

# **Does Independent Locomotion Influence the Age-of-Attainment of Proto-Declarative Pointing?**

by

**Debra Ingrid Kumarie Lall**

A Thesis submitted to the Faculty of Graduate Studies of

The University of Manitoba

in partial fulfilment of the requirements of the degree of

**Master of Arts**

Department of Psychology

University of Manitoba

Winnipeg, Manitoba, Canada

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## Abstract

A baby's ability to move her body through space by crawling may facilitate the development of joint attention. To test the hypothesis that earlier crawling onset would predict one aspect of joint attention skills, pointing, we analyzed prospective daily checklist parent reports. Proto-declarative pointing or "pointing to share interest with another" was selected as a good measure of joint attentional competence in infancy, and hands-and-knees crawling was selected as a measure of locomotor ability. Ages of attainment for these two competences were studied by using different threshold definitions for estimating when attainment occurred. The reliabilities for the various definitions were estimated with a split-half procedure and found to range from .95 - .99. The age of first crawling attainment was then used to predict age of first pointing in a survival analysis, along with other factors (age of sitting, gender, family income, mother's age, gestational age, children in the household, Ponderal Index, and mother's education). Age of sitting was included as a baseline measure of prior non-locomotor development and was a significant predictor of pointing. Mother's education and Ponderal index also predicted age of pointing. Most importantly, age of crawling was a significant positive predictor of pointing, above and beyond the predictive influence of all other predictors. The finding that earlier crawling uniquely predicts earlier pointing highlights the contribution of infant motor experience and attainment to the early aspects of joint attention.

## Acknowledgements

I sincerely thank my advisor, Dr Warren Eaton for his commitment, patience, support, careful feedback, his tremendous kindness, especially during my many humiliating SAS moments, and his great wit while working with me to complete this thesis. I would like to thank my thesis committee members Dr Rosemary Mills and Dr Judy Chipperfield for their thoughtful ideas and great enthusiasm for my work. In addition, I want to express my sincere gratitude to Dr Rosemary Mills for her ongoing encouragement and support for me. Thank you Dr Michelle Corley, my dearest friend, you stayed on the telephone with me for hours from Virginia State, to listen to my oral defense rehearsals. Thank you Dr Kimberley Arbeau for your cheerful support and endless words of encouragement during this time. Also, I would like to thank my lab members, Amy De Jaeger, Samantha Lewycky and Jennifer Schultz for their generous comments. Thank you Manitoba Health Research Council for awarding me a Graduate Studentship, which funded my Master's degree. Finally, I thank Dr. Timothy Racine, for his encouragement, genuine feedback, and for caring about psychological theories of development, as much as I do.

## Dedication

This thesis is dedicated to my mother Merlyn Lall, my beloved grandmothers,

Roni and Rachael, and my Aunty Ena.

Thank you for your love, support and encouragement over the years. In order to complete this degree, I had to spend time away from you, which was never easy.

## Table of Contents

Title Page .....	i
Abstract.....	ii
Acknowledgements.....	iii
Dedication.....	iv
Table of Contents.....	v
List of Tables.....	vii
List of Figures.....	viii
Chapter I: INTRODUCTION.....	1
Theories of Joint Attention.....	3
Individualistic Theories of Joint Attention.....	3
Relational Theories of Joint Attention.....	7
Independent Locomotion and Joint Attention.....	9
CHAPTER II: LITERATURE REVIEW .....	10
Proto-Declarative Pointing.....	10
What Factors are Related to the Development of Proto-Declarative Pointing? .....	12
Independent Locomotion and Proto-Declarative Pointing.....	12
<u>Assessing Rates of Development of Proto-Declarative Pointing and Crawling.....</u>	16
The Present Study.....	17
CHAPTER III: METHODS AND MATERIALS .....	19
Recruitment and Procedure.....	19
Participants.....	20
Exclusions.....	21
Checklist Data .....	21

Outcome Variable.....	23
Attainment Event Definition.....	23
Age of First Attainment.....	23
More Stringent Attainment Criteria.....	24
Predictors.....	26
CHAPTER IV: RESULTS.....	29
Reliability.....	29
Survival Analysis.....	31
Censoring Variables for Survival Analysis .....	33
Multicollinearity.....	33
Survival Analysis Results.....	34
Infant Demographics.....	34
Multiple Imputation.....	40
CHAPTER V: DISCUSSION.....	37
Age of Attainment Definition.....	42
Independent Locomotion and Proto-Declarative Pointing.....	44
Theoretical Implications of the Significant Findings.....	45
Additional Contributions.....	46
Sitting, Ponderal Index, Mother's Education and Proto-Declarative Pointing.....	47
Strengths, Limitations and Conclusions.....	49
References.....	53
Appendix.....	62

## List of Tables

Table 1.....	29
List of possible predictors of infant development included in the analysis model.	
Table 2.....	30
Intraclass correlation (ICC) reliability estimates and sample sizes for crawling and sitting by age of attainment definition.	
Table 3.....	35
Summary information for categorical predictor variables.	
Table 4.....	36
Summary information for continuously distributed predictor and outcome variables.	
Table 5.....	37
Summary of survival analysis model.	
Table 6.....	42
Summary of significant survival analysis parameter estimates before and after multiple imputation.	

## List of Figures

Figure 1.....	26
Illustrations of four event attainment criteria as applied to four different patterns of daily checklist observations.	
Figure 2.....	38
Age at pointing as predicted by mother's age.	
Figure 3.....	38
Age at pointing as predicted by age of sitting.	
Figure 4.....	39
Age at pointing as predicted by Ponderal Index.	
Figure 5.....	40
Age at pointing as predicted by Age at Crawling.	

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A baby's ability to move her body through space by crawling may facilitate the development of joint attention. To test the hypothesis that earlier crawling onset would predict one aspect of joint attention skills, pointing, we analyzed prospective daily checklist parent reports. Proto-declarative pointing or "pointing to share interest with another" was selected as a good measure of joint attentional competence in infancy, and hands-and-knees crawling was selected as a measure of locomotor ability. Ages of attainment for these two competences were studied by using different threshold definitions for estimating when attainment occurred. The reliabilities for the various definitions were estimated with a split-half procedure and found to range from .95 - .99. The age of first crawling attainment was then used to predict age of first pointing in a survival analysis, along with other factors (age of sitting, gender, family income, mother's age, gestational age, children in the household, Ponderal Index, and mother's education). Age of sitting was included as a baseline measure of prior non-locomotor development and was a significant predictor of pointing. Mother's education and Ponderal index also predicted age of pointing. Most importantly, age of crawling was a significant positive predictor of pointing, above and beyond the predictive influence of all other predictors. The finding that earlier crawling uniquely predicts earlier pointing highlights the contribution of infant motor experience and attainment to the early aspects of joint attention.

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## Table of Contents

Title Page .....	i
Abstract.....	ii
Acknowledgements.....	iii
Dedication.....	iv
Table of Contents.....	v
List of Tables.....	vii
List of Figures.....	viii
Chapter I: INTRODUCTION.....	1
Theories of Joint Attention.....	3
Individualistic Theories of Joint Attention.....	3
Relational Theories of Joint Attention.....	7
Independent Locomotion and Joint Attention.....	9
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Exclusions.....	21
Checklist Data .....	21

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Attainment Event Definition.....	23
Age of First Attainment.....	23
More Stringent Attainment Criteria.....	24
Predictors.....	26
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Reliability.....	29
Survival Analysis.....	31
Censoring Variables for Survival Analysis .....	33
Multicollinearity.....	33
Survival Analysis Results.....	34
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Independent Locomotion and Proto-Declarative Pointing.....	44
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References.....	53
Appendix.....	62

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Figure 5.....	40
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## CHAPTER I

### INTRODUCTION

The ability to share and coordinate one's attention with another person's is a critical developmental achievement. An early form of joint attention is first observed in typically developing 3-month-old infants (Scaife & Bruner, 1975), and more complex forms appear to emerge reliably in a particular developmental order (Carpenter, Nagell & Tomasello, 1998; Carpenter, Pennington & Rogers, 2002). First, around two or three months of age, infants share attention by meeting their caregivers' gaze (Scaife & Bruner, 1975), and by around six months, infants start to follow their caregiver's changing visual focus of attention (Scaife & Bruner, 1975). Eventually, infants begin to engage with their social partners around a common object or experience. These later triadic interactions include behaviours such as object-based imitation (Carpenter et al., 1998), referential pointing and social referencing. Referential pointing includes pointing to request an object (the so-called *proto-imperative* point), and pointing to share interest in an object (the so-called *proto-declarative* point). Referential pointing and object-based imitation emerge sometime between 9 to 14 months (Butterworth, 2003; Butterworth & Morrisette, 1996; Camaioni, Perucchini, Bellagamba & Colonesi, 2004; Murphy 1978); whereas, social referencing emerges closer to 14 months of age (Walden & Ogan, 1988). An infant's ability to initiate and engage in triadic social interactions is considered a robust indicator of the emergence of early social understanding and a "necessary" prerequisite for the development of language (Morales, Mundy, Delgado, et al., 2000), and social and cultural pragmatics (Tomasello, Carpenter, Call, Behne & Moll, 2005).

In particular, the proto-declarative point (Bates, Camaioni & Volterra, 1975), or pointing to engage another's attention to an object or event of interest to the infant, is of considerable developmental importance. Researchers have linked the proto-declarative point to children's later advanced social cognition or theory-of-mind (Camaioni, et al., 2004), children's later language acquisition (Butterworth, 2003; Butterworth & Morissette; 1996; Tomasello, et al., 2005), and language competence (Morales, et al., 2000; Tomasello et al., 2005). Moreover, the absence of, or low frequencies of, proto-declarative pointing, has been linked to the childhood psychopathology of autism (Baron-Cohen, 1989; Bruinsma, Koegel, & Koegel, 2004), and the order of development of joint attention skills for children with autism is different than that of typically developing children (Carpenter et al., 2002). Furthermore, deficits in joint attentional skills are associated with poor infant mental health (Trevarthen & Aitken, 2001), and deficits in both joint attention and theory of mind are present in persons with schizophrenia (Brune, 2005). Because impairment in proto-declarative pointing is associated with at-risk health trajectories, understanding how the proto-declarative point develops has important health-related implications.

Recently, theory suggests that the onset of independent locomotion in infancy may influence when babies start using proto-declarative pointing. However, this relationship has not yet been examined by developmental researchers. Thus, the primary goal of this study is to investigate the influence of an earlier form of independent locomotion, crawling, on the developmental timing of the proto-declarative point.

### *Theories of Joint Attention*

Several theoretical explanations for the development of joint attention have been proposed. Some center on the following themes: evolutionary endowment (Baron-Cohen, 1995; 1999; Butterworth, 2003), the presence of an innate capacity (Meltzoff, 2002; 2006; Trevarthen & Aitken, 2001), the neuro-biological perspective (Gallese, 2005) and infant-cognitive factors (Tomasello, 1995). Other theories propose that the infant is able to process and understand environmental influences, which in turn leads to the development of joint attention (Barresi & Moore, 1996; Moore & Corkum, 1994). Although these theories differ, they emphasize maturational, evolutionary, biological or cognitive causes “within” the individual infant to explain the development of joint attention. More recently, explanations of joint attention moved beyond infant-specific factors to consider other developmental processes, such as parent-infant socio-emotional interactions (Carpendale & Lewis, 2004; Greenspan & Shankar, 2004; Hobson & Hobson, 2008; Racine & Carpendale, 2007; Reddy, 2003; Rodriguez & Moro, 2008), and the influence of independent locomotion (Campos, Anderson, Barbu-Roth, Hubbard, Hertenstein, & Witherington, 2000; Lindholm & Ziemke, 2006; Racine & Carpendale, 2008), the main focus of this current project, on the development of joint attention. Before elaborating on how independent locomotion may influence the development of joint attention, I will discuss the various theoretical frameworks proposed to explain the development of joint attention.

### *Individualistic Theories of Joint Attention*

The following theories were grouped under the heading individualistic theories of joint attention because they explain the development of joint attention by looking for causal factors within the infant. The evolutionary perspective on joint attention argues that pointing

is an innate ability uniquely evolved in humans (Baron-Cohen, 1995; 1999; Butterworth & Franco, 1993), and that there are four evolution-based modules responsible for the development of joint attention. These modules are the intentionality detector (ID), the eye-direction detector (EDD), the shared/attention mechanism (SAM), which facilitates early triadic social interactions, such as pointing, and the theory-of-mind module (TOMM), which facilitates the onset of perspective taking in early childhood. These various modules are activated sequentially at different ages as the infant matures (Baron-Cohen, 1995).

The neuro-biological explanation for social understanding is based on the discovery of mirror neurons in the premotor cortex of monkeys. Research with rhesus macaque monkeys (*Macaca Mulatta*) revealed that their mirror neurons will fire in the same manner when an action is performed by them, and when that identical action is performed by another (Gallese, 2005). The neuro-biological explanation for social understanding argues that we understand another's behaviour because their behaviour will resonate within us in the same manner, and using the same neural mechanisms through which we process our own emotions and perceptions (Gallese, 2005). Because of the similarity in how self-behaviour and other-behaviour trigger the neural system, the neuro-biological perspective on joint attention proposes that mirror neurons may explain both how we come to understand shared attention, and our capacity to take another person's perspective (Gallese, 2005). Wolf, Gales, Shane and Shane (2000) claim that mirror neurons are also present in humans. However, although the mirror neural systems are involved in joint attention, the field is still unclear about whether mirror neurons underlie and cause joint attention, or whether mirror neuron pathways are established from early infant experiences (Shankar, 2004).

Trevarthen proposes an innate-cognitive explanation for the development of joint attention (see Beebe, Sorter, Rustin & Knoblauch, 2003; Gallager, 2004 for reviews; Trevarthen & Aitken, 2001). Trevarthen argues that joint attention is explained by the development of “primary intersubjectivity,” followed by “secondary intersubjectivity.” Primary intersubjectivity is the newborn’s ability to use her rudimentary perceptual capacities to coordinate her innate awareness of her social partner’s intention to interact, when engaged in one-to-one interactions. Thus, the infant is predisposed to an innate awareness of others, and the biological capacities that the infant is born with, for example, her eyes, will facilitate joint attention. Then, at around 9 months-of-age, the infant will demonstrate her capacity for secondary intersubjectivity, which includes competence in triadic joint interactions.

Trevarthen claims that competence in triadic interactions first originates from the infant’s innate ability to sense and understand another person’s subjective states, for example, their motives and desires (Beebe et al., 2003), and is next reflected in the infant’s capabilities for agency in her environment (Gallager, 2004). Agency is the infant’s control over her “bodily movements,” which enables her to engage in triadic interactions. Trevarthen’s biologically based, cognitive explanation for joint attention, attempts to integrate the infant’s biological capacities, which first enable primary intersubjectivity, with her later abilities to interact with others, and her environment (secondary intersubjectivity). Trevarthen sees the newborn as biologically predisposed to be an involved learner, with innate capabilities for understanding her own, as well as another’s desires and intentions (Trevarthen & Aitken, 2001).

Tomasello proposes another cognitive-based explanation for the development of joint interactions (Tomasello, 1995; Tomasello, et al., 2005). According to him, an infant develops social understanding by first gaining insight into the effects of her own behaviours on her

environment. By first understanding her own direct effect on objects in her environment, the baby will learn about cause and effect. And from the understanding that in order to achieve her goals she needs to take certain actions, she will begin to develop an understanding of her own intentions to act. Following from her understanding of her own intentions to act, and by comparing others' observed behaviours to her understanding of her own goal-directed behaviours, the infant comes to understand other people's behaviours and intentions. According to Tomasello's explanation, it appears that joint attention reflects the infant's ability to introspect upon her own behaviours, and then apply these self-reflections to others during shared interactions (Tomasello et al., 2005).

The final proponent of the cognitive-analogical argument for joint attention is Andrew Meltzoff. According to Meltzoff (2006), the infant gains an understanding that another is "like me," because of her innate ability to imitate. The baby is able to understand the meaning behind another person's behaviours, by imitating that person's behaviours. Thus, social understanding develops because the infant makes an inference from her own subjective feelings about these imitated behaviours to understand another's intentions (Beebe et al., 2003) during bouts of joint attention.

Other theoretical approaches focus on environmental influences on the infant that facilitate the development of joint attention (Barresi & Moore, 1996; Moore & Corkum, 1994). For example, Moore and Corkum (1994) propose that social conditioning explains the development of gaze following, while Barresi & Moore (1996) attempt to explain the development of social understanding in its entirety. Moore and Corkum (1994) challenge the innate perspectives on joint attention, and propose instead that infants develop expectations of other people's behaviour during social interactions that are reinforcing to the infant. Thus,

the infant will follow the direction of another's gaze because the infant has learnt that by looking where someone else is looking, she will eventually see some interesting things (Moore & Corkum, 1994).

Finally, Barresi and Moore (1996) propose a four-level framework for social understanding that they refer to as Intentional Relations Theory (IRT). According to IRT, only adults will attain the highest level of social understanding, while typically developing children will attain up to the third level. Children with autism on the other hand, will not be able to reach the third level of development as would typically developing children. IRT proposes that during infancy, information about another's intentions is available to an infant as he observes the spatiotemporal movements of himself, in relation to the spatiotemporal movements of another person. Thus, the infant gains both a first-person and a third-person perspective of events. And by "matching" these "world-caused and self-caused" perceptions of movement (Barresi & Moore, 1996, p.14), the infant is able to understand self in relation to other.

#### *Relational Theories of Joint Attention*

Relational theories of joint attention adopt a social-constructivist perspective (Vygotsky, 1978). The social-constructivist perspective on joint attention emphasizes the importance of everyday infant-caregiver interactions. They suggest for example, intimate moments during which infants and their caregivers play, or snuggle together, as they express their affection for each other (Greenspan & Shankar, 2004). It is specifically argued that these parent-infant moments are the "opportunities" for children to develop complex forms of emotional understanding and expression, which in turn is the developmental pathway to age-appropriate, communicative gestures, such as pointing, language, theory of mind, and general

long-term healthy development (Greenspan & Shanker, 2004). Key to the relational based account of joint attention are everyday caregiver-infant interactions and the meaning of these interactions for the dyad (Carpendale & Lewis, 2004; Racine & Carpendale, 2007; Reddy, 2003; Rodriquez & Moro, 2008).

As a consequence of considering the role of the caregiver and the infant in the development of joint attention, it becomes necessary to account for the emotional functioning of the parent-infant dyad and the infant's emotional development (Greenspan & Shanker, 2004; Hobson & Hobson, 2008; Reddy, 2003). For example, Racine and Carpendale (2007) suggest that infant-caregiver attachment patterns may influence the development of joint attention. In fact, there is some preliminary evidence substantiating this claim. Scholmerich, Lamb, Leyendecker and Fracasso (1997) found that secure infants maintained more social attention towards their parents compared to resistant, avoidant and disorganized infants. Thus, according to the relational theories of joint attention, the quality of the parent-infant dyad's emotional engagement may be a primary mediating influence on the development of early social understanding.

The importance of joint attention is reflected by the amount of theoretical attention it has received. However, the previously discussed theoretical explanations share little common ground with respect to the developmental pathway that leads to successful joint attention abilities. In summary, the mirror-neural system provides us with the necessary neural basis for triadic social interactions, whereas the evolutionary modular perspective provides a possible explanation for why a healthy infant will developmentally first gaze follow before engaging in referential pointing. From the cognitive perspectives, we have Tomasello who argues for the emergence of innate cognitive capacities to understand other's intentions,

Trevarthen who argues that innate, biological predispositions are responsible for infants' social competence, and Meltzoff who argues that the ability for joint attention begins with the innate ability to imitate another. Meanwhile, Moore and Corkum (1994) argue that the positive reinforcing aspects of the environment encourage infants to engage more often in gaze following. IRT (Barresi & Moore, 1996) argues that joint attention begins with the infant's understanding of the spatiotemporal components of social interaction. Finally, as described above, relational theories of joint attention suggest that the quality of the parent-infant emotional relationship leads to the development of healthy joint attention capacities. To recapitulate, the development of joint attention in infancy is an important developmental achievement that is the building block for children's later theory of mind ability, language acquisition and language competence. Also, of the various joint attentional abilities identified, proto-declarative pointing is considered by most in the developmental literature to be the clearest indicator of joint attentional competence.

#### *Independent Locomotion and Joint Attention*

Recently, however, Lindblom and Ziemke (2006) suggest that another factor may influence the development of joint attention. They point out that current explanations for joint attention fail to consider the influence of self-produced locomotion on the development of joint attention abilities. According to Lindblom and Ziemke, it is possible that developmental changes, such as the onset of self-produced locomotion, may provide perceptual opportunities and perspective changing experiences that advance joint attention abilities. Others (e.g., Campos et al., 2000; Racine & Carpendale, 2008; Smith, 2005) support this position, and argue that social understanding in itself is not only relational and contextual, but is also embodied. Social understanding is considered embodied because social-cognition is thought

to develop as the infant physically interacts with the environment through sensory-motor activities like touching, seeing and movement.

There is some preliminary research evidence indicating that independent locomotion may be a “sufficient” mechanism providing experiences that advance the development of one type of joint attention ability, that of proto-declarative pointing. In this regard, Campos et al., (2000) cite empirical evidence indicating that infants who had earlier locomotor experience were advanced in their understanding of referential gestures and socio-emotional interactions, compared to same-aged infants with no prior locomotor experience. Their evidence does suggest that independent locomotion facilitates infants’ understanding and the production of proto-declarative pointing (Campos, Kermoian, Witherington, Chen & Dong, 1996; Campos et al., 2000), but systematic examination of this relationship is still required (Campos et al., 2000; Lindholm & Ziemke, 2006). In the present study I begin that examination by extracting locomotion and pointing attainments from longitudinal data.

## CHAPTER II

### LITERATURE REVIEW

#### *Proto-Declarative Pointing*

An infant’s ability to express himself using communicative gestures is considered an important developmental milestone that indicates healthy development. In particular, pointing has received greater interest in the developmental literature, than other communicative gestures (Blake et al., 1994). The proto-declarative point is considered an essential aspect of communication (Masataka, 2003), and a vehicle for the development of social cognition and language (Franco, Perucchini, & March, 2008). Physically, the proto-declarative point is “characterized by an arm and index finger extended in the direction of the interesting object,