activity ‘rock and roll ball’ 1/7. This subsequent positioning was preferred as many families and community health care professionals are unfamiliar with many vestibular actions and also unaware of the importance of daily vestibular activities relating to infant motor development (Le Gall et al., 2019; Schreiber-Nordblum, 1995; Wiener-Vacher et al., 2013).

Introducing these actions on the lower half of page 2 of the program enables the parents and carers to initially interact on page one with more simple and family friendly supine activities. Also, the first vestibular focus in 1/7 has a clear tummy time emphasis in the diagram/sketch and the step by step instructions are written to subtly introduce tipping the infant forwards. The balance response (vestibular system) is then introduced in the adjoining 'why' text. The 'rock and roll ball' focuses on linear acceleration, and gravitational pull with an arrow depicting forward and backward motion. This action tilts the head forward with any accompanying head lift thus stimulating the inner ear's otolith organs. The 'why' section also outlines that the inner ear is stimulated and responds to the pull of gravity, connecting to infant head control and later balance.

Activity 1/7a is found in the corner of activity 1/7 (un-named) with the diagram containing arrows depicting cicular motions. This activity is chosen to activate angular acceleration of the semi-circular canal, possibly the lateral (horizontal) canal. The 'back rock and roll' 1/8 action produces linear acceleration, activating a response to gravity and also inducing muscle tone reactions.

Similary the 'tip back' 1/9 produces a parallel vestibular otolith reaction to 1/8 although the 'Why' text outlines that this action is developing the infant's body awareness (baby is upright or tipped upside down).

The vestibular focus continues with activity 'side to side rug' 1/10 with a swaying or swinging action whilst the infant is placed supine on a baby rug. Two swaying actions are suggested- side to side (angular- perhaps posteria and anterior) and forward and back (linear) thus stimulating numerous peripheral vestibular organs. Smith-Roley, Singer, and Roley (2016) support the act of swinging and moving infants through space as these actions engage vestibular inputs, assisting and improving overall sensory motor coordination.

Proprioceptive Sensory System.

The proprioceptive sensory system is described as a response to muscle force, effort, joint position and movement (Taylor, 2009). These responses strengthen the neural connections assisting the motor control areas necessary for locomotion (Sisk, 2019). The proprioceptive sense is activated through the musculoskeletal system to provide awareness of where the body parts are, with this sensory system appearing to show faster adaption after supportive exercises (Aksoy & Bursa, 2018; Smith-Roley et al., 2016).

In the Section one (blue), the first of the five proprioceptive determined activities begins with ‘open shut them’ 1/1 (also classified under the flexing and stretching category: Postural control). The early post-birth infant may still be in a slightly flexed posture and is described in the ‘Why’ section of this activity. This same limb action of arms moving out and in encourages extension together with a proprioceptive resistance response to this muscle force.

Similarly, opposite limb action ‘meet in the middle’ activity 1/2 responds with crucial flexing and stretching. Sisk (2019) also confirms that cross patterning hand to opposite knee action activates segmental spinal cord components whilst also providing proprioceptive inputs to the motor cortex. The ‘why’ text simply outlines the value of connecting opposite sides of the body parts together with the two hemispheres of the brain.

The third activity in this sensory system, the ‘knees up’ 1/3, equally contributes proprioceptive resistance together with awareness of the lower limbs body parts. In the ‘push away’ 1/5 proprioceptive action, the infant is actively encouraged to apply force with the feet against the parent’s hands, encouraging leg strength and hip mobility. The ‘why’ links up the stretching and flexing action to beginning infant leg awareness. An explanation is outlined for parents and carers adjacent to the diagram of 1/5 in the “why’ text section with the infants participation described as the result of the reflexive push (discussed in primitive reflex category below).

The ‘supported head lift’ 1/6 activity encourages muscular effort as the infant seeks to lift the head and neck, shoulders and back joint positions, thus activating the proprioceptive sense to respond to promote muscle and ligament strength.

Tactile Sensory System.

The tactile sense is very well developed at birth, being one of the first sensory systems to develop in utero (Marcus et al., 2012). The tactile sensory action offered post birth, provides the infant with valuable touch sensations, stimulating tactile receptors in the skin. Early infant stimulations include hand stroking and brushing, together with soft, hard and rough textures (Cascio, 2010).

Applying a hand massage approach is observed in activity ‘body awareness massage’ 1/4 with a sequence from head/neck, arms, torso, legs, and back. The ‘Why’ text describes the contribution of this action to body awareness together with the infant experiencing the body as separate parts and as a whole. Yunus, Liu, Bissett, and Penkala (2015) report that tactile-based interventions are commonly used in reducing childhood behavioural issues and the BAC-Program tactile massage activities are also focused on contributing to infant well-being and body awareness. The specific tactile contact occurs with the infant’s back and tummy connecting with the ‘fit ball’, and with the rug/blanket, contributing to tactile stimulation. The numerous sensory modalities inputs from multiple sources within the BAC-Program including tactile and vestibular, combine together for effective sensory processing and integration in early motor development (Chuang & Kuo, 2016).

Visual Sensory System

The impact of the visual inputs is very closely aligned with the vestibular system as this later sensory system, particularly the pull of gravity, can influence the stability of the infant’s head and neck movements, thus affecting visual eye tracking. Responses from the vestibular receptors are received in the Vestibular Ocular Reflex (VOR) within the brainstem, thus prompting infant eye movements and providing spatial information and perception (Kushiro, 2012). Due to this close sensory connection there is an assumption that visual stimulation is being activated and effected through the BAC-Program’s many vestibular activities. The program did not include specific eye tracking activities due to the very young ages of the participants. The actual activities denoted with a visual focus include ‘back rock and roll ball’ 1/8 and ‘tip back 1/9. There is no text reference to any visual impact on the infant although the diagram/sketches have deliberately positioned the adults head and neck to be angled slightly forward in line with the infant’s eyes. This visual connection is also for reassurance between parent and infant to encourage communication through eye contact during the movement actions (Farroni, Csibra, Simion, & Johnson, 2002).

There appears a requirement in future BAC-Programs editions in Section one blue activity 1/3-‘knees up’ and 1/9-‘tip back’ to include a drawn arrow between the adult’s tilted head and the infant’s face to denote this eye contact aspect. Incidentally, Section two green has activity 1/8 (‘pull up’) with arrows directed from the infants eye path towards the parents face and eyes. Finally, these actions do encourage near and far infant visual stimulation as the gentle rocking or tipping occurs, towards and away from the parent's face.

c: Primitive Reflexes

The four primitive reflexes (Crawling, Moro, ATNR, TLR) that are identified in the BAC-Program are active in utero and at birth (Capute et al., 1984; Malina, 2004; Sekulić et al., 2009; Zafeiriou, 2004). To varying degrees these reflexes have assisted in the birth process and are also activated by the birth process (Berne, 2006; Pecuch et al., 2020). It is important to continue to activate these reflexes post birth and this is achieved with activities selected mirroring the reflex actions (Bilbilaj et al., 2017). This physical activation together with sensory stimulation supports the maturation (peak) and then the inhibition (fading) of the primitive reflexes within the infant's nervous system. The procedure concedes a lessening of the stimulus reactions over the 6-12 months post birth period (Melillo, 2011).

In the Section one (blue), parents and carers are gradually informed that their 'baby came into the world using very clever reflexes and still has them now'. The text begins the information regarding the reflexes and is then linked to the activities with the sentences 'the following activities re-engage these birth reflexes'…. and 'allow the baby's nervous system to begin to release the reflexes to develop head control'……..'. This script is presented both to inform parents that early reflexes exist and to reaasure families to engage in the following head control activities whilst enjoying tummy time. The Section one heading wording is carefully scripted to reinforce the importance of this first section's activities and the impact they can have on the infant developing body awareness and head and neck strength.

Generally, all the thirty four BAC-Program activities include the 'why' text section to provide simple explanations behind the neurological principles. Although there are nine activities within Section one blue designated as influential in activating and inhibiting the four mentioned reflexes, a decision was made to only reference reflex information to one activity. The 'why' text next to activity 1/5 'push away' (crawling reflex) includes a small comment that the push away *reflex* helps to develop leg strength and hip mobility. To include additional specific neurological knowledge within the other eight activities seemed to be an information overload for new parents and carers (Nordhov et al., 2010). The actual information included in the 'why' text focuses more on the vestibular responses in activities 1/8 and 1/9 (Moro reacting); stretch and flexion in activities 1/1 and 1/2 (ATNR inhibiting); and more strengthening and vestibular actions within activities 1/6, 1/7, 1/8 and 1/9 (TLR reacting).

Crawling Reflex

The BAC-Program activities that are recorded in the Primitive reflexes elements begin with the 'push away' activity, 1/5. The aim of this activity is to activate the infant's 'crawling reflex (pattern)' as the action produces leg flexion and extension (Forma et al., 2019) when pressure is applied to the plantar area of the infant's foot (Sekulić et al., 2009). Therefore, a reflexive reaction is elicited, and the text describes the parent placing their thumbs to the sole of the infant's feet, with knees bent and arm slightly forward. This action supports leg strength with the very young infant reflexively moving forwards in the prone position, albeit in slightly jolting motions. In certain conditions this crawling motion may be coordinated with the arms if the infant is able to lift their head and chest, freeing the arms to propel forwards together with the legs (Forma et al., 2019; Hym et al., 2021). The 'push away' activity has prone, muscle tone and proprioceptive components and is included in three different 'infant core muscle and neurological elements' categories in Table 3.1.

Moro Reflex

The Moro reflex has two focused activities within Section one (blue). The supine 'rock and roll ball' backwards and the supine 'tip back' activities-1/8 and 1/9 both enable the infant's head to be tipped backwards. Lowering of the infant's head backwards elicits the Moro reflex, whereby the arms and legs reflexively stretch out from the normal flexed position, then returning beside the body thus inducing and stimulating muscle tone (Bilbilaj et al., 2017; Goddard Blythe, 2002; Sohn et al., 2011). If the Moro is retained into childhood, poor balance and coordination may be observed (Pecuch et al., 2020). Research indicates that the Moro reflex is generally strongly elicited with an activated vestibular nuclei that is located in the medulla and pons section of the brainstem (Futagi et al., 2012).

Asymmetrical Symmetrical Tonic Neck Reflex

Activation of the Asymmetrical Tonic Neck Reflex (ATNR) is observed in two activities in the Section one (blue), namely 'open shut them' 1/1 and 'meet in the middle' 1/2. It is worth commenting that these activities do not purely elicit the ATNR as this action is required by gently turning the infants head to the side. This reflexive response produces the same sided extension of the infant's arms and legs, with the opposite limbs flexing (Chandradasa & Rathnayake, 2020; Zafeiriou, 2004). Although the ATNR is an asymmetrical or one sided posture, inhibition can still be supported with certain symmetrical movements as symmetry can counteract the asymmetry of this reflex (Goddard, 1995).

Activity 1/1 is included as a reflex activation as it promotes the arms moving together 'out then in' symmetrically in extension and flexion. The action 1/2 'meet in the middle' also lessens the asymmetrical reaction of the ATNR with the opposition limbs (left hand to right knee) touching in-line with the infant's vertical midline (Bilbilaj et al., 2017).

A retained ATNR may keep the body more lateral (single sided) than bilateral thus affecting eye tracking and later handedness skills, with difficulty encountered when crossing both the visual and overall body midlines (Dusing, 2016; Gieysztor et al., 2018; Pecuch et al., 2020). In development, contra or bi-laterality activities support the nervous system's sensory and motor fibres when crossing the midline within the cortex, brainstem and spinal cord affecting a variety of motor and coordination skills (Carlier et al., 2006 ; Doyen et al., 2017; Ocklenburg et al., 2016; Whitehead & Banihani, 2014).

Tonic Labyrinth Reflex

The Tonic Labyrinth Reflex -TLR which is linked to four Section one (blue) activities specifically 1/6, 1/7, 1/8, 1/9. This reflex has a similar response to the Moro reflex particularly when the infant's head is positioned backwards although there is also a forward head response elicited also denoting the TLR reaction. The TLR response firstly appears with a noticable extension of the infant's entire body when in a supine position with arms extended out slightly lower than in the Moro. The lower limbs visibly straighten when the head is tipped backwards below the same level as the spine (Accardo & Barrow, 2015). The flexed TLR response activated in either the supine or prone position, occurs when the infant's head tilts forwards, with the arms and legs curling inwards. This position mirrors an infant's posture often observed when in the mother's womb (Goddard Blythe, 2005). The TLR forward can be activated especially when the infant's head lift tires and drops forward eliciting a more curled or flexed posture.

As mentioned in the Moro reflex section, supine activities 1/8 and 1/9 involve backwards tipping of the infant with the former activity on the 'fitball' –'back rock and roll' and the latter activity 'tip back' with the infant held in the parent's arms. These activities induce the infants body to extend increasing muscle tone. Goddard Blythe (2005) reports that it is important for the infant to experience opportunity in both supine and prone positions to ensure head control develops especially in this horizontal plane to support the rolling over milestone. An additional gentle head lift backwards occurs in the prone position in 'supported head lift' activity 1/6 that also elicits an extension posture. This activity is more focused on prone time with head lift and head control although the TLR reflexive extension response can also assist the infant head lift.

The TLR (forwards) is activated in prone activity 1/7 with the infant tipped forward in 'rock and roll ball'. Activity 1/7 both supports prone time, vestibular and TLR forwards reaction. Goddard Blythe (2002) proposes that the TLR is the infant's first mechanism to respond to gravity (pre head righting reactions) after birth. Therefore with suitable head lifting activities particular in the prone position, the infant begins to gain more control against the TLR allowing strengthening of the neck muscles together with upper trunk and overall body muscle tone (Gieysztor et al., 2018). Chandradasa and Rathnayake (2020) and Pecuch et al. (2020) outline that a retained TLR induces poor balance and difficulty with over head ball tracking skills in later childhood.

d: Bilateral Movement Actions.

Bilateral actions in the Section one (blue) includes only one activity being 'meet in the middle' 1/2 that is also mentioned in the primitive ATNR reflex segment. This action involves bringing one of the infant's hands in to touch the flexed opposite knee at the midline of the body then both limbs are extended out. The 'why' outlines the significance of moving opposite sides (arms and legs) of the infant's body and the link to the slowly emerging brain's left and right hemisphere's communication at the infant's midline (Melillo, 2011). Regarding bilateral actions, Section three (purple) 'push and pull across the floor' and the Section four (red) 'preparing to crawl on hands and knees' together include four and three bilateral activities respectively. Section one (blue) due to the young age of participants, contains only one bilateral activity. These later BAC-program sections focus on major locomotion milestones that are very bilateral or opposite arm/leg limb dependent. If the lateral sided ATNR is retained it creates difficulty with crossing the body's midline, forms left right confusion affecting the bilateral or cross lateral coordination required in the crawling milestones (Gieysztor et al., 2018). The brain's two hemispheres appear almost identical although the neuronal networks are distinct within each allowing for specialization of function (Halpern et al., 2005). Hence bilateral actions activate these neural networks within each hemisphere and stimulate passage across the brain's midline or the corpus callosum.

Part 2: The BAC-Program Sections 2, 3, 4 Correlating to Central Elements: a-d.

The Table 3.1 outlines the BAC-Program milestones sections with detailed corresponding numbered activities against the 'Infant core muscle and neurological responses' central elements. The following sections will analyze the remaining three BAC-Program sections: namely Section 2 (green), 3 (purple) and 4 (red), presenting a more general and condensed coverage of each the remaining twenty seven activities within the Table 3.1's muscle and neurological elements .

Section Two (green): 'Aware of my Body and Preparing to Roll'.

The section depicts a more edited focus on the BAC-program 's Section two (green): 'Aware of my body and preparing to roll. The focus is on the rolling over prone milestone and the related activities. This generalized approach will alleviate duplication as many of the four main muscle and neurological components are already discussed above. The suggested age range for this sector is for infants from 4 -7 months. The emergent of this first locomotive milestone initially occurs with the infant rolling from the prone to supine pose, then progressing to rolling from supine to prone position (Robertson, 2011; Shumway-Cook & Woollacott, 2007) This initial propulsion sequence is regularly reversed (Jantz et al., 1997; Salls et al., 2002).

The suggestion of the prone to supine sequence is based on the infant experiencing daily prone-tummy time combined with emerging head and neck control to enable the locomotive roll from front to back (Lenke, 2003; Majnemer & Barr, 2006). An infant's head is predominately large in relation to the total body length, perhaps one quarter while an adults head can be up to only one eighth of their body length (Burdi, Huelke, Snyder, & Lowrey, 1968; Forma et al., 2019). This proportionally bigger head, when lifted by the infant with adequate head and neck control, can initiate this prone to supine, propelling the infant into this rolling over action. If the infant spends awake time predominately in the supine position, growth in the flexor muscles exceeds growth in the extensor muscles, and when coupled with lack of head control, there may a delay in the rolling over milestone (Salls et al., 2002).

Rolling Over Targeted Activities

Section two (green) includes three specific and targeted 'rolling over' directed milestone activities specifically 2/2, 2/3, 2/8 within the nine activities presented.

The first rolling over directed milestone activities beginning with 'tummy to back roll' 2/2. This action entails placing the infant in the prone position. This activity text depicts the infant lifting up their head to look up with the activity's first diagram depicting a rattle being jiggled to attract the infant's attention. The adjacent diagram in 2/2 shows the infant's moving to the side lying pose position. Liddle (2004) suggests that this movement appears to be a 'falling' over action although contends that side rolling then becomes a controlled infant action. The final diagram in 2/2 portrays the body completing the roll over ending on the infant's back. A more fluid rolling action develops to become a single motion with hips and shoulders together as a 'log roll', and graduates to the 'segmented roll' milestone with practice and maturity (Capute et al., 1984; Shumway-Cook & Woollacott, 2007). The 'why' text suggests that with the infant's emerging head control, together with early reflexes now less reactive, the infant can begin to explore the rolling over movements (Lange-Küttner, 2018).

Rolling from 'back to tummy' (supine to prone) 2/3 was the next proposed milestone delineated activity in the green section two of the BAC-Program. The text outlines positioning the baby on the back and lifting one leg across the other leg (Liddle & Yorke, 2004). Adjacent diagrams in 2/3 shows the rotation of the hips then shoulders with the head to follow, slowly rolling the infant onto the tummy. The rolling action often begins as a roll without rotation graduating to a distinct turn motion with head and shoulders no longer aligned (Gabbard, 2012; Piper & Darrah, 1994; Shumway-Cook & Woollacott, 2007). The 'why' discusses that increasing hip flexion and mobility supports the baby to explore this rolling over action, allowing the infant to begin to experience the lower and upper body segments moving independently (Jantz et al., 1997; Piper & Darrah, 1994).

The remaining diagram in 'back to tummy' 2/3 shows the infant finishing in a poised and balanced prone position. The continued and practiced head lift whilst in the prone position can activate the TLR reflex to extend the body for back and neck muscle strength required for both rolling over milestone actions (Chandradasa & Rathnayake, 2020). The ATNR primitive reflex is still active (largely lessening between 4-6 months) and elicited in the supine when the infant's head turns sideway, subsequently extending out the same sided arm. This reflexive arm action can often interfere with the sideways roll over from supine to prone (Gerber et al., 2010; Goddard Blythe, 2002). The ATNR reflex is not described in the text of activity 2/3 in Section two (green). This decision was to keep this new rolling over action and text quite simple for parents and carers with the emphasis to develop confidence to practice this activity with their infant.

The final activity specific to supporting the rolling over milestone is ‘pull up’ movement 2/8. The text describes lying the baby on their back, perhaps on the change table, holding the hands as the infant attempts (with support) to participate with the pull up action. This activity is identified here as its objective is to develop infant neck and head control, arm strength and core muscles (outlined in the ‘why’ text) as all are fundamental to participating and exploring the roll over milestone in both directions (Liddle & Yorke, 2004).

Rolling Over Related Activities

The remaining six activities also relate to the ‘rolling over’ action but the focus of these are more generally linked to the central elements of ‘infant core muscle and neurological responses’ (Table 3.1). These additional six activities (2/4, 2/5, 2/6, 2/7, 2/8, 2/9) within Section two (green) may occur in more than one central element category as they often include several core/ neurological components. These four elements with specific activity numbers according to appearance in the BAC/program sections include:

- *postural control- prone, muscle tone and flexibility*

  2/4, 2/5, 2/6, 2/7

- *sensory systems*

  vestibular 2/4, 2/5, 2/6, 2/7

  proprioception 2/6, 2/7

  visual 2/4, 2/5, 2/6, 2/7

  tactile 2/9

- *primitive reflexes*

crawling reflex 2/6,

Moro 2/5, 2/6, 2/8,

ATNR 2/1

TLR 2/4, 2/5, 2/6, 2/7

- *bilateral category*

2/1.

Section Three (purple): 'Arms and Legs are Preparing to Push and Pull across the Floor'

Section three (purple) presents a focus on the commando crawling (tummy prolusion) milestone and the selected movement activities. There is no actual age range suggested for this purple section as the wording beneath the main heading states the 'commando crawling may appear at a time very specific to your baby'. This script is included to insinuate parents and carers that the progression to this locomotion milestone is more meaningful than the age of occurrence (Hadders-Algra, 2018). There is usually a predictable sequence of infant milestone attainment although the time of occurrence and progression between infants is quite variable (Adolph et al., 2018; Flensborg-Madsen & Mortensen, 2017; Sauve & Bartlett, 2010). The rudimentary locomotion stages of motor development progress from the rolling over milestone to the action of prone circular pivoting then emerging to the commando (belly) crawling action (Piper & Darrah, 1994; Shumway-Cook & Woollacott, 2007). The action often begins by infant pushing backwards as the upper body does not initially coordinate with the lower body. Subsequently, when propelling forwards, the right limbs also do not combine with left limbs showing a more ipsilateral (same arm/leg) pattern, with the action generally maturing into a contralateral (opposite arm/leg) commando crawling motion (Goodway et al., 2019; Liddle & Yorke, 2004).

A developed commando crawl action evolves depicting the infant in prone pose, the arms pulling, the toes curled against the ground with the feet and legs propelling the infant forward in a contralateral (bilateral) pattern as the stomach remains in contact with the ground (Goddard Blythe, 2005; Lenke, 2003). Bartlett and Fanning (2003) and Piper and Darrah (1994) propose an alternative commando crawl term as 'reciprocal crawling', describing the infant moving in a coordinated right hand/forearm with opposite left leg/knee/toes reciprocal pattern.

Commando Crawling <u>Targeted</u> Activities

The four activities that are specifically relevant to attaining the commando crawling action will be analyzed beginning with 'crossing over II' 3/3. This activity describes how the adult can move one of the infant's hands together with the opposite (bilateral) knee, to touch and meet each other at the infant's midline. This is repeated with the other hand and foot. The text continues, suggesting that the adult then connects and cross patterns other body parts including one hands to touch the opposite shoulder and then touch the opposite ear.

The 'why' outlines that this bilateral action allows communication between both hemispheres of the brain and also facilitates different body parts moving across the body midline and the brain corpus callosum (Sigmundsson & Whiting, 2002). This cross pattern (bilateral) action assists the inhibition of the ATNR, lessening the impact of asymmetrical muscle distribution (Gieysztor et al., 2018; Goddard Blythe, 2005). Even though this activity was presented in Section two (green), continuing here in Section three closely links to the emerging bilateral action of commando crawling milestone.

The 'tummy turn' or prone pivot 3/4, places the infant prone on a slippery or non-carpet surface. As the parent places colourful toys laterally to the side of the infant to attract arm reaching, the baby stretches the arms and consequently pushes with hands in a pivot, circular motion (Liddle & Yorke, 2004; Piper & Darrah, 1994). Lateral trunk flexion allows the infant to initially push/pull with the arms and over time begins to coordinate with the legs (Shumway-Cook & Woollacott, 2007). The 'why' discusses that the activity will develop upper body muscles together with encouraging eye-hand coordination. This 'tummy turn' activity is a pre-curser to the infant propelling initially backwards then forward in a bilateral commando crawling movement (Adolph & Robinson, 2013).

Activity 'bilateral ball tap' 3/5 where the parent taps the infant's right (left) hand taps rhythmically with the left (right) foot whilst lying prone on a large ball. This activity stimulates the baby's right and left brain hemispheres to cooperate in a cross patterned (bilateral) motion (Goodway et al., 2019; Lenke, 2003; Piper & Darrah, 1994). This bilateral activity is also important in developing the commando crawling cross-patterned motion.

The 'roly-poly hand/foot push' 3/8 and the similar 'back roly-poly' 3/9 are included as the final two specific actions in the designated commando crawling activities. These activities involve the infant being positioned on their tummy (and back) on a medium sized ball (Liddle & Yorke, 2004). This slightly smaller ball (than used in Section one) is selected as these movement actions aim to encourage the infant to touch the ground with their hands and feet as they are rocked forward and backwards- firstly on tummy and then on the back. The text comments on encouraging the infant's hands and feet to explore pushing against the floor particularly as arm push and strength are indictors of progressing motor development (Senju et al., 2018).

The 'why' in 3/8 as well as reinforcing the activity's vestibular reactions, outlines that this forwards/backwards tipping action supports infant's hands and feet strength as a push away action against the floor develops. The 'why' in 3/9 continues with the vestibular comments regarding tipping the infant backwards encouraging a natural response to gravity whilst developing confidence and body awareness when up-side down. The 3/9 ‘why’ also references that the action of the infant pushing against (off) the floor can also stimulate important muscle tone (Le Gall et al., 2019; Nandi & Luxon, 2008) vital for commando propulsion forwards. The ‘heading’ on each page of this Section three (purple)reads:

> ‘Your baby no longer needs the early reflexes and is preparing to move forwards. Baby is encouraged to practice the individual arm and individual leg activities for muscle tone needed for the commando crawling action. The activities using opposite arm/leg movements specifically develop the cross patterned (bilateral) action. Baby may initially push backwards before the forwards pull (commando crawl) movement is mastered’.

Gabbard (2012) highlights that as the infant’s primitive reflexes are becoming suppressed, the emerging postural reactions provide the ability to react to gravity creating changes in equilibrium and then the rudimentary locomotor skills crawling (commando) and creeping (hands and knees crawling) begin to emerge.

Commando Crawling <u>Related</u> Activities

The remaining six activities (3/1, 3/2, 3/6, 3/7, 3/9, 3/10) within Section three (purple)are also highly relevant to the commando crawling action and motor development and are included to show the multiple links to the Table 3.1 central elements of ‘infant core muscle and neurological responses’. The following four major elements with specific activity codes according to appearance in the BAC/program sections include:

- *postural control including prone, muscle tone and flexibility division* activities
    - 3/1, 3/2, 3/6, 3/7
- *sensory systems*

    - vestibular 3/7, 3/10
    - proprioception 3/2, 3/6, 3/7
    - visual 3/2, 3/6, 3/7
    - tactile systems 3/3, 3/10
- *primitive reflexes*
    - Moro 3/7,
    - ATNR (3/3 targeted activity)
    - TLR 3/7, 3/10
- *bilateral activities*
    - 3/5, 3/10. (3/3 targeted activity)

Section Four (red): 'Preparing to Crawl on Hands and Knees across the Floor'

Section four (red) considers the rudimentary milestone of crawling (creeping) on hands and knees and includes eight selected activities. There is no defined age for achieving this crawling milestone in Section four as also discussed in Section three. The BAC-Program text heading outlines that the crawling action may develop at a time very particular to each infant. This locomotion milestone is positioned in this final section four as research reveals that the infant naturally progresses from commando crawling to hands and knees crawling and this progression greatly increases the proficiency regarding the action and speed of the quadrupedal crawling movement (Adolph & Robinson, 2013; Malina, 2004; Yamamoto et al., 2021). The mature hands and knees crawling action graduates from the stationary hands and knees four point pose with the infant often rocking forward and back but not progressing forward (Howard, 2007; Piper & Darrah, 1994). The infant's first attempts at travelling forward on hands and knees are observed with the infant moving one limb at a time and consequently with practice the action becomes a more contralateral right hand/arm and left knee/leg synchronized motion (Gabbard, 2012; Gallahue et al., 2012).

There appear to be changes in the infant's cortical brain organization between the onset of hands and knees crawling (novice) and later crawling experiences with pruning of cortico-cortical connections occurring including the reduction of the over production of synapses connections as the quadrupedal skill progresses (Bell & Fox, 1996). Visser and Franzsen (2010) outline that the crawling stage involves weight shifting of the limbs together with trunk counteractions requiring strength to lift the trunk up from the floor. These authors suggest that the crawling action can become a preparation for walking together with assisting in the infant's development of motor planning, visual perception and eye-hand coordination. Furthermore, McEwan et al. (1991) highlight that the practice of crawling supports vestibular processing, improves balance, tactile input and spatial awareness and facilitates social maturation.

Hands and Knees Crawling Targeted Activities

There are two activities that are particularly relevant to realizing the hands and knees crawling action. Firstly, the activity 'up onto hands and knees 4/1. The text for this action outlines for the parent to place the infant on a small roll (sleeping bag or rolled towel) with the infant's hands and knees touching the floor. To further support the infant, the parent places their hands on the infant's hips. The infant is encouraged to reach for a toy placed further away on the floor to enable a forward motion. This allows the infant to take their body weight onto and thus strengthening the arms and hands. The text indicates moving the infant back onto their knees and repeating the action again. The 'why' outlines the emphasis on upper body muscles development necessary for moving forward on the hands and the knees (Soska et al., 2015). It is also explained that this activity allows the infant to experience a relationship between the hands and knees (upper and lower) body segments that the crawling action requires (Visser & Franzsen, 2010).

The next relevant activity in Section four (red) support the infant to move to the hands and knees crawling action. The action is ‘forwards on hands and knees’ 4/3. The text information indicates placing the infant in a hands and knees pose, with parents positioning their thumbs and hands behind the infant’s knees. This action encourages the infant to bend their knees, taking their body weight onto both the knees and the hands (Fox et al., 2002; Piper & Darrah, 1994). To experience the action of moving forwards, the parent is directed to place a toy to attract the infant, whilst gently moving one knee and then the opposite arm hand towards the toy (Liddle & Yorke, 2004). The ‘why’ describes the crawling action with the right hand coordinating with the left (opposite) knee. The impact of pressing against the back of the infant’s knee enables the leg to move whilst reaching for the toy, promoting the appropriate bilateral action (Gabbard, 2012; McEwan et al., 1991). Patrick, Noah, and Yang (2009) highlight that infants move diagonal limbs together when hands and knees crawling thus coordinating this interlimb behaviour as part of normal motor development.

Section four (red) includes a smaller explanation heading beside the larger hands and knees milestone action heading. This additional text outlines to parents and carers information regarding the core, back, arms and legs strength required when approaching the weight bearing required for this crawling milestone. Also, this segment outlines that the following activities in Section four will assist in the development of infant muscle tone entailed in the cross-patterned (bilateral) arm and leg action. Finally, the information continues by summarizing that the crawling milestone’s attributes of sustained head control and balance, contribute to the subsequent motor skills of upright sitting and cruising (Bell & Fox, 1996; Patrick et al., 2012).

Hands and Knees Crawling Related Activities

The remaining six activities all contribute to the crawling motor skill and they also provide input to the central categories of 'infant core muscle and neurological responses'. These response elements together with their relationship to the six activities (4/2, 4/4, 4/5, 4/6, 4/7, 4/8) within Section four (red) are included to outline the importance of these selected actions.

- *postural control including prone, muscle tone and flexibility division* activities
  - 4/5, 4/6, 4/8
- *sensory systems*
  - vestibular 4/4, 4/5, 4/6, 4/8
  - proprioception 4/4, 4/6, 4/8
  - visual 4/6, 4/7
  - tactile systems 4/2, 4/7
- *primitive reflexes*
  - Moro backwards 4/6
  - ATNR 4/2
  - TLR forwards and backwards 4/6
- *bilateral activity*
  - 4/2

Although the primitive reflexes presented here are generally weakened by this milestone stage, the continued repeating of the defined program activities above can support further inhibition and contribute to the subsequent nervous system control and maturation (Gabbard, 2012; Malina, 2004).

Summary:

This chapter provides the theoretical context and selection rationale for the movement activities in the BAC-Program. The overall objective for the BAC-Program focuses on the infants progressive realisation through the four rudimentary milestones being Body awareness, head control, tummy time; Rolling over; Commando crawling and Hands and knees crawling.

The text outlines and describes the key elements of the core muscle and neurological responses involved in achieving the above observable outcomes. These being Postural control; Sensory systems; Primitive reflexes and Bilateral actions. Each of these elements are considered within the individual targeted activities and their relevance to the milestone grouping (Table 3.1).

The actual design of the BAC-Program booklet includes thirty four professionally drawn diagrams within the four coloured sections with accompanying descriptive text., including the important 'Why' written explanations. The coloured coded booklet is designed with simplicity to encourage parents and carers of young infants to interact in a fun way to achieve the developmental milestones.

Chapter three has developed a sequential movement milestone program to support the principle that exposure to appropriate prone and vestibular motor actions in early infancy, can support the maturation of neural pathways, and have an impact on infant locomotor behaviour and overall motor development (Dewolf et al., 2021). As Soska et al. (2015) succinctly highlight: 'motor achievements can be more than benchmarks of development; they can also facilitate progress.' (p 206).

CHAPTER 4: EXPERTS' EVALUATION OF AN INFANT WAKEFUL PRONE AND VESTIBULAR ACTIVITY PROGRAM: STUDY ONE.

Study One was designed to evaluate the content of the Baby Activity Chart-Program (here after known as BAC-Program) focusing on the responses and opinions of experts in the early childhood field. This research aimed to explore all four movement milestone sections of the BAC-Program to determine expert's opinions of all the selected activities within the tummy time and vestibular focused infant activities program. The validation process incorporated an Experts Response Questionnaire (here after known as ERQ) presented to selected experts in the infant motor development discipline. Of the sixteen participating experts, two were early childhood university lecturers, three were early years movement/physical education educators. Thirteen were involved with paediatric practice or paediatric support services and included Maternal and Child Health nurses (MCH) , midwives, osteopaths, physiotherapists and chiropractors.

The design perspective that shaped this research methodology was the constructivism paradigm. Researchers within the constructivism perspective view participants as core to the design and the eventual realization of the research project (File, Mueller, Wisneski, & Stremmel, 2016). Given that this paradigm is generally associated with the qualitative research method, this study also incorporated the qualitative data analysis approach method (mixed methods). This approach was adopted to acknowledge a further analysis of the research question (Newman, Lim, & Pineda, 2013) with the enquiry being **: '**Experts' evaluation of a wakeful prone, vestibular activity program focusing on early infancy motor development'.

Method

Research Design

A research paradigm affords the researcher an overall theoretical framework or template, while supporting the selection of methods, instruments, tools and participants involved in the study (Denzin & Lincoln, 2000). This study's research process was formulated to test the validity and practical relevance of a selection of prone (tummy time) and neuro-vestibular movement activities for normalizing of motor milestones in young babies with relevant experts in the early childhood field. Thus, the constructivism paradigm approach enabled an interaction between this researcher and the experts to develop a deeper understanding or solution to the research question (File et al., 2016). The researcher and the participants (in this case the Experts) collaborate to determine the implementation of a research project (Hittleman & Simon, 2006; Ponterotto, 2005). Ponterotto (2005, p. 129) implies that an attribute of the constructivism paradigm is the enablement of 'deeper meaning' to be discovered as the interdependence between the researcher and the experts unfolds. Therefore, in this study the responses of the Experts were used to afford a deeper meaning to the relevance and appropriateness of the BAC-Program's activities in this overall evaluation process.

The content validation approach initially appears to fit within the qualitative research method where researchers place their work within a closer association of other participants or other researcher's work to help establish what is understood at this moment in time (File et al., 2016). File et al. (2016) summarize qualitative methodologies as 'Researchers engage in an accounting of findings and a discussion of their relevance ….' (P.33). Then, again the research process in this study also adopts a more mixed methods paradigm. The mixed methods in this study can be defined as the qualitative data, being collected through the expert's responses to the questionnaire's categories and consequently converted into quantitative numerical scores or percentages (Newman et al., 2013). Ultimately, this study pursues a positive or negative percentage acceptance score regarding the program's validity in the eyes of the experts.

The evaluation of the BAC-Program, through expert responses, utilized a two- step validation research design incorporating both content and logical validity approaches (Lodico, Spaulding, & Voegtle, 2006; Rubio, Berger-Weger, Tebb, Lee, & Rauch, 2003). This design approach determined that the evaluation questionnaire (ERQ) targeted both significant and comprehensive responses in relation to the content of the instrument (BAC-Program) and is in addition, an *accurate sampling* of knowledgeable persons (Hittleman & Simon, 2006, p. 304). The research design was foremost when preparing an instrument to be used exclusively in the subsequent Study Two-Chapter 5 (Alghwiri et al., 2012). Study Two proposed to investigate the 'influence of a wakeful prone, vestibular activity program (BAC-Program) on early infancy motor development'.

The term validity refers to whether a researcher actually measures what they are proposing to measure. Thus, in the context of this study will also refer to the feedback, reflection and endorsement results from the experts participating in the BAC-Program evaluation. Fraenkel, Wallen, and Hyun (2012, p. 148) summarize that ' Validity, therefore depends on the amount and type of evidence there is to support the interpretations the researchers wish to make concerning data they have collected'. In summary, the accuracy of the data collected and collated through the ERQ and its subsequent examination determined its validity in relation to the evaluation of the BAC-Program.

Some studies in research methodology raise the issues as to whether exact validity or more correctly 'estimates of validity' (Newman et al., 2013). To determine exact validity is highly improbable and difficult to ascertain due to factors such as differences in the timing of data collection and actual precision of items of the questionnaire (Newman et al., 2013). The term 'estimates' refers to applying the closest possible estimation of the study's validity and appears to be a more commonly used research term when assessing and validating data (Herrett, Thomas, Schoonen, Smeeth, & Hall, 2010; Judge, Piccolo, & Ilies, 2004). This study acknowledged this definition and concluded that the research design is an 'estimate of validity' and a proposed endorsement of the specific BAC-Programs content.

The content and logical validity design approach was utilized to collect data as evidence to support and evaluate both the format and content of the BAC-Program. In the case of this study, the Expert's responses within the ERQ were analyzed and formed the evaluation of the corresponding sections of the BAC-Program (instrument). It was assumed that when collecting data to evaluate an instrument, a fewer number of informed experts are required (Fraenkel et al., 2012). This type of research approach can be viewed as the relationship between knowledge of the selected Expert of a given research topic and the actual content of the instrument or program being evaluated (Davis, 1992; Zamanzadeh et al., 2015). It appears that validity becomes a measured outcome of the selected judges or experts determining the representativeness of program's relevant concepts or constructs (Drost, 2011; Stemler, 2004; Yaghmale, 2003). Fraenkel et al. (2012) define content validity and in the case of this study, and thus when pertaining to a questionnaire format as '…. judgements on the content and logical structure of "a tool" as it is to be used in a particular study' (p 162). This design approach resonates with this study as ERQ format and content, while the inclusion of sections subsequent to obtain Expert's responses were designed to evaluate the activities and logical structure of BAC-Program.

To further analyze this study's research design approach, Rubio et al. (2003) discuss that content validity also has two approaches- face validity and logical validity. It is suggested that face validity places the significance of the instrument more within the whole study rather than the sampling accuracy or validity of the actual instrument's contents and topics (Gaber & Gaber, 2010; Hittleman & Simon, 2006). Face validity proposes a more subjective good or not good judgement of the measurement instrument whereas logical validity is a more comprehensive measure using an expert panel's constructive feedback to determine that the items are objectively evaluated (Fitzner, 2007).

This study adopted the logical content evaluation measure: a more in-depth and thorough process being validated by experts according to their respective and collective responses, and consequently contributing to the BAC-program's review (Rubio et al., 2003). Thus, the design or logical content validity approach of the response measure being the ERQ, was to process and examine in detail the selection of the activities within in the BAC-Program. The independence of the validation process was also achieved in this research process through the comprehensive and varied selection method used to choose the relevant experts and judges (Grant & Davis, 1997; Sutherland & Burgman, 2015). This approach further reinforced this study's content analysis design. Particular authoritative groups are fundamental to evaluation of the instrument's items (Cresswell & Cresswell, 2018; Hittleman & Simon, 2006; Zamanzadeh et al., 2015). Rubio et al. (2003) articulate clearly: 'Using a panel of experts provides constructive feedback about the quality of the newly developed measure and objective criteria with which to evaluate each item'(p.95). This statement supports the validity approach used in this study.

As previously mentioned, the evaluation process outlined in this chapter utilized both the qualitative and quantitative research methods approach so ultimately a mixed methodology design was adopted. There is often discussion amongst researchers on the main differences between qualitative and quantitative research methods. Quantitatively measuring content validity is a more objective approach using a judgement scale where experts evaluate the tool and rate the items (Fraenkel et al., 2012). A quantitative measure of content validity is determined by the agreement percentage of the experts (Newman et al., 2013). Qualitative content analysis brings the information concept to the data without theoretical evaluations and to answer logically questions of practice rather than to espouse theory (Forman & Damschroder, 2008).

A thematic approach to data analysis provides further support for content analysis when analyzing data as this approach also provides the identification of common threads enabling descriptive interpretation of aspects of the research questions (Braun & Clarke, 2006; Vaismoradi, Turunen, & Bondas, 2013). If the goal of the study was both to make theoretical generalizations based on numbers as utilized in quantitative methods, and to understand a trend, then a combination of both research approaches was best employed. The quantitative methods numerically analyses the specific differences in the responses and the qualitative method looked at specific categories to detect patterns. Thus, this doctoral researcher combined both approaches: it estimated content validity quantitatively by numerically analyzing the specific percentage responses and subsequently used qualitatively analysis of emerging response patterns of the items within the BAC program. Newman et al. (2013, p. 244) outline succinctly:

‘The researcher attempts to estimate the agreement of the items of the assessment element with the alignment of these concepts empirically and therefore it is inherently mixed methods. In essence, content validity is the alignment of the assessment items with the theoretical constructs. The theoretical constructs are qualitative, and the assessment of the accuracy of the alignment of the items with the theoretical construct is a quantitative process; therefore, this process is mixed methods'.

Interestingly, it is important to outline that initially the validity of the content of the BAC-Program was assessed through both the judgment and the development stage. Yaghmale (2003) presents these two stages as the 'judgement' stage, more linked with the quantitative or 'objective' approach and the subjective 'development' stage or instrument development more aligned to the qualitative methods. With a carefully constructed measure namely the questionnaire, the Experts could offer positive solutions for further development and offer Sampling Process for Validation academic support to the existing and developing instrument (Rubio et al., 2003). Thus, the validation (or estimation) of the BAC-Program was designed to produce an endorsement or an expert modified BAC-Program/2 to be utilised in study two of this doctoral research.

Sampling Process for Validation Participants

An expedient, purposive sampling method was used as the selection method for Study one. A random sample selection process would not assure this study of the specific participant expertise required for validation of the BAC-program. The purposive sampling approach is suited to both the qualitative and quantitative research methods and assists the researcher to best respond to the research question through purposefully selecting the individuals (Sutherland & Burgman, 2015). A smaller sample also characterizes this design although there are no actual or absolute defined numbers (Cresswell & Cresswell, 2018; Denscombe, 2010; Zamanzadeh et al., 2015). After a review of research studies, Cresswell and Cresswell (2018) suggest a number between 3-10 when the study is informed by the participants in response to the researcher's identification of phenomenon or trend. A similar participant cohort requirement by Yaghmale (2003) was based on the figure of between five to ten experts when the judgement of the content domains is to be validated. Zamanzadeh et al. (2015) outline that as the number of experts increases the issue surrounding sufficient control over the chance effect is likely to decrease.

The actual recruitment of the Expert participants relied on endorsements from educators, and recommendations from allied health professionals. Several experts were identified as authors of recent PhD's and research articles that this researcher had studied during a previous MEd qualification. The methods of communicating with potential subjects was via email and phone calls, and this allowed the search for candidates to states other than this researcher's home state of Victoria. Three interstate experts were contacted and two from Western Australia agreed to partake. After contacting up to twenty prospective participants, and with several withdrawing due to various conflicting commitments, the final number of sixteen experts agreed to participate.

Sample composition

Consequently, this researcher reconciled on a total of sixteen experts. Eligibility criteria relied on a background in early childhood, with a particular interest or expertise in early childhood movement and development. The aim of the selection process was to source a diverse group of experts from a range of vocations.

The final group included five educators (two preschool movement teachers, a secondary physical education teacher and two early education university lecturers). Eleven allied health professionals were also selected including three paediatric midwives, two paediatric chiropractors, two physiotherapists, two paediatric osteopaths, and two community maternal and child health nurses (MCHN). The two parents within the group included a qualified mid-wife nurse and physical education teacher.

The group's selections were based on the BAC-Program having an emphasis on the infant's nervous system and sensory motor development. The BAC-Program is designed to focus on early rudimentary movements and the activities to support these motor milestones. The six allied health experts were divided equally between physiotherapy (movement efficiency, muscles and joints), osteopathy (biomechanics and musculoskeletal) and pediatric chiropractic (musculoskeletal and spinal alignment) practices. They all had an interest in the infant motor milestone development and showed knowledge on muscle actions to develop these movement skills. It was important to recruit allied health professions, to allow their expertise to evaluate that the BAC-P's activities were correctly drawn and appropriate for young infants. Five of the six allied health professional were additionally qualified in pediatrics with the other being a physiotherapist with a focus on vestibular rehabilitation. The five nurses were all qualified in the infant domain with three midwives and two maternal and child health nurses. Further qualifications and experience are presented in **Table 4.1**.

Table 4.1.

Total numbers and professions of recruitment of all sixteen study experts

Profession	Expert	Expert
Educators	Age: 60-70. PhD and Professor in Motor Development at a Western Australian University for 20 years. No 7	Age: 40-50. PhD and Senior Lecturer at the Faculty of Education at a Melbourne University in Child and Family Development, and Exceptionality Education. No 8
	Age: 50-59, Early years Physical Education teacher and 15 years as a Motor Development Infant teacher (Gymbaroo). No 3	Age: 60-69, Early years Primary teacher and 26 years as a Motor Development Infant teacher (Gymbaroo). No 4
Parents	Age: 30-39. Utilised the BAC program as a parent of young infant and is a qualified Physical Education teacher. No 12	Age: 30-39. Utilised the BAC program as a parent of a young infant and is a qualified ICU nurse and Midwife. No 13
Paediatric midwives	Age: 50-59. Midwife (30 years) and neonatal observation/resuscitation certificates. Conducts birth classes and post-natal education at Women's hospital. No 14	Age: 50-59. Master's in nursing, Midwife and MCH nurse in interacting with 'New Mums Groups' in Northern suburbs of Melbourne. Graduate Diploma in Child and Family Health. No 15
Paediatric chiropractors	Age: 40-49. Paediatric Chiropractor neuro-development. Post graduate educator in functional neurology. No 10	Age: 20-29. Paediatric Chiropractor for 5 years with specialization in children's neurological development. No 9
Physiotherapists,	Age: 40-49. Physiotherapist specialising in vestibular complaints. PhD in Vestibular Rehabilitation. No 5	Age: 50-59. Physiotherapist specialising in infants with disabilities. PhD student in infants displaying plagiocephaly. No 6
Paediatric osteopaths,	Age: 40-49. Biodynamic Paediatric Osteopathy with16years specializing in paediatrics and family care. No 1	Age: 30-39 Biodynamic Paediatric Osteopathy with 10 years clinical experience. No 2
Maternal and Child Health nurses.	Age: 50-59. Maternal and Child Health nurse interacting with 'New Mums Groups' in Inner Western suburbs of Melbourne. No 15	Age: 50-59. Maternal and Child Health nurse interacting with 'New Mums Groups' in Country Eastern Gippsland Victoria region. Graduate Diploma in Advanced Nursing specialising in Family and Child Health -13 years. No 16

The participants age groups presented in Table 4.2 ranged from the 20- 60 years categories with an approximate calculated mean of *M= 48.12* and comprising fifteen females and one male.

Table 4.2.

Total numbers study experts in specific age groups

Age groups	Numbers
20-29	1
30-39	3
40-49	5
50-59	6
60 plus	2
Total	16

Procedure

Ethics approval was obtained from the Victoria University Ethics Committee (Application number HRE14-169) on 30/06/2014 (see Appendix A). Ethics approval was also obtained for the Education Department (Application number 2014_002475) on 10/11/ 2014 (Appendix B). An email was sent to several Early Childhood managers within a selection of Melbourne and Country Municipal Councils to outline the study and to seek interest from Maternal Child Health nurses (MCHN) to join the study as experts (Appendix C). Data for this study from participating experts was collected over a six-month period from January 2015 to July 2015.

After locating the perspective experts for the study, each participant was initially approached via a phone call or email to explain the aims of the research. Information and concepts – both spoken or written were presented to outline the background behind the development of the BAC-program, the expert's involvement required, and a suggested time required to respond to the questionnaire. A letter of introduction, a BAC-Program (Appendix F) and an accompanying ERQ questionnaire (Appendix E) were subsequently mailed as a package to each expert who agreed either verbally or in a return email, to join the study. A ‘consent form for ‘participants involved in research’ (Appendix D) was also included in the original package together with an accompanying stamped, self-addressed envelope directed back to this over a six-month period from January 2015 to July 2015.

After locating perspective Experts for the study, each participant was initially approached via a phone call to explain the aims of the research. Information and concepts were presented to outline the background behind the development of the BAC-program, the expert’s involvement required, and a suggested time required to respond to the questionnaire. A letter of introduction, a BAC-Program and an accompanying questionnaire were subsequently mailed as a package to each Expert who agreed either verbally to join the study. Experts were advised that they could withdraw from the study at any time. If returned questionnaires were not received by the researcher within a two week period following experts receiving the package, then an email or phone call served as a polite reminder. Each of the sixteen participants were given a specific number by this researcher to maintain confidentiality. Any discussion regarding the Experts’ responses was undertaken ethically to ensure that the actual identity of the experts was not published.

Development of the Experts Response Questionnaire ERQ.

Given that this evaluation was seeking to validate the uniqueness and purposefulness of the BAC-Program, it was not possible to use a previously authenticated demographic questionnaire. Therefore, in designing the Expert Response Questionnaire (ERQ) this doctoral researcher affirmed the intent of the research being: the evaluation of the BAC-Program. The intent impacted on the careful selection and standardization of questions and procedures.As this ERQ was initially developed by this researcher (in consultation with a supervisor), a detailed investigation was undertaken of the study’s research question in relation to research questionnaire designs, standards and procedures.

The aim of the ERQ was to evaluate the content appropriateness regarding the selection of the movement activities for infants, together with the layout and format design within the BAC-Program. Another aim of the ERQ centred on assessing the Expert's opinions on whether the BAC-Program could contribute to parent and carer's knowledge and confidence regarding infant motor development. A standardized questionnaire design was adopted so that all the Experts were requested to answer identical questions enabling the responses to be uniformly recorded thus increasing reliability (Drost, 2011). The ERQ thus measured knowledge and opinions of the experts in relation to the planned questions. Result differences should occur due to Expert differences and not from question phrased inconsistencies (Boynton & Greenhalgh, 2004; Bubela, Mykyychuk, Hunkalo, Boyko, & Basalkevych, 2016; Lindstädt, Proksch, & Slapin, 2018; Podvezko, 2007). The inference being that the questionnaire's responses (or information collected) from a specific population, would correlate to the wider population (Rattray & Jones, 2005).

The questionnaire was prepared as a hard copy and printed on A4 size paper. The ERQ consisted on an introductory page in the format of a letter, followed by four pages of questions or statements that required responses. Experts were directed to circle a response and then to add comments after each statement. Each Expert was also instructed to include their age, occupation and any area of specific interest in early years motor development field.

ERQ Format and Measurement Methods.

The questions or statements within the questionnaire were presented in a specific order to maintain the respondent's interest. The questionnaire's design followed rules suggested by Leung (2001) where the layout goes from broad to a particular and from closed to open question formats. The format and choice of questions needed to be relevant, clearly set out and appropriate to the selected experts. This study therefore selected the Likert style scale format.

Likert scales are effective when researching participants 'attitudes' in research projects (Croasmun & Ostrom, 2011; Lindstädt et al., 2018). The scale approach, using the 'closed ended' (fixed number of responses) Likert design, allowed the respondents to subjectively evaluate each question according to a set of values. The odd and even point Likert style was adopted in the questionnaire and the choices of responses varied from 3 to 2 selections. The most positive Expert's responses in the three choices category were referred to as the 'first or highest ranked tier answer, with the next positive response as the second ranked tier answer. The final response or the least positive answer became the third-tier answer. This close ended layout allows the researcher to gather data efficiently, quickly and with consistency and uniformity (Reja, Manfreda, Hlebec, & Vehovar, 2003).

The evaluation of the BAC-Program also required further written responses from the experts, so every section included an open-ended comment or opinion option (Adcock & Collier, 2002; Sutherland & Burgman, 2015; Zamanzadeh et al., 2015). Rattray and Jones (2005) remind researchers when developing the item generation within the questionnaire, to continue to revisit the research question to ensure that the items remain relevant. Gaining participant comments and importantly, opinions on all sections of the ERQ enabled this researcher to more accurately pursue the logical content validity.

Structure of the ERQ:

The ERQ was divided up into five sections namely:

Section one: *'format'*: a) the concept of the BAC-Program is *beneficial:* b) the activity diagrams are *suitable*: c) the addition of the accompanying texts is *supportive*: d) the layout of four activities per page is *helpful.* Experts' choices involved choosing to circle **one** of the following: highly: moderately; could be improved: and comments.

Section two: *'text and diagrams within the overall format'*: a) introduction. b) body awareness- 12 activities. c) preparing to roll- 8 activities. d) push and pull across the floor- 10 activities. e) preparing to crawl- 8 activities. Experts' choices involved choosing to circle **one** of the following*:* appropriate, needs additional, removed, and comments.

Section three: '*The contribution of BAC-Program's content to develop parents/carer's knowledge' r*egarding infant motor development*.* Experts' choices involved choosing to circle **one** of the following*:* high contribution, average contribution, low contribution, and comments.

Section four: *'The contribution of BAC-Program's design (diagrams and text) to promoting parents/carers' confidence'* to physically interact with young infants. Experts' choices involved choosing to circle **one** of the following*:* high contribution, average contribution, low contribution, and comments.

Section five: Participants/Experts: "I would/would not recommend the BAC to parent/carer, comments. Experts' choices involved choosing to circle **one** of the following: Yes- I would: No- I would not: and comments.

In Question one of the ERQ questionnaire, the BAC-Program's overall concept and format design was examined. Experts' response choices in this section of the questionnaire were purposely explored including the four carefully worded terms: *beneficial* (overall concept), *suitable* (diagrams), *supportive* (text) and *helpful* (four activities per page). This approach enabled the respondents to read the statements and then circle their responses including 'highly', 'moderately', 'could be improved'. To avoid ambiguity of questions or statements, a careful selection of precise wording was used to ensure reliable and uniformity of responses (Leung, 2001).

In Question two of the ERQ, the five specific sections were pitched to align with the introduction and the four BAC-Program's content milestone segments. The BAC-Program content layout as outlined in Chapter 3, was divided after the introduction section, into four major motor milestone sectors. Subsequently, the experts were requested to respond to the correctness and accuracy of each diagram and accompanying text within each motor milestone sector. Wording responses to be circled in the questionnaire included 'appropriate text/diagrams', 'needs additional text/diagrams' or needs particular text/diagram removed. This part of the questionnaire was investigating the suitability, accuracy and correctness of each of the movement and milestone actions and the accompany text.

The design layout of the questionnaire changed in Questions three and part four from a table format to a full-page response format. These questions also included both closed and open-ended response designs, although the open-ended comments section was larger, inviting more personal opinions. The different design for the questionnaire's Part three and four was to ensure and encourage the experts to specifically focus on two different statements relating to specific aims of the BAC-Program: being to create a usable chart with appropriate activities to encourage parents/carers to be more knowledgeable and to be confident about their baby's motor development. Question three directed the experts to rate the contribution of BAC-Program's content to develop parents/carer's knowledge. Question four focused on the contribution of BAC-Program's design (diagrams and texts) to promoting parents/carer's confidence to physically interact with young infants. Wording to be circled in sections three and four according to the expert's opinions on these statements included 'high contribution', 'average contribution' or 'low contribution'.

The questionnaire's carefully spaced layout asked the experts to respond to one of the 'wordings' and then allowed an additional three to four lines for personal knowledgeable comments and opinions. The importance of space between questions/statements improves the professionalism and increases the response rate and accuracy of the responses (Lee, 2006). This alternative full page response format within Questions three and four was adopted to further the consistency of the data collection where the aim of the specific and personalised questions was to provide a greater understanding of participant's opinions and knowledge (Adcock & Collier, 2002; Bubela et al., 2016; Davis, 1992; Hayes & Hatch, 1999). Question five continued with the full-page response format where the choice was only between two choices- namely: "I would or would not 'recommend' the BAC-Program to parent/carers. This question again included a comment section so that the experts could present a more detailed overall assessment of the BAC-Program providing further data towards answering the study's evaluation research question.

There was a pretesting and evaluation of the drafted ERQ before Study one commenced. This evaluation included three Victoria University Early Education colleagues and two parents of young infants. All the participants had backgrounds in either/or early childhood motor development, early childhood or physical education. Several minor changes were made to wording inaccuracies post this pretesting. This was to ensure that the individual questions were as 'relevant, appropriate, intelligible, precise and unbiased' (Leung, 2001, p. 189) as possible. Finally, the design and layout of the questionnaire focused to how each statement and subsequent response was to be analysed, what actual information will be provided and the future purpose of that information (Lee, 2006).

Data analysis Methods

A data analysis was undertaken to compute the Expert's responses to the items within ERQ with the aim of identifying areas of consensus consensus on the individual activities within the BAC-Program. Both a quantitative and qualitative analysis procedures were adopted.

Quantitative statistical analysis involved the following procedures:

1. Descriptive analysis to determine the mean and the standard deviation from the Expert's scaled responses to the items within the five sections of the questionnaire.
2. The data was categorized within the sections of the questionnaire's format and then 'quantified into numeric values and scores and rankings' (Newman et al., 2013, p. 44). The evaluation for ERQ's sections one - four were rated on a three-point ordinal (or tier) scale: 3= highly, 2= very, 1= moderately (Section one); 3= appropriate, 2= needs additional, 1= needs particular text/diagram removed (Section two); 3= achievable: highly, 2= achievable: average, 1= achievable: low (Section three/four). Section five was rated on a two-point ordinal scale: 2= would recommend, 1= would not recommend (Section five).
3. A content frequency percentage score was calculated to determine the questionnaire item's percentage agreement per item (total out of 16 experts) scored within each of the format's specific five sections (12 answered items). The analysis for quantifying Experts' degree of conformity used the average of the Experts' assessment on item relevance (Alghwiri et al., 2012; Brodsky & Van Dijk, 2008; Hayes & Hatch, 1999). To calculate these scores the cut-off point (or highest ranked response category) for predictable value for content measurement for each item was a rating of 3 in questionnaire sections 1-4 and the rating of 2 in section 5.
4. Calculations adopted an inter-rater expert's level of agreement on each questionnaire item at 75%. This figure can range from 70-80% (Grant & Davis, 1997) with Graham, Milanowski, and Miller (2012) suggesting that although consensus varies, a lower measure of 70% is also considered sufficient for research purposes. Alghwiri et al.

(2012) also chose the 70% figure for experts item agreement particularly if the data may appear in a new instrument. Consequently, the settled 75% majority figure was selected in this study, based on the high number of 16 participating experts, thus contributing to a higher consistent accuracy of results (Zamanzadeh et al., 2015). The accompanying experts' comments were also instrumental in evaluating the thoroughness of the BAC-Program's content (Adcock & Collier, 2002).

Qualitative analysis involved the following procedures:

1. A thematic analysis was adopted to report patterns, key words or trends within the experts' responses (data) column. This method was also used to determine common threads across the sets of questions and between particular experts (Braun & Clarke, 2006; Vaismoradi et al., 2013). How many experts recorded a particular theme or suggestion over the five questionnaire sections and within individual items? Did this theme occur in other items?
2. The content analysis was also centred on questionnaire item responses scoring an item measurement of less than 75% of first tier responses (Alghwiri et al., 2012; Graham et al., 2012) . In those items with evaluation scores of < 75%, the responses from the experts who rated items in the second and third ranked response category were thoroughly examined for trends, patterns and suggestions.(Hayes & Hatch, 1999; Stemler, 2004). These responses formed several changes that initiated the formation of the BAC-Program/2.
3. Comparisons were reviewed of the relevant themes or suggestions posed by the experts and whether they were representative of the BAC-Program's aims, tasks, and design layout. If collectively, judged to be very positive and important additions

to the second edition of the newly named BAC-Program/2, then changes were implemented.

4. The ticked and written responses to Section 5 of the questionnaire collectively determined the expert's overall recommendations of the BAC-Program.

There was an assumption that the item content percentage scores for the questionnaire's sections would then be considered an equivalent to a corresponding evaluation of each item or activity within the BAC-Program. This implication is assumed as the questionnaire items and presumed responses were closely formatted on the content of this activity program. Waltz, Strickland, and Lenz (2010) outline that validity is not fully linked to the questionnaire but more the 'property' of actual scores received from the respondents and analyzed for a specific purpose. In the case of this study one, the overall aim was to review the expert's responses in relation to the consensus of the questionnaire's scores and to apply resultant evidence to the evaluation of the BAC-Program.

Results

In total, sixteen experts responded to the study one's questionnaire. The evaluations of these experts in the BAC's sections one, three and five totaled sixteen participants. In sections two and four the total was only fifteen participants as a different expert in each of these sections omitted a response in these relevant sections. Expert 7 had section 5 unfortunately missing from their questionnaire. Expert 6 omitted to tick the boxes in section 2 of the questionnaire but did add comments to this section.

Statistical analysis

This analysis was carried out using the SPSS Statistics analysis. Descriptive statistics for the individual items of the questionnaire present the means and the standard deviation are presented in Table 4.3. The percentage score was calculated and shown in table 4.4 as the proportion of experts rating an item at the level 3 (highest tier out of three choices) at each section of the questionnaire excluding section five. Level three comprised the term ‘highly’ and referring that the respondent expert had highly agreed to the question/statement. Level two included the term ‘very’ accepting that the responded was very accepting of the question/statement. Finally, the term ‘moderately’ referred to the respondent expert was only moderately in agreement with the question/statement.

In section five the percentage rating was calculated at 2 (highest level out of two choices). A score of 75% and above was considered excellent when scored by 6 or more experts (Grant & Davis, 1997).

Table 4.3

Descriptive Means and Standard Deviations for the individual items (section 1-5) of the Experts Response Questionnaire.

SECTION ONE: FORMAT	**N=16**	N=16
ITEM RATING: HIGHLY; VERY; MODERATELY.	Mean/3	SD
1. THE *BAC* CONCEPT IS A BENEFICIAL EDUCATIONAL GUIDE TO A BABY'S OVERALL DEVELOPMENT IN THE FIRST 12 MONTHS	2.43	1.41
2.THE ACTIVITY DIAGRAMS ARE SUITABLE FOR PARENTS/CARERS TO UNDERSTAND	2.43	1.41
3. THE TEXT ACCOMPANYING THE DIAGRAMS IS SUPPORTIVE TO THE ACTIVITIES	2.43	1.41
4. THE FORMAT OF 4 ACTIVITIES PER PAGE WILL BE HELPFUL TO ASSIST PARENTS TO UNDERTAKE AND REMEMBER EACH ACTIVITY	2.62	1.36
SECTION TWO: BAC-PROGRAM	N=15	N=15
ITEM RATING: APPROPRIATE; ADDITIONAL: REMOVED.	Mean/3	SD
1. INTRODUCTION	2.6	1.05
2. AWARE OF MY BODY AND PREPARING TO ROLL	2.2	1.37
3. AWARE OF MY BODY AND PREPARING TO ROLL	1.9	1.52
4. ARMS AND LEGS PREPARING TO PUSH AND PULL ACROSS THE FLOOR	2.6	1.05
5. PREPARING TO CRAWL ON HANDS AND KNEES	2.2	1.37
SECTION THREE: PARENT/CARERS KNOWLEDGE	N=16	N=16

	Mean/3	SD
1. THE BAC HAS A *HIGH, AVERAGE, LOW CONTRIBUTION* TO DEVELOP PARENT/CARERS KNOWLEDGE	2.43	1.20
SECTION FOUR: PARENT/CARERS CONFIDENCE	N=16	N=16
	Mean/3	SD
1. THE BAC HAS A *HIGH, AVERAGE, LOW CONTRIBUTION* TO PROMOTE PARENT/CARERS CONFIDENCE	2.25	1.34
SECTION FIVE: RECOMMENDATION	N=15	N=15
	Mean/2	SD
1. I WOULD/WOULD NOT RECOMMEND THIS BABY ACTIVITY CHART TO PARENTS	1.86	.051

Table 4.3 outlines that the highest mean scores occurred in Questions 1d regarding the BAC-Program's design format of four activities per page. The low mean score recorded with Question 2c relating to the BAC-Program's part 3: 'preparing to roll'. Interestingly, question five also returned a similar low mean score of 1.86 as this mean was calculated from only two questions.

The percentage results within all three tier columns (or two tiers in section 5) from highest to lowest ranked categories of the questionnaire, are presented in Table 4.4. Interestingly, the results from Section 1 *'Format'*: 1a-1d produced scores of 81%; 81%; 81% and 87% respectively within the first tier column. These scores provided support to the format of the BAC-program as all scores were above the accepted percentage figure of 75%.

Next, the results from questionnaire Section 2 *'Text and diagrams within the overall format':* 2a-2e delivered scores of 86%; 73%; 60%; 86% and 73% respectively within the first tier column. Sections 2b, and 2e produced scores slightly below the of 75% cut off score with 2c more markedly below with 60%. Consequently, these lower scores required Expert's comments to be carefully analyzed to determine what necessary changes may be required towards the development of the ultimately required second program edition: namely the BAC-Program/2. These changes are outlined in this study's section 4.3.2 below.

With regard to the results from Section 3- '*The BAC program has been prepared to expand parent/carers knowledge*'- a singular score of 81% was recorded. This result endorsed the potential *contribution of the BAC program to developing parent's knowledge* was endorsed as the score was above the accepted figure of 75%. Analysis of results from Section 4- '*The BAC program has been prepared to enhance to parent/carers confidence'* produced another acceptable score of 75%. Finally, an important outcome from Section 5 '*Recommendation of the BAC-Program': Yes or No'*: returned a very positive result with 93% of the experts ticking the 'yes' choice. This conclusion reinforced that overall, the experts' recommendation of the BAC-Program was confidently acknowledged.

Expert's Responses: Quantitative Percentage Results

- The frequency percentage within the highest response tier in Table 4.4 shows the overall results (out of 16 experts) calculated within each of the format's specific five sections.
- Next to the actual scores in the two lower response columns are codes of the specific experts (Ex 1) who have scored accordingly

- The percentage score was calculated and shown in table 4.4 as the proportion of experts rating an item at the level 3 (highest tier out of three choices) at each section of the questionnaire excluding section five.
- Level three comprised the term ‘highly’ and referring that the respondent expert had highly agreed to the question/statement. Level two included the term ‘very’ accepting that the responded was very accepting of the question/statement. Finally, the term ‘moderately’ referred to the respondent expert was only moderately in agreement with the question/statement.
- In section five the percentage rating was calculated at 2 (highest level out of two choices). A score of 75% and above was considered excellent when scored by 6 or more experts (Grant & Davis, 1997).

Table 4.4

ERQ Questionnaire item calculation of the percentage agreement per item from the 16 experts within the three response columns in questionnaire sections 1-5.

Section 1: Format	**Highly**	**Very**	**Moderately**	
1a: The **BAC** concept is a beneficial educational guide to a baby's overall development in the first 12 months	13/16 **81%**	2/16 (7; 8) (12.5%)	1/16 (6) (6.25%)	
1b: The activity **diagrams** are suitable for parents/carers to understand	13/16 **81%**	2/16 (7; 9) (12.5%)	1/16 (6) (6.25%)	
1c: The **text** accompanying the diagrams is supportive to the activities	13/16 **81%**	1/16 (14) (6.25%)	2/16 (6; 7) (12.5%)	
1d: The **format** of 4 activities per page will be helpful to assist parents to undertake and remember each activity	14/16 **87%**	2/16 (6; 7) (12.5%)		
Sections 2: BAC-Program	**The text/diagrams are appropriate**	**Section needs additional text/diagram**	**Section needs particular text/diagram removed**	**Section not ticked**
2a: Introduction	13/15 **86%**	1/15 (14)	1/15 (2)	(6)-insert references
2b: 1: Body Awareness Head Control Tummy time 12 activities:	11/15 **73%**	3/15 (7; 9; 14)	1/15 (10)	(6) no comment
2c: 2: Aware of my body and preparing to roll 8 activities:	9/15 **60%**	5/15 (1; 3; 10, 13; 14)	1/15 (7) Not sure of baby 'pull up' activity	(6) Discus core muscles stabilizing trunk
2d: 3: Arms and Legs preparing to push and pull across the floor 10 activities:	13/15 **86%**	2/15 (1; 9)		(6) references

Section 3: The BAC program has been prepared to <u>increase</u> parent/carers knowledge about their infant's motor development:	**Highly contribution**	**Average**	**Low**
	13/16 **81%**	2/16 (7; 14)	1/16 (6)
Section 4: The BAC program has been prepared to <u>enhance</u> to parent/carers confidence to physically interact with their young infant:	**Highly contribution (3)**	**Average (2)**	**Low (1)**
	12/16 **75%**	3/16 (7; 9; 14)	1/16 (6)
Section 5: Recommendation of the BAC program	**Yes**	**No**	**<u>Question omitted</u> from participant's questionnaire**
	14/15 **93%**	1/15 (6)	(7)

Table 4.4 outlines the Expert's responses to the ERQ in the five sections with each section receiving varied overall results. Section one 'Format' received <u>above</u> 80% responses to all 4 questions. Section two of the 'BAC-program' had more varied results between a low of 60% to a high of 86%. This was the important section of the ERQ that explored and questioned the Expert's on each of the BAC-Program's 4 specific movement segments (blue, green, purple, red) and more specifically each of the program's individual activities. The ERQ's sections three and four were focused on the function of the BAC-Program's aims to increase 'parent's knowledge' and 'confidence' when interacting physically with their infants and this section received scores of 81% and 75% respectively. The final responses to section five that referred to the over-all 'Recommendation of the BAC-Program', scored 93%. All the Expert's statistically collated responses and written comments (Table 4.5) are expanded and examined below.

Experts' Written Response Analysis

A thematic content analysis (Miles & Huberman, 1994) served as the method of qualitative analysis of the comments relating to the individual sections of the BAC-Program. This approach intended to identify key themes (similarities and differences) emerging from the individual comments as presented in Table 4.5. The item response scoring approach enabled this doctoral researcher to analyze the experts' comments particularly in the Section two where the scores were below the recommended 75% total (Table 4.5-section 2). It is important to note that the detailed responses and comments provided in Table 4.5 below outline specific expert's responses to shape the changes needed for the subsequent revised BAC-Program/2. The numbers below the second and third tiers responses relate to the individual expert's identification code. This identification approach shows trends from experts, specifically if certain experts are consistently in the first, second or third tiers. In the later discussion section of this chapter, specific experts will be discussed in relation to their comments and their professional occupation or expertise.

Table 4.5.

Sections 1-5. Experts format responses and comments

Section one: Format	**Experts comments**
1A: The *BAC* concept is a <u>beneficial</u> educational guide to a baby's overall	**Highly: (81%)** Program is simple/easy to read/a visual aid/loved the 'Why" section/informs and assists parents/beneficial to parents/participation is fun and enjoyable/ links motor and cognitive development. **Very:** *Numbers refer to specific experts* <u>7.</u> parents will appreciate ideas and activities. <u>8.</u> A well conceptualised program. **Moderately:** <u>6</u>. Parents interacting with a passive infant with some active assist approaches.
1B: The activity diagrams are <u>suitable</u> for parents/carers to understand:	**Highly: (81%)** Diagrams are clear/concise/brilliant/well-presented/easy to follow (especially for a sleep deprived mother)/I like the way the pictures are silhouettes of men and women'/Great illustrations. **Very:** *Numbers refer to specific experts* 7. yes- I could follow clearly. 9. Upside down activity needs more clarity. **Moderately:** 6. Drawings are well done and clear. Some may require a physically confident parent.
1C: The text accompanying the diagrams is <u>supportive</u> to the activities	**Highly: (81%)** Text explain the drawings well/easy to read and understand/support diagrams and language is appropriate for the intended audience/I used diagrams and my husband used the texts/The 'Why' section outlines the reasons behind the activities/helps parents/rationale for each activity. **Very:** *Numbers refer to specific experts* 14. Most text is clear if target population is semi-professionals but need simplification for parents with limited English. **Moderately:** 7. Noted his/her language and text gives evidence to support in the 'Why' section. 8. Parents may need references.
1D: The format of 4 activities per page will be <u>helpful</u> to assist parents to undertake and remember each activity	**Highly: (87%)** Good sizing/fits well/small knowledge build up/effective/sufficient/jolts memory Previous moves section is positive/allows repetition **Very:** *Numbers refer to specific experts*

Section 2: BAC-Program Sections	Experts comments
2a Introduction:	**Appropriate: (86%)** Fantastic overview/understandable/simple and clear/information logical in a clear way/add a diagram to add clarity to brainstem, medulla with directing arrows/perhaps medulla, pons terms are not required for this audience (x2). **Additional:** *Numbers refer to specific experts* 14. Text needs simplifying for parents with limited English. **Remove:** 2. Nervous system information (medulla etc) is too technical.
2b: Body Awareness ***Head Control*** ***Tummy time*** 12 activities	**Appropriate: (73%)** Very appropriate:/comprehensive yet simple (x4)/each activity has a s pecific purpose (x2)/text assists parent's confidence. **Additional:** *Numbers refer to specific experts* 7. A lot of focus on 'vestibular'- keep explanations clear 9. Push away: text could be in 'bullet points' 14. Most of text is clear. May need to simplify language if target is parents with limited English **Remove:** 10. Baby on back on the ball – best done actively.
2c*: Aware of my body* and preparing to roll 8 activities	**Appropriate: (60%)** Lovely variety of vestibular activities/sections are purposeful and appropriate and look fantastic (x4)/perhaps laugh and talk/look at baby /upside down hang may need extra safety/explain ATN reflex. **Additional:** *Numbers refer to specific experts* 1. Suspend from above a soft surface 3. Upside down could have adult on their knees here as this is a challenging activity for parents to try initially 10. May need to comment more on pelvis rotation 13. Bullet points and maybe realistic baby faces 14. Suggest with 'birthing reflex' and 'labyrinth reflex' comments- support with definition first **Remove:** 7. Not sure of 'baby pull up'.

2d: ***Arms and Legs preparing*** **to push and pull** across the floor, 10 activities	**Appropriate: (86%).** Meets development requirements/very appropriate/ok/very welcoming activities particularly for my baby who was not initially advancing developmentally. Appropriateness of upside down hang activity/activity is confronting **Additional:** *Numbers refer to specific experts* 1. Add a soft surface below upside down hang, 13. Add bullet text for' flying baby' activity.
2e: ***Preparing to crawl*** **on hands and knees** 8 activities	**Appropriate: (73%)** Good to mention variability of age to reach milestones/great overall coverage/easy to follow/ practical/ clearly illustrated. **Additional:** *Numbers refer to specific experts* 1. Suspend from above a soft surface. 3. Crossing over the midline repeated here; add another similar. 4. Forwards on hands and knees- remind parents that this is a cross pattern action. 9. Maybe sing to baby whilst doing exercises. **Remove:** Nil 6: Did not tick any boxes in section 2 but commented: 'I think age reference points may be useful. Discussed difference between 'reflex' and 'postural reaction'. Outlines personal perspective of Reflex Stimulation- Voijta as opposed to Goddard.

Section 3: ***The BAC program has been prepared to increase parent/carers knowledge about their infant's motor development.***	**Experts comments**
	High (81%) Agree completely (x2)/contributes highly/most impressive/provides appropriate milestone information/increased my knowledge (x2)/easy to follow (x2).
	Average. *Numbers refer to specific experts* 7. Great idea but perhaps too many vestibular activities. 14. Could contribute higher if language simplifies for parents/carers with ESL.
	Low 6. There are some good sensorimotor activities, but parents may need references.

Section 4: ***The BAC program has been prepared to enhance to parent/carers confidence to physically interact with their young infant***	**Experts comments**
	High (75%) Great for parents- giving a sense of confidence; clear concise; can be hung on wall and is a good reminder; confidence to know parents are doing something beneficial with their babies; very engaging and easy to follow promoting confidence with their babies; explanations simple and directive (x11)
	Average *Numbers refer to specific experts* 7. This chart highlights the importance of multiple positions and that it's ok to put infants in their tummies 9. Perhaps tweak to include emotional feedback between parent/carer and baby. Laugh, smile and sing as they do exercises together 14. Diagrams are excellent. Could contribute highly (i.e. above section) if language was simplified according to the target of parents (English as a second language) the Chart is addressing
	Low 6. There are parts that promote parent's confidence and other parts that challenge. A DVD would add parent confidence. (x1)
Section 5:	**Experts**
Recommendation of the BAC-Program	**Yes: (93%)** A great tool to educate parents/activities allows parents to enjoy their babies/chart is simple and informative/very happy with the quality and the underlying themes/very helpful in the community to overcome low muscle tone/chart promotes development (x4)/Program should be compulsory/ assisted our family more than four paediatricians/definitely- I support this concept
Non-Recommendation of the BAC-Program	**No:** *Number refer to specific expert* 6. Many of the activities contradict my theoretical point of view of 'how infants acquire motor abilities and functional motor independence

In Table 4.5 all the Experts' responses from the first tiers of each of the twelve questions sections have been presented collectively in short phrases. This grouping approach was adopted as these first tier responses comprised positive common threads in relation to the questions and were supportive of the particular question's aspect of the BAC-Program. The more detailed comments from the second and third tiers are recorded individually accompanied by the respondent's identification code. Modifications to the BAC-Program were considered from the comments from these lower two tiers particularly within the lower scoring questions. The identification codes provided each expert's specific vocation or profession to add clarity and expertise to these detailed and valued suggestions.

Implications of ERQ results for BAC-Program

The overall results indicated that experts responded supportively in nine questions out of the total of 12 questions within the questionnaire's five sections with Experts' responses scoring in the highest tiered response category a result of 75% or above. Of the three remaining questionnaire scores below the recommended measure, the outcomes were recorded at 73% (2b and 2e) and 60% (2c) respectively. Responses to these questions within the second-tier scales responses (additional and average) were then analyzed with resulting corrections or additions or merely acknowledgements (if in some situations only one Expert commented). These changes very stringently considered and formed the basis of the new BAC-Program/2 (Appendix J).

Predominately, the lower response scores occurred in Section two of the questionnaire. This section specifically centred on the actual BAC-Program's introduction and the four separate infant milestone activity components. More specifically, the experts had been asked to respond to the 'appropriateness' (first tier response); 'needs additional text/diagram' (second tier response); or 'needs particular text/diagram removed' (third tier response) according to all the thirty nine activities within the program over the four milestone components. The following detailed analysis was determined by the specific scores received. In particular, the analysis was also focused on particular comments to Questions 2b (body awareness, head control, tummy time), 2c (aware of my body and preparing to roll) and 2e (preparing to crawl on hands and knees) due to receiving evaluation scores of less than 75%. Comments on Questions 2a (introduction) and 2d (arms and legs preparing to push/pull across the floor) were also briefly analysed as comments presented were deemed relevant to be included in the evolving BAC-Program/2. Although these two questions received positive scores of 86%, small changes were made in relation to several important comments referring to the need to include less technical wording. This collective or 'constructivist' approach supports the mixed methods approach utilizing both the quantitative figures and the qualitative 'thematic' method to explore resolutions to the experts' responses.

Section 2a: This positive scoring question related to the BAC-Program's Introduction section scoring 86% (13/15) within the first tier column. This high result originally determined that this section did not necessarily require any defined changes. But, expert's 5, 10 and 15 interesting commented within this first tier (appropriate) column, that the 'Nervous system information may be a little too technical' for the infant's parents/carers. This 'overly technical' comment was repeated in the third tier (needs text removed) by Expert 2, with Expert 14 ticking the second tier (needs additional text) column and adding the need to simplify the language to accommodate ESL parents. Consequently, the references to the nervous system including medulla, pons, midbrain and cortex in the introduction were deleted and replaced with friendlier phrases such as 'Prepare them (your infant) for the future'; 'Stimulate and love your baby through movement' and 'Loving touch and gentle activities help stimulate your baby's neurological pathways to provide them with the best possible advantage in their future development'.

Section 2b: This question referred to the BAC-Program's section one (blue): 'Body awareness, Head control and Tummy Time'. The score of 73% (11/15) resulted in response to the question regarding whether the BAC-Program's Texts and Diagrams in this section are

‘Appropriate’. Three Experts, 7, 13 and 14, responded to ‘needs ‘Additional’ text/diagrams’. Expert 10 had responded in the third-tier scale responses: ‘Needs particular text/diagrams removed ’. This Expert’s concern relating to ‘back roll on the ball’ was also reviewed but not acted upon as not deemed applicable in relation to the majority of other experts’ positive comments. In response to specific comments relating to simplification of language by expert 14 and subsequently other experts within the EQR, an additional page (page four was introduced into the BAC-Program/2 with clearer and more supportive wording (see dot points below). A bullet type layout design was adopted (Expert 13) within a specifically designed - big red circle in page four. This page was planned with language to be more supportive to parents with ‘limited English’ as requested in several later questionnaire sections by expert 14. Expert 7 commented on need to focus on handling baby appropriately in relation to the number of ‘vestibular’ activities in the BAC-Program’s first section (blue). This comment was acknowledged and although several vestibular activities were relocated within the sections two, three and four, it was decided that the wording was appropriate for parent/carers when handling their infants in the vestibular focused activities.

A summary of the new dot points on page four of the new BAC- Program/2 included:

- ‘BAC supports your baby’s development by engaging the developing brain through movement’. ‘Stimulate (your little one) …….through touch and movement’.
- ‘No specific time framework for how quickly your baby should progress through the program………..’
- ‘These activities simply activate and support your baby’s progression………’
- ‘The Chart is a fun and relaxed way………..

With the attention and appropriate adjustments to experts 7, 9 and 14 comments, the new blue section one- Body awareness, Head control and Tummy Time' of the BAC-Program/2 was established.

Section 2c: This question referred to the BAC-Program's section two (green): 'Aware of my body and preparing to roll'. The score of 60% (9/15) again questions as to whether the Texts and Diagrams are 'Appropriate'. Five experts (1, 3, 10, 13 & 14) responded to 'needs 'Additional' text/diagram'. The 'Upside-down hang' activity generated comments from Expert 1 and 3 and also Expert 16 who actually ticked the 'appropriate' box. Expert's 1 and 3 comments regarded 'suspend above a soft surface' and 'parents on their knees' respectively. As one comment related to a safety aspect and the second to the challenge of this activity to new parents/cares, this action was therefore replaced with the activity 'Leg flip over'. This new activity addition to this section two was already in the following Purple section 3 of the initial BAC-Program. It was considered that 'Leg flip over' was a gentler action for the younger infant and more appropriate for parents who were newly introduced to vestibular actions. Expert 10 suggested 'suspend from pelvis…' and the 'Leg flip over' activity involved suspending baby from the pelvis or hips. Comments from all these three experts were addressed by introducing the 'Leg flip over' and removing 'upside-down hang' from this section.. A soft pillow together with parents on their knees was also included in the later inclusion of 'Upside-down hang' in the third BAC-Program/2 sections (see 2d comments below). Comments from Expert 13 were analysed regarding adding 'bullet points' and these comments were addressed in section 2b above.

The 'Note' section at bottom of page seven, introducing advice on whether parents/carers initiate early sitting activity of their infants, was also amended in BAC-Program/2. It was decided that rewriting this information would address Expert 14 who had commented several times in the questionnaire regarding the need to simplify the wording to accommodate ‘English as a second language’ (ESL) parents. Also, Expert 6 commented on the ‘sitting’ information but did not circle this section. Comments by Expert’s 1, 3, 10, 13 and 14 were all responded to in BAC-program/2 and a revised section two (green) was created.

Section 2d: This question referred to the BAC-Program’s section three (purple): ‘Arms and Legs preparing to push and pull across the floor’. Although the score of 86% (13/15) as to whether the Texts and Diagrams are ‘Appropriate’ suggested that changes were not required, there was a very important comment from expert 1 in “needs ‘Additional’ text/diagram” section. The new addition included the requirement of a soft pillow below the ‘upside-down hang from hips’ diagram in section three (purple) of the BAC-Program/2.

Section 2e: This question referred to the BAC-Program’s section four (red): ‘Preparing to crawl on hands and knees’. The score of 73% (11/15) questions as to whether the Texts and Diagrams are ‘Appropriate’. Four experts (1, 3, 4 and 9) responded to ‘needs ‘Additional’ text/diagram’. Changes in this section again included the sketch of a soft pillow in ‘upside-down hang’ diagram and the moving of the suspension- ‘by the ankles’ activity to this fourth section of the BAC-Program/2 in agreement with expert 1. Comments from Expert 3 and Expert 4 regarding crossing the midline and cross pattern actions were reviewed and it was considered that both these sections were written clearly in pages four, eight and ten of the initial BAC-Program. These two important nervous system related midline actions would remain unchanged following the previous decision the keep the text clear and simple for parent/carers from various cultural backgrounds. Expert 9 suggested singing whilst doing the exercises and although a rhythmic poem was included on pages six and eight, this proposal was not adopted in BAC-Program/2. With attention to Experts 1, 3 and 4, section four (red) of the BAC-Program/2 was consequently slightly adjusted.

Discussion

Study one of this doctoral thesis investigated the evaluation of a wakeful prone, vestibular program (BAC-Program) in relation to the responses to a questionnaire from the Expert panel of sixteen participants. Through comparisons to previous ‘content validity of measurement’ study designs (Post et al., 2008; Wilkie, Peat, Thomas, Hooper, & Croft, 2005), this doctoral thesis’ ERQ measure similarly collected constructive participants responses in relation to an analysis and evaluation of a defined participation program. The interpretation of results utilized the percentage score of 75% from the expert’s highest responses tier as the consensus agreement criteria (Grant & Davis, 1997; Hayes & Hatch, 1999). Alghwiri et al. (2012) suggest that the level of consensus is generally the decision of the researcher according to the study’s design as this level often varies between studies. Interestingly, there were no remarks from any of the participating Experts that suggested ambiguity of a particular question, and Lynn (1986) suggests that analysis is more precise when the questionnaire items or statements have clarity and where they can be quantified with unified responses. The design approach of the questionnaire thus evaluated the accurate sampling of the informed participants (Hittleman & Simon, 2006) by collating the tool’s (questionnaire) authoritative and applicable responses in relation to the overall judgement of the BAC-Program (instrument).

Relationship of Expert’s responses to current research and theory

This first study of this doctoral thesis provided responses from early years movement experts in the evaluation of the BAC-Program. Overall the infant movement program was positively reviewed, and comments closely analyzed. This analysis contributed to small changes to certain sections of the BAC-Program in response to suggested modifications from the collective experts' comments. When comparing with previous research on the advantages on early movement support programs for families of very young infants (Gross et al., 2017; Hewson, 2011; Jennings et al., 2009; Lee & Galloway, 2012), the BAC-Program's activities maintain similar content and movement information text, although in much more explicit pictorial detail. The initial BAC-Program presented as a supportive platform for families to engage with their infants in tummy time and vestibular activities to encourage the development of motor milestones. The subsequent modifications from study one led to the creation of the BAC-Program/2.

The procedure of Study one in using Experts to decide on the best outcomes was reliant on the selection of a diversity of experts within a specific field to ensure that alternative ideas were not overlooked. Ideas and suggestions needed to be systematically reviewed on their relevance and the subsequent evidence supported within the literature. This ensured that valuable alternatives were evaluated, and knowledge gaps pursued (Grant & Davis, 1997; Sutherland & Burgman, 2015).

This following discussion section maintained an important link between the present doctoral research and infant motor development theory, ultimately ensuring that all responses were interpreted and contrasted to show trends and patterns in the evolution of the BAC-Program/2. Through the analysis of all the expert's collective responses, five principal target areas of the BAC-Program are now discussed. These include:

- impressions of the layout, texts and designs of the individual activities:
- the appropriateness of all the movement actions within the programs four sections to support infant motor development and milestones;

- the expectation of increasing parents' and carers' knowledge regarding infant milestones:
- the confidence of parents' and carers' to physically interact with their infants:
- the overall recommendations of the BAC-Program.

Impressions on the layout, text and designs of the movement activities

Within this study, it was important to determine if the design or blueprint of the BAC-Program's diagrams, texts and layout (four activities per page) were able to contribute to parents/carers' understanding of relevant activities for young infants. The four questions relating to these design concepts within the questionnaire's first section, all received positive responses. To achieve this consensus from Experts on the movement activities, together with their opportunity to provide further comments when evaluating a movement activities measure is affirming (Alghwiri et al., 2012). The texts and diagrams were very positively reviewed with responses including "beautiful illustrations, visually aid the user, easy to read, are clear to follow, baby is shown as the focus". Three Experts (one parent and two MCH nurses) collectively commented on the '*clarity of the diagrams'*.

The 'Why' section that was part of the text accompanying each diagram, also received positive comments. The five Experts (parent, chiropractor, MCH nurse and two preschool movement teachers) mutually associated the value of the 'why' explanation section contributed to a rationale or justification for each movement action. Responses included "very informative, increases knowledge, reasons why to do them regularly, increases compliance and contributes to the specific reasons behind each activity". One Expert (chiropractor) suggested that the 'Why' section *'aids understanding and thus educates'*. These responses to the text 'Why' sections are further supported by Hewson (2011) and Jennings et al. (2009) as examples of successful infant movement research programs where actual written advice was available to parents. The comments relating to the layout of four activities per page included *'increases repetition and knowledge'* (second chiropractor), *'reduces clutter'* (preschool movement teacher), *'not too over whelming'* (osteopath), whilst the small repeated diagrams at the bottom of each page "allows a constant reminder" (early education movement lecturer).

In contrast, the comment surfaced several times with an Expert (MCH nurse-midwife) pertaining to the text needing to be simplified if the parents/carers are from ESL families. Another expert (osteopath) agreeingly reported that the nervous system information may be a little too technical. These comments were examined and supported the modification to the Introduction section of the BAC-Program/2 (see response two). As these reoccurring simplicity comments were carefully and commonly reviewed, a new page four was also included between the 'body awareness, head control and tummy time' (section one {blue}) and 'aware of my body and preparing to roll' (section two [green]) in the new BAC-Program/2. This addition allowed simple wording in dot formation to be more readily accessed and accepted by the intended audience. Ricard and Metz (2014) supported the notion to keep the information (particularly relating to tummy time positioning) simplified ensuring that parents and carers are both aware and confident when implementing movement activities with their infants.

The appropriateness of the BAC-Program's movements and infant milestones

The next section of the BAC-Program namely - 'aware of my body and preparing to roll' section two (green), received four slightly varied comments regarding the 'upside-down hang' activity. This activity received the most comments from experts compared to all the remaining 34 activities within the BAC-Program. The responses to this activity may have contributed to this section's lower evaluation by Experts responding to the appropriateness section of the text and diagrams within the questionnaire. An Expert (osteopath) proposed that it would be more appropriate to suspend the infant *'from the pelvis'* and *'above a soft surface'* in this activity. Another Expert (MCH nurse) agreed and added the recommendation of a safety pillow addition. A third Expert (preschool movement teacher/lecturer) advocated to "have (the) adult on their knees here as this is a challenging activity for parents". The final Expert (chiropractor) commented on the need for more information regarding 'pelvis rotation'.

Consequently, on careful analysis by this researcher, the 'upside-down hang' activity was removed from section two. This activity re-emerged in a modified form in section three and then less modified in the later section four of the BAC-Program/2. Therefore, this feedback informed the decision to replace the upside down activity with the more gentle and simplified activity- namely 'Leg flip over'. Interestingly, the new activity was originally offered in the section three (purple) of the BAC-Program and shows the parent in a sitting position, supporting the infant by the hips. This more simplified action, now in Section two of the BAC-P/2, became more appropriate for parent/carers' who are newly introduced to a vestibular type activity. Supporting parents when interacting with vestibular actions is consistent with various research studies relating to the confusion experienced by parents/carers when interacting with these type of actions with their infants (Bachmann, Lavender, & Castiglione, 2018; Jahn, 2009; O'Reilly et al., 2011). This doctoral researcher's response was to acknowledge the advice from all the above Experts. It is relevant to also note that two further Expert's (preschool movement teacher/lecturer and MCH nurse) commented that the original *'upside-down hang'* activity would appear *'challenging'; 'confronting'* to parents and it was agreed by this doctoral researcher that this is possible when positioned early in the BAC-Program.

The 'Note' section at bottom of page within this second section (green) regarding additional advice on early sitting, was also adapted in BAC-Program/2. This rewrite was in response to comments to simplify the program's text and to also accommodate an Expert's (Physiotherapist) singular response regarding the relationship between 'core muscles stabilizing trunk' and the rolling and sitting milestones. There are divided opinions as to relationship between the infant moving onto hands and knees and the sitting alone milestones. There is a view from various researchers that the sitting alone milestone precedes crawling on hands and knees (Davis et al., 1998; Hewitt et al., 2017; Robertson, 2011). Other researchers view the sequence with the infant initially crawling on hands and knees first and then levering themselves into a sitting position as the correct transition sequence (Kuo et al., 2008; Soska et al., 2015). The BAC-Program/2 adopted the latter view as the sitting action can be encouraged too early (pre-crawling), affecting infants developing important arm and leg strengthening and overall balance required for coordinated crawling on hands and knees (Freedland & Bertenthal, 1994; Soska et al., 2015). The sitting infant with poor core strength and low balance reactions can lead to the infant adopting a 'bottom shuffling' locomotion. This method of moving in the sitting position, on the bottom with a leg pushing action, does not encourage cross patterned arm and leg actions required when hands and knees crawling, often affecting later coordination (Goddard Blythe, 2002).

The third section (purple) of the BAC-Program namely -'arms and legs preparing to push and pull across the floor' became the most rearranged section and also received a newly designed activity. As discussed in the second section, and on the suggestion of four experts, a newly revamped 'upside-down hang from hips' diagram was included in section three in BAC-Program/2. It is interesting to note that an additional Expert (another MCH nurse) relating to section three activities in the original BAC-Program, commented on the concern for this original upside-down (from feet) action. This Expert did not comment on this same action that was originally introduced in section two. Thus, design changes to this diagram now included the suspending of the infant by the 'hips', the addition of a soft pillow below the infant, and the parent drawn in the kneeling position. This activity was originally located as activity three (3/3) in this third section, but the now modified action was then relocated to activity ten (3/10).

This doctoral researcher acknowledged the advice of the two health care professionals, two MCH nurses and an infant movement teacher. The acknowledgment of the changes allows the process of using experts' opinions, whether highlighting weaknesses or strengths, to assist in developing new ideas and effective programs (Ouimet, Bunnage, Carini, Kuh, & Kennedy, 2004). Due to the modified 'upside-down hang from hips' diagram's new relocation, there was a general rearrangement of all the other diagrams to ensure the parent/carers confidence was both acknowledge and supported particularly in the vestibular focused actions (Abad & Edwards, 2004; Cohn, 2001).

Lastly, Section four (red) of the BAC-Program was well supported by the experts. The main modification occurred in the re-introduced 'upside-down hang from the feet' as it was reasoned that parent/carers had been gaining confidence and knowledge in the modified vestibular actions during interaction within the previous three BAC-Program sections. A soft pillow was again included as a result of the previously discussed experts' concerns. This activity with the infant suspended by their ankles benefits the infant as this gravity inversion action allows the spine to relax and release (Boocock, Garbutt, Reilly, Linge, & Troup, 1988). Voss (2014) outlines that the inverting actions with infants assists in the regulation of the nervous system, can be calming and alerting and provides a unique vestibular experience. The upside-down hang encourages the infants head and back to arch (head control) as the infant orientates themselves in space (Lackner & DiZio, 2005). Furthermore, an Expert (ICU nurse and midwife and a parent) added these comments:

'My baby was slow in her development. She was treated for colic and vomiting etc. but as she appeared to have a vestibular problem, within a month of practicing the BAC's exercises she became a happy, laughing child. No longer vomiting she caught up and took off crawling'.

The relationship between an under responding vestibular sensory system and slow infant motor development is discussed by Jouen (1984) as an undeveloped co-relationship with the infant's visual system. This researcher proposes that visual-vestibular interactions can be inter-linked with the actions involving the infant's head control. A large body of literature focuses on evolving sensory pathways such as auditory, tactile, visual and vestibular sensory systems in the development of behavioral responses particularly in preterm infants (Holditch-Davis et al., 2014; Nelson et al., 2001; White-Traut et al., 2002). In support, the BAC-Program outlines various activities to assist the development of head control, together with visual/vestibular reactions that promote the infants nervous system and subsequently the motor milestones.

Another Expert (infant movement teacher) supported the introduction of the specific text (included in Sections three and four) relating to the *'variability'* or specific age as to when infants may achieve each movement milestone. This variable approach is comparable to previous research (Adolph et al., 2011; Quezada & Haan, 2012) as infants may begin commando crawl at six months but the duration of this rudimentary skill varies greatly before generally progressing to hands and knees crawl at perhaps nine months. These are generalized predictions that are very specific to individual infants ((Gerber et al., 2010).

The expectation of increasing parent/carers' knowledge regarding infant milestones

The BAC-Program was initially developed as a concept to inform and to increase parent/carers knowledge on infant motor development including infant milestones. This model was reiterated in other studies (Jennings et al., 2009; Koren et al., 2010; Ricard & Metz, 2014) which discuss the need for uniform and readable information be available to the parent population regarding the importance of daily tummy time. The contribution of the program to develop parent/carers knowledge was shown as a positive endorsement from the majority of experts who ticked this section. This conclusion was supported by the following respondents (parent, MCH nurse, physiotherapist, midwife) who wrote: *'agree completely'*; *'definitely and highly informed parents'*; *'most impressive'; 'gave parent's ideas and actual activities'*. One parent interestingly identified that *'we need to know more about motor development'*.

The BAC-Program presented beneficial '*neurological' and 'cognitive'* background relating to infant motor development according to Experts (two chiropractors) when responding to the contribution of program as an educational guide. These opinions seem to slightly contrast to one of the MCHN Experts (midwife) who suggested that the BAC-Program "could contribute highly" if the text was simplified especially for families with English as a second language. These contrasting responses maybe a result of the challenge facing the researcher that all selected experts meet the content criteria (Grant & Davis, 1997) together with the individual's different values and their varying professional audiences and/or experiences (Sutherland & Burgman, 2015). Furthermore, this later response appears consistent with Devolin et al. (2013) and Moran and Ghate (2005) who report that parents of young children seek information and programs to support their parenting particularly those in non-English speaking or lower socio-economic groups. The Expert's (midwife) response regarding the need to simplify the *'language'* was again in contrast to another expert (physiotherapist) who suggested that more 'reference links' were needed to better inform parents/carers regarding sensorimotor play activities. Polit, Beck, and Owen (2007) interestingly proposed that knowledgeable researchers are defended in resolving whether a result value is within a particular range, if supported by logical conclusions in relation to their particular expertise.

A review of the relevant responses provided this doctoral researcher for material for amendment of the Introduction section of the revised BAC-P/2. Previously, the components of the nervous system and the brainstem including the medulla, pons midbrain and the cortex were presented in the BAC-Programs first page. Although these terms are important in relation to infant motor milestones literature (Quezada & Haan, 2012; Zafeiriou, 2004), this technical information was considered quite technical for the intended parent/carer target population and re-assessed for the BAC-Program/2 second edition. Specifically, one Expert (health professional) commented on the technical emphasis of the wording within the Introduction suggesting the *'removal of this more technical nervous system information'*. On reflection, the language was refined by the use of less specialized wording: 'gentle activities help stimulate your baby's neurological development' to support the parent/carer audience, including ESL families. An additional Expert's comment to include actual research references was reviewed but considered not appropriate for the BAC-Program's target population.

Thus, the data collected to inform a second edition of the BAC-Program/2 was an evaluative procedure that is comparatively considered by Brown and Kiernan (2001) as a 'formative' evaluation approach (judging the value of a program while the program is still being formulated) and a measured analysis of the experts' comments. These authors concluded that future program implementations and changes can be positively impacted thus strengthening the redefined programs to further diffuse new knowledge. Alghwiri et al. (2012) add that experts contribution to the formation of a new instrument provides clinicians and researchers with a more relevant and effective measure or program.

Confidence of parent/carers' to physically interact with their infants

The BAC-Program's ability to increase parents/carers' confidence (Section four of the questionnaire) received supportive scores and responses. These replies were consequently reviewed and analyzed. The result was slightly skewed as the Expert (midwife) who ticked the 'average' (second-tier) box for contributing to parent/carers' confidence, and was very complimentary, again reiterated the request for simplification of the text to accommodate ESL parents. Another Expert who also interestingly ticked the 'average' box but added: *'This chart highlights the importance of multiple positions and that its ok to put infants on their tummies'*. These comments appear very positive in this second-tier response category. Largely, the comments within the first-tier *'high contribution'* segment were confirming including two Experts (osteopaths) who indicated that the BAC-Program concept was a similar approach adopted by their profession and is a '*great tool for parents and gives a sense of confidence'*.

Two Experts, who were also parents (one was a midwife and one a Physical Education teacher), commented *'yes-it gave us confidence'* and *'it promotes high level of confidence……is very engaging*'. Further comments from Experts (early childhood lecturer, chiropractor and MCH nurse) included "the chart provides parents with easy ways to interact with their infant; is simple and effective; clear and directive". In contrast, one Expert (physiotherapy) suggested that certain activities may require a physically confident parent as there were *'tasks that would promote parent confidence whilst other may challenge that confidence'*. Interestingly, this expert also added that '*drawings and illustrations [are] well done and are clear*'.

Principally, the majority of Study one's Experts accepted and supported the BAC-Program's ability to contribute to parents/carers' confidence. Several other studies (Jennings et al., 2009; Lobo & Galloway, 2012; Ricard & Metz, 2014) also centred on supporting parents self-assurance to interact with their infants, particularly baby positioning approaches including tummy time. There was an assumption that the new and more simplistically written additional text including the changes to the Introduction, the addition of New page four and the changes to the Note section wording would be a factor in maintaining and contributing to the confidence levels for parent/carers when interacting with the program. Thus, consideration of the replies and comments also reinforced this Study's format to gather knowledge from professionals 'on a topic on which they have expertise' (Lindstädt et al., 2018, p. page 2) in the pursuit of the evaluation of the BAC-Program.

The overall recommendations for the BAC-Program

The questionnaire's Section five responses, relating to the Expert's overall recommendation of the BAC-Program to parent/carers, produced an almost unanimous majority of 93% who agreed that they would recommend the BAC-Program. Consequently, this result in Section five's evaluation, advocates the positive support to this Study one's overall evaluation process of the motor activity program. This finding is consistent with other assessment methodology research when depending on expert's agreement and consequently when results show that judgements are in accord (Podvezko, 2007). This evaluation process can also provide positive evidence to validate the concepts and content contained in a study's main focus (Adcock & Collier, 2002).

To achieve this authenticity in Study one, there was an emphasis on the extent and the type of evidence that was central to the purpose of this study: being the recommendation by the experts of the BAC-Program (Fraenkel et al., 2012). Specifically, three Experts (midwife and two MCH nurses) commented in the *'Yes'* recommendation box: '*the chart gives families specific activities and skills to encourage age appropriate development as well as reasons behind it'; 'Explained the importance of basic motor activities'* and *'I like the information and the presentation; Very beneficial for baby's motor skill development and spatial awareness'*. Another Expert (chiropractor) commented positively on the quality and underlying themes of the BAC-Program and information within the written text, also adding *'feel parents would be* *comfortable using this chart'*. A further Expert (also a chiropractor) remarked with an encouraging BAC-Program recommendation *'Communities need all the help they can get to support development and overcome the shift towards low (muscle) tone'*.

One Expert (osteopath) discussed that health care professionals can also have a large role in educating and encouraging parents on physically interacting with their infants. This particular critique is supported by studies by Jennings et al. (2009); Lobo and Galloway (2012); Mildred, Beard, Dallwitz, and Unwin (1995); Ricard and Metz (2014); Zachry and Kitzmann (2011) confirming that community educators can play a more active role to assist parents to be more knowledgeable on the importance of awake prone play in early in infancy. The overall support for the conception and concept of the BAC-Program was very explicit and aligned positively to comparable 'prone playing' home based infant motor programs by Hewson (2011) and Lobo and Galloway (2012).

An Expert (physiotherapist) ticked the *'did not'* recommend the program in Section five and attached the comment *'Many activities contradict my theoretical point of view'* of *'how infants acquire motor abilities and functional motor independence*'. There is an assumption by this doctoral researcher that the 'point of view' may be linked to this Expert's professional background and work in a developmental coordination disorder research group. The Expert's emphasis and interest appear focused in the clinical areas of assessment of motor disorders in preterm and term infants to young adults. To add clarity to the area of paediatric physical therapy, Hakstad (2017) outlines that prevention, detection and treatment of motor impairments are key fundamentals in this therapy domain. There is a further assumption that some fields of Physiotherapy can be aligned with the clinical 'Motor Learning' theory (Hakstad, 2017; Zwicker & Harris, 2009) and the contemporary- the Dynamic systems theory (Thelen, 1995). These domains emphasize the infant's development is dependent more on the specific task and the nature of the environment together with practice and natural feedback to achieve goal directed skills.

This may contrast with the BAC-Program's focus on tummy time activities to promote infant head control, and limb strength activities to support a more natural progression into infant motor milestones. The BAC-Program also has an emphasis on vestibular, proprioceptive and tactile sensory actions with a link to the Occupation Therapy discipline including the Sensory Integration theory (Dunn, 2007) rather than focusing on the infant's motor impairments. Thus, the BAC-Program is more aligned with the developmentalist and neuro-developmental theories (Javier, Antonia, & Julio, 2012). These neuro-developmentalist theorists (motor milestones progressions) can often differ from the dynamic theorists (environment and task together with proprioceptive information regulation and movement control) according to each researcher's interpretation of how infants acquire motor skills (Brown & Greenwood, 1999; Thelen, 1995; Zwicker & Harris, 2009).

Interestingly, the Study Two's other physiotherapist provided a positive *'yes'* recommendation response to BAC-Program and wrote- *'Clear and understandable activities allow parents/carers to enjoy their babies'.* There were further supportive comments and conclusive recommendations from the other eleven allied health professionals including midwives, paediatric chiropractors, paediatric osteopaths, and MCHN nurses. Lindstädt et al. (2018) interpretations are relevant here. These researchers propose that experts are unlikely to be equally conversant and discuss the difficulty of the researcher to gauge each expert's actual knowledge and point of view. Furthermore, Lindstädt et al. (2018) and Podvezko (2007) suggest, when analysing the difference of opinion between the experts, it is acceptable to review the participants resultant scores on the highest ranked -Likert scale score to ascertain agreement. Thus, if some experts have different opinions, the robustness of these overall results are examined and ranked (Berrittella, Certa, Enea, & Zito, 2008). The overall results of the ‘Yes’ score received for the BAC-Program recommendation from the highest ranked column, was 93%. The non-recommending Expert’s comments were reviewed and welcomed but did not influence the overall supportive evaluation for the BAC-Program.

Summary and Subsequent Thesis Research

The first Study in this research has achieved a positive evaluation of the BAC-Program. The large majority of experts contributed supportive responses and also further suggestions to the creation of the second edition: the BAC-P/2 program. There was also strong positive support for the notion that the BAC-Program would be a contributor to the parents/carers becoming more knowledgeable about their baby’s motor development. In addition, the concept of diagrammatic movement sketches and texts (with minor adjustments) would enhance parents/carer’s confidence to physically interact with their young infant was constructively supported.

These Study one results were very promising as the impetus behind the creation of the original BAC-Program was a global reluctance from parents/carers to fully participate in awake tummy time (Majnemer & Snider, 2005; Nitsos et al., 2017; Waitzman, 2007). Accordingly, this program was designed to assist parents to explore fun ways to place their infants on their tummies during awake periods and to additionally explore vestibular actions to support the emergence of relevant motor milestones, together with the enhanced growth of the nervous system of their infants.

Research on full term infant’s likely progression into prone locomotion motor milestones and the relationship to later fundamental motor skills development is limited (Piek, Dawson, Smith, & Gasson, 2008). More studies appear to focus on infants born preterm or brain affected infants (Prosser, Ohlrich, Curatalo, Alter, & Damiano, 2012; van de

Weijer-Bergsma, Wijnroks, & Jongmans, 2008; Wijnroks & van Veldhoven, 2003). The BAC-Program therefore endeavoured to become an instructional program and a valuable resource to support for all parents in their interaction with both pre-term and full term young infants. The revised BAC-P/2's format became a more accurate visual program with specific infant movement sketched activities that particularly encouraged awake prone time and vestibular actions, for all infants. Therefore, further research in Study two will continue to investigate the influence of this awake prone, and vestibular activity program (BAC-P/2) on participating infant's motor development.

CHAPTER 5: AN INVESTIGATION OF THE INFLUENCE OF A WAKEFUL PRONE AND VESTIBULAR ACTIVITY PROGRAM ON EARLY INFANCY MOTOR DEVELOPMENT: STUDY TWO

With the early 2000's recommendation to sleep new-born infants on their back as a result of the 'Back to sleep and tummy to play' initiative (Blanchard et al., 2004; Willinger, Hoffman, & Hartford, 1994), parents and carers of young infants were subsequently encouraged to undertake awake, tummy time activities (Majnemer & Barr, 2006; Malina, 2004). The Baby Activity Chart-P/2 (BAC-P/2) was thus created (post Study one) to provide easy to follow tummy time and vestibular focused actions for infants and families. The initial supine sleep campaign of the mid 1990's was in response to the Sudden Infant Death Syndrome (SIDS) associated with sleeping infants in the prone position as one of the several risk factors (Bales & Godfrey, 2013). A more recent promotion changed the name to: 'Safe to sleep campaign' (Safe Infant Sleeping Environment) for more clarity (Moon, Hauck, & Colson, 2016). The initial BAC-program was positively evaluated by early childhood movement Experts in Study one. The Experts' responses were very supportive, and several minor changes were also undertaken as a result of particular expert's comments, thus creating the BAC-P/2. These changes focused on simplifying the wording to cater more closely with all families. The BAC-P/2 also adapted and re-positioned several vestibular actions to allow the program to be more suitable and practical to parent/carers' of young infants.

Subsequently, Study two was initiated to investigate the influence of the BAC-P/2 on the milestone development of infants ranging in age for 6-9 months. This investigation incorporated two study groups: namely the BAC group (experimental) and the non-BAC group (control). The BAC group of infants and families (n=29) was introduced to and presented with the BAC-P/2 at approximately 10-11 weeks post birth. The Non-BAC group (n=34) did not receive the BAC-P/2 until after each infant was observed and data collected, post 6-9 months of age. The division of the study into two infant participation groups (Charitou et al., 2010; Van Haastert, De Vries, Helders, & Jongmans, 2006) enabled the doctoral research to analyze any observed and collated differences between these groups in infant motor milestone development over the period of 6-9 months post birth. This study aimed to develop a rigorous investigation of the influence of both tummy time and vestibular activities (BAC-P/2) on infant motor development utilizing the Alberta Infant Motor Scale (AIMS) assessment tool.

The research paradigm, design and methods adopted in this study were paramount to ensuring that the research question was answered as unambiguously and accurately as possible (de Vaus, 2001). The research intention being *'an investigation of the influence of a wakeful prone and vestibular activity program on early motor development'*. A dominant perspective that has influenced this research paradigm is the positivists approach that commonly relies on empirical evidence (Hittleman & Simon, 2006). Thus, the research design centered on the experimental approach within the quantitative design category adopting the components of cross-sectional and comparative design approaches (Denscombe, 2010; Lodico et al., 2006; Mann, 2003). As the BAC-P/2 included predominately tummy time and vestibular based activities, two sub questions were included to review any association between the daily time spent by each study group in these type of activities in relation to the overall milestone (AIMS) results received. The sub aims were:

- Review the amount of time infants and parents in both sample groups participate in 'tummy time' (prone) activities in relation to milestone development.
- Review the amount of time infants and parents in both sample groups participate in 'vestibular time' (vestibular) activities in relation to milestone development.

Method

Research Process

The research approach for Study two involved the quantitative design methodology. This research approach endeavoured to clarify if a specific intervention influences an outcome. In other words, the quantitative approach focused on measuring a series of variables to find answers to the research question (Cresswell & Cresswell, 2018; Lodico et al., 2006). As such, the hypothetic deductive method was adopted, initially forming a research premise that can be tested by the collection of data (Lodico et al., 2006). The present research applied an aspect of deductive reasoning or a 'top down' approach where the researcher initially forms a general question, then pursues specific evidence that may support or invalidate that statement (Ciania, Summers, & Eastera, 2008). Consequently, the analysis of the data concentrated on the use of descriptive statistics. The quantitative approach supports the researcher in coordinating and reviewing the collected data and summarizing the results to discuss any subsequent correlations or relationships (Denscombe, 2010). 'All quantitative research approaches summarize results numerically. However, the approaches differ in their goals and the procedures used to collect data' (Lodico et al., 2006, p. 12) **.**

Research Design.

Experimental research figures strongly in quantitative design. This design approach centred on studying the consequence or power of a research approach under rigorous and specific conditions to answer questions about causality (Hittleman & Simon, 2006; Lodico et al., 2006). It is important that a researchers carefully consider all aspects of the design as the evidence being collated supports and pursues answers to the important research question. Keeping in mind that cause can perhaps be inferred but cannot be observed and it is central in a research design to dissuade conclusions that cannot be substantiated (Hittleman & Simon, 2006). This quantitative doctoral study incorporated a cross-sectional design applying the observational tool- the Alberta Infant Motor Scale (AIMS) to examine the motor skills of 6 to 9 month-old subjects. The cross-sectional design approach supported this study's goals and intentions as presented in de Vaus (2001, p. 50) design objectives:

- Relies on existing variations in the independent variables
- One independent variable with at least two categories
- Data is collected at one point
- No random allocation of groups.

This design was distinctive as being a group based approach albeit without random allocation and was used to pursue prevalence to a greater degree than causality (Mann, 2003). This approach influences the predictive value of the investigation and shows a slight differing path to experimental design studies. The cross-sectional design method examines data at particular point in time interpreting single variables across differing subgroups or sample groups (Cummings, 2018). Thus, the current doctoral researcher selected this research method to examine differences due to an intentional and structured intervention- being determined by selection and participation in the BAC-P/2 by the BAC group as opposed to no participation by the non-BAC group. The descriptive nature of the design approach allowed the researcher to describe and make inferences regarding the subgroups, particularly the relationship of the BAC-P/2 to overall infant motor milestones and motor development. Data was also collected on two further independent variables (namely tummy time and vestibular time) to examine whether there is a relationship with the critical variable – the AIMS total percentage scores of both sample groups. Usually there is no hypothesis as such in cross-sectional studies, although intending to describe a population or a subgroup within that population in particular respect to an outcome is feasible (Levin, 2006).

Participants

The study's final sample total consisted of 63 families with 29 participants in the BAC group (experimental) and 34 participants in the non-BAC group (control). These two sample groups were categorized according to whether each sample of infant's parents received a BAC-P/2 consisting of planned and evaluated infant motor activities. The original sample size for this study was targeted at 80 with an anticipated probable size of 70 participants. This probable sample size is supported by Pin, Darrar, and Eldridge (2009) who highlight that a sample size of more than 40 is estimated to be appropriate to detect a difference between groups when calculating the AIMS total means score. Specifically, this suggested statistically determined sample size is sufficient to detect this difference with a 90% power and a two-sided alpha of 0.05. Subsequently, there was a suggested target of 40 in each experimental and control group with an estimated dropout rate of 5 participants per group. The final total of the doctoral thesis became 63 families due to various difficulties in finding parents of young and very infants. These difficulties included parent's tiredness, poor sleeping infants and unsureness of the commitment involved.

There were no major differences observed in the final sample of participants with Table 5.1 outlining the gender, mean age, birth weight and sleep positions of each specific sample group. The Non-BAC sample has five more overall participants and this group's mean age shows a slightly higher recording of 7.7 to 7.4 respectively. Both groups have nearly half of all their participants scoring in the 3-3.5 birth weight range and the sleeping patterns appear very similar, with supine sleeping predominating.

Table 5. **1**

Demographic data for the BAC and Non-BAC groups

Infant demographics	**BAC group (29)**	**Non-BAC Group (34)**
Gender	Female= 16 (55%) Male = 13 (45%)	Female= 18 (53%) Male = 16 (47%)
Mean age	7.4 months	7.7 months
Birth weight	48% recording within the 3 to 3.5 kilogram birth range	44% recording within the 3 to 3.5-kilogram birth range
Early sleep position	93% sleeping on back with 2 infants sleeping on their side	100% sleeping on back

Overall, the study's participants were recruited from several sources as outlined in Tables 5.2 and 5.2.1 below. Twenty-one families in the BAC group and fifteen in the Non-BAC group were enlisted from three Melbourne, Victoria, Australian Maternal Child Health Nurse (MCHN) centres. These included Kensington (City of Melbourne), Carlton (City of Melbourne) and Heidelberg/Greensborough (City of Banyule). The participating municipalities were selected due to the differing socio-cultural-economic municipalities and also due to the positive and timely responses of the Maternal and Child Health (MCH) nurses to being involved in the research. The MCHN coordinator at the City of Brimbank was also contacted but no follow up email was returned to this doctoral researcher after several requests. A further eight families in the BAC group and nineteen from the non-BAC group were recruited through 'word of mouth' (W of M) contacts with this researcher. This later selection enabled this research to recruit families from further diverse socio-cultural-economic areas of Melbourne.

Initially forty-two families were recruited into the BAC sample group with thirteen families withdrawing. Tables 5.2 and 5.2.i outlines a higher dropout rate with the BAC group.

This difference may have been attributed to the commitment of being part of a research study together with the very young ages (10-12 weeks post birth) of the infants with perhaps less confident, first-time parents. Other factors included the multicultural blend within the Carlton families including several non-English speaking families. The non-BAC group recruited thirty-nine families with five withdrawing. The lower drop out figure may be the result of this sample having a shorter three to four week recruitment period from initial contact to observation/assessment visits, compared to the BAC group period of between sixteen-twenty weeks. Another factor may be due to the parents being more confident and experienced with their infants aged between 6-9 months old.

Table 5**. 2.**

Total numbers of recruitment of BAC study participants including 12 out of total of 29 recruited via W of M

Experimental (BAC) Participants Recruitment	Actual Participants	Withdrawn Participants
2016		
Word of Mouth-Group 1	8	2
MCHN Heidelberg/Greensborough	6	1
MCHN Carlton Group A	3	4
MCHN Kensington	4	3
2017		
MCHN Carlton Group B	4	3
Word of mouth-Group 2	4	0
Total *W OF M 12/29*	**29**	**13**

Table 5. 2.i

Total numbers of recruitment of Non-BAC study participants including 19 out of total of 34 recruited via W of M

Control (Non-BAC) Participants Recruitment	Actual Participants	Withdrawn Participants
MCHN Carlton A	7	1
MCHN Heidelberg/Greensborough	6	1
Word of Mouth-Thornbury	5	0
2017		
Word of Mouth General Group	4	1
MCHN Carlton Group B	2	2
Kensington/Essendon Word of mouth	4	0
Word of Mouth- Melton	6	0
Total *W OF M 19/34*	**34**	**5**

As outlined in Table 5.3, the infants' observation/assessment ages ranged from 6 to 9 months which is a slight increase from the originally targeted age of 7 month old infants as per the Ethics proposal (see appendix p. 259). This change was to enable the researcher further time to reconnect with BAC families, to recruit Non-BAC families and for the time consuming AIMS assessment analysis. Due to the logistics of the initial recruitment, following up parent phone calls, parent work commitments, variable infant sleep patterns, visits over more than three Melbourne municipalities, the final infant observation/assessment ages in both groups was expanded (from the original proposed 7 month old target group) to assessment infant age ranging from 6.5 months and 9.4 months. Interestingly as shown in Table 5.3, the 7-month age category produced 62% of the BAC group and 52% of the Non-BAC group with both participant groups recording 18 infants respectively. Overall the 7 month category produced 57% of all subjects.

Table 5.3

Frequency and percentages of infant participants of the BAC and the Non-BAC groups within each assessment age (in months) range

Frequency of Sample infants	BAC (n)	Percentage of total	Non-BAC (n)	Percentage of total
6 months	4	13.8	3	8.8
7 months	18	62.1	18	52.9
8 Months	5	17.2	9	26.5
9 Months	2	6.9	4	11.8
Total	29	100.0	34	100.0

The study adopted the 6-9 months observation age as the data collection period. This age group range also has important relevant links with the motor developmental patterns aligning with motor milestone charts (Malina, 2004; Meduri, 2020). Interestingly, several infant milestones that occur within the 6-9 months observation age including rolling over, commando crawling and hands and knees crawling with these three milestones featuring in the BAC-P/2's sections two, three and four. Various motor milestone chart sequence motor milestones as rolling over from front to back and from back to front; crawling actions on the stomach, crawling on hands and knees; beginning to sit without support; taking weight on feet when assisted standing (Kuo et al., 2008; Malina, 2004; Nitsos et al., 2017). These motor skills are also all included in the AIMS assessment's four subscales of prone, supine, sitting and standing actions.

Procedure

Ethics approval was obtained from the Victoria University Ethics Committee (Application number HRE15-124) on 2/12/2015. Ethics approval was also obtained for the

Education Department (Application number 2015_002909) on 9/12 2015. A written consent was also obtained for all the participating families of the infants included in this study.

The study concentrated on recruiting 10-12 week post birth infants (experimental group) for the BAC-P /2 participation program. This recruitment age allowed a defined infant and family activity period of around 18-20 weeks before the data could begin to be collected at 6-9 months. Thus, the BAC group, on receiving the BAC-P/2 were encouraged to select a variety of movement activities each day, leading up to the observation/assessment age. The Non-BAC group also received the BAC-P/2 but post the 6-9 months observation/assessment. This delayed assigning of the BAC program was to ensure that only the BAC sample group was exposed to these specific 'tummy time' and vestibular' based activities.

As outlined in Tables 5.2 above, a section of the BAC group families was recruited through the Maternal Child Health (MCH) nurses 'First-time Parents' group sessions funded by the Department of Education and Training, Victorian government. This doctoral researcher visited these municipal sessions after initially contacting the incumbent MCH nurses individually, outlining the research, together with the focus to recruit young infants and their families. Dates to visit were arranged and the project was subsequently presented to each of the new parent's groups. This presentation was followed by a demonstration on several of the BAC-Program/2 activities. Parents questions were answered, and willing parents placed their name, email address and phone numbers on a form supplied by the researcher.

All participants of these MCHN sessions were given a BAC-P/2 regardless of whether they had agreed to take part in the research or not. This doctoral researcher outlined that instructions (text) accompanied each pictorial activity and all parents were encouraged to interact initially with those actions that they felt most confident with. The participating families were then advised that they would be contacted by one phone call or email regarding the observation/assessment home visit in 4-5 months' time and approximately 7-8 months post birth. Reassurances were given that these families could withdraw from the research at any time. It was encouraged that parents could contact the researcher at any time via email if further information was needed.

The families recruited through 'word of mouth' (contact made through referrals from professional colleagues and referrals from various pre-birthing educational information groups) received similar instructions except via an individual and detailed phone call. Once there was an understanding of the commitment and a verbal agreement to join the program, a BAC-P/2 was posted to those interested families together with an introductory explanatory letter**.**

Initially, the parents taking part in the infant activity program were verbally supported to choose activities mainly from within the first section of the BAC-P/2 namely 'body awareness/head control/tummy time'. Over the duration of approximately 18 -20 weeks (i.e. age 10 weeks to age 26-36 weeks) activities from the subsequent sections two and perhaps three of the program were encouraged to be explored and practiced. This suggested progression was very individual and totally chosen by each family. The parents were consequently contacted closer to the targeted 7-8 month observation age to schedule a home visit by this doctoral researcher to observe (and assess) their infant. All parents were again reassured that they could withdraw from participation in the study at any time.

A section of the Non-BAC families (control group) was also recruited through the MCH nurse centres and were similarly visited after a phone call to the individual nurses. These infants and families were either attending an on-site at MCH nurses centre 'Infant Literacy Program' or an 'on-site playgroup' for infants around six months of age. An explanation of the research project was outlined in the presentation minus the actual handing out of the BAC-P/2. The proposed home visit and the observation/assessment procedure were explained with an assurance of the families receiving a BAC-P/2 together with a personal demonstration of relevant activities. Parents were then invited to place their names and infant's names, phone numbers, email addresses on the sheet provided. Individual parents were subsequently contacted regarding dates, times and length of visit for their infant's home observation. The observations/assessment procedures were again explained during these follow up phone calls. The Non-BAC families who were contacted due to word of mouth contact, also followed a similar recruitment procedure as previously outlined, except that contact was made via a phone call. These participants received calls to invite them to participate in the study after a detailed discussion explaining their involvement. Generally, these families had already been made aware of the research (and agreed to their phone numbers being forwarded) by a mutual acquaintance, that the researcher would be contacting them. During the subsequent home observations/assessment procedures, these families also received a copy of the BAC -P/2 and individual demonstrations as per conditions of the Victoria University Ethics Committee.

In summary, the allocation of Study Two's 63 infant participants is outlined for additional clarity. Firstly, the BAC group (experimental) infants were recruited from MCHN 'new parents groups' or from 'word of mouth' (contact made through referrals from professional colleagues and referrals from various pre-birthing educational information groups). The target age was between 8-10 weeks post birth. Secondly, the Non-BAC families (control group) was also predominately recruited through the MCH nurse centres but at around 6 months of age as they attended Infant Literacy Program or an on-site playgroup. Additional control group infants were recruited between 7-9 months via 'word of mouth' from professional colleagues or through independent infant play groups.

Instrument: Baby Activity Chart-Program/2 (BAC-P/2)

This activity program was initially created and extensively researched in Chapter three of this doctoral thesis. The program included the selection of 34 activities collated over four sections of the booklet. The initial BAC-Program was evaluated by sixteen Experts in Chapter four with the content thoroughly examined. Several activities were adjusted, and particular script was rewritten with an overall 93.3% of the Experts recommending the program. The minor changes resulted in the production of the BAC-P/2 with this revised program utilized in Study 2.

Measure: Alberta Infant Motor Scale (AIMS)

The measurement employed in this study was the Alberta Infant Motor Scale: AIMS (Piper & Darrah, 1994). This data measure was employed to investigate the influence of a wakeful prone and vestibular activity program on early infancy motor development which is the main aim of this study. The AIMS assessment tool is a norm referenced scale evaluating infants gross motor development from birth-18 months (Blanchard et al., 2004; Charitou et al., 2010; Kennedy et al., 2009; Syrengelas et al., 2014). Gross motor items to be assessed are divided between four subscales or positions namely prone (21), supine (9), sitting (12) and standing (16). Each movement item is observed for the components of weight bearing, posture, and anti-gravity movement. Administration time is approximately 20-30 minutes.

The AIMS measurement is designed for naturalistic observation of quality motor development (Blanchard et al., 2004). The tool's normative data collection enables the determination of the percentile ranking of each infant's motor development with peer group matched for her or his age. When scoring, subscales are calculated giving the infant a score for observed items within the motor window, in addition to scoring a point for all the less mature items before the window. The infants score can be converted to a percentile and compared with age equivalent peers from the normative sample. The AIMS has established interrater reliability and has concurrent and predictive validity (Blanchard et al., 2004; Darrah, Redfern, Maguire, Beaulne, & Watt, 1998; Jeng, Tsou Yau, Chen, & Hsiao, 2000). It is important to note that although the AIMS is appropriate between 0-18 months, several authors have suggested that the identification of milestones is most effective between 3 and 9 months (Kolobe & Bulanda, 2006; Liao & Campbell, 2004).

This doctoral study engaged an independent AIMS motor skill tester who was an infant motor development specialist. To establish interrater reliability, both this doctoral researcher and the invited specialist met to discuss the AIMS assessment procedures and viewed an AIMS demonstration assessment video. The two testers then individually reviewed two 'test' infant videos. Discussion followed so that there was a testing procedure agreement and an agreed score for both test infant videos. This interrater reliability process was supported by research undertaken by Blanchard et al. (2004) and Jeng et al. (2000). Independently, both testers rated videotapes of six infants aged 6-9 months over the following few weeks. The invited tester had no knowledge as to which group (BAC or Non-BAC) each of the six infant subjects had been assigned to (Briggs-Gowan, Carter, Irwin, Wachtel, & Cicchetti). Both this doctoral researcher and the invited tester achieved a 90% plus item agreement with the criterion standard scoring total of 6 infants raw scores of 207 to 206. The results are as follows with this doctoral researcher's scores first mentioned: 34/33; 31/30; 24/25; 52/52; 33/33; 33/33.

PIIQ Questionnaire

The 'parent and infant information questionnaire' (PIIQ) questionnaire was proposed and designed to collect further data at the time of the infant's 6-9 month observation/assessment. This approach allowed the researcher to review the sub- questions of this doctoral study namely ‘the amount of time infants participated in tummy time and in vestibular activities in relation to developmental milestones’. More specifically, the questionnaire produced questions as a type of convenience sampling (used in both qualitative and quantitative studies) where a process of sampling or questioning of a non-random selection of participants of the population is used, to gain vital information on an area of interest to the researcher (Etikan, Musa, & Alkassim, 2016). This style supported the researcher to collect data and to review trends relating to ‘tummy time’ and ‘vestibular time’ positions. The information collected allowed the researcher to collate what was considered a ‘typical parents’ approach towards positional aspects in support of their infant’s early motor development (Abbott & Bartlett, 1999). Two separately worded questionnaires were designed for the BAC group parents/carers (experimental) and the Non-BAC group parents/carers (control). The requirement for two questionnaires was to cater for the slightly different responses anticipated due to the BAC group interacting with the BAC-P/2 for between five to seven months.

The amount of time infants participated in tummy time and in vestibular activities questions.

Two important PIIQ specific questions for both groups focused on the approximate amount of time that the infants were positioned in firstly on their tummy (prone) and secondly undertaking vestibular activities. As the majority of all parents were not familiar with the vestibular term, the wording used in both questionnaires included ‘upside down position’ and clarified by i.e. ‘*gently tipped upside down/placed and gently rolled on a large ball; infant rocked or placed in a swing/hammock; infant gently tipped by parent/carer with head lower than body?’*.

In detail, these two positioning questions focused on using ‘parent friendly’ terms i.e. “How often each day (approximately) was your infant placed on or played with on his/her tummy? Circle one of the following: rarely: 15 minutes: 30 minutes: 45 minutes: 60 minutes”. “How often each day (approximately) was your infant placed ‘in an upside down’ position? Circle one of the following: rarely: 15 minutes: 30 minutes: 45 minutes: 60 minutes”.

To assist with calculations post data collection, these five time choice options were converted into two groupings from ‘rarely to 30 minutes’ and ‘30 to ‘60 minutes’. These grouping were selected as recent researchers (V. Carson et al., 2017; Guidetti et al., 2017; Hewitt, Kerr, et al., 2020; Hewitt, Stanley, Cliff, & Okely, 2019; Russell et al., 2009) recommend that it is beneficial for infants to be exposed to thirty minutes of prone (tummy) time daily. Interestingly, the Australian guidelines recommendation of 30 minutes plus tummy time per day spread over the waking hours for children under one year of age was only attained by only 30% of four month old infants in 2008 (Hesketh et al., 2017).

Consequently, the vestibular grouping became ‘rarely to 15 minutes’ and ‘15 to ‘60 minutes’. These categories are notably modified from the two tummy time category groupings. The variation occurred as activities that promote the nervous system to respond to gravity and to develop balance responses are not commonly identified in early infant settings. In general, compared to the numerous supportive tummy time materials available to young families together with tummy time recommendations from Maternal Child Health Nurses (MCHN), vestibular actions are rarely presented to new parents. Therefore, the tummy time lower limit of 30 minutes daily appeared too high for the vestibular categorization and the lower limit of 15 minutes was adopted (Clark et al., 1977; White-Traut et al., 2002) .

Dividing these daily tummy time and vestibular time criteria into two distinct groupings allowed the researcher to analyse the responses statistically in relation to the AIMS data.

Pre-testing PIIQ

Initially, the PIIQ was pre-tested with four families with young infants that resulted in slight wording changes made in accordance with the responses received. An important change occurred as the first draft referred to terms 'mother' and 'father'. The second draft referred collectively to parents and carers to ensure that all families were represented, particularly families with two mothers or two fathers. Finally, the PIIQ presented to the BAC parents/carers varied from the final questionnaire to Non-BAC parents/carers in the following ways:

- *Section 1*: Parent/carers' information. Questions 1- 5 were identical and covered parent age, occupation, education level. Infant name, date of birth, birth weight and birth history, baby's sleeping posture back/side/tummy.
- *Section 2:* Q1: Varied slightly as BAC parents were requested to include the six favourite BAC-P/2 activities. Non-BAC parents were asked to list six activities that their infant enjoyed including movement activities/games/dancing.

Q2: Same for both groups and involved 'daily tummy time' from rarely to 30 minutes, and 30 to 60 minutes daily.

Q3: Same for both groups and involved 'daily vestibular time' from rarely to 15 minutes and 15 to 60 minutes daily.

Q4: Varied slightly as parents were asked to include any 'aspects' of their interaction with their infant that may have contributed to their infant's general development. The BAC-P/2 group questionnaire added '*new ideas from'* the BAC program.

Results

Statistical Analysis

The research question for this study is 'an investigation of the influence of a wakeful prone, vestibular activity program (BAC-Program/2) on early infancy motor development (AIMS total percentage mean scores)'. The quantitative data collected was analyzed to determine if there are significant differences between the various percentile rankings of the two subject groups according to the AIMS normative data. The statistical software program, IBM SPSS Statistics Grad Pack 23 was chosen to evaluate the data. The following statistical procedures were undertaken:

- Descriptive statistics for each specific sample group (BAC and Non-BAC) including means, standard deviations and standard error of the means were calculated.
- T-test for Levene's Test for Equality of Variances and for Equality of the Means both to test the robustness of the results and to determine if there was statistical evidence that the two sample groups AIMS total percentage means were significantly different from each other.
- One/Two Way ANOVA for comparing the multivariate of the dependent variable (AIMS total percentage score) and the independent variables:
    - tummy time category at 3-7 months and the difference between the two study groups
    - vestibular positions category at 3-7 months and the difference between the two study groups.
    - An inferential contrast approach was adopted to identify patterns and the relationship of the predictors (daily tummy and vestibular time) as the independent variables.

The Independent Samples t-Test

An independent-samples t-Test approach outlined in Table 5.4 discloses whether there is statistical evidence that the two dependent sample group's BAC (experimental) and Non-BAC (control) means of the AIMS total mean percentage scores were significantly different from each other. The mean of the AIMS percentages scores for the BAC group's twenty-nine infants (experimental) and the Non-BAC group's thirty-four infants (control) are presented in Table 5.4. The table outlines that the AIMS calculations for the 29 BAC group produced a Mean score of 55.1 with the equivalent Mean score for the 34 Non-BAC group of 41.5. Each AIMS total percentage mean score of the BAC and the Non-BAC groups was calculated through the SPSS Independent Sample *t*-Test applied to the individual infant's AIMS results of each sample group and then an overall mean score for each sample group equated.

This result indicates that the BAC infants group achieved significantly higher total mean percentage motor scores on the AIMS assessment compared to the Non-BAC infants. The interpretation at a practical level infers that this difference in the overall AIMS score results was likely influenced by the infants and their families interaction with the BAC-P/2 program's activities. The results detail that on average, the infants who interacted with the activities within the BAC-P/2 for approximately five to six months, were further developed with their rudimentary motor maturation than the infants that did not participate in this movement program.

Table 5.4

SPSS Independent Sample t-Test to compare the AIMS total percentage mean scores between the BAC and the Non-BAC groups

		N	Mean	Std. Deviation	Std. Error Mean
AIMS %	BAC group	29	55.103	22.4378	4.1666
	Non-BAC group	34	41.529	23.5259	4.0347

The test of importance is the *t*-Test for Equality of the Means which provides the *t* obtained, degree of freedom (df), the two tailed level of significance and the mean difference between the two group means. Interestingly the Levene's Test for equality or homogeneity of the variances records a result of .550 indicating that the variances are even across the two groups (i.e., *p*-value large).

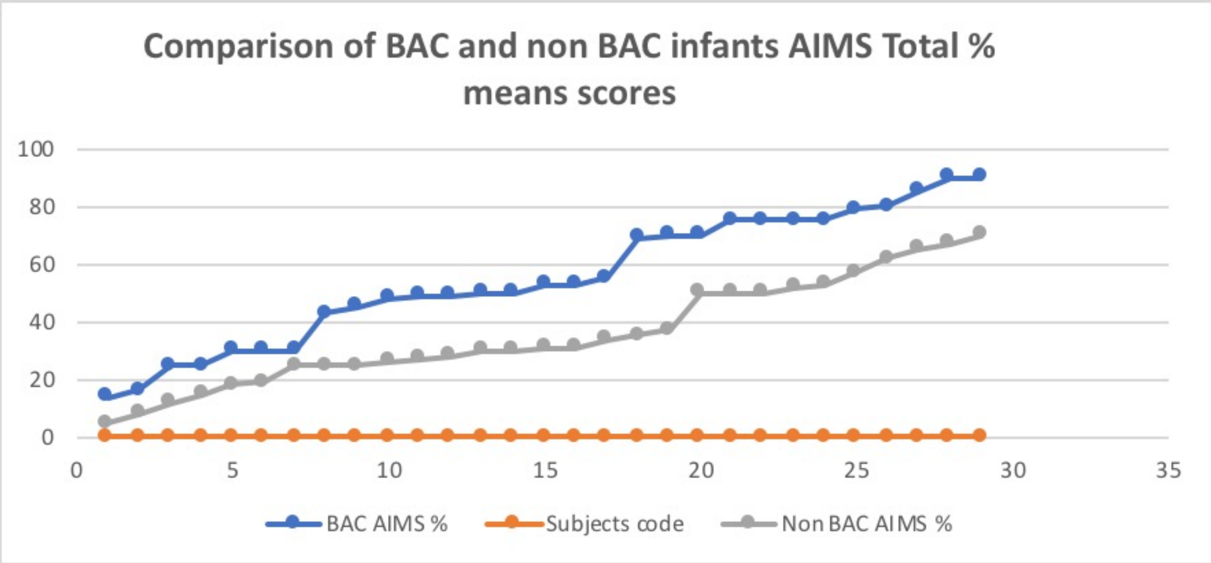
The *t*-Test for Equality of the Means showed a significant difference in the scores for BAC group (M=55.1, SD= 22.4) and Non-BAC group (M=41.5, SD=23.5) conditions t(61)=2.33, p=.023. These results propose that those infants interacting with the activities within the BAC-Program/2 have indicated a trend towards higher AIMS total percentage mean scores collectively.The interpretation at a practical level suggests that the participation by parents and carers in the activities within the BAC-P/2 have contributed to the overall differences in the recorded scores when comparing the means between the sample groups using the independent sample *t*-test.

Thus, this study was able to reject at the .05 level, the null hypothesis that the population means on the AIMS total percentage scores difference between BAC and Non-BAC infants was due to chance. The significance was set at .05 . The difference was significant at **.**023 alpha level with this result being less than .05. Overall, the AIMS total percentage mean score for BAC infants was significantly higher than the AIMS total percentage mean score of population of Non-BAC infants. These results reveal that participation of infants in the BAC-Program/2 may statistically record an effect on their total motor infant scale score.

A parallel variability from low to high AIMS total percentage scores in both sample groups is depicted in Graph 5.1. The graph shows the y axis as the AIMS Total Percentage Mean scores for each infant subject and the x axis shows each individual subject in both sample groups. The graph's trend depicts the BAC group consistently scoring higher mean scores compared to the Non-BAC sample group across all participants.

Graph 5. 1

Comparison of the BAC and Non-BAC infants AIMS Total percentage Mean scores. Y axis = AIMS scores



The Power aspect.

The AIMS total percentage scores comparison between the BAC and the Non-BAC groups outlined in the *t*-Test results (Table 5.4) allows Cohens'd to be calculated as a definition of the Power, measuring the effect size. The Power aspect of this overall thesis sample's AIMS total percentage mean results was calculated to determine the meaningfulness of the collated data to the broader population. In other words, the relevance of the sample size having the ability (power) to generalize the statistical significance of the results. A calculation was performed to determine that the sample size (n=63) was large enough to have the ability (power) to generalize the statistical significance of the results. Calculation achieved the Cohens'd value of 0.59. Thus, with this study's effect size results of (almost) 0.6, the score of the average infant in the experimental group was 0.6 standard deviations above the average infant in the control group (Cohen, 1992).

SPSS Comparison of the AIMS means results (AIMS four subscales) between the BAC and the Non-BAC groups

Table 5.5 outlines the means differences recorded in both sample groups according to the AIMS assessment's four subscales. The BAC infant group (29 infants) consistently generated higher scores across all subscales than the Non-BAC infant group (34 infants) although the prone section shows the smallest comparison. To analyse more specifically, the prone subscale of the 7 month old infants is also presented in Table 5.5 This comparison depicts the BAC sample group of eighteen 7 month old infants scoring noticeable higher mean scores in the prone subscale than the Non-BAC group of also eighteen 7 month old infants. This 7 months age group also produced the highest number of participants in both samples groups (Table 5.5).

Table 5.5

AIMS mean score results according to AIMS four subscales between the BAC and the Non-BAC groups

	BAC Mean of AIMS total **numbers = 29 infants**	**Non-BAC Mean of AIMS total** **numbers = 34 infants**
Prone subscale	13.759	13.735
Supine subscale	8.000	7.765
Sitting subscale	8.966	8.380
Standing subscale	3.138	3.029
#Prone subscale age 7 months group	13.333 18 infants	12.889 18 infants
Overall Total percentage mean	**55.1**	**41.5**

The SPSS Univariate analysis of Variance of Tummy Time (daily) and Vestibular Time (daily) analysis:

The Two-Way or Factorial ANOVA procedure incorporates more than one independent variable and whether group means differ significantly from each other. Thus, Two-Way ANOVA results involved the testing for interaction effects of the relationship of an independent variable and the dependent variable according to or effected by another independent variable (Aspelmeier & Pierce, 2009). This analysis involved the mean differences between BAC and Non-BAC groups AIMS total percentage scores in relation to the time spent in firstly in daily high or low Tummy Time (infants between 3-7 months) groupings and then in daily high or low Vestibular time (infants between 3-7 months) groupings. The three to seven age range was selected in the parents/carers' questionnaire as this range led up to the AIMS testing (observational) age.

Daily Tummy Time Analysis and the AIMS Total Percentage Scores of the Two Sample Groups.

The Two-Way ANOVA in this section determined whether the AIMS groups (BAC and Non-BAC) differ significantly from each other in relation to two independent tummy time variables, with the dependent variable being the AIMS total percentage scores. The first independent variable became the daily tummy time parent ratings from the two daily categories being 1: daily tummy time: 'rarely to 30 minutes' (low) and 2: daily tummy time '30 to 60 minutes' (high) in relation to overall AIMS scores. The second independent variable was the difference between the two samples study group's AIMS percentage total in relation to the scores within these two tummy time categories.

Table 5.6 outlines the Descriptive Statistics total AIMS mean differences between the two sample groups according to the time infants spent in their daily tummy time categories. Interestingly, the BAC group shows numbers of 8 and 21 infants in each daily category (rarely to 30 minutes' and '30 to 60 minutes' respectively) with the Non-BAC groups showing more equal participants in each with 16 infants in the lower daily and 18 infants in the higher daily tummy time category. The BAC group produced higher AIMS means scores in both tummy time category with 29.6 and 64.8 to 24.8 and 56.3 respectively in favour of the BAC infant sample. These results show a positive descriptive interaction between the BAC group's higher amount of daily tummy time and a correspondingly higher AIMS mean score. Finally, both study groups scored higher AIMS mean scores with the higher amount the daily tummy time showing a very positive link between increased tummy time and the effects on infant's motor development.

Table 5.6

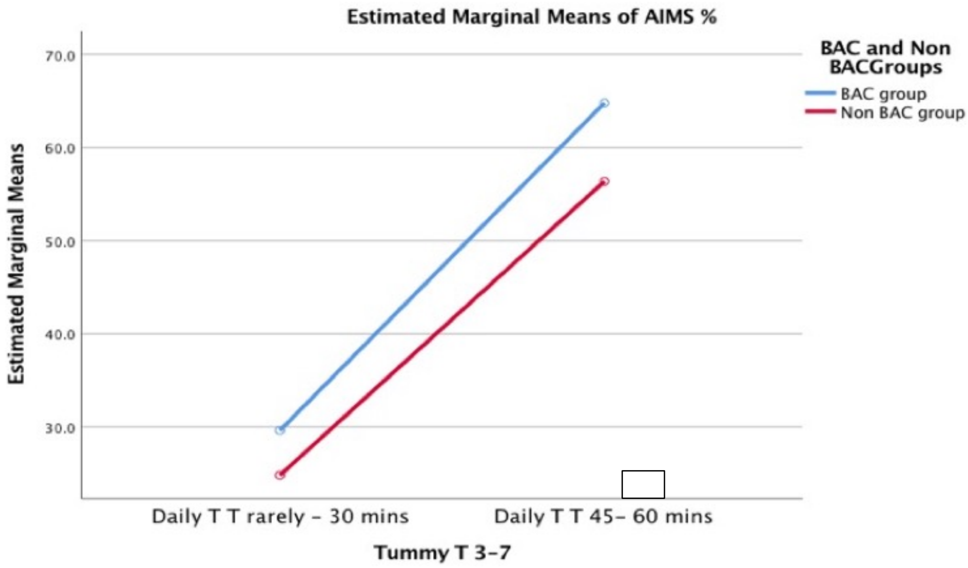
Descriptive statistics comparison between the BAC and the Non-BAC Aims total percentage mean scores with the two Tummy Time categories

Descriptive	**Statistics**					
Dependent	**Variable**	**AIMS %**				
BAC and	**Non-BAC**	**Groups**	**Tummy time T 3-7**	**Mean**	**Std Deviation**	**N**
BAC	**group**		Daily T T rarely- 30 mins	29.67	11.98	8
			Daily T T 30 plus- 60 mins	64.81	17.20	21
			Total	**55.10**	**22.43**	**29**
Non- BAC	**group**		Daily T T rarely- 30 mins	24.81	16.90	16
			Daily T T 30 plus- 60 mins	56.38	18.03	18
			Total	**41.52**	**23.52**	**34**
Total	**2 Groups**		Daily T T rarely- 30 mins	26.41	15.34	24
			Daily T T 30 plus- 60 mins	60.92	17.87	39
			Total	**47.77**	**23.84**	**63**

The Two-Way ANOVA in Tests of Between-Subjects Effects the hypothesis asks if the overall mean AIMS total percentage score received in the overall Study group is different for the BAC and the Non-BAC groups in relation to the two Tummy Time groupings. In the effect of Study Group $F(1, 59) = 2.12$, p= 0.15; the value of the p value equals .150, which is greater than .05 (α) so this study failed to reject H_0. Thus, there is insufficient evidence to assume that the BAC and the Non-BAC groups AIMS means score in the two Tummy Time categories (‘rarely to 30 minutes’-low and ‘30 plus to 60 minutes’-high) are significantly different. The Univariate test of between subjects’ effects revealed a main effect of Tummy Time , $F(1, 59) = 54.03$, $p = .000$. There was sufficient evidence to conclude that with increased tummy time there is an effect on the AIMS mean result. More generally, increased daily tummy time may positively affect the infants motor scale score, particularly in this study's sample. The hypothesis again asks if the effect of high versus low daily tummy time (two categories) is the same or different for subjects in the BAC as it is for subjects in the Non-BAC. When the BAC program was coupled with the higher daily tummy time (30 plus-60 mins daily) the highest AIMS means scores were received. But there was no significance as the Non-BAC sample also produced higher AIMS mean percentage scores in the higher daily category. The *F* statistic in the combined variable 'StudyGroup*Tummy Time' was $F(1, 59) = 0.16$, $p = 0.69$. This result shows the main effect of this combined variable as not significant. This data reveals that the interaction between the two study group's AIMS scores may be influenced by, but not determined on the differing amount of daily tummy time.

It is relevant to discuss the Partial Eta squared results as a value of .525 or 52% of the variance was found (or proportion of variability) in the AIMS percentage motor score, this result was predicted by or accounted for by the effect of the amount of times parents participated in tummy time activities. This score also supported a positive and significance relationship between tummy time and the AIMS total percentage scores for both groups.

Graph 5. 2
Estimated marginal means of AIMS %.



Graph 5.2 presents the comparison between BAC and Non-BAC Aims total percentage scores and amount of daily Tummy Time in two categories: rarely- 30 minutes daily and 30+ -60 minutes daily. This comparison presents the AIMS scores for both daily categories and shows a greater trend towards the BAC group than in the Non-BAC group. This tendency outlines a non-significant slant in the predicted direction indicating a positive inclination (Guadagno, 2010). This visual example depicts the BAC group's higher AIMS results when compared to the Non-BAC group, in response to the amount of daily tummy time undertaken in both daily categories. This graph also outlines a positive link or relationship between greater daily tummy time and higher motor scores for both sample infant groups in this doctoral research.

Daily Vestibular Time Analysis and the AIMS Total Percentage Scores of the Two Sample Groups.

The Two-Way ANOVA continues in this next section to ascertain if the AIMS study groups- BAC and Non-BAC, differ significantly from each other in relation to two independent vestibular time variables. Again, the dependent variable being the AIMS total percentage scores. In slight contrast to the tummy time analysis section, the independent variable being the daily vestibular time parent ratings category, was modified and the two categories became 1: 'rarely- 15 mins' (low) and 2: 'and '15 -60 mins daily' (high) and in relation to overall AIMS total percentage score scores. The other independent variable was again the difference between the two samples study group's AIMS percentage total in relation to the scores within the two categories.

Table 5.7 outlines the two sample groups BAC and Non-BAC with the AIMS means score for each of the two categories (rarely- 15 mins and 15 -60 mins daily). In both sample groups, the higher daily vestibular time participation equated with higher AIMS mean scores. The BAC groups show almost equal numbers of daily vestibular participation in both categories (15 and 14 infants respectively), with the Non-BAC groups showing greater participants in the lower daily category (24 to 10 infants). In relation to the AIMS total percentage scores, the BAC group recorded a mean score 52 in the lower daily vestibular category compared to the mean of 34.1 for the Non-BAC group. Examination of both the BAC and the Non-BAC groups in the higher daily category produced very similar scores 58.4 and 59.3 respectively. Notably, for both sample groups, a relationship was found with the higher the daily vestibular time the higher the AIMS mean scores.

Table 5.7

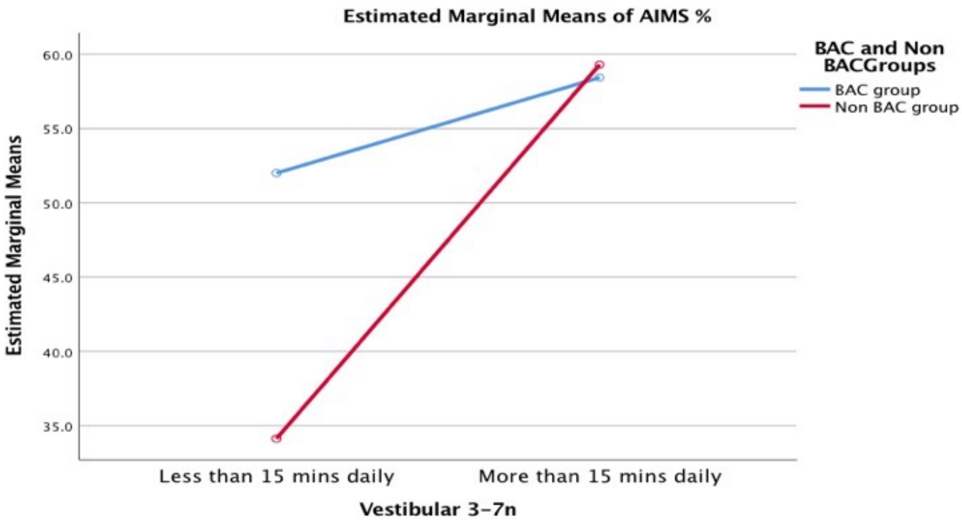
Descriptive statistics comparison between the BAC and the Non-BAC Aims total percentage mean scores with the two daily Vestibular Time categories (rarely – 15mins and 15-60mins)

Descriptive Statistics					
Dependent	**Variable**	**AIMS %**			
BAC and	**Non-BAC**	**Groups**	**Vestibular time T 3-7**	**Mean**	**Std Deviation**
BAC	**group**		Daily V T rarely- 15 mins	52.01	26.84
			Daily VT 15 plus- 60 mins	58.42	16.89
			Total	**55.10**	**22.43**
Non- BAC	**group**		Daily V T rarely- 15 mins	34.12	20.58
			Daily V T 15 plus- 60 mins	59.3	21.19
			Total	**41.52**	**23.52**
Total	**2 Groups**		Daily V T rarely- 15 mins	41.02	24.48
			Daily V T 30 plus- 15 mins	58.79	18.36
			Total	**47.77**	**23.84**

Analysis continues on the Test of Between-Subjects Effects between BAC and Non-BAC Aims total percentage scores and amount of daily vestibular time in the two categories. This procedures responds to the hypothesis that the overall AIMS mean score received in the StudyGroup is different for the BAC and the Non-BAC groups in relation to the two vestibular time groupings. In the effect of Study Group $F(1, 59) = 2.21$, p= 0.14 where the value of the p value equals 0.14, which is greater than .05 (α) so this study failed to reject H_0. There is not sufficient evidence to conclude that the BAC and the Non-BAC groups AIMS means score in the two vestibular time categories are significantly different. The Univariate test of between subjects' effects revealed a main effect of Vestibular Time , $F(1, 59) = 7.63$ $p = .008$. There was again (as in the tummy time results) appropriate evidence to assume that with increased vestibular time there is a main effect on the AIMS mean score. Thus, with increased vestibular time daily there is a significant effect on the overall infants' AIMS total percentage motor scale scores. The analysis continues as the hypothesis asks if the effect of higher versus lower daily vestibular time is the same or different for participants in the BAC group as it is for participants in the Non-BAC group. The results show the *F* statistic in the combined variable 'StudyGroup*Vestibular Time' was $F(1, 5) = 2.68$, $p = .10$ This result shows the main effect of this combined variable as not significant. Conversely, this suggests that the association between the two study group's AIMS scores may be shaped by but not necessarily subject to the varying amount of daily vestibular time.

The Partial Eta squared results indicate that .217 or 21% of the variance (or proportion of variability) in the AIMS total percentage motor score is predicted by or accounted for by the effect of the amount of times parents and carers participated in daily vestibular time activities. There is a positive and significant relationship between vestibular and the AIMS mean scores as confirmed above. Conversely, when analyzing the between study groups data according to daily vestibular participation, there appears a positive relationship with the AIMS mean scores but not a significant correlation.

Graph 5. **3**
Estimated marginal means of AIMS %.



Graph 5.3 outlines the tendency that generally the more daily infant vestibular time participated in between 3-7 months for both sample groups, the higher the AIMS motor development score. This graph further reveals the AIMS mean score in the BAC group in the less than 15 mins daily was greater than the scores for the Non-BAC group. Subsequently, the AIMS percentage mean scores in the more than 15 mins daily were very similar for both the doctoral study's sample groups.

DISCUSSION

The examination of the influence of a wakeful prone, vestibular activity program on early infancy motor development has revealed that the difference between the two sample groups AIMS total percentage motor scores was significant and meaningful. The infants participating in the BAC-P/2 consisting of predominately prone and vestibular activities over a four to five month duration were found to be further advanced with their motor development than the infants that did not participate in this movement program.

The discussion section will provide an interpretation and contextualisation of the overall results of this doctoral study in relation to current research involving infant motor development. It will continue with a discussion on how the results of the present doctoral study can be interpreted in the intent of supporting parent/carers knowledge and confidence to undertake both tummy and vestibular activities to impact on the natural progression of their infant's motor milestones.

The discussion will explicitly refer to the size of the effect of the AIMS motor score results, with reference to actual differences in the overall scores between the two sample groups. The interpretation of the study's overall sample size of sixty three participants will be compared with the findings of studies involving a variety of sample sizes used in other prominent motor development studies. The discussion will also outline how the current study's AIMS motor results relating to participation in the BAC-P/2, compare with comparable infant movement research programs.

Findings associated with the comparison of AIMS scores achieved by both sample groups with the specific age group AIMS scores, particularly focusing on the 6-9 month old infant age groupings results. The discussion will also examine each sample group's daily tummy time AIMS motor scores within the defined daily time grouping, in relation to the overall motor scores for each of the sample groups. This review compares the impact on those infants' participating in the BAC-P/2 in relation to daily tummy groupings and consequently on motor development.

Finally, the discussion will interpret and contrast each sample group's daily vestibular time AIMS motor scores within the defined daily time grouping, in relation to the overall motor scores for each of the sample groups. This enables comparison of the impact on those infants' participating in the BAC-P/2 in relation to daily vestibular groupings and consequently on motor development. An overall comparison will be undertaken of the similarities of the doctoral results to similar prone, vestibular, prone and vestibular focused infant research studies and their impacts on infants' motor development.

Overall AIMS Results Comparison Between BAC and Non-BAC Groups

The results generated in this doctoral study support the premise that a wakeful prone and vestibular activity program- BAC-P/2 can influence early infancy motor development. The examination addressed the motor development differences between the two sample groups, BAC and Non-BAC by observing their motor skills development. The data analysis revealed a significant difference in the scores for BAC group with a significance level of $p = .023$. This indicates that the BAC infants group achieved significantly higher total mean percentage motor scores on the AIMS assessment compared to the Non-BAC infants. An interpretation at an applied level presumes that this difference in the overall AIMS score results was likely affected by the infants and their families interaction with the BAC-P/2 program's activities. The results detail that on average, the infants who interacted for approximately five to six months with the activities within the BAC-P/2, were further developed with their rudimentary motor skills than the infants that did not participate in this movement program.

The AIMS total mean score differences between the two sample groups allows the researcher to measure the effectiveness of participation in BAC-P/2 activities. Also, on a more practical level, the differences displayed in the differing AIMS scores may be interpreted as the BAC infant's exhibiting more mature rudimentary movements, supporting future planning programs to promote infant's rudimentary actions. The differences in the scores of those infant interacting with the BAC-P/2 supports educators to promote and inform families about the early motor skills that are emerging or may soon develop (Majnemer & Snider, 2005).

Several studies have implemented infant prone or vestibular support or intervention programs at young ages and for comparable durations, recording similar positive results with their participating infants (Clark et al., 1977; Guidetti et al., 2017; Hewson, 2011; Hunter & Malloy, 2002; Lee & Galloway, 2012; Lobo & Galloway, 2012; Rine et al., 2004). In the thesis research, multiple sections of the BAC-P/2's diagrams and text concentrated on prone and vestibular activities that contribute to normalizing infant motor development (Le Gall et al., 2019; Malina, 2004; Senju et al., 2018). Gerber et al. (2010) acknowledge the importance of infants experiencing early reflex maturation, sensory stimulation and age-appropriate tummy time opportunities to promote prone-specific milestone.

The study's positive result concurs with research where parents/carers were presented with infant movement and tummy time ideas leaflets, small brochures with prone ideas, or infant photo sheets (Clark et al., 1977; Hewson, 2011; Jennings et al., 2009; Lee & Galloway, 2012; Lobo & Galloway, 2012; Rine et al., 2004). In these studies, the participating subjects also produced higher scores in postural control and motor milestones than the control participants. The current thesis study findings reinforce that with support and encouragement of infants and families to interact with a variety of daily tummy time activities can impact on infant motor development skills (Koren, Kahn-D'angelo, Reece, & Gore, 2019).

The size of the difference between the BAC and the Non-BAC sample groups in overall AIMS score was determined using the Cohens'd effect size calculation as an interpretation of Power (LeCroy & Krysik, 2007). The calculation of this study's effect size resulted in a very acceptable score of .6. Héroux (2017) outlines that in educational research, the average/moderate effect size is lower at d = .4, with .2 and .6 correspondingly considered as the small and large effects. Thus, the influence of the effect of the group differences or the result's practical implication, reinforced the importance of the experimental BAC group's scores (Lakens, 2013). The computed mean score for infants in the BAC group was higher than the infant score in the Non-BAC group and thus exceeds the scores of 73% of the control group. This effect size aligns with similar early infant motor behaviour research conducted by Baraldi-Cunha, Lobo, Kokkoni, Galloway, and Tudella (2016) The 2016 study examined the motor movement parameter' reaching behaviour' of three to four month old intervention infants. The study results of a *t*-test with independent sample groups reported an effect size of d = .42. This finding is comparable with the current thesis research AIMS mean score effect size of d= .58. demonstrating that an intervention programs with six to nine month intervention infants can lead to positive outcomes in infant motor behaviour.

Accordingly, the overall sample size of sixty three compares favourably with similar infant movement studies including Guidetti et al. (2017) and Hewitt et al. (2019) with thirty two subjects; Hewson (2011) had thirty infants; Jennings et al. (2009) recruited thirty four subjects, Lee and Galloway (2012) selected twenty two infants in their study and finally Lobo and Galloway (2012) had a cohort of twenty eight participants. The present research was undertaken with almost double the sample size in comparison with the afore mentioned studies, further supporting the overall positive motor milestone result recorded

Subscale AIMS Results Comparison Between BAC and Non-BAC Groups

The *t*-Test results for the four subscales of the AIMS assessment indicate that the BAC infant group consistently presented higher scores for each of the four subscale namely prone, supine, sitting, standing. The prone result is of particular interest as there is a prone-tummy time focus in the BAC-P/2 program undertaken by the BAC infants. The overall prone subscale (infants aged 6-9 months) produced the smallest comparison of .024 inferring very little difference between each sample group's prone score. This difference is noticeably greater when the prone subscale score for the specific 7-8 month age group of eighteen infants in both sample groups is analysed. The 7-8 month groups comparison prone score was .44 in favour of the BAC infant group adding additional support for the BAC-P/2 program's tummy time activities emphasis. These results are reinforced by several studies reporting that infants who are exposed to a variety of daily prone experiences tend to achieve developmental milestones earlier (Dudek-Shriber & Zelazny, 2007; Gross et al., 2017; Kuo et al., 2008; Salls et al., 2002).

Current AIMS Results in Comparison to Similar Research Findings

It was important to ensure that the doctoral study's AIMS recorded results for the both sample groups mean scores were representative of similar infant motor development. research. Comparable studies covering age divisions between 6 to 10 months are presented in Table 5.8. Syrengelas et al. (2014) report data that highlight infant's AIMS mean scores increase with age group increases, confirming that generally motor behaviour scores progress with infant's ages. The AIMS scores reported in this doctoral research for both the BAC and the Non-BAC groups compare favourably with this 2014 research and with the other similar studies as shown in Table 5.8.

This table outlines four infant age groups being 6-7, 7-8, 8-9 and 9-10 months post birth. The results are presented for the BAC and Non-BAC samples' AIMS mean and standard deviation total score. These scores are compared to results produced in Greece and Canada (Syrengelas et al., 2016; Syrengelas et al., 2014) and Brazil (Saccani et al., 2016). It is important to note that although the present study has a very positive sample size particularly in research involving movement program's intervention and control infants, the other studies mentioned have very large sample sizes. These comparison studies were essentially focused on measuring and recording their countries specific infants AIMS mean scores, hence the large sample sizes.

Table 5.8

Comparison of study's AIMS total percentage mean results with Greece, Canada and Brazil studies.

	BAC sample (N=29)	**Non-BAC** (N=34)	**GREECE** Syrengelas et al. (2016)	**CANADA** Syrengelas et al. (2016)	**BRAZIL** Saccani et al. (2016).
AIMS Mean for 6-7 month	32.2 (n=4) ↑ SD 2.21	28.7 (n=3) → SD-2.51	27.6 (130) SD 4.8	28.3 (225) SD 5.5	23.9 (90) SD 7.69
AIMS Mean for 7-8 month	32.7 (18)→ SD 5.44	31.7 (18) → SD 4.63	32.6 (113) SD 5.4	32.3 (222) SD 6.9	30.5 (108) SD 6.58
AIMS Mean for 8-9 month	35.4 (5) ↓ SD 5.31	35.7 (9) ↓ SD 4.33	38.8 (n=56) SD 6.4	39.8 (220) SD 8.7	35.7 (n=84) SD 8.96
AIMS Mean for 9-10 month	44.0 (2) → SD .00	35.8 (4) ↓ SD 10.9	46.6 (87) SD 6.5	45.5 (189) 7.5	39.6 (100) SD 8.61

Both the BAC and the Non-BAC groups show score similarities in the four age ranges (pertaining to this doctoral study), particularly this study's largest age group being the 7-8 months' group, with eighteen subjects in both samples. The comparisons in this age group include mean scores of 32.7 and 31.7 respectively for the BAC and Non-BAC groups, with corresponding age group scores for Greece and Canada being 32.6 and 32.3 Brazilian infants scored slightly lower with a score of 30.5 although Saccani et al. (2016) concluded that Brazilian infants generally exhibited lower motor scores in various ages when compared to the Canadian sample. These authors presume that these low results are due to infant and family social, birth and health factors. The arrows directions depicted in Table 5.8 refer to the results from both sample groups being higher, same or lower than the comparable results for the other countries AIMS scores. These similarities of results principally allow a generalisation and endorsement of the present study's overall AIMS results for both the BAC and the NON-BAC subjects in relation to results from previous research.

Tummy Time and Vestibular Time AIMS Motor Scores Comparisons

The sub aims outlined in this chapter centre on examination of the relationship of daily tummy time and vestibular time undertaken by the thesis study's infants in relation to their motor development scores. The BAC-P/2 program introduced both tummy time and vestibular time activities within the four sections of the booklet, catering for infants from birth to approximately nine plus months. Consequently, the discussion will explore the effect that varying daily time in both tummy and vestibular positions can have on infants motor milestone skills in both the BAC and the Non-BAC groups. This section will also compare and contrast the literature regarding the recommended daily tummy time (prone) and daily vestibular time to support motor development.

Daily Tummy Time and AIMS Motor Scores.

The study was designed to review the effectiveness of the BAC-P/2 program by comparing the differing amounts of daily tummy time undertaken by both sample groups. Study two presents the amount of actual time each groups recorded in daily awake prone (tummy time) positions in comparison with their overall AIMS motor scores. This study presumes that an increase in daily tummy time equates to higher AIMS mean motor scores with either sample groups. Several studies support this presumption (Davis et al., 1998; Dudek-Shriber & Zelazny, 2007; Monson et al., 2003) and report that more infant awake prone positioning is equated with significantly advanced infant motor scores on the AIMS assessment.

The analysis revealed that the two daily tummy time categories (grouping of infants aged between 3 to 7 months) comprised category one: ‘rarely to 30 minutes’ and category two: ‘30 to 60 minutes’. These grouping were supported by research (Australian Government, 2017b; Guidetti et al., 2017; Hewitt et al., 2019; Hewitt, Stephens, et al., 2020; Russell et al., 2009) recommend thirty minutes of daily tummy time for infants under one year of age. Additional studies report that only 30% of infants actually undertake the recommended daily tummy time (Hesketh et al., 2017; Yin et al., 2014).

The ‘rarely to 30 minutes’ activity category comprised eight infants (28% of the total) within the BAC group whilst the Non-BAC group included sixteen infants (46% of the total). The control group percentage compares closely to the Zachry and Kitzmann (2011) study that revealed that 53% of their sample appeared in this ‘rarely to 30 minutes’ daily tummy time category. The percentage of the experimental group was less in this lower daily category suggesting that the program was supporting parents to undertake greater daily time in prone activities.

One of the doctoral study’s sub aims was to evaluate the differences in the amount of time infants and parents in both sample groups participate in ‘tummy time’ (prone) activities.The BAC sample produced twenty one infants (72%) in the ‘30 to 60 minutes’ category in contrast to the Non-BAC sample recording eighteen infants (54%). These higher daily tummy time numbers in the BAC-P/2 intervention group reinforce the premise that the availability of the ideas in the program booklet encouraged parent/carers to interact with supportive prone activities. The Non-BAC group compares closely with the Zachry and Kitzmann (2011) study where a score of 47% was reported in the plus 30 minutes daily tummy time category. Interestingly, all three 30 plus minutes category results (72%, 54%, 47%) are above the reported 30% of Australian infants receiving the recommended 30 minutes plus of tummy time per day (Hesketh et al., 2017).

The AIMS total percentage mean scores of both sample groups within each of the daily tummy time categories were compared. In the ‘rarely to 30 minutes’ category, the BAC sample returned an AIMS mean score of 29.6, with the Non-BAC sample scoring lower at 24.8. A higher score for the BAC group was again achieved in the ‘30 to 60 minutes’ category with the BAC sample registering an AIMS score of 64.8 compared to 56.3 for the Non-BAC sample. Both sample groups produced higher AIMS mean scores in the higher daily tummy time activity category, irrespective of the actual infant numbers in each category. This positive outcome reflects existing research indicating that increased daily tummy time shows a significant effect on the AIMS percentage totals (Davis et al., 1998; Dudek-Shriber & Zelazny, 2007; Majnemer & Barr, 2006; van Vlimmeren et al., 2007). Participation in the BAC-P/2 program and the higher daily tummy time involvement for the participating BAC infants indicates an influence on the motor development scores of these infants.

Researchers have reported parents’ reluctance to find the recommended daily 30 minutes in tummy position can be due to their infant’s intolerance (often distressing) to prone positioning (Davis et al., 1998; Dudek-Shriber & Zelazny, 2007; Guidetti et al., 2017; Salls et al., 2002). This intolerance of prone time presents a barrier to families although Mendres-Smith et al. (2020) appeared to find solutions to wary infants by encouraging mothers to interact face to face on the floor with their prone infants together with the inducement of toys resulting in improved infant head lifting. To reduce infant intolerance to tummy time, there is a need to identify factors that influence and encourage parent/carers to facilitate daily tummy time (Hewitt et al., 2017; Hewitt, Stephens, et al., 2020). The BAC-P/2 program endeavours to reduce parent's lack of confidence and tummy time ideas by planning a variety of daily fun and parent friendly prone time activities to support and encourage parents/carers. The study data indicates that the BAC families interacted in higher daily tummy time numbers in comparison to the Non-BAC cohort.

Daily Vestibular Time and AIMS Motor Scores.

The body's sensory system including the vestibular, proprioceptive, tactile, visual and auditory senses are all interlinked with the former two senses central in developing postural control (Hlavacka, Mergner, & Krizkova, 1996). It was important to examine the recorded time that both sample groups engaged in daily vestibular positions in relation to their overall AIMS motor scores. There is the notion that an increase in daily vestibular time may equate to higher (AIMS) motor scores with either of the doctoral study's sample groups (Clark et al., 1977).

Results from Study two were organized according to the daily vestibular time data, collated from infants aged 3-7 months, and sorted into two groupings or categories. Category one daily vestibular participation became 'rarely to fifteen minutes' and category two converted into 'fifteen to sixty minutes'. There are no comparable daily vestibular time Australian guideline recommendations for children under one year of age as studies are more focused on prone and tummy time daily participation (V. Carson et al., 2017; Hesketh et al., 2017). Therefore, the tummy time lower limit of 30 minutes daily appeared too high for the less common vestibular categorisation and the lower limit of 'rarely to fifteen minutes' was adopted (Clark et al., 1977; White-Traut et al., 2002).

As a guide, Kanagasabai et al. (2013) offered 12 minutes (five times per week) of multisensory stimulation (ATVV) of which vestibular actions consisted of 4 minutes to preterm infants until discharge from hospital. Nelson et al (2001) also presented preterm infants to the ATVV multisensory program. The vestibular rocking only action was recommended for 5 minutes twice daily. However, the BAC-P/2 program included a varied selection of vestibular activities throughout the booklet's four Sections supporting the new daily vestibular minimum of 15 minutes as appropriate for the infants in the research study.

Within the BAC sample, fifteen infants (51% of sample group) were included in the 'rarely to fifteen minutes' daily category. This compared to twenty four infants (70% of sample group) of the Non-BAC cohort. In the 'fifteen to sixty minutes' daily category, fourteen (49% of sample group) of the BAC participants were recorded compared to ten infants (30% of sample group) in the Non-BAC group. The infants involved in the BAC-P/2 program produced greater numbers in the higher daily vestibular time category indicating that the activities presented in the BAC-P/2 booklet provided a variety of ideas and examples to undertake daily vestibular participation.

The differences between both sample groups were greater in the lower 'rarely to fifteen minutes' category. The BAC sample produced an AIMS total percentage mean score 52.0 with the Non-BAC infants scoring 34.1. With these lower daily vestibular participation numbers in the BAC group compared to the Non-BAC group, the markedly higher AIMS mean percentage score is noteworthy. Perhaps the differences in the 'rarely-15 minutes' activity category scores occur because the BAC infants are interacting with more specific and effective vestibular actions albeit in the same shorter daily time category. More equitable sample group results appear in the 'fifteen to sixty minutes' activity category. The BAC group scored an AIMS mean percentage score of 58.4 (49%of sample group) to 59.3 (30% of sample group) in the Non-BAC group. The similarity of motor scores for both groups is the first result where the BAC group has not produced a noticeable higher score even with higher percentage of daily vestibular participants. The smaller infant numbers in the Non-BAC vestibular 'fifteen to sixty minutes' activity category combined with parallel motor scores is .interesting.

However, a significant outcome is reflected in the higher AIMS total percentage scores observed for both sample groups with increased daily infant vestibular time. There appears evidence that with greater daily levels of vestibular time for both sample groups, again irrespective of infants numbers, a positive effect on infant's motor scores can be achieved.

The BAC-P/2 program in Comparison with Previous Infant Prone Programs.

The pattern of infant motor performance scores detailed in existing research are comparable to the results reported in the current thesis study. Lobo and Galloway (2012) engaged in an enhanced handling experimental study of infants participating within a 'Prone Playing program' including early infant prone head lifts, pull ups, sitting and vertical swaying activities. The program gains included significant differences between the experimental and control groups on the AIMS scores when tested at three months post birth. An additional positive hands and knees crawling milestone result was also recorded at follow-up assessments with the experimental infants achieving the milestone four weeks before the control group. The BAC-P/2 program also presents movements to support and contribute to the commando and hands and knees crawling milestones, paralleling with Lobo and Galloway. In addition, these results relate to the research of van Vlimmeren et al. (2007) where the higher AIMS mean scores of young participants were also indicators of achieving subsequent primary infant motor milestones. When comparing to the 2012 study, the BAC-P/2 program focuses on developing core strength, head control together with hand midline touching actions, paralleling with the Lobo and Galloway's observations of infant head righting skills and infant midline hand movements. The doctoral study also produced significant motor results through the AIMS testing methods as did the 2012 research although Lobo and Galloway utilised a therapist visiting on six occasions to support parents early in intervention program. The thesis study's overall positive AIMS results suggest that the BAC-P/2's diagrams and simple texts (without home visits) may be effective in encouraging and enabling the parents/carers to participate in activities to assist in their infant's motor milestone development.

Prone intervention programs have been undertaken and involve similar activities to the specific prone -Section one (blue) related activities of the BAC-p/2 program. Hewson (2011) introduced an infant prone program, namely the Infant Postural Control Programme (IPCP) to a group of infants at eight weeks of age, post term birth. The ICPC produced pictorial prone activities including postural head lifting, core strength pull-ups, prone rugby hold, prone lying across parents legs and arm and shoulder weight bearing. These action photographs match closely to activities in the BAC-P/2 program's first section. Additionally, similar activity diagrams including *'back to tummy roll'* and *'prone pivoting'* (tummy turns) from BAC-P/2 Sections two (green) and three (purple) were activities offered in both studies. The Hewson study and the present thesis invited Experts to review all movement activities undertaken in their research. These responses were then evaluated and contributed to each program's content. Both research studies involved assessing the infant's motor development at similar ages, around 6 months post term birth. Although the actual motor skills assessed differed with Hewson viewing reflex integration, locomotion, grasping and visual motor integration compared with this thesis observing prone locomotion, supine, sitting and standing, both studies produced significant differences in equated results for the experimental infants.

An important design characteristic of the BAC-P/2 program was the incorporation of movement sketches and texts. Lee and Galloway (2012) conducted a postural and movement training research involving a prone program including photo activity sheets applicable to the infant experimental group. The participating infants had higher motor (TIMP) scores both during the initial four week intervention program and continued to show advanced head control at 3 and 4 months of age. Prone activities included infant tummy lying on the floor time, stimulated with a baby toy or parent's face and infant prone lying on parent's chest. These choices appear simplified when compared to the five varied prone actions in Section one (blue) of the BAC-P/2 booklet. The 2012 study's positive motor score results including advanced head control and higher general motor development align with the findings of the BAC groups' higher prone and overall motor scores.

The Jennings et al. (2009) study relates favourably to this present doctoral research. The similarities between the two studies are depicted with positive motor score results recorded with the relevant intervention infants including advanced prone and motor locomotion skills. Both research program assessments were conducted with infants at ages 6 to 9 months post birth. Jennings et al. introduced a take home tummy time brochure which enabled the families to continue with the activities after the initial interaction with nurses had concluded. Therefore, each program offered visually depicted prone activities presented in booklets with the intention to support families to undertake tummy time activities in the home.

Positively, the overall alignment in findings between a range of infant motor development research studies support the premise that infant prone or tummy time activities can impact and support infant motor and milestone development. There is an indication from the present doctoral study's positive and significant motor score results that the BAC-P/2's program booklet's content and design was appropriate in encouraging and communicating with the BAC families to undertake the core, prone and vestibular activities with their infants..

The BAC-P/2 program in Comparison with Previous Infant Vestibular Programs.

Another important motor development emphasis of the BAC-P/2 program was the varied selection of vestibular activities. In comparison, Clark et al. (1977) present a research study that incorporates only one infant vestibular chair rotation positioning. However, at the conclusion of the four week intervention research, the results recorded significantly advanced infant head, neck and trunk control scores and significant primitive reflex inhibition findings with the intervention infants. These results match the positive motor score outcomes in the doctoral thesis although within the BAC-P/2 program, the vestibular activities focused more on upright, prone and supine lying positions combined with swaying, tipping, bouncing and rocking motions. The Clark study concentrated on one aspect of vestibular stimulation with duplication of these chair actions difficult for parents to reproduce in the home.

Although the BAC-P/2 program has a focus on a variety of vestibular actions, the overall selection of activities was also based on the inter-relationship of all the sensory systems. Two multisensory targeted intervention programs to be evaluated have incorporated auditory, tactile, visual and vestibular activities (Kanagasabai et al., 2013; Nelson et al., 2001) and were undertaken with preterm infants. Results from these studies outline that the experimental subjects displayed increased neuromotor scores including increased tonal maturation compared to control infants. In comparison to the varied BAC-P/2 vestibular activities, the vestibular stimulation centred on horizontal rocking up to five minutes twice daily with parents in the home (Nelson et al., 2001) and horizontal and vertical (Kanagasabai et al., 2013) rhythmic prone rocking during the infant's hospital stay. Interestingly, these activities mirror the BAC-P/2 Section one (blue) prone rocking action of 'rock and roll ball' and the 'rugby ball hold'. In comparison to the Kanagasabai et al. (2013) infant study results, the Section one (blue) of the BAC-P/2 accentuates very similar components including increasing muscle tone and developing head control. In addition, the BAC-P/2 vestibular actions focus on responses to gravity with both pre-term and term infants incorporating gentle but active linear and circular movements, developing adjustments to imbalance (Dieterich & Brandt, 2019; Le Gall et al., 2019). The specific activities within the four sections of the BAC-P/s booklet are particularly planned and directed to achieve response to gravity reactions together with developing balance and muscle tone. Sandler and Coren (1981) report that providing the infant with rocking, spinning and turning activities can influence arousal levels, visual alertness and tracking, reflex maturation and motor development.

The BAC-P/2 program in Comparison to Prone and Vestibular programs.

There are three predominately prone programs, including IPCP, Enhanced Handling and Postural and Movement Training, for term infants that imply vestibular activities, paralleling several of the BAC-P/2 vestibular activities (Hewson, 2011; Lee & Galloway, 2012; Lobo & Galloway, 2012). These research programs all include two vestibular based actions comprising infant swaying, swinging, up and down lifting (in the prone position) and sideways rocking actions. Interestingly, these studies do not actually refer to the term vestibular although the activities outlined include specific vestibular components. Similarities with the three research study programs swaying and rocking activities are observed in the various vestibular actions presented in the BAC-P/2 Section one (blue).

The results reported in these prone and response to gravity studies displayed positive and significant differences in the participating infant's motor scores. These researchers also outline improvements including advanced locomotion (rolling over), improved reflex integration and head control compared with each studies control group infants. This doctoral study reflects similar positive motor development outcomes particularly those assessed in the AIMS total percentage mean scores for those infants participating in the BAC-P/2 activities. The main advantage with the BAC-P/2 program is reflected on the concentrated variety of both prone and vestibular activities together with the specific focus on specific motor actions to promote the development of the rudimentary motor skills of rolling, commando and hands and knees crawling.

Summary

This investigation of the influence of a wakeful prone, vestibular activity program on early infancy motor development has revealed that the difference between the two sample groups' AIMS total motor percentage scores was significant and meaningful. The infants participating in the BAC-P/2, consisting of predominately prone and vestibular activities over a three to four month duration, were found to be more advanced than the control infants in regard to their overall motor development.

The doctoral study's intervention group recorded higher percentage numbers in the 30-60 minute daily tummy time categories and in the 15-60 minute daily vestibular time category together with higher overall AIMS total percentage scores (including the prone score) compared to the Non-BAC infants. A thesis intention to assist and upskill parents to facilitate daily tummy time with their infants through interacting with the BAC-P/2 program is reflected in the higher participation time undertaken by the BAC infants. The thesis study's findings highlight that higher daily vestibular time participation for the infants can also impact on motor development. Verrecchia et al. (2019) report that a functioning vestibular sensory system is fundamental to newborns and young infant's motor development and essential to their ongoing motor skill achievement. These results support the quest to increase both parents and early childhood practitioners awareness of the benefits of vestibular activities that currently receive little emphasis the infant motor development domain.

An important finding within this study relevant to future research has revealed that the more time spent participating on daily tummy time and daily vestibular time activities by both the experimental and the control cohort resulted in higher infant's motor scores. The doctoral research and other research can reveal that increased tummy time can impact on infant motor development (Dudek-Shriber & Zelazny, 2007; Hunter & Malloy, 2002; Jennings et al., 2009; Mendres-Smith et al., 2020). Similarly, participation in vestibular activities can also affect infants development particularly ensuring the basic functions of response to gravity and balance (Le Gall et al., 2019).

CHAPTER 6 GENERAL DISCUSSION

An emphasis of this doctoral research was to explore, plan, design and construct a program that encompassed prone (tummy time) and vestibular activities to promote infant motor prone milestone development. The BAC-Program became a carefully developed booklet of infant movement activities to promote motor development. This first version of the BAC was refined through the integration of the selected Expert's responses within the content validity procedure, to create the updated BAC-P/2. The Expert's evaluation equated to a 93% approval to recommend the BAC-Program to parents and carers of young infants. An investigation of the revised BAC-P/2 was undertaken to consider the program's influence on infant motor development as a critical element of Study two. Additionally, Study two considered the impact that daily tummy time and daily vestibular time may have on infant motor development. In summary, the content validity of the program's format and selection of activities was evaluated by Experts from early childhood and health practitioner domains (Study one) with replies carefully examined and responded to creating the formation of the BAC-P/2, edition two.

The investigation within Study two, of this BAC-P/2 program was undertaken with a sample cluster (BAC group) of twenty nine, 10-12 week old infants. The families of these infants were presented with the BAC-P/2 program's activities and encouraged to undertake the activities daily if possible, until around 6-9 months post birth. This group was assessed to determine an overall motor development score using the AIMS assessment tool. Another cohort of 6-9 month old infants (non-BAC group) was also tested using the AIMS assessment procedure and the total motor scores of each group compared. This comparison was to determine if a significant difference was detected and to investigate whether this result might be linked or influenced by the BAC-P/2 program's prone and vestibular activities.

Promisingly, the BAC infants interacting with the movement program recorded significantly higher results suggesting that their motor development was advanced in comparison to the Non-BAC infants.

An analysis will be outlined regarding the amount of time both sample group of infants (BAC and Non-BAC) in Study two participated in daily tummy time and daily vestibular time in relation to the overall motor development results of each group. In the 30-60 minute daily tummy time category, the BAC group infants recorded 72% of all infants compared to 52% for the non-BAC-P/2 infants. Similarly, 49% of the BAC infant group undertook more than 15 minutes daily vestibular activities in comparison to 30% of the Non-BAC infants. This general discussion also discusses the contribution of the BAC-P/ as a support to parents and early childhood health professionals to encourage daily tummy time and vestibular time to promote infant motor development.

This chapter discusses: the effect of the concept of the BAC-Program to impact on infant motor development together with a comparison of the accuracy of the AIMS results reinforced by the Study two sample size. The efficacy of the BAC program's diagrams and text to support parents is presented followed by the importance of the sequential order of the rudimentary milestone stages with the BAC-Program. Finally, the relevance of the BAC-Programs activities to impact motor development is outlined, the effect of daily prone and vestibular participation on infant motor development and the effect of the BAC-Program to increase parent's knowledge and confidence.

The Concept and Design of BAC-Program to Impact on Infant Motor Development.

The evaluation of the BAC-Program's concept and design was undertaken by sixteen Experts (Study one) within the early childhood and allied health professions. A similar procedure was undertaken by Hewson (2011) utilizing allied health experts to view and comment on prone activities to encourage the developmental of infant motor milestones. The current evaluation process resulted in the BAC-Program and concept being content validated and subsequently modified to produce BAC-P/2 (edition two). Experts responded to questions regarding the BAC-Program's format, layout, diagrams. text. motor milestone order and page configuration. The compiled results outline that all questions received positive and informative responses.

As outlined, a total of 93% of the Experts in Study one supported the overall recommendation of the BAC-Program. This high support rating was also reinforced by the positive motor development results outlined by the families participating in the BAC-P/2 activities in Study two. The subsequent results for the 29 BAC infants (Study two) who undertook the modified activities recorded an AIMS total percentage means score of 55.10. The Non-BAC group's 34 infants generated a score of 41.52. This meaningful result demonstrates that the concept of the BAC-Program can effect infant motor development.

The Accuracy of the AIMS Results Reinforced by the Study Two Sample Size

The positive results reported in Study two necessitate discussion according to the accuracy of the AIMS percentage mean scores in relation to other equivalent infant motor research, together with the doctoral thesis' actual sample size of overall infant participants. The results from the individual BAC and Non-BAC infant's AIMS scores across a 6-9 month age range acknowledges an acceptable equivalence when compared with infants in the corresponding age ranges from Greece, Canada and Brazil (Saccani et al., 2016; Syrengelas et al., 2016; Syrengelas et al., 2014). The comparable AIMS percentage mean scores from all five cohorts of infants, namely BAC, Non-BAC, Greece, Canada and Brazil, are all within two percentage points of each other particularly in the 7-8 month age range. This specific age range was specified for comparison as this sample age group contained the thesis' largest and correspondingly identical infant sample numbers (18) within both sample groups. Interestingly, the BAC group record almost identical AIMS scores to the Canadian and Greek infant sample groups in the 7-8 month age group with the Non-BAC group's scores slightly lower. The comparison of results with research from other countries supports the accuracy of this doctoral research's AIMS scores.

In addition, the BAC-P/2 investigation study's overall sample size of 63 compares confidently with other motor development research sample sizes, revealing a range from these studies of 22 to 34 infants in predominately tummy time programs (Guidetti et al., 2017; Hewitt et al., 2019; Hewson, 2011; Jennings et al., 2009; Lee & Galloway, 2012; Lobo & Galloway, 2012). The relevance of the thesis' sample size broadens the meaningfulness of the collated data, thus having the ability (power) to detect and support the significance of the BAC group's higher AIMS total percentage mean score results (Pin et al., 2009). The importance of the large sample of 63 infant participants highlights a detectable influence on AIMS infant motor development scores, particularly on the higher scores of the 29 infants who participated with these BAC-P/2 prone and vestibular activities.

In summary, the overall AIMS total percentage mean score resulted in a significant difference in the motor scores compiled between the two sample groups. This result suggests that the BAC infants who interacted with the BAC-P/2 program were further advanced with their motor maturation than the infants who did not participate in this movement program.

The higher motor scores reported for the BAC infants suggests support for daily prone and vestibular activities, effectively those within the BAC-P/2 booklet for infants up to nine months post birth. Hunter and Malloy (2002) highlight that appropriate tummy play time can support the development an infant's anti-gravity head responses together with strengthening flexor and extensor motor patterns to assist the progression of motor skills**.** Previous prone time and also vestibular time research studies have documented positive motor development outcomes with their participating infants undertaking intervention movement programs at young ages and for comparable durations, (Clark et al., 1977; Guidetti et al., 2017; Hewson, 2011; Hunter & Malloy, 2002; Lee & Galloway, 2012; Lobo & Galloway, 2012; Rine et al., 2004). These similar studies and programs that highlight positive impacts on infant motor development, add support that the current doctoral research results are relevant.

Interestingly, the majority of these investigation studies either offer tummy time or minor vestibular focused activities. Lobo and Galloway (2012) and Hewson (2011) are predominately prone focused research findings with minor vestibular activities included. The Lee and Galloway (2012) study is also mainly prone activity engaged although this research selected two vestibular activities (infant lift –'baby fly' and infant 'sideways rocking') that are also similarly offered in the BAC-P/2 program booklet. The BAC-P/2 program has a strong vestibular action focus interspersed throughout the total of thirty four activities These specific comparisons to other research study's actual movement programs reinforces this doctoral study's results data, offering the provision of encouraging and supporting families with young infants to participate in a wide variety of prone and vestibular activities, to subsequently impact on their infant's motor maturity.

The Efficacy of the BAC Program's Diagrams and Text to Support Parents

An important sub aim of this doctoral research was the creation of the initial BAC-Program. The focus in relation to the design of the program's text and diagrams was to provide parents and carers with a variety of clear and practical prone and vestibular movement activities designed for infants from 6 weeks post term to the hands and knees crawling milestone. Hewitt, Kerr, et al. (2020) and Hewson (2011) present research outlining that mothers respond positively when supported to accept and maintain motivation to participate in daily tummy time activities. Therefore, the doctoral study undertook an evaluation of the initial BAC-Program's design and activities through relevant early childhood Experts responding to a questionnaire on specific sections of the movement program. Particular questions also covered aspects of the BAC-Program's contribution to providing both knowledge and confidence to parents and carers on the motor development of their infants.

Positively, the results of the Expert's replies produced 81% agreements that the diagrams and the text are both suitable and supportive for parents to implement. Interestingly, the high percentage score provided confidence that the BAC-Program's simplistic design was well received, with the Expert's individual comments outlining more specific ideas and suggestions to shape the BAC-P/2. Responses from several Experts regarding diagrams suitability included: *'clear; concise; brilliant; well-presented; easy to follow (especially for a sleep deprived mother); I like the way the pictures are silhouettes of men and women'.* Expert's response to the text's supportiveness included that the script: *'explains the drawings well; easy to read and understand; support diagrams and language is appropriate for the intended audience.* The provision of appropriately written material and images when presented to parents and carers, assists in the gaining of confidence to place their infant's particularly, in prone positions (Hewson, 2011; Jennings et al., 2009). The support for the overall concept and design that produced the initial BAC-program appears to have been realized.

The Sequential Order of the Rudimentary Milestone Stages within the BAC-Program

The main focus of the doctoral research was to create a wakeful prone, vestibular activity program with a focus on infant prone specific milestone development. The selection of the actual order of infant rudimentary milestones that would define the booklet's four sections, required research. Fundamentally, the layout of the BAC-Program was to be based on the first four rudimentary (prone) milestone stages that infants generally achieve over the first twelve months (post birth) before reaching the upright walking stance (Dudek-Shriber & Zelazny, 2007; Kimura-Ohba et al., 2011; Piper & Darrah, 1994). These stages (sections) included prone head control (body awareness and tummy time), followed by rolling over (prone to supine, supine to prone), commando tummy crawling and concluding with hands and knees crawling (Gerber et al., 2010; Hadders-Algra, 2018; Kuo et al., 2008). This choice of prone specific milestones progression was foremost to achieving a program relevant to promoting infant motor development, particularly locomotion movements.

There are differing opinions on the sequence of the rudimentary milestone progression with several researchers placing the 'supported' sitting milestone before commando crawling (Kimura-Ohba et al., 2011; Robertson, 2011; Senju et al., 2018). Several factors relating to the sitting milestone ultimately influenced the researcher's decision not to include this positioning within the BAC-Program's four sections. Research highlights that the sitting milestone focuses more on the reaching and exploration of objects whilst in comparison, the emphasis of the BAC-Program's centered on prone, locomotion milestones (Soska et al., 2015). Also, the progression to locomotion on hands and knees may be delayed, missed or appear as 'bottom shuffling' with an early introduction and over reliance on the sitting posture. (Howard, 2007).

This doctoral study utilized the AIMS motor assessment with the 'sitting subscale' being one of the four assessment areas. Piper and Darrah (1994) reinforce that infant motor assessments are usually performed for identification and classification of all infant motor performances. Therefore, this motor milestone assessment tool performs a different function in comparison with the motor development program that facilitates motor milestones. The assessment of the infant sitting milestone functions as a different focus from fostering or promoting this sitting milestone. There appears to be evidence that the sitting skills require trunk and upper extremity strength that can be achieved through time placed in the prone position (Dudek-Shriber & Zelazny, 2007). Dudek-Shriber and Zelazny reinforce that the link between time spent in prone positions and the development of patterns counteracting gravity together support the attainment of prone and non-prone milestones.

This exploration of various research studies provides support for the particular selection of the four prone milestone sections (core/head control; rolling, commando and hands and knees crawling) within the BAC-program (Gerber et al., 2010; Hadders-Algra, 2018; Kuo et al., 2008). The incorporation of the sequence of milestones within the BAC-Program enhances a sub aim of this doctoral research. This intention centres on promoting prone specific milestone development, specifically the rudimentary locomotion milestones that precede walking. Incidentally, the AIMS prone subscale identifies prone head control, rolling over, commando and hands and knees crawling as four of the twenty one observation components thus reinforcing the relevance of this assessment motor tool within the current thesis.

A review of the Experts opinions relating to the BAC-Program's milestone sections was required as part of the content validation of the program. There were no actual comments explicitly in relation to the prone milestone sequence or observations that the sitting milestone was not included in the program. Only one Expert referred to a milestone specifically and noted, in the hands and knees Section four (red), that *'forwards on hands and* *knees- remind parents that this is a cross pattern action'*. Overall, the specific intent of the Expert's responses within the four milestone sections was more directed to ascertaining the appropriateness of the wording, sketches and explanations associated within each specific activity.

The Experts responses to BAC-Program's activities within the four milestone sections were calculated from responses in questionnaire (ERQ) section's 2b-2d. The tier one response section referred to whether the Experts agreed that the activities were considered 'appropriate' to support infant motor development. The percentage scores from tier one 'appropriate' response, compiled from each of the four milestone sections were 73% (head control), 60% (rolling over), 86% (commando crawl) and 73% hands and knees crawl). Experts were also encouraged to include comments to provide opinions within each rating column. All written comments within all three response tiers were also evaluated and appropriate suggestions would contribute to the formation of the BAC-P/2 edition.

The 'rolling over' Section (green) milestone received the lowest Expert's score of 60% and requires discussion. The comments within this first tier were still positive including several Experts replying: *'sections are purposeful; appropriate; look fantastic'*. This milestone section received five comments from Experts in the 'additional text' or second tier responses. These comments mainly related to safety additions (include cushions, hold infant by the hips) for several vestibular actions together with attuning the correctness of the written text. All the suggestions were analysed and responded to producing redrawn sketches including safety additions together with clearer text. In general, the analysis of the pertinent research together with the Expert's scores and responses supported and justified the selection of the sequential sections in the formation of the BAC-P/2 booklet. The relationship of each selected milestone and the progression to overall infant motor development became the catalyst for selection of each activity.

The Relevance of the BAC-Programs Activities to Impact Motor Development

A consistent intent within this doctoral thesis was the concept of developing a prone and vestibular activities program consisting of a selection of interconnected and correlated activities to promote infant motor milestones. It is accepted that although infant movement development fundamentally requires a relationship with task factors within the environment, development also depends on physical forces interacting with the infant's nervous system (Adolph & Franchak, 2017). Primarily, the selection of activities within the BAC-Program focused on the approach that early brain experiences are principally linked with the infant's motor development (Als et al., 2004; Hadders-Algra, 2018; Horak, 1991). The selection of activities within the BAC program also centred on several factors affecting infant's participation in movement actions within the home environment, including the tasks being appropriate, readable and clear to parents and carers. This dual emphasis concerning the cognitive and the environmental factors, guided this doctoral researcher's scope to interpret different motor development approaches to influence the selection of the final activities within the BAC-Program.

An understanding of various approaches enables a researcher to explore motor development with a resolve to develop best practice movement concepts for infants and children (Dewolf et al., 2021). Consequently, the Williams and Shellenberger (1996) model of motor development was adopted to effect the selection of activities within the BAC-Program. The paradigm of this 1996 model supports and provides a schema to integrate the sensory, cognitive and behavioural systems of overall learning (Kurniawati et al., 2018).

Within the model's designated pyramid of learning sections, several categories were evidently relevant and contributed to the BAC-Program's activities selection process.

The categories that correlated included prone postural control (core and head control), maturity and inhibition of primitive reflexes, sensory systems/sensory motor development, and bilateral actions. Collectively, these four central categories link closely to the infant's central nervous system thus fostering infant motor development and demonstrate a correspondence or connection between the brain, the spinal cord, and the sensory systems (Malina, 2004). The model's behavioural connection to activity selection related to the diagrams and text being presented in a specific manner to appeal to a wide variety of families and allied health professionals. Even though the Experts were not requested in the questionnaire (EQR) to comment specifically on motor development theoretical concepts involving infant motor development, one Expert recapped positively that the BAC-Program *'links motor and cognitive development'*.

The Consequence of the Prone Postural Category

As outlined in the selection of four central categories that influenced the selection of BAC-program's activities, the prone postural category requires particular discussion. The prone positioning component *features* in the creation of the BAC-Program as tummy time-Section one (blue), was *commented* on by the Experts in Study one, *observed* in the prone subscale of the AIMS assessment tool and finally *analysed* in Study two according to participation of daily tummy time. This discussion relates to the resultant AIMS' prone scores resulting from the investigation of the BAC-P/2 on the two participating infant groups- namely the BAC and the Non-BAC infants.

Although the AIMS total percentage means score of 55.10 for the BAC group was significantly higher than the Non-BAC group's score of 41.52, the comparable scores in the four AIMS subscales are also slightly higher for the BAC infants group but not markedly. The difference between the prone mean scores for both sample groups (63 infants collectively aged 6-9 months) is the smallest and is very minimal. The BAC group prone mean score was 13.759 compared to the Non-BAC group score of 13.735. There appears to be no clear distinction for the BAC infants participating in the BAC-P/2 activities according to this AIMS Subscale. However, although the BAC-P/2 had a variety of prone activities (influenced by the prone postural category) that appears to have contributed to higher daily tummy time for the BAC infants (72% of total infants) and Non-BAC (52% of total infants), the AIMS prone subgroup results are similar for both infant sample groups. Perhaps this small difference relates to the BAC-Program's activities being more a combination of prone, vestibular, bilateral and early reflex inhibiting components as supported in the Williams and Shellenberger model.

In closer analysis, the specific 7-8 month infants groups consisting of 18 infants in both sample groups, produced a larger difference in AIMS Prone subscale comparison score. This comparison score is noticeably higher in favour of the BAC infant group. The result is generally positive for the infants undertaking the BAC-P/2 program and may add additional support for the program's specific tummy time activities emphasis.

The Multi-layered BAC-Program activity selection

This multi layered approach to activity selection within the BAC-Program allows the overall focus to centre on infant motor milestone development of which specific prone motor skills is one part. As previously discussed, placing infants in prone positions can impact on non-prone motor milestones including sitting and standing (Dudek-Shriber & Zelazny, 2007).

Adolph and Franchak (2017) detail the importance of postural control including stability and imbalance, to allow the infant to achieve motor skills including supine, prone, sitting and standing.

The motor rudimentary milestone skills specifically focused on in the BAC-Program are created from the Williams and Shellenberger (1996) pyramid categories, particularly the prone actions (postural control) together with vestibular, bilateral and reflex inhibition activities. The category focused activities are selected to impact on the motor milestones (prone and non-prone) achieved in the infants first 12 months post birth. The higher score highlighted within all four AIMS subscales in relation to the BAC group, together with the total AIMS percentage means score showing a significant difference in favour of the BAC group, indicates that collectively the BAC-Program's activities can impact on infant motor development.

To consolidate, many of the infant focused movement activities were essentially selected according to the prone and vestibular emphasis of the BAC-Program. An early objective was that postural, core and head control activities within the Section one (blue) of the BAC-Program will enable infants to gain these core skills to begin the journey to locomotion. This aim was reinforced with one Expert commenting that the overall program may be '*very helpful in the community to overcome low muscle tone'*. It is very supportive to communicate to parents and carers that the awake infant prone (or tummy time) position is a valuable strengthening activity of the head, arms, and upper body of young infants (Nitsos et al., 2017). Interestingly, there are variety of factors that may hinder parents and carers from encouraging their infants to spend the suggested awake tummy time of 30 minutes daily (Mendres-Smith et al., 2020). These influences include the low knowledge regarding the actual implementation of tummy time and lack of choices of diverse prone positions accessible to parents and carers (Ricard & Metz, 2014). Encouragingly, one Expert responded on the questionnaire that '*This chart (BAC-Program) highlights the importance of multiple positions and that it's ok to put infants in their tummies'.* This response is promising as a previous study indicated that many caregivers were unaware of the importance of tummy time and that low daily participation may cause motor delays and positional plagiocephaly (Zachry & Kitzmann, 2011).The BAC-P/2 Section one (blue) offers five specific prone actions catering for infants from 6 weeks to 4 months, considered important ages for prone time experiences.

The Effect of Daily Prone and Vestibular Participation on Infant Motor Development

Although there has been discussion on the multi layered approach to the activity selection within the BAC-Program, it is important to keep the emphasis on the prone and vestibular activities to maintain clarity with the doctoral thesis' intention. Firstly, there appears support for the contribution of the prone activities within the BAC-P/2 as encouraging results were recorded in Study two. As mentioned, there was a higher daily tummy time percentage participation in the 30-60 minutes daily classification with the BAC infants when compared to the Non-BAC infants. This higher participation result is also coupled with the higher overall AIMS total percentage mean motor scores achieved in the BAC group who interacted with the BAC-P/2 program. Interestingly, specific motor scores are compiled to those infants recorded in the 30-60 minute daily tummy time category, with the BAC group scoring 64.8 in the AIMS means score compared to 56.3 for the Non-BAC infants. There was sufficient evidence to conclude that with increased tummy time there is an effect on the AIMS mean result particularly in this Study's BAC sample group. This result concurs with the Jennings et al. (2009) study highlighting that the infants' families who also received written information (brochures), produced greater daily tummy time participation and also achieved higher prone and locomotion scores. There is encouragement for the contribution of the prone activities offered within BAC-P/2 program that is represented with the recorded positive daily tummy time participation of the BAC group. The premise is that the BAC group's positive AIMS results may be influenced by the availability of the prone activities, but also influenced by the interaction with the vestibular, bilateral and reflex inhibition activities within the program booklet format. The collection of the BAC-P/2 program's thirty four activities were encouraging parent/carers to interact with these clearly presented movement actions.

In conjunction with prone focused activities, the vestibular activities are also important to be practised daily by parents with their infants. The vestibular sensory system responds to gravity affecting early head control and later balance contributing to the early stages of infant's sensorimotor development (Le Gall et al., 2019). Additionally, informing early years professionals that the 'daily vestibular time' (parallel to 'daily tummy time') term is acknowledged as equally important for infant motor skills as is the tummy time expression is a challenge for infant motor development researchers (Schreiber-Nordblum, 1995).

The composition of the sixteen Experts from diverse early childhood related fields responded with a varied set of comments regarding the vestibular activities within the initial BAC-program. Responses included '*Lovely variety of vestibular activities'* but also included the comment *'too many vestibular activities'*. To maintain parents and carers confidence with these lesser known gravity reacting activities, several changes and rearrangements to particular vestibular actions were taken when producing the BAC-P/2.

The BAC-Program Section one (blue) offered six introductory vestibular actions and the Experts did not suggest any changes to this section. Specifically, these gentle tipping and swaying vestibular actions were chosen to introduce families to the 'response to gravity' concept slowly. These are simplistic vestibular actions are closely aligned with mimicking the early primitive reflexes. Vestibular actions are closely linked to primitive reflexes to assist the process towards reflex maturation or inhibition (Bilbilaj et al., 2017).

Acknowledging the comments of the Expert's regarding various vestibular activities was an important component of the design approach of the first Study's questionnaire including an accurate sampling of the relevant participant's responses (Hittleman & Simon, 2006). As mentioned previously, various vestibular activities were modified due to the responses from several experts. An interesting response from one Expert's questionnaire inc*luded 'There are some good sensorimotor activities*'; a comment without singling out vestibular sensory system even though the BAC-Program has such a strong vestibular text presence distributed throughout the four prone rudimentary sections.

From a results perspective, the infants involved in the BAC-P/2 program produced higher numbers percentages in the 'fifteen -60 minutes' daily vestibular time classification. These higher percentages appear to endorse the specific BAC-P/2's vestibular activities from the participation point of view with the additional provision of simple response to gravity sketches together with clear explanations**.**

Interestingly, the more daily vestibular time within the higher daily vestibular classification appears to have had a curious association on the infant AIMS total percentage motor scores. The BAC-P/2 participating infants recorded almost equal AIMS scores of 58.4 (49%) in comparison with 59.3 (30%) for the Non-BAC infants**.** These high AIMS mean score for both groups as a consequence of both groups interacting with daily vestibular activities is encouraging. Infant motor development can possibly be shaped by the amount of daily vestibular activities undertaken.

Clark et al. (1977) similarly present results that indicates that increased vestibular stimulation effected a significant improvement in motor skills for infants with a mean age of seven months. The Clark study is one of the few researches that presents a vestibular program with term infants with the sample age being very similar to the present doctoral thesis' 6-9 month old subjects. Similarly, Lee and Galloway (2012) introduced quite minor vestibular actions with full term 4-16 week old infants, with the intention to promote postural head control. The results indicated increased head control and advanced motor development for the infants participating in the training group. Thus, there appears collated and comparable evidence within the present thesis and with previous research (Clark et al., 1977; Lee & Galloway, 2012) that increasing daily levels of vestibular time can positively affect the infant's motor scores and subsequent motor development. This discussion reinforces an intention of this doctoral thesis to investigate the impact of vestibular activities on infant

The Effect of BAC-Program to Increase Parent's Knowledge and Confidence.

Interestingly, the research by Nelson et al. (2001) achieved positive changes to infant motor development in relation to a sensorimotor program with preterm infants. An unanticipated result was recorded as the mother and infant sensorimotor interaction remained low post the intervention program. These authors suggest that lack of parent physical interaction in the actual sensory program that was undertaken mainly by the researchers, may have contributed to the low post study involvement result. An important intention when creating of initial BAC-Program was that the concept of the program's simplistic diagrams and text could build a trust with parents and carers and encourage parent's physical interaction with their infants. The emphasis was for families to view the program predominately as a compilation of ideas that can support their infant's movement development.

This intent was examined in sections three and four of the questionnaire regarding the BAC-Program's contribution to parent's knowledge and confidence. Eighty one percent of Experts 'highly' agreed in section three (tier one) of the questionnaire that the BAC-program could increase parents and carers knowledge. Comments such as '*Agree completely; contributes highly; most impressive; provides appropriate milestone information; increased my knowledge; easy to follow'*. This result and comments show alignment with the Mendres-Smith et al. (2020) research demonstrating that parent-led interactions, particularly involving increased knowledge about infant prone positioning, were more effective in developing infant head elevation motor skills.

In respect to the questionnaire responses to section four, 75% of the Experts 'highly' agreed (tier one) to the increase in parents and carers confidence due to the BAC-Program's design. Of those Experts who responded 'adequately' (tier two), the responses were still quite positive. These included '*This chart highlights the importance of multiple positions and that it's ok to put infants in their tummies' and 'Diagrams are excellent, although could contribute highly if language was simplified'*. In response to this latter comment, the language within the BAC-P/2 edition's 'Introduction' section was markedly simplified to cater for ESL families. In addition, the technical sections that included several brainstem terms were replaced with more appropriate language. The new introduction page began with '*This easy to follow program supports your baby's development by engaging the developing brain through movement'* to connect with a greater range of families'. Devolin et al. (2013) and Moran and Ghate (2005) support this approach and highlight that parents of young children, particularly those in non-English speaking or lower socio-economic groups, seek relevant and appropriate information and programs to support their parenting.

The positive findings from the Experts in questionnaire (ERQ) sections 3 and 4 in Study one, reinforce the BAC-program's intention to increase the confidence and knowledge of parents. This aim is further supported with the infants (parents and carers) higher daily prone and vestibular participation percentage scores recorded from the BAC infants in Study two. Thus, the Experts' support for the BAC-Program's family accessibility and the higher daily participation from the BAC-P/2's experimental group, reinforce the doctoral research intention to help families to engage more readily and confidently on daily prone and vestibular activities with their infants.

It is interesting to view the reported factors hindering particularly daily infant tummy time. These factors include the SIDS supine sleeping information, individual parents factors including ages, education and maternal anxieties and early infant poor initial head and neck strength (Feldman et al., 1997; Hewitt et al., 2017; Majnemer & Barr, 2006; van Vlimmeren et al., 2007). Therefore, simply sketched activities together with relevant text within the BAC-Program appear to be well received by the Experts including '*I used diagrams and my husband used the texts; The 'Why' section outlines the reasons behind the activities; helps parents with a rationale for each activity'.* And as two Expert respondents who were also parents *added 'very welcoming activities particularly for my baby who was not initially advancing developmentally' and 'assisted our family more than four paediatricians'.*

Recommendations for Practice

The current doctoral research could assist Maternal Child Health Nurses (MCHN) to communicate with an increased understanding of tummy time to parents of young infants through providing access to BAC-P/2 booklets. Within most Australian municipalities, families are encouraged to attend the 'First Time Parents Groups' support program for families with newly born infants. These programs are offered once per week for six to eight consecutive weeks (https://www.education.vic.gov.au, 2121). Participation and information regarding the importance of daily tummy time sessions is currently one of the program's focuses and recommended by the nurses to parents and carers. The BAC-P/2 booklet could be a valuable option to pictorially present a greater variety of tummy time activities to support information currently available. The diagrams and accompanying text within the booklet could be discussed together, with MCH nurses offering guidance and answers to parents' questions. Additionally, the response to gravity- vestibular activities could also be introduced and the reasons behind these vestibular actions outlined. Feedback from parents would also contribute to future modifications to the BAC-P/2. This approach would continue the focus of family involvement, thus supporting and promoting parents and carers' confidence and knowledge regarding their infant's motor development.

An additional provision to making the BAC-P/2 program available to parents and carers would be the provision of an accompanying letter to both the MCHN and families, presenting a short summary of the program's aims and activities content. This letter or pamphlet could further engage and support parents and carers to enjoy and engage in tummy time activities (Hewitt, Kerr, et al., 2020; Hewson, 2011). To accompany the letter there is the provision to include an instructional video. The video would include visual action examples of infants and families undertaking the BAC-P/2 activities to clarify the actions in more detail.

A further recommendation would be to make the BAC-P/2 booklet available to staff in Children's hospitals and Women's hospitals where premature and term babies are delivered. In particular, research details that when introduced gently and at shorter intervals, prone and sensory activities can support premature infant's nervous systems to adapt to the incoming environmental stresses (Mohamed et al., 2018; White-Traut et al., 2002). A future BAC-P/2 edition could be specifically written including modified prone and vestibular, diagrams and text to cater for premature infants. Additional sensory activities could be researched and added together with primitive reflexes peaking and maturing actions.

Responses from particular Experts in Study one revealed that more simple language (text) would be beneficial to families from other cultures to encourage participation with the BAC-Program. This leads to a recommendation to produce the BAC-P/2text in several languages to cater for families from other countries and cultures. Research is presented by Devolin et al. (2013) outlining that families in non-English speaking settings request appropriate ideas to enable and support their overall parenting practice.

An added provision would be to include the booklet with the pre-birth or prenatal classes package. Availability pre-birth is an advantage as families could have time to read and understand the ideas before the new world of parenting begins.

Recommendations for Future Research

Future research into early infant motor development could be conducted to undertake assessments with infants initially between 6-9 months and then to additionally post-test both sample groups at 18 months. The AIMS assessment tool be used to determine infants total percentage mean scores of motor development up to 19 months post birth. This pre and post-test procedure would allow an examination as to whether the recorded differences in AIMS percentage means score between the two groups (BAC and Non-BAC) are maintained post the rudimentary milestone stages of development.

A further area of investigation could also involve the pre-testing of very young infant groups at 8-10 weeks (post birth) and then post-test at 7-9 months. An experimental group (BAC) would be interacting from 8-10 weeks with the BAC-P/2 program booklet and a control group (Non-BAC) would participate in usual MCH nurses tummy time sessions. The control group would not be offered a BAC-P/2 prone and vestibular program that can facilitate motor milestone development until after post testing between 6-9 months. There is an ethical issue with this recommendation as the findings from both this doctoral thesis and other relevant early motor development research (Guidetti et al., 2017; Hewitt et al., 2019; Hewson, 2011; Jennings et al., 2009; Lee & Galloway, 2012; Lobo & Galloway, 2012) outline that tummy time and/or vestibular time can affect differences to infant motor development scores. The alternative would be to source another study's AIMS data from an assessment of 8-10 week old infant's motor development and contact the data set at 7-8 months for a follow up AIMS assessment.

Another recommendation concerns incorporating a Parent interview questionnaire within Study two. Questions would be phrased that particularly focused on the parents and carers awareness of the importance of tummy time and vestibular time post the intervention. Although Study two included a questionnaire, this demographic format focused more on the specific details of each infant rather than the parents opinions.

Future research would benefit from the addition of Experts firstly from the paediatric occupational therapy domain to provide a different perspective on activities that regulate infants and children's sensory input and secondly from the paediatrician medical domain to provide a perspective on the infants' neurological development. The establishment of a wider range of experts reviewing an infant movement development program could enable a very comprehensive selection of acceptable and neurologically appropriate infant motor activities.

The validated Delphi methodology may be a research method to adopt for future Expert responses as this process can be used to determine a group opinion or decision by adopting a face to face method to probe, value and appraise a panel of experts. The experts may or may not adjust their answers to each question due to expressed views and opinions on how they interpret the "group response" provided as opposed to the individual supplied questionnaire methodology approach.

Future research will continue to invite additional Experts in the field to clarify the role of the various prone and vestibular activities offered in the BAC-P/2, to encourage the motor development of infants. This approach to interact and seek opinions closely with experts with theoretical and professional knowledge would add thoroughness and diligence when designing the BAC-P/3 edition three.

In future this researcher will investigate the use of additional phone calls to infant participant families to further develop research procedures and to maintain closer contact with both infants and families.

Limitations of the Study

Within Study one, sixteen Experts undertook a content validation of the initial BAC-Program. The eligibility of these Experts was based on a background in early childhood, focusing on a particular interest or expertise in early childhood movement and development. The final group included five educators (one as a parent) and eleven allied health professionals including three paediatric midwives (one as a parent), two paediatric chiropractors, two physiotherapists, two paediatric osteopaths, and two community maternal and child health nurses (MCHN). A limitation of this Expert selection group centred on the non-inclusion of two sensory motor occupation therapists and two paediatricians to add greater depth to the overall experts' specialization.

Section 1 of the ERQ could include a further response to high, moderate, low and include an option of 'no contribution' when expert's responded to the contribution of the BAC-Program's diagrams, text and format.

A further limitation of this doctoral thesis may be that the motor assessment in Study Two were not conducted by an independent assessor. The observational assessments were undertaken by this doctoral researcher. Funding was not available to engage an independent assessor within the current research. To maintain tester credibility and reliability, procedures were therefore undertaken to guarantee that an interrater reliability was established. Therefore, an independent AIMS motor skill tester (infant motor development specialist) was engaged and together with this doctoral researcher, viewed an AIMS demonstration assessment video to upskill both assessors on the correct procedures. The interrater reliability score was determined at 90% item agreement on the AIMS assessment tool, post both assessors viewing six infant videos (Blanchard et al., 2004).

Additionally, to engage an independent evaluator for the entire sample group who was blind to whether the infants were from the experimental or control groups, would further support the independence of the AIMS motor scale results (Briggs-Gowan, Carter, Irwin, Wachtel, & Cicchetti, 2004).

The data gained from the parent's demographic questionnaire within Study two focused on identifying how often each day (approximately) that the infant was place on their tummy or in a vestibular (upside down) position. The choices to circle within both these categories included rarely, 15 minutes, 30 minutes, 45 minutes or 60 minutes. The 3-7 months age group became the infant's age frame. To ensure in future that these results are even more exact and to eliminate the memory component, an outcome would be to supply diaries for parent to fill in participation scores twice weekly or monthly. In the doctoral thesis, parents were required to remember and estimate daily activity participation over 3-4 month periods. Overall, the parents responded positively to this question with estimations readily recorded, with no parent commenting on any difficulty concerning this task.

A limitation to Study Two could be associated with the selection of participating BAC parents as non-random participants rather than adopting the specific random selection approach. This voluntary selection method may have unintentionally nominated parents with an interest in the motor development of their child. Although an additional methodology procedure namely '*randomized controlled trial methodology'* was outside the scope of the current thesis, this approach would allow greater clarity and transparency to data collection in relation to infant motor scores.

CHAPTER 7 CONCLUSION

Infant motor development is a progression through which infants and children explore motor patterns and motor skills (Malina, 2004; Meduri, 2020). Research has indicated that infant motor development has been affected as a consequence of the recommendation to sleep newborn babies on their backs post the SIDS campaign of the 1990's and more recently in 2016 (Davis et al., 1998; Moon, 2016; Speltz et al., 2010). Evidence implies that lack of prone or tummy time negatively impacts on infants achieving motor milestone development (Guidetti et al., 2017; Majnemer & Barr, 2006; Ricard & Metz, 2014).

Infants displaying delayed motor milestone development may lack coordination, balance, speed and strength in later years (Gerber et al., 2010) and Hitzert et al. (2014) suggest that cognition and behavioural performance by early school age may also be impacted by motor development deficiency. Research also suggests that the age of infant motor milestones attainment may predict adult cognitive or higher educational level outcomes (Flensborg-Madsen & Mortensen, 2017; Taanila et al., 2005). These studies motivate further research to develop a methodology to encourage families to interact with infant prone tummy time activities to support and enable the development of rudimentary milestones. Several studies identify the need to facilitate parent involvement in tummy time participation and the subsequent need to provide resources to educate and support parental involvement (Hewitt, Kerr, et al., 2020; Hewson, 2011; Mendres-Smith et al., 2020).

In response, the doctoral study created, evaluated and measured the effectiveness of an interactive prone and vestibular activity program to facilitate infant motor development. Subsequently, the BAC-Program format that includes both diagrammatic sketches and descriptive text of sequential prone and vestibular activities was produced following extensive theoretical research. The BAC-Program was validated by a range of selected Early

Childhood allied professionals. This evaluation produced the edited BAC-P/2 that was distributed to parents of 8-10 week old term infants (BAC group) to interact together with the range of progressive movement activities. The BAC experimental cohort recorded a positive outcome of higher motor scores on the AIMS observation assessment, evaluated at 6-9 months, when compared to the Non-BAC control group. Data from this doctoral research also established that higher AIMS total percentage motor scores were recorded in both sample groups as daily tummy time and daily vestibular time participation increased.

Implementation by the BAC group parents in the BAC-P/2 activities and the subsequent positive motor scores of the experimental infants supports the contention of the doctoral study that with supportive easily understood content regarding prone and vestibular activities, families can positively impact on their infant's motor milestone development. Early Childhood professionals in their role assisting and guiding parents with young infants, could be assisted with current educational and information resources such as the BAC-P/2 to help parents to meet daily tummy time objectives.

Future research could focus on how to increase parental awareness of the importance of tummy time and vestibular time in infant motor development through the creation of strategies and programs to enable families to facilitate this focus. Whereas, the doctoral research study measured the immediate effect of a movement program on infant motor scores, longer term studies could measure the impact of infant motor development on later fundamental motor skills with preschool and school aged children.

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APPENDICES

Appendix A: Human Research Ethics Approval (Study One)

quest.noreply@vu.edu.au
Mon 30/06/2014 3:57 PM
To:
Anthony.Watt@vu.edu.au;
...
Cc:
brenda.lovell@live.vu.edu.au;
Michael.Spittle@vu.edu.au;

Dear DR ANTHONY WATT,

Your ethics application has been formally reviewed and finalised.

» Application ID: HRE14-169
» Chief Investigator: DR ANTHONY WATT
» Other Investigators: MS Brenda Lovell, ASPR MICHEAL SPITTLE
» Application Title: Experts' evaluation of a wakeful prone, vestibular activity program focusing on early infancy motor development.
» Form Version: 13-07

The application has been accepted and deemed to meet the requirements of the National Health and Medical Research Council (NHMRC) 'National Statement on Ethical Conduct in Human Research (2007)' by the Victoria University Human Research Ethics Committee. Approval has been granted for two (2) years from the approval date; 30/06/2014.

Continued approval of this research project by the Victoria University Human Research Ethics Committee (VUHREC) is conditional upon the provision of a report within 12 months of the above approval date or upon the completion of the project (if earlier). A report proforma may be downloaded from the Office for Research website at: http://research.vu.edu.au/hrec.php.

Please note that the Human Research Ethics Committee must be informed of the following: any changes to the approved research protocol, project timelines, any serious events or adverse and/or unforeseen events that may affect continued ethical acceptability of the project. In these unlikely events, researchers must immediately cease all data collection until the Committee has approved the changes. Researchers are also reminded of the need to notify the approving HREC of changes to personnel in research projects via a request for a minor amendment. It should also be noted that it is the Chief Investigators' responsibility to ensure the research project is conducted in line with the recommendations outlined in the National Health and Medical Research Council (NHMRC) 'National Statement on Ethical Conduct in Human Research (2007).'

On behalf of the Committee, I wish you all the best for the conduct of the project.

Secretary, Human Research Ethics Committee
Phone: 9919 4781 or 9919 4461
Email: researchethics@vu.edu.au

Appendix B: DEECD Research Ethics Approval (Study Two)

Department of Education and Early Childhood Development

Strategy and Review Group

2 Treasury Place
East Melbourne, Victoria 3002
Telephone: +61 3 9637 2000
DX 210083
GPO Box 4367
Melbourne, Victoria 3001

2014_002475

Ms Brenda Lovell
426 Arden Street
KENSINGTON 3031

Dear Ms Lovell

Thank you for your application of 27 August 2014 in which you request permission to conduct research in Victorian government schools and/or early childhood settings titled *Experts' evaluation of a wakeful prone, vestibular activity program (Infant Activity Chart-IAC) focusing on early infancy motor development.*

I am pleased to advise that on the basis of the information you have provided your research proposal is approved in principle subject to the conditions detailed below.

1. The research is conducted in accordance with the final documentation you provided to the Department of Education and Early Childhood Development.

2. Separate approval for the research needs to be sought from school principals and/or centre directors. This is to be supported by the DEECD approved documentation and, if applicable, the letter of approval from a relevant and formally constituted Human Research Ethics Committee.

3. The project is commenced within 12 months of this approval letter and any extensions or variations to your study, including those requested by an ethics committee must be submitted to the Department of Education and Early Childhood Development for its consideration before you proceed.

4. As a matter of courtesy, you advise the relevant Regional Director of the schools or governing body of the early childhood settings that you intend to approach. An outline of your research and a copy of this letter should be provided to the Regional Director or governing body.

5. You acknowledge the support of the Department of Education and Early Childhood Development in any publications arising from the research.

6. The Research Agreement conditions, which include the reporting requirements at the conclusion of your study, are upheld. A reminder will be sent for reports not submitted by the study's indicative completion date.

7. If DEECD has commissioned you to undertake this research, the responsible Branch/Division will need to approve any material you provide for publication on the Department's Research Register.

State Government Victoria

I wish you well with your research study. Should you have further enquiries on this matter, please contact Youla Michaels, Project Support Officer, Research, Evaluation and Analytics Branch, by telephone on (03) 9637 2707 or by email at michaels.youla.y@edumail.vic.gov.au.

Yours sincerely

Susan Thomas.

Susan Thomas
Director
Research, Evaluation and Analytics Branch

10/11/2014

enc

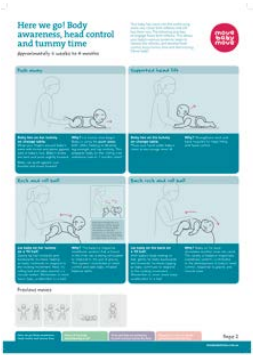
Appendix C: Email to Municipality MCHN Organisation Managers

Email to organization managers

To Attention manager of … City of ……. Maternal and Health Nurses

Dear ….,

I am looking to recruit early childhood motor milestone development experts to undertake a review of an Infant Activity Chart. The chart consists of a selection of age appropriate activities including tummy time actions (see example below) designed to support parents and carers to undertake awake time prone movements.



This review will be in a questionnaire format and it is devised that expert's responses will be measured as responses to a selection of wakeful prone, vestibular activities focusing on early infancy motor development.

I would appreciate hearing from two or three Maternal and Child Health nurses in your organisation who would be interested in participating in this short response (questionnaire). I anticipate that the time required by participants to undertake this questionnaire would be between 30 - 45 minutes.

You will find attached a consent form that can be filled in and returned via email.

I look forward to hearing from your organisation,

Kind regards,

Brenda Lovell
Motor Development and PE lecturer
College of Education
Victoria University
Melbourne Australia
T 9919 2185

Brenda.lovell@vu.edu.au

Appendix D: Consent Form for Participants Involved in Research (Experts)

CONSENT FORM FOR PARTICIPANTS INVOLVED IN RESEARCH

INFORMATION TO PARTICIPANTS:

We would like to invite you to be a part of a study titled 'Experts' evaluation of a wakeful prone, vestibular activity program focusing on early infancy motor development'.

The aim of this project is intended to test the theoretical and practical relevance of neuro-vestibular movement activities for normalizing of motor milestones in young babies.

CERTIFICATION BY SUBJECT

I, "[Click here & type participant's name]"
of "[Click here & type participant's suburb]"

certify that I am at least 18 years old* and that I am voluntarily giving my consent to participate in the study:

Investigating 'Experts' evaluation of a wakeful prone, vestibular activity program focusing on early infancy motor development' by: Brenda Lovell, Anthony Watt, and Michael Spittle.

I certify that the objectives of the study listed hereunder to be carried out in the research, have been fully explained to me by Brenda Lovell – Student Researcher and that I freely consent to participation involving an expert response measure.

I certify that I have had the opportunity to have any questions answered and that I understand that I can withdraw from this study at any time and that this withdrawal will not jeopardise me in any way.

I have been informed that the information I provide will be kept confidential.

Signed:

Date:

Any queries about your participation in this project may be directed to the chief researcher
Dr Anthony Watt
Ph: 9919 4119

If you have any queries or complaints about the way you have been treated, you may contact the Ethics Secretary, Victoria University Human Research Ethics Committee, Office for Research, Victoria University, PO Box 14428, Melbourne, VIC, 8001, email Researchethics@vu.edu.au or phone (03) 9919 4781 or 4461.

[*please note: Where the participant/s are aged under 18, separate parental consent is required; where the participant/s are unable to answer for themselves due to mental illness or disability, parental or guardian consent may be required.]

Appendix E: Baby Activity Chart- Program ERQ Questionnaire

Baby Activity Chart Questionnaire

Dear ,

Thank you for agreeing to participate in the accompanying questionnaire.

The questionnaire is investigating responses to the accompanying Baby Activity Chart (BAC). To ensure that the activities presented in the Chart have face content and validity standards, experts in the Early Childhood and Motor Development field have been selected to respond to a variety of questions. Responses to these questions will help to shape the chart's development.

This chart has been designed and planned to provide parents/carers with simple activities to encourage fun infant tummy time and muscle strengthening activities. The chart aims to foster infant's to explore and reach the basic developmental milestones creating the foundation for physical, neurological and social development. These milestones involve rolling-over, commando crawling and hands and knees crawling.

I have prepared, practiced and chosen the activities through my role as a preschool physical education teacher, with a Master of Education in Motor Development, and 15 years' experience teaching movement sessions to infants and pre-schoolers.

The responses to these questions will enable the modification of the contents to ensure the aims of the Chart are achieved. The Chart will subsequently be incorporated in an Infant Developmental Study as part of a PhD requirement.

Thank you for taking the time to participate in this questionnaire.

Yours sincerely,

Brenda Lovell

Motor Development and PE lecturer

College of Education; Victoria University

Melbourne Australia

T 9919 2185

Brenda.lovell@vu.edu.au

Section 1: Format

	Highly	Very	Moderately	Could be improved
The ***BAC*** concept is a beneficial educational guide to a baby's overall development in the first 12 months				
Comments: Please provide details to support the above response				
The activity **diagrams** are suitable for parents/carers to understand				
Comments: Please provide details to support the above response				
The **text** accompanying the diagrams is supportive to the activities				
Comments: Please provide details to support the above response				
The **format** of 4 activities per page will be helpful to assist parents to undertake and remember each activity				
Comments: Please provide details to support the above response				

Section 2: Sections: text and diagrams

Chart Sections	**The text/diagrams are <u>appropriate</u>**	**Section needs <u>additional</u> text/diagram**	**Section needs particular text/diagram <u>removed</u>**
Introduction			
Comments: Please provide details to support the above response			
Body Awareness Head Control Tummy time 12 activities			
Comments: Please provide details to support the above response			
***Aware of my body* and preparing to roll** 8 activities			
Comments: Please provide details to support the above response			
***Arms and Legs preparing* to push and pull** across the floor 10 activities			
Comments: Please provide details to support the above response			
Preparing to crawl on hands and knees 8 activities			
Comments: Please provide details to support the above response			

Section 3

A specific aim of the BAC is to create a usable chart with appropriate activities to educate Parents/carers to be ***more knowledgeable*** about their baby's motor development.

Please provide your **response** as to the **contribution of the IAC to develop parents/carers knowledge**

Respond to **ONE** of the following

The BAC has a *High Contribution* to develop parent/carers knowledge:

Comment____

____

The BAC has an *Average Contribution* to develop parent/carers knowledge:

Comment____

____

____

The BAC has a *Low Contribution* to develop parent/carers knowledge:

Comment____

____

Section 4

The BAC **design layou**t (diagrams and texts) is created to enhance parents/carer's **confidence to physically interact with their young infant.**

Please provide your **response** as to the contribution of IAC's design **to promote parents/carers confidence.**

Respond to **ONE** of the following:

The BAC has a *High Contribution* to promote parents/carers confidence:

Comment____

____

The BAC has an *Average Contribution* to promote parents/carers confidence:
Comment____

____

The BAC has a *Low Contribution* to promote parents/carers confidence:

Comment____

____

Section 5:

***Please choose one of the following responses:**

I **would** recommend this Baby Activity Chart to parents/carers because:

I **would not** recommend this Baby Activity Chart to parents/carers because:

Appendix F: BAC-Program booklet (front cover)

Appendix G: Human Research Ethics Approval (Study Two)

Study 2

Quest Ethics Notification - Application Process Finalised - Application Approved

QU quest.noreply@vu.edu.au t;> Reply all lv

To: Anthony.Watt@vu.edu.au; Cc: Brenda Lovell; Michael.Spittle@ Wed 2/12/2015 12:13 PM

Inbox

Dear DR ANTHONY WATT,

Your ethics application has been formally reviewed and finalised.

» Application ID: HRE15-124
» Chief Investigator: DR ANTHONY WATT
» Other Investigators: ASPR MICHEAL SPITTLE, MS Brenda Lovell
» Application Title: An investigation of the influence of a wakeful prone, vestibular activity program on early infancy motor development: Study B
» Form Version: 13-07

The application has been accepted and deemed to meet the requirements of the National Health and Medical Research Council (NHMRC) 'National Statement on Ethical Conduct in Human Research (2007)' by the Victoria University Human Research Ethics Committee. Approval has been granted for two (2) years from the approval date; 01/12/2015.

Continued approval of this research project by the Victoria University Human Research Ethics Committee (VUHREC) is conditional upon the provision of a report within 12 months of the above approval date or upon the completion of the project (if earlier). A report proforma may be downloaded from the Office for Research website at htt p:// researc h.vu.edu.au/ hrec.php .

Please note that the Human Research Ethics Committee must be informed of the following: any changes to the approved research protocol, project timelines, any serious events or adverse and/or unforeseen events that may affect continued ethical acceptability of the project. In these unlikely events, researchers must immediately cease all data collection until the Committee has approved the changes. Researchers are also reminded of the need to notify the approving HREC of changes to personnel in research projects via a request for a minor amendment. It should also be noted that it is the Chief Investigators' responsibility to ensure the research project is conducted in line with the recommendations outlined in the National Health and Medical Research Council (NHMRC) 'National Statement on Ethical Conduct in Human Research (2007).'

On behalf of the Committee, I wish you all the best for the conduct of the project.

Secretary, Human Research Ethics Committee
Phone: 9919 4781 or 9919 4461
Email: researchethics@vu.edu.au

Appendix H: DEECD Research Ethics Checklist

Department of Education and Early Childhood Development
Performance and Evaluation Division

Conducting research in Victorian government schools and/or early childhood settings

Checklist of Attachments

	ITEM All items should be individually identified clearly	**YES or NO**	**If NO give REASON**
1.	a copy of the proposed letter to principals or directors requesting approval to conduct the research in their settings	YES	
2.	a copy of the proposed letter of invitation and/or plain language statements to each participant group	YES	
3.	a copy of the proposed letter to parents/guardians, inviting children to participate in the research	NO	Not required as covered in item 2
5.	separate consent forms for principals/directors, teachers/staff, parents/guardians and students (where applicable)	NO	Separate consent forms are not required
6.	copies of all research instruments (questionnaires, surveys, interview schedules)	YES	
7.	signatures on the completed Research Agreement	YES	
8.	indication of your HREC application status	YES	
9	Example of Baby Activity Chart	YES	

Appendix I: DEECD Research Ethics Approval (Study Two)

9/12/2015

Dear Mr Watt
I refer to your Research in Schools and/or Early Childhood Settings application titled: *An investigation of the influence of a wakeful prone, vestibular activity program on early infancy.*
Please find attached your Research in schools and/or early childhood settings letter of approval.
Please quote the application number 2015_002909 in any further correspondence.

If you have any questions regarding your application, please email the Performance and Evaluation Division at: research@edumail.vic.gov.au

Kind regards
Youla

Youla Michaels | Project Support Officer
Performance and Evaluation Division | Strategy and Review Group
Department of Education and Training

Level 3, 33 St Andrews Place, East Melbourne VIC 3002 T: 03 9637 2707
E: michaels.youla.y@edumail.vic.gov.au
W: http://www.education.vic.gov.au/

VICTORIA State Government | Education and Training

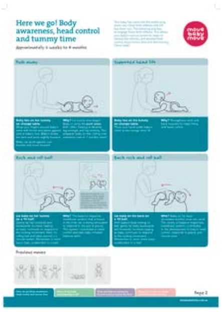
Appendix J: Email to Municipality MCHN Organisation Managers

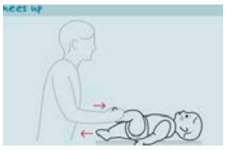
Email (example) to Managers/

To Maternal and Child Health Nurses

My name is Brenda Lovell and I am currently teaching the Early Years movement units at Victoria University in the Bachelor of Education degree course. I am presently undertaking my PhD and am looking to recruit parents/carers to undertake an infant activity program using the validated Baby Activity Chart (BAC see below). The chart consists of a selection of age appropriate activities including tummy time actions designed to support parents and carers to undertake awake time tummy time and core strength movements.

Examples of the chart below include:






The chart will provide parent/carers with fun activities to undertake over a four to five -month period (10-12 weeks –28 weeks). Participants will be supported by weekly phone calls or ‘email’ sessions and will be required to fill in a questionnaire at the completion of the study. Infant’s motor development will be measured at 7 months using Alberta Infant Motor Scale (AIMS).

I am available to visit a ‘New Parents’ session to explain the program in more detail to parents/carers at a time that would suit you.

Feel free to contact me at Brenda.lovell@vu.edu.au and my phone number is 0408322435.

I look forward to hearing from your organisation,

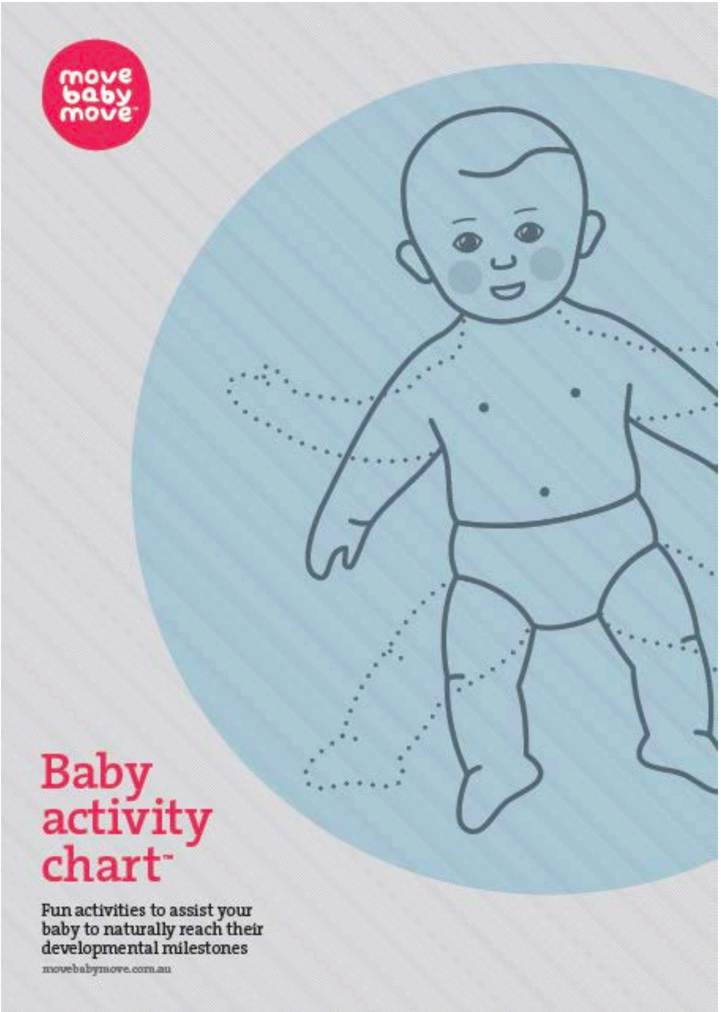
Kind regards,

Brenda Lovell
Motor Development and PE lecturer
College of Education
Victoria University
Melbourne Australia
T 9919 2185

Brenda.lovell@vu.edu.au

Appendix K: BAC-P/2 booklet (front cover)

BAC-P/2



Appendix L: Information Form To Parents/Carers Involved in BAC-P/2

Appendix iii a

INFORMATION TO PARENTS/CARERS INVOLVED IN PROGRAM EVALUATION

Dear ………

You are invited to participate in a research project involving participation with your young baby in a program of fun, researched tummy time activities.

This project is being conducted by a student researcher Brenda Lovell as part of a Doctorate of Education at Victoria University under the supervision of Dr Anthony Watt and Dr Michael Spittle.

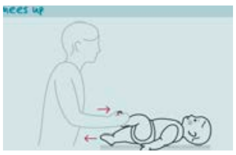
Project explanation

This project is looking to provide you with an easy to follow program of fun activities for babies from 10 weeks of age. The activities (see examples below and the attached A4 entire program) appear in an A3 sized calendar that is designed to present easy to follow sketches for parents/carers to interact with your young baby.

The activities are compiled into the ‘Baby Activity Chart’ that contains four sections of colourful, easy to follow diagrams. These diagrams and supportive text guide you and your baby through the major developmental milestones. The milestones include developing head control, rolling over, commando crawling and hands and knees crawling. The Infant Activity Chart can be used with infants from 6 weeks of age through to walking.

The chart will provide you with daily fun ‘tummy time’ activities to undertake over the four to five -month period (10-12 weeks –28 weeks) of the project. You will be supported by regular information emails and questions and queries can also be responded to by phone calls. You will be asked to fill in a short questionnaire at the completion of the study. Your baby’s motor skills will be measured at 28 weeks (7 months) in your home using the popular assessment – the Alberta Infant Motor Scale (AIMS). The AIMS collects observations of baby’s actions including spontaneous movements that reflect the quality of weight-bearing, antigravity skills when on tummy, back, reclining, and weight on feet positions.

Examples of the chart include



What will I be asked to do?

We are suggesting that you will interact with favourite activities for about 30 minutes each day although we encourage spreading the actions throughout the day over your baby’s wake periods. You will be guided to move through the charts activities at your own pace and will be encouraged to interact with Brenda via emails. Participation in this study will conclude with a short 30 minute assessment of your infant’s motor development (AIMS) at 7 months as previously mentioned. We will also provide you with a short questionnaire regarding your involvement in the activities, including your favourite and your baby’s favourite activities.

Appendix M: Information Form To Parents/Carers of 7 Month old Infants

Appendix iii b

INFORMATION TO PARTICIPANTS of SEVEN MONTH OLD INVOLVED IN PROGRAM EVALUATION

Dear Parent/carer

You are invited to participate in a research project involving participation with your young baby in a program exploring infant motor development.

This project is being conducted by a student researcher Brenda Lovell as part of a Doctorate of Education at Victoria University under the supervision of Dr Anthony Watt and Dr Michael Spittle.

Project explanation

You and your baby will join the group of parent/carers and infants to be recruited when their infant is 28 weeks to complete the Alberta Infant Motor Scale (AIMS) test. The research project is investigating the Motor Skills of 7 month infants using the Alberta Infant Motor Skills test (AIMS).

What will I be asked to do?

his study is inviting you and more specifically your baby, to be assessed for motor skill developments at 28 weeks in your own home. The assessment will take only 30 minutes.

The motor skills assessment (AIMS identifies the level of tummy, back, and core strength of your baby at 7 months and looks at the milestones your baby is participating at. We will share all information with you and answer any questions regarding your baby's development.

You will be asked to complete a questionnaire at the completion of the AIMS assessment. The questionnaire covers your infant's birth details, favourite movement activities and how often movement were undertaken each week.

What will I gain from participating?

You will be provided with a Chart known as the Baby Activity Chart. This chart consists of easy to follow fun activities for babies from 10 weeks of age to walking. The activities (see examples below and in the accompanying handout) are provided in an A3 sized calendar that is designed to present easy to follow sketches for parents/carers to interact with their young babies.

The benefits to you will be an opportunity to further develop their knowledge and interaction of skills associated with 'tummy time', core strength and rocking activities specifically selected for young infants. The involvement of you and you infant will provide valuable information to help us to acquire a clearer understanding of the current pattern of physical activities on the motor development of infants.

Appendix N: Consent Form for Parents/Carers Involved in BAC-P/2 Program

Appendix iv

CONSENT FORM FOR PARENTS/CARERS INVOLVED IN RESEARCH

INFORMATION TO PARTICIPANTS:

We would like to invite you to be a part of a study titled ‘An investigation of the influence of a wakeful prone, vestibular activity program (Baby Activity Chart) on early infancy motor development’.

The aim of this project is to examine the effect to which the utilization of the activities within the BAC make a difference to the motor development of 7-month-old infants in comparison to the development of babies not exposed to these activities.

CERTIFICATION BY SUBJECT

I, ____
(Parent/Carers name)

of ____
(Parent/carers suburb)
certify that I am at least 18 years old and that I am voluntarily giving my consent for

my child ____
(Participant/child’s name, date of birth

to participate in ‘An investigation of the influence of a wakeful prone, vestibular activity program on early infancy motor development:’ by: Brenda Lovell, Anthony Watt, and Michael Spittle.

Participants in this phase will participate in the IAC’s activities over a 4 month period to investigate development of infant’s motor development and parent’s confidence in interacting physically with infants.

I freely consent to my infant’s and my own participation in the following:

- Interact with the Baby Activity Chart (IAC) on a regular basis- Yes/No
- Participate in the Alberta Infant Motor Scale (AIMS) assessment at 28 weeks Yes/No
- Complete a questionnaire including my infant’s history and my interaction with the BAC - Yes/No
- Complete a weekly activity diary for my infant over the 4 month program Yes/No

I certify that the objectives of the study to be carried out in the research, have been fully explained to me by Brenda Lovell – Student Researcher and that I freely consent to participation involving an expert response measure.

I certify that I have had the opportunity to have any questions answered and that I understand that I can withdraw from this study at any time and that this withdrawal will not jeopardise me in any way.

I have been informed that the information I provide will be kept confidential.

Appendix O: Consent Form for Parents/Carers of 7 Month old Infants

Appendix iv
CONSENT FORM FOR PARENTS/CARERS OF 7 MONTH INFANTS INVOLVED IN RESEARCH

INFORMATION TO PARTICIPANTS:

We would like to invite you to be a part of a study titled 'An investigation of the influence of a wakeful prone, vestibular activity program (Baby Activity Chart- IAC) on early infancy motor development'.

The stage of the project that we would like you to be involved in is the assessment of your 7 month aged infant using the Alberta Infant Motor Scale (AIMS).

CERTIFICATION BY SUBJECT

I, ____
(Parent/Carers name)

of ____
(Parent/carers suburb)
certify that I am at least 18 years old and that I am voluntarily giving my consent for

my child ____
(Infant's name, date of birth

to participate in a section of 'An investigation of the influence of a wakeful prone, vestibular activity program on early infancy motor development:' by: Brenda Lovell, Anthony Watt, and Michael Spittle.

I freely consent to my infant's and my own participation in the following:

- Participate in the Alberta Infant Motor Scale (AIMS) assessment at 28 weeks Yes/No
- Complete a questionnaire including my infant's history and my interaction with the BAC - Yes/No

I certify that the objectives of the study to be carried out in the research have been fully explained to me by Brenda Lovell – Student Researcher and that I freely consent to participation involving an expert response measure.

I certify that I have had the opportunity to have any questions answered and that I understand that I can withdraw from this study at any time and that this withdrawal will not jeopardise me in any way.

I have been informed that the information I provide will be kept confidential.

Signed:

Date:

Any queries about your participation in this project may be directed to the chief researcher
Dr Anthony Watt
Ph: 9919 4119

Appendix P: Review Questionnaire of Parents/Carers using the BAC-P/2

Review of the Participation of Parents/carers using the Baby Activity Chart.

Questionnaire

Dear ……..,

Thank you for agreeing to participate in both the study on the participation of the Infant Activity Chart and this accompanying questionnaire.

The questionnaire is gathering your infant's specific details. This questionnaire is collecting information regarding the responses of your infant to the accompanying Baby Activity Chart (BAC). It is important for this study to record how often the activities were practiced and which activities were more enjoyable for both parent and infant.

This chart has been designed and planned to provide parents/carers with simple activities to encourage fun infant tummy time and muscle strengthening activities. The chart aims to foster infant's to explore and reach the basic developmental milestones creating the foundation for physical, neurological and social development. These milestones involve rolling-over, commando crawling and hands and knees crawling.

I have prepared, practiced and chosen the activities through my role as a preschool physical education teacher, with a Master of Education in Motor Development, and 15 years experience teaching movement sessions to infants and pre-schoolers.

The responses to these questions will provide interesting information to support the physical evaluation of each infant's motor development at 7 months of age. The study is in relation to Infant's gross motor skills and is part of a PhD requirement.

Thank you for taking the time to participate in both the study and this questionnaire.

Yours sincerely,

Brenda Lovell

Motor Development and PE lecturer

College of Education; Victoria University

Melbourne Australia

T 9919 2185

Brenda.lovell@vu.edu.au

Questionnaire

Section 1: Parent/carer Information

Please answer the questions below and add comments where possible. Please read the question carefully before answering. Thank you!

1a. Name of parent/carer:____

1b. Age:_________________

1c. Occupation: (past or present)____

____

1d. Highest level of education: (circle one): Completed secondary schooling: Diploma: University Degree; Masters; PhD.____

1e. Relationship to infant:____

1f. Current location of household

Suburb:_____________________________________

2a. Name of

Infant:____

2b. Date of Birth: ______________________ 2c.

Girl/Boy__________________

2d. Birth weight: ______________________ 2e. Birth

order________________

3. Birth History of your baby: *Circle*

3a. Vaginal birth: Comments:____

____

3b. Approximate length of labour____

____

3c. Caesarean: Comments:____

____

4. Further birth information:

4a. Baby Induced: Comments:____

____

4b. Forceps used: Comments:____

____

4c. Suction used:

Comments:____

____

5. Baby's sleeping posture: _Circle_

5a. Sleeps on back

____

5b. Sleeps on stomach

____

5c. Sleeps on

side____

6. Infant feeding:

Breast fed:_________________Length of time_________________________________

Bottle fed ____

Question 1:

Since undertaking the BAC program list 6 activities from any section that you and your <u>infant enjoyed</u> and <u>practised</u> most. <u>Attach photos to this questionnaire return if possible.</u>

!;

____

2:____

_

3:____

_

4:____

_

5:____

_

6:____

Comment:____

____

Question 2:

List the 3 favourite other activities that you and your infant <u>enjoyed playing</u> i.e. <u>finger rhymes, dancing,</u>

!;

____

2:____

_

3:____

Comment:____

____

Question 3:

How often each day (approximately) was your infant placed on or played with on his/her tummy

Birth to 3 months: ***circle one of following***

Rarely: 15 minutes daily: 30mins 45mins 60mins

Comment:____

3 months to 7 months: ***circle one of following. (This section may include rolling/commando crawling etc.)***

Rarely: 15 minutes daily: 30mins 45mins 60mins

Comment:____

Question 4:

How often each day (approximately) was your infant placed in an upside down position i.e. infant gently tipped upside down/placed and gently rolled on a large ball; infant rocked or placed in a swing/hammock; infant gently tipped by parent/carer with head lower than body.

a. 2 to 3 months: ***circle one of following***

Rarely: 15 mins daily: 30mins 45mins 60mins

Comment:____

b. 3 months to 7 months: ***circle one of following.***

Rarely: 15 mins daily: 30mins 45mins 60mins

Question 5:

Discuss <u>any</u> <u>aspects</u> *(i.e. new ideas/motivation to interact with infant)* of the BAC that may have contributed to your infant's general development over the study's duration:

____

____

____

Appendix Q: Review Questionnaire of Parents/Carers of 7-9 month old infants

Review of Motor Skill Activities of Twenty Eight week old infants

Questionnaire

Dear Parent/Carer,

Thank you for agreeing to participate in both the study to identify the Gross Motor Skill of 7-8 month old infants and this accompanying questionnaire. In response to your participation you have been supplied with a Baby Activity Chart (BAC) program that has been designed and planned to provide parents/carers with simple activities to encourage fun infant tummy time and muscle strengthening activities. The program aims to foster infant's to explore and reach the basic developmental milestones creating the foundation for physical, neurological and social development.

The questionnaire is gathering your infant's specific details. The responses to these questions will provide interesting information to support the physical evaluation of infant's motor development at 7-8 months of age. The study is in relation to Infant's gross motor skills and is part of a PhD requirement.

Thank you for taking the time to participate in both the study and this questionnaire.

Yours sincerely,

Brenda Lovell

Motor Development and PE lecturer

College of Education; Victoria University

Melbourne Australia T 9919 2185

Brenda.lovell@vu.edu.au

Note: The term 'carer' used in this form refers to a non-parental primary care giver, who is entrusted with the care and management of an infant.

Questionnaire:

Section 1: Parent/carer Information

Please answer the questions below and add comments where possible. Please read the question carefully before answering. Thank you!

1a. Name of parent/carer:____

1b. Age:__________________

1c. Occupation: (past or present)____

____

1d. Highest level of education: (circle one): Completed secondary schooling: Diploma: University Degree; Masters; PhD.____

1e. Relationship to infant:____

1f. Current location of household

Suburb:_______________________________________

2a. Name of Infant:____

2b. Date of Birth: ________________________ 2c. Girl/Boy___________________

2d. Birth weight: ________________________ 2e. Birth order_________________

3. Birth History of your baby: *Circle*

3a. Vaginal birth: Comments:____

____

3b. Approximate length of labour____

____

3c. Caesarean: Comments:____

____

4. Further birth information:

4a. Baby Induced: Comments:____

____

4b. Forceps used: Comments:____

____

4c. Suction used: Comments:____

____

5. Baby's sleeping posture: *Circle*

5a. Sleeps on back ____

5b. Sleeps on stomach ____

Question 1:

List the 6 favourite activities that you and your infant enjoyed playing)*i.e. physical movement activities/games, dancing).* **Attach photos to this questionnaire return if possible.**

!; ____

2:____

3:____

4: ____

5:____

6:____

Comments: Please add <u>where or who</u> suggested these activities to you (the source).

____

____

Question 2:

How often each day (approximately) was your infant placed on or played with on his/her tummy

<u>a: Birth to 3 months:</u> ***circle one of following***

Rarely: 15 mins daily: 30mins 45mins 60mins

Comment:____

____

<u>b. 3 months to 7 months:</u> ***circle one of following. (This section may include rolling/commando crawling etc.)***

Rarely: 15 minutes daily: 30mins 45mins 60mins

Question 3:

How often each day (approximately) was your infant placed in an upside down position i.e. infant gently tipped upside down/placed and gently rolled on a large ball; infant rocked or placed in a swing/hammock; infant gently tipped by parent/carer with head lower than body?

<u>a. 2 to 3 months:</u> ***circle one of following***

Rarely: 15 mins daily: 30mins 45mins 60mins

Comment:____

____

<u>b. 3 months to 7 months:</u> ***circle one of following.***

Rarely: 15 mins daily: 30mins 45mins 60mins

Question 4:

Discuss any <u>aspects</u> of your interaction with your infant that may have contributed to your infant's general development:

____

____

____

Appendix R: Consent Form for Sue C to verify AIMS Testing Procedures

Hi Bren
I would love to take part in the program, sounds very exciting 😊

Sue

From: Brenda Lovell
Sent: Wednesday, May 20, 2015 2:49 PM
To: Sue Crisp
Subject: re Ethics proposal

Hi Sue,

I hope things are going smoothly for you this week.

I am in the library today trying to finalise my PhD Ethics proposal that is due in next week!!!

I would like to invite you to be a tester of the Alberta Infant Motor Skills (AIMS) test for the infant subjects of my PhD study. Over 4 months there will be 40 29 week (7months) infants that will need to be tested. Each test will take 30 minutes and hopefully we can test in a central location. I will be recruiting parent and infant participants from the Geelong/Kensington/Footscray regions so not sure yet where testings will be.

You will have time to practice the test and we will recruit some babies to practise on.

I am hoping that you would be willing to be part of this study. You will be paid for each infant tested as I have a budget from the university. The payment will be $50 per infant but may include travel.

The testing will be from September 2015– Dec/January2016.

Please let me know if you are willing to take part. I totally understand if this doesn't suit you.

Talk soon,

Bren

Appendix S: Psychologist consent form

Support for PhD as a Psychologist

Success, I will update the details
Tony

From: Romana Morda **Sent:** Wednesday, 29 April 2015 12:10 PM **To:** Anthony Watt **Subject:** RE: Hoping for assistance on ethics application

Hi Tony,
I am happy to be listed on your ethics application.

Kind regards,
Romana

From: Anthony Watt **Sent:** Tuesday, 28 April 2015 2:07 AM **To:** Romana Morda **Subject:** Hoping for assistance on ethics application

Hi Romana.
I am hoping you will consider being the listed psychologist for the project listed below. Your role will be in relation to minor psychological risks associated with parents completing a questionnaire regarding how they engaged their infant in the program. Let me know
Kind Regards
Tony

An investigation of the influence of a wakeful prone, vestibular activity program on early infancy motor development

Study B: Analysis of motor development 40 twenty-eight week old babies.
The quantitative approach selected for the practical component of this study will draw on the testing of the motor skills assessment of young infants utilizing the Alberta Infant Motor Scale –AIMS (Piper & Darrah, 1994). This motor assessment procedure will generate evidence to address the Study B research questions and will comprise between group milestone and motor development comparisons. The groups will be defined as:
a: 25 (compensating for drop out number of 5 infants/parents/carers) infant participants selected to participate in the IAC program from 10 weeks of age

b: 25 infants who have not participated in the IAC activities will be contacted at 6 months and 20 selected and tested at 7 months. These subjects and parents will be supplied with the ongoing IAC post analysis.

A diary will be supplied to each parent/carer in group a. A short questionnaire will be sent to each parent/carer in group a and group b to ascertain details and backgrounds of each family.

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Phillips, J., & Backous, D. (2002). Evaluation of vestibular function in young children. *Otolaryngologic Clinics of North America, 35*(4), 765-790,. doi:10.1016/S0030-6665(02)00062-2.

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