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INVESTIGATING JOINT ATTENTION BEHAVIORS AND EPISODES IN 18-MONTH TODDLERS BORN VERY LOW BIRTH WEIGHT COMPARED TO TODDLERS BORN NORMAL BIRTH WEIGHT

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ABSTRACT

Background: Prior studies have shown that joint attention (JA) behaviors and episodes, which involve person-person-object awareness, serve an important role in toddlers' cognitive and social development. There are two forms of JA behaviors in which a toddler can engage: responding joint attention (RJA) behavior in which the toddler shifts attention to an object to which the mother is attending, and initiating joint attention (IJA) behavior in which a toddler bids for the mother's attention around an object. If a JA behavior is responded to, it becomes a JA episode. Prior research suggests that these different JA behaviors (RJA and IJA) rely on different underlying cognitive processes (Mundy, Card, & Fox, 2000; Vaughan Van Hecke et al., 2007). Furthermore, prior research has made a distinction between earlier (gaze following) and later developing (pointing and showing) forms of RJA and IJA behaviors because these behaviors occur at different points of development (Tomasello, 1995; Vaughn van Hecke

et al. , 2007). Specifically, gaze following occurs earlier in development than showing and pointing (Van Hecke et al., 2005). The few studies that have examined RJA and IJA behaviors in toddlers born very low birth weight (VLBW) have been mixed, with some studies suggesting toddlers born VLBW show deficits in RJA but not in IJA behaviors (Landry, Schmidt, & Richardson, 1989) and other studies suggesting toddlers born VLBW show deficits in both RJA and IJA behaviors (De Schuymer et al., 2011). To our knowledge, only one study has explored joint attention *episodes* in a VLBW sample, and no study has examined RJA and IJA behaviors examining gaze and point behaviors separately within this population. The current study hypothesized birth weight group (VLBW, normal birth weight (NBW)) differences in RJA-gaze, RJA-point, IJA-gaze, and IJA-point behaviors such that toddlers born VLBW would engage in fewer of these behaviors than toddlers born NBW. It was further hypothesized that toddlers born VLBW would engage in fewer RJA-point, RJA-gaze, IJA-gaze, and IJA-point episodes with their mothers compared with toddlers born NBW. It was also hypothesized that there would be no group differences in "missed episodes."

Methods: Participants included 52 toddler-mother dyads (50% VLBW) between the ages of 18 and 22 months (M = 19.0). The VLBW cohort was born under 1,250g and at fewer than 32 weeks (N = 26, 46% female); and the NBW cohort was born at or after 37 weeks gestation (N = 26, 42% female). Mothers completed a set of sociodemographic questionnaires, and mother-toddler dyads were videotaped for 10 minutes of free play with a set of toys. Joint attention behaviors and episodes were coded using Tasker's (2012) Coding Manual for Mother-Child Joint Attention. RJA-gaze behaviors included the toddler's attention shift to a mother's gaze, and RJA-point behaviors included the

toddler shifting attention to the mother's point to a toy. IJA-gaze behaviors were defined by a toddler trying to get their mother's attention by glancing at an object, and IJA-point behaviors were defined by a toddler trying to get their mother's attention by pointing and showing an object (Tasker & Schmdit, 2008; Tasker, 2012; Mundy et al. 2007). If the JA behavior was responded to within 5 seconds, then this was considered a successful episode (Tasker, 2012). If no response occurred to the JA behavior, it was considered a "miss." These JA episodes were divided into four types of JA, which can be distinguished by the "successful" JA behavior that began the episode: RJA-gaze, RJA-point, IJA-gaze, and IJA-point. Inter-rater reliability was considered almost perfect with all Fleiss Kappas > .94.

Results: RJA-gaze behaviors did not differ significantly by birth weight group. However, toddlers born VLBW displayed significantly less RJA-point behaviors than toddlers born NBW. Contrary to hypotheses, toddlers born VLBW displayed *more* IJA-gaze behaviors than their NBW counterparts. IJA-point behaviors did not significantly differ by birth weight group. JA episode findings paralleled JA behavior findings. RJA-gaze episodes did not significantly differ by birth weight group. Toddlers born VLBW and their mothers displayed significantly fewer RJA-point episodes than toddlers born NBW. Interestingly, toddlers born VLBW displayed more IJA-gaze episodes than toddlers born NBW. IJA-point episodes did not differ significantly by birth weight group. As expected, toddlers born VLBW and born NBW did not differ in the number of JA misses.

Conclusions: These findings partially support the hypothesis that JA behaviors and episodes differ by birth weight group. As expected, toddlers born VLBW engaged in fewer RJA-point behaviors and episodes than toddlers born NBW. Differences in RJA-

point behaviors and episodes show that, in this sample, mothers of toddlers born VLBW bid less frequently for their toddlers' attention by pointing and showing than did mothers of toddlers born NBW. This study found no differences between groups for RJA-gaze behaviors and episodes, and this may be due to the low frequency of occurrence of these behaviors and episodes for toddlers born VLBW as well as NBW. The finding that toddlers born VLBW displayed more IJA-gaze behaviors and episodes than toddlers born NBW was not anticipated. One possible explanation for this finding is a methodological artifact in the coding system: an IJA episode may not have entailed an intention from the toddler to engage in an episode but rather included a mother being more sensitive to her toddler's behavior. Mothers of toddlers born VLBW may notice exactly when their toddler shifts his/her attention to another object and may begin play around the object without the toddler having intended to engage with the mother. This maternal sensitivity to the shift in their toddler's attention may be propelling the toddler's gaze behavior into joint attention gaze episodes. In addition, if increased maternal sensitivity by mothers of VLBW toddlers explains the increased IJA-gaze behavior and episodes found among this group, it may also explain the lower frequency of RJA-point behavior and episodes in this group: mothers of toddlers born VLBW may be highly responsive to their toddler's cues and, simultaneously, not initiating many point and show behaviors to gain their toddler's attention. If this hypothesis about the coding system is correct, these data would suggest that mothers of toddlers born VLBW show greater sensitivity to their toddlers' behavior rather than the alternative interpretation that toddlers born VLBW exhibit more gaze initiation behaviors. This unique finding is congruent with the literature to the extent that mothers of toddlers born VLBW have been found to be more responsive to their

toddler's behavior (Salerni, Suttora, & D'Odorico, 2007). Whether this explains the greater number of IJA-gaze behavior episodes among the VLBW dyads remains to be investigated. No differences were found between birth weight groups on IJA-point behaviors or episodes. Interestingly, almost all JA behaviors for both groups became JA episodes, as there were very few JA misses. Overall, the current study's results suggest similarities as well as differences in JA behaviors and episodes for toddlers born VLBW compared to toddlers born NBW. If further corroborated, these findings may suggest early intervention targets for mothers of toddlers born VLBW that include supporting more initiation of RJA with their toddlers.

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 1: INTRODUCTION

The Importance of Studying Attentional Processes in Toddlers Born VLBW

Due to neonatalogy advances, infant mortality has greatly decreased in the United States over the past couple of decades, and there has been a subsequent increase in the rate of infants born VLBW (Guyer et al., 1998). Although mortality rates of infants born VLBW are decreasing, there has been no decrease in poor neurodevelopmental outcomes (Tommiska et al., 2007). Infants born VLBW show delays in multiple neurodevelopmental domains, including language, cognition, and attention (Allen, 2008; van Baar et al., 2005; Woodward et al., 2009), and these disabilities are very costly to society (Rushing & Ment, 2004). These neurodevelopmental deficits remain apparent at school age, particularly in the domains of executive control and attention (Hack, Flannery, Schluchter, Carter, Borawski, & Klein, 2002; Dahl et al., 2006). Toddlers born VLBW have shown attention difficulties starting in infancy and continuing through adolescence (Botting, Powels, Cooke, & Marlow, 1997; Saigal et al., 2003; McCormick et al., 1992; Weisglas-Kuperus et al., 1993; Hoy et al., 1992). For example, infants born VLBW begin to have difficulty with maintaining visual attention and require longer periods of focused attention to process a visual stimulus than do NBW infants, starting at 3 months of age (Cohen & Parmelee, 1983; Rose, 1983). At the end of the first year of life, infants born VLBW show less focused attention and take longer amounts of time to engage in exploratory responses (Rose, 1983; Ruff et al., 1984). Because these delays are evident throughout development, gaining an understanding of early manifestations of attention deficits may help identify toddlers at risk for continued difficulties.

Joint Attention

As a multidimensional construct, there are many forms of attention. One form of attention that may be particularly relevant for toddlers born VLBW is joint attention. Before defining the construct, it is important to understand that this literature has been fraught with confusion related to the term joint attention. By its nature, joint attention is meant to be dyadic and requires behaviors from both a mother and a toddler simultaneously (Tomasello, 1995). The term "joint attention behaviors" is used to describe the social behaviors required for person-person-object awareness (Tomasello, 1995), and these behaviors are suggested to be a precursor to understanding the point of view of others (Baron-Cohen & Ring, 1994). This attention shift in infants and toddlers can occur by following a social partners' gaze, actively gazing at an object, pointing at an object, or picking up an object and showing it to a social partner (Markus, Mundy, Morales, Delgado, & Yale, 2000). This literature often confuses joint attention behaviors and episodes. JA behaviors are required for a joint attention episode. Joint attention episodes are defined by the intentional use of acts of communication to direct a social partner's attention to an object, symbol, or event in the environment while sharing the experience and attention together (Tasker & Schmidt, 2008). This construct involves a triadic coordination of person-person-object awareness also known as the reference triangle (Tomasello, 1999). Person-person-object refers to the way that a toddler and a social partner actively shift their attention to an object, which can be led either by the toddler or the social partner, while sharing contact between each other, e.g., when a toddler looks from a toy to the mother to a toy (Tomasello, 1995). Again, "joint attention episode" occurs during and after a bid for a social partner's interaction in which both

social partners are actively engaged in an interaction for a period of time. The distinction between joint attention behaviors and episodes is critical because a toddler could bid for a joint attention episode (by gazing at mom, then at a toy, then at mom), but this does not mean that a joint attention episode will necessarily be successful.

Joint attention has been studied extensively over time, and is referred to by many different terms including: joint visual attention, joint engagement, joint attention behaviors and episodes, responding joint attention, initiating joint attention, mother joint attention, toddlers joint attention, protodeclarative joint attention, and established joint attention (Butterworth & Cochran, 1980; Schaffer, 1984; Tomasello, 1995; Tasker & Schmdit, 2008; Mundy et al., 2003;). The literature is not consistent with terminology or definition of these constructs (Tasker and Schmidt, 2008).

Joint attention was first discussed in the literature by Werner and Kaplan (1963) and was described as a sharing situation. Schiafe and Bruner (1975) showed that infants can change their line of sight to attend to something on which an adult is focusing, and then the dyad can focus its shared attention on an object. Butterworth and Cochran (1980) also found that infants and toddlers between 6 and 18 months of age can adjust their gaze to where a mother's attention was focused. Butterworth and Cochran's (1980) paradigm for studying joint attention included mothers and toddlers in an experimental setting and asked the mother to bid for the infant/toddler's attention without pointing to an object. In this experimental paradigm, a mother would be asked to bid for their toddler/infants attention across multiple trials with multiple different objects. This study found that infants at 6 months could follow mother's line of vision to an object if it was in their visual field and that infants who were 18 months could follow mother's line of vision

outside of their visual field. In another study by Butterworth and colleagues (1980), infants' joint attention was investigated between 9 and 15 months of age over time. Data were collected for each month between 9 and 15 months, and they measured joint attention (which included gaze and point following) in a series of experimental paradigms with a mother and her toddler. Over time, they found that toddlers progress from following their mothers attention (both gaze and point) to beginning to direct their mothers attention (through both gazing and pointing). In this series of experiments, one experiment of particular relevance to the current study included free play between mother and toddler in which the time spent in joint attention episodes was related to the toddler's language production and comprehension (Butterworth, & Cochran,1980).

Joint Attention Behaviors

The JA literature often has distinguished between two types of joint attention behaviors. One involves a toddler following the mother's lead and the other involves a mother following a toddler's lead. The toddler following the mother's lead has many terms in the literature, with the three of the most common terms being "responding joint attention (Mundy and Gomes, 1998)," " toddlers joint attention," and " attention directing behaviors" (Tasker and Schmidt, 2008). Similarly for mothers, the terms for the mother following the toddlers' lead has been commonly referred to as "initiating joint attention," " mother joint attention," and "attention-tracking behaviors. "Studies are difficult to compare with these different sets of terminology and differences in how these terms are operationalized. To address this problem with the language in the literature, the current study will use the terms IJA behaviors and RJA behaviors to follow the most recent line of literature. When describing the existing literature, this study will comprehensively

review the literature using this newer terminology in an effort to make terms and ideas consistent across the literature even though the original authors used different terminology.

There is substantial literature addressing RJA behaviors and IJA behaviors. RJA behaviors involve the ability to follow the attention (shown by gaze, head turn, or pointing) of a social partner in order to share a reference point in their environment (such as a toy) (Schaife & Bruner, 1975). The second major type involves active attempts at initiating, not merely responding to, joint attention. IJA behaviors refer to the toddler's ability to direct the *attention* of a social partner to another object in the environment with gestures (i.e., pointing, showing, eye contact) (Seibert et al., 1982). It is important to note that, by definition, these JA gestures involve an important social component. It is possible to gaze, show, or point for a very functionally different reason from wanting to engage in a social interaction, and that is to make a request for an object. This type of pointing or showing is not considered a joint attention behavior. An example of this would be pointing to a food because it is out of reach and a toddler is hungry. RJA and IJA behaviors serve a social function of bidding for their mother's attention and are not just an instrumental request (i.e., joint attention requires the mother to attend to an object together with a toddler. It is not joint attention if the toddler looks at a cup and at their mother for the sole purpose of the mother handing the toddler the cup so the toddler can drink).

Although RJA and IJA behaviors are both social in nature, it has been suggested that these behaviors are functionally different (Carpenter, Nagell, & Tomasello, 1998). It was previously thought that RJA and IJA behaviors included a set of similar processes

and that these joint attention behaviors would be equally associated with social growth (Carpenter et al., 1998). However, the currently accepted model of joint attention is a multi-process model (MPM), which suggests that these different behaviors (RJA and IJA) rely on different underlying cognitive processes (Mundy, Card, & Fox, 2000; Vaughan Van Hecke et al., 2007). Mundy, Card, and Fox (2000), have shown evidence that RJA and IJA behaviors rely on distinct neuropsychological correlates and pathways, suggesting that the two forms of joint attention involve two different underlying attention networks. At 14 months and 18 months, RJA behaviors have been found to be associated with parietal and temporal activity, part of the posterior system, while IJA behaviors have been found to be associated with frontal cortical activity and the anterior system (Mundy et al., 2000). Mundy et al. (2000) suggest that RJA behaviors are supported by the posterior orienting and perceptual attention system while IJA behaviors are associated with the later developing anterior attention system which controls goal- directed attention and is associated with executive functioning (Posner & Peterson, 1990; Mundy et el., 2000; Posner & Rothbart, 2007).

The MPM model has construct validity evidence to suggest that RJA and IJA behaviors are two separate constructs. For example, discriminant validity studies have found small statistically significant correlations between the frequency and consistency of RJA and IJA behaviors in infant/toddler samples ranging from 9 to 18 months (Meltzoff & Brooks, 2008; Mundy et al., 2007; Sheinkopf et al., 2004). In addition, RJA behaviors have been more highly associated with self-regulation (Vaughan Van Hecke et al., 2007), while IJA behaviors have been more highly associated with affective development (Vaughan et al., 2003).

Further support of the MPM model includes the finding that RJA and IJA behaviors show different developmental trajectories in atypical and typically developing toddlers. In toddlers with autism, RJA and IJA behaviors have shown different developmental pathways (Mundy, Kasari, Sigman, & Ruskin, 1995). Specifically, RJA behavior deficits are profound in early development, but are less prominent after 36 months (Mundy et al., 1994), whereas IJA behavior impairments are more pervasive over time (Charman, 2004; Hobson & Hobson, 2007). In typically developing infants, RJA behavior has been found to increase very little between 9 to 15 months, while IJA behavior has been found to increase steeply between 9-15 months (Carpenter et al., 1998; Mundy et al., 2007).

Joint Attention Behaviors in Typically Developing Infants and Toddlers

Developmental Sequence. Infants progress in a stage-like fashion in their development of joint attention behaviors. Between 2 and 6 months of age, infants begin to follow the gaze of their mother's, RJA-gaze (Butterworth & Grover, 1990; Morales, Mundy & Rojas, 1998; D'Entremont, Hains, & Muir, 1997; Butterworth & Cohran, 1980) and this ability is well established by 6-9 months (Butterworth & Grover, 1990). At around 1 year of age, infants begin displaying a number of new behaviors that seem to indicate a newly emerging understanding of other persons as intentional beings whose attention to outside objects may be shared, followed, and directed in various ways (Carpenter et al., 1998). By the end of their first year, infants began to learn to intentionally signal for social synchronization of a joint attention object within their own visual field with a social partner, RJA, point, and IJA point (Bakeman & Adamson, 1984; Leung & Rheingold, 1981; Butterworth & Cochran, 1980). At between 12 and 18 months

of age, toddlers begin to follow a mother or experimenter's show or point to an object (RJA-point) (Butterworth & Grover, 1990) and initiate interaction with a partner by pointing and showing (Butterworth & Cochran, 1980).

.Given that RJA and IJA gaze behaviors develop before RJA-point and IJA-point behaviors, Vaughn van Hecke (2007) suggests that pointing, gesturing, and showing might represent a different and developmentally later form of RJA and IJA behavior that emerges later in a toddler's development sequence than RJA and IJA gaze behaviors.

There is also some concern in the literature that RJA-gaze and IJA-gaze behaviors lead to researchers implying an infant or toddler's ability, purpose, and intention, when in fact, an infant or toddler might just be gazing at a toy without the intention of interacting with a social partner (Mundy & Acra, 2006). In contrast, it has been suggested that later developing forms of JA (showing and pointing) might be less prone to these assumptions about an infant's behavior (Tomasello, 1995; Vaughn van Hecke, 2007). Operationalizing both types of joint attention behaviors (RJA and IJA) into different forms based on development is important to better understand the nature of these joint attention behaviors in infancy and toddlerhood. For clarity, these behaviors will be referred to as RJA-point, RJA-gaze, IJA-gaze and IJA-point (rather than using Van Hecke's terms of higher-level and lower-level RJA and IJA).

There is also data to suggest that JA episodes may play an important role for learning during 14 to 18 months of age. In a study by Moll and Tomasello (2007), toddlers at 14 and 18 months of age observed an adult interacting with an object in one of three ways: by a joint attention episode with the toddler, by the adult engaging without the toddler with the toy (manipulating and inspecting the toy), and by the adult watching

the toddler playing alone with the toy (on looking). After one of these three conditions, the experimenter left the room and after a delay returned and asked the toddler to give them the toy. Interestingly, *only* in the joint attention episode condition was the toddler able to give the correct toy to the experimenter, and, as Moll and Tomasello (2007) argue, to understand that the adult had experienced an object. This suggests that joint attention may play a critical role in 14month to 18month toddler's ability to learn knowledge of other people's experiences and about nature of social interaction.

Joint Attention Behavior Correlates. There has been a surge of joint attention research in the past 20 years with healthy infants and toddlers. As a major hallmark in early infant and toddler development, joint attention behaviors have been associated with communication, cognition, social learning, and theory of mind (Carpenter, Nagell, & Tomasello, 1998; Mundy & Gomes, 1998; Tasker & Schmidt, 2008). Findings from the literature will be discussed to highlight the importance of studying joint attention and to further support studying RJA and IJA as separate constructs in the current study.

It is suggested that JA behaviors are associated with areas in the brain (e.g., frontal, temporal cortical, and subcortical areas) that have been shown to be associated with executive functioning abilities (e.g., attention and emotion regulation). Individual differences in JA behaviors may be associated with executive functioning abilities and can help explain individual differences in social emotional competence (Mundy, Fox, & Card, 2003; Baron-Cohen & Ring, 1994). Better understanding the nature of joint attention behaviors is important because the associations with executive functioning abilities. It is well successful that joint attention behaviors are important for early language acquisition (Mundy & Gomes, 1998; Morales, Mundy, & Rojas, 1998; Mundy

& Jarrold, 2010). Joint attention creates an environment for the caregiver or social partner to facilitate word-object mapping (Dunham & Dunham, 1992).

RJA (but not IJA) behaviors through the age of 18 months (assessed at 6, 8, 10, 12, and 18 months) were associated with vocabulary size at 30 months (Morales et al., 2000). Mundy and Gomes (1998) found that RJA behaviors were correlated with receptive language development and that IJA behaviors were associated with expressive language development at 14 to 17 months. This work supports the multi-process model of joint attention, and shows that RJA and IJA behaviors may have different neurocognitive correlates and underlying cognitive processes (Mundy & Sigman, 2006).

In fact, RJA behaviors have been found to predict language above its shared variance with standardized neuropsychological measures of cognition and language development (Mundy & Gnomes, 1998; Mundy et al., 1995), and RJA behaviors might be of particular use as an assessment tool in at-risk toddlers for language delays such as toddlers born VLBW. This is further evidence to suggest studying RJA and IJA behaviors separately and this highlights the importance of studying these constructs in a VLBW sample.

Joint Attention Behaviors and Social Interaction. Joint attention episodes and behaviors are considered important for social learning. These episodes are essential to the nature of human social interaction, learned in infancy, and built upon in childhood (Mundy & Sigman, 2006; Tomasello, 1995). During infancy and toddlerhood, JA behaviors are defined and measured by overt instances (such as pointing, showing, or handing a toy to an adult), but as a toddler develops further, this ability eventually becomes covert as well, including following along with a topic of a teacher in a

classroom (Mundy & Sigman, 2006) or the sharing of an idea or intention with another person during a social interaction (Tomasello, 1995). Better understanding joint attention behaviors in toddlerhood could help inform early interventions for different at-risk groups including toddlers born VLBW.

Differences in JA Behaviors and Episodes

Most JA research has focused at the level of the individual behavior rather than at the dyad as a whole. Most experimental studies involve a researcher in an experimentally contrived situation bidding for an RJA or IJA behavior of the toddler to occur without ever becoming a joint attention episode or a mother bidding for the toddler's behavior when asked by an experimenter (also without becoming a JA episode) (Mundy et al. 2007 Butterworth & Cochran, 1980). These experimental paradigms do not allow for the study of the nature of the JA episode. Though further understanding the individual contribution of both the mother and the toddler during joint attention episodes is needed, little attention (in both VLBW and non-VLBW samples) has focused on the level of the dyad. As highlighted out by Nowakowski, Tasker, & Schmidt (2012) it is important to consider the dyad itself at the unit of analysis because of the bidirectional nature of the mother-toddler interaction and the importance of the social context with which the individuals are engaging.

Tasker and Schmit (2008) posit that there is a dual-usage problem in the literature such that the term "joint attention" refers both to joint attention behaviors and joint attention episodes. Joint attention behaviors are necessary to engage in joint attention episodes, but are not sufficient. A toddler could point to an object in the environment, but if the mother does not respond to the joint attention behavior, the

mother and toddler cannot engage in a joint attention episode. This would be considered an instance of a joint attention behavior, but not of a joint attention episode. Tasker and Schmit (2008) refer to this as "successful episodes" and "misses." It is important to get at the distinction between bidding for joint attention that leads to a successful joint attention episodes and those behaviors that are "misses" that don't lead to joint attention episodes. A joint attention episode becomes successful when a toddler or a caregiver bids for their social partner's attention to an object or event, the social partner responds to this bid, and both social partners share attention both on each other and on an object for a given period of time. Few studies have looked at the amount of joint attention *episodes*.

Joint Attention Episodes in Toddlers born NBW

There is a dearth of literature that explores JA in terms of episodes instead of behaviors. To our knowledge, there is only one study that investigates episodes instead of behaviors among toddlers born NBW. This study showed that the total amount of time spent in joint attention episodes with their caregiver initiated by the toddler (IJA but not RJA) at 14 months predicted expressive language outcomes at 18 and 24 months (Carpenter et al., 1998).

Joint Attention Behaviors in Toddlers born VLBW

There is a dearth of literature addressing JA behavior among toddlers born VLBW. In one of the few studies, Gardner, Landry, and Richardson (1991) compared high-risk VLBW, low-risk VLBW, and NBW controls on joint attention behaviors across the first two years of life (measured a 6, 12, and 24 months of age). Infants born VLBW who had high medical risk showed problems only with RJA and IJA behaviors and low-

risk infants born VLBW only showed problems with RJA behaviors as compared to NBW controls. This finding further supports studying RJA and IJA behaviors separately.

Smith and Ulvind (1996) found that among toddlers born VLBW (low and VLBW), joint attention behaviors at 13 months (IJA but not RJA behaviors) were associated with cognitive and language behaviors at 2, 3, 5, and 8 years of age. It is important to note (as was the same with NBW controls by Mundy & Gomes, 1998; Mundy et al., 1995) that joint attention behaviors were the most consistent predictor and explained variance above and beyond other predictors of later cognitive and language outcomes. Similar to findings with typically developing toddlers, this work also suggests that joint attention behaviors in toddlers born VLBW is made up of responding and initiating joint attention behaviors, which reflect two different processes, and that these behaviors might be important predictors/indicators of later cognitive and language issues. Smith and Ulvind (1996; 2003) also found different cognitive correlates for RJA and IJA behaviors, further suggesting that RJA and IJA behaviors are separate behaviors representing separate processes.

In a longitudinal study by De Schmuymer et al. (2011), JA behaviors in toddlers born VLBW were assessed at 6, 9, and 14 months. At 6 months, infants were rated during the still face episode of the still-face paradigm for frequency of toddler's motor attempts at adult re-engagement (clapping, waving, banging, and reaching to the social partner). At 9 months infants were assessed for RJA behaviors, and at 14 months the toddlers were assessed for RJA and IJA behaviors. The amount of joint attention behaviors at these ages were different at each time point and were associated with both expressive and receptive language ability at 30 months (De Schuymer et al., 2011). Further, De

Schuymer and colleagues (2011) found that language behaviors in infants born VLBW were partially mediated by aspects of JA behaviors. De Schuymer found that infants born VLBW at 14 months with more IJA behaviors were associated with higher receptive and expressive language behaviors at 30 months. De Schuymer et al. (2011) found that RJA behaviors was a unique predictor for receptive language behaviors and that both RJA and IJA behaviors explained some of the variance in expressive language behaviors between NBWs and toddlers born VLBW. It is important to note that in all of these studies investigating JA behavior in VLBW samples, they did not examine gazing and pointing as separate JA behaviors, but rather lumped them together into RJA and IJA (as opposed to RJA-gaze, RJA-point, IJA-gaze, and IJA-point).

Joint Attention Episodes in Toddlers born VLBW

Similar to JA research with toddlers born NBW, most of the research on JA with VLBW toddlers has focused on the level of individual behavior rather than the dyad as a whole. In the one study (Landry, 1986) investigating JA episodes among infants born VLBW and their mothers, 6 month old infants born VLBW engaged in less joint attention episodes than NBW controls. Specifically, infants born low birth weight (less than 2500 grams regardless of gestational age) and VLBW (less than 1,500 grams) had difficulty engaging in joint attention episodes and free play with their caregiver (Landry, 1986). Preterm infants showed more frequent gaze aversion and more movement away from joint attention episodes with their caretaker than NBW controls (Landry, 1986). This has yet to be studied in toddlers (18months) born VLBW. Also, because the literature suggests that JA episodes create a unique environment for a toddler to learn about language and social behaviors, such as turn taking and emotional regulation (Sheinkopf,

Mundy, Classen, Willoughby, 2004; Landry, 1995; Moll and Tomasello, 2007), studying the amount of joint attention episodes in addition to the amount of joint attention behaviors appears warranted.

Limitations of Past Research

A limitation within joint attention research is that most studies utilize an experimental paradigm rather than studying these behaviors within a naturalistic mother-toddler interaction. Most studies use the experimental paradigm, the early social communication scales (ESCS; developed by Mundy & colleagues, 1995; 2003), in which joint attention is studied in the context of an experimenter-toddler interaction or in an experimental mother-toddler paradigm (Butterworth & Cochran, 1980). In this standardized procedure, an experimenter bids for joint attention episodes in different ways with a toddler or an experimenter prompts a mother to bid for their toddler's attention at particular times to particular objects. Using these experimental paradigms, only the toddler's joint attention behaviors can be assessed, not behaviors at the level of the dyad (JA episodes). Another important limitation of this paradigm is that the number of tasks in which the experimenter bids or asks the mother to bid for the infant or toddler's attention affects the amount of joint attention responses given by the infant or toddler. This could create a ceiling effect for the amount of joint attention behaviors and could lead to decreased variability.

A more ecologically valid paradigm is to view toddlers in a free-play interaction with their mothers. The importance of the mother-toddler dyad context in relationship to social emotional development in both typically developing toddlers and in toddlers born VLBW has been emphasized in the literature (Campbell, Shaw, & Gilliom, 2000;

Nowakoski, Tasker, & Schmidt, 2012). Infants typically learn joint attention behaviors within the context of mother-toddler interactions throughout infancy, starting with face-to-face interaction and gaze following at 6 months, and continuing throughout infancy/toddlerhood. Using the mother-toddler naturalistic interaction allows for joint attention to be measured at the level of the dyad.

Understanding differences between later developing conventional gesture measures (such as showing and pointing) versus earlier developing measures (eye gaze behaviors) may be important because research with toddlers born NBW suggests that these forms of joint attention behaviors and episodes may be differentially associated with outcomes (Van Hecke et al., 2007). This distinction may also be important because pointing and showing begins to occur around 14 to 18 months of age and may play a critical role in a toddler's ability to learn knowledge of other people's experiences and about the nature of social interaction by about 18 months (Moll and Tomasello, 2007; Butterworth and Cochran, 1980). This distinction between gaze and pointing forms of joint attention has been well accepted and operationalized in the literature with NBW samples (De Schuymer, 2011; Mundy, 2003; Tasker, 2012; Nowakowski, Tasker, & Schmidt, 2012). Studying gaze and point forms of JA separately have yet to be studied in a VLBW sample, and could be particularly important to better understand the nature and correlates of mother-toddler JA behaviors in this vulnerable population.

The Current Study

Little is known about joint attention behaviors in toddlers born VLBW and even less is known about JA episodes. To our knowledge, there have only been two studies have examined JA episodes in a naturalistic setting and only one of them included a

VLBW sample. JA episodes have yet to be studied when separated into developmentally different forms (gaze and show) with a VLBW sample in the naturalistic setting of caregiver-toddler play. Given this paucity of research, this study has the following aims.

Aim 1. The first aim was to investigate, within a naturalistic toddler-mother play interaction, if there were differences in joint attention behaviors (RJA-gaze, RJA-point, IJA-gaze, IJA-point behaviors) between toddlers born VLBW and toddlers born NBW.

Hypothesis for Aim 1. Toddlers born VLBW would show fewer RJA behaviors (gaze and point) and IJA behaviors (gaze and point) than toddlers born NBW.

Aim 2. The second aim was to investigate if there were differences in joint attention episodes (RJA-gaze, RJA-point, IJA-gaze, IJA-point) between toddlers born VLBW and toddlers born NBW in the context of free-play interactions with their mothers. These differences were investigated for both the developmentally different forms of both RJA and IJA episodes (gaze and point). In addition, we investigated if there were birth weight group differences in the number of JA behavior "misses", in which one partner in the dyad fails to respond to a bid for JA.

Hypothesis for Aim 2. Toddlers born VLBW would engage in fewer RJA-gaze, RJA-point, IJA-gaze, and IJA-point episodes with their caregiver than toddlers born NBW. No birth weight group differences in "missed episodes" are hypothesized.

CHAPTER 2: METHODS

Participants

The participants for the current study included a subset of toddlers born VLBW and NBW who participated in a study examining long term developmental outcomes. Toddlers and their mothers participated either at the University of New Mexico Hospital,

Department of Pediatrics, the University of New Mexico Psychology Department, the Mind Research Network, or at the participant's home. The UNM Institutional Review Board approved this on-going study.

A power analysis with software titled GPower was used to determine the necessary sample size for this project. With the predicted (low end) medium effect size of .4, the power analyses indicated an N of 52 total participants (26 in each subsample) was necessary to detect a minimum difference in JA scores between the two samples (26 VLBW, 26 NBW) for 80% power, and an alpha level of .05 for the proposed ANCOVAs. The current subset of 52 toddler-mother dyads was randomly selected from a larger pool of participants using a random number generator. Toddlers were excluded if no video-taped play interaction was collected at the time of the original visit and another dyad was randomly selected. If a mother scored at or above the mild range of depressive symptoms on the Beck Depression Inventory II (BDI-II; Beck & Beamesderfer 1974; Richter et al., 1996), the dyad was excluded and another dyad was randomly selected. This cutoff was never met by, and hence this exclusion criterion was never applied to, any randomly selected VLBW or NBW dyad. Both sets of toddlers were seen at an average of 20 months of age, with age ranging from 18 to 23 months (SD=1.33). For the gender and ethnic composition of the sample, see Table 1.

The VLBW cohort. VLBW dyads were recruited during developmental follow-up evaluations through the NICU developmental follow-up clinic. Exclusionary criteria included prenatal drug exposure, vision and hearing impairments, multiple births, not living with their biological families, and no video-taped free-play interaction. To see the

demographics of the toddlers and mothers of the VLBW sample refer to Tables 1 and 2, respectively.

Toddlers. The VLBW sample consisted of 26 toddlers (46% female) born weighing less than1250g (M=882g; SD=195g) and/or born before 32 weeks gestation. Medical risk status was assessed by days on ventilation, with the average days on ventilation ranging from 2 to 66 (M=24.62SD=27.12). Toddlers ranged in age from 18 to 23 months adjusted age.

Mothers. All primary caregivers were mothers, ranging in age from 18 to 25 (M=28 years old, SD=1.33 years).

The NBW infant cohort. Toddlers born NBW were recruited from the University of New Mexico Health Sciences Center's Pediatric Continuity Clinics, local private pediatrician offices and day-care centers, following the IRB protocol. Toddlers were eligible to participate if they were born at 37 to 42 weeks gestation, had no medical problems at birth or serious problems after birth, had parents who had no psychiatric history or drug and alcohol problems, and lived with their biological families. To see the demographics of the toddlers and mothers of the VLBW sample refer to Tables 1.

Toddlers. The NBW sample consisted of 26 toddlers (42% female) born an average weight of 3,271g (SD=486g) and born at or later than 37 weeks gestation. Toddlers ranged in age from 18 to 23 months of age.

Mothers. All primary caregivers were mothers. Mothers of toddlers born NBW ranged in age from 18 to 34 years old (M=28 years old, SD=5.817 years).

Procedures

Written informed consent was obtained from all mother participants for both the mother and the toddler. First, a developmental evaluation was conducted for both VLBW and NBW toddlers at either the Mind Research Network, the Department of Pediatrics at the University of New Mexico Hospital, or at the participants' home. Second, mothers completed a set of questionnaires, which included sociodemographics and the Beck Depression Inventory II (other questionnaires were given but were not utilized in the current study). Following the testing and questionnaires, mother-toddler dyads were videotaped during 10 minutes of free play. A standardized set of toys was used for all participants. Parents were told to "play with their toddler as they would at home."

Measures

Sociodemograpic variables. Demographic data were collected in the form of a self-report questionnaire. Items included maternal education level, toddler and caregiver ethnicity, toddler gender, medical severity (days of ventilation), and birth weight. Maternal education was used as a proxy for socioeconomic status (SES) and was determined by a likert-like scale which included: 1) less than 12th grade, 2) completion of high school, 3) completion of at least 1 year of college (but did not receive a degree), 4) an Associate's degree from a two year college, 5) a bachelor's degree from a 4-year college, 6) some graduate school but did not receive a degree, or 7) a masters degree or higher.

Beck Depression Inventory-II. The Beck Depression Inventory-II (BDI-II; Beck & Beamesderfer 1974; Beck et al., 1996) was used to measure depressive symptomology. This self-reported questionnaire consists of 21-items that comprehensively assesses dysphoric symptoms, including affective, cognitive, somatic, overt behavior and

interpersonal symptoms of depression. The BDI-II was administered because depression is a potential confound of studying joint attention wherein depressed mothers have been found to interact differently with their toddlers than mothers who are not depressed (Field, Healy, Goldstein, & Guthertz, 1990; Reck et al., 2004). The BDI-II possesses a high degree of internal consistency with a mean alpha coefficient of .81 for non-psychiatric populations (Beck et al. 1996; Richter et al. 1998), and a reasonable level of validity with mean correlations of the BDI-II with clinical ratings and other questionnaires being 0.60 and 0.74, respectively, in non-psychiatric populations (Beck et al. 1996; Richter et al. 1998). A BDI-II score of 10 or higher (mild range or above) led to exclusion from this study because this cut-off score was considered mild depression by both by Beck & Beamesderfer (1974) and The Center for Cognitive Therapy. No randomly selected dyads had a BDI-II scores of 10 or greater, so no dyads were excluded from the study for this reason.

Coding Joint Attention Behaviors and Episodes

Eight minutes of the videoed play interaction (the first codeable section of the tape when the experimenter was not present) was coded independently by one of two undergraduates and a graduate student for joint attention behaviors and episodes.

Joint Attention Behaviors. Joint attention behaviors *are necessary but insufficient building blocks* to establish JA episodes. In the current study, JA behaviors were coded and the subsequent interactions were evaluated to determine if the behaviors resulted in successful JA episode, or if the responses were terminated before a JA episode was successful (Tasker & Schmidt, 2009). All JA episodes were defined in terms of the toddler (Mundy et al. 2009). This can cause confusion because even though these

behaviors are defined in terms of the toddler, both the mother and the toddler engage together in interaction in order to establish a "successful" episode.

JA behaviors by toddlers were divided into four categories: RJA-gaze, RJA-point, IJA-gaze, and IJA-point. All types of JA behaviors involve a toddler shifting attention between their mother and an object simultaneously (person-person-object awareness). All of these behaviors are nonverbal and have the purpose of sharing the object with the social partner (Mundy, 1995; Tasker, 2012; Tasker & Schmidt, 2008). These behaviors may or may not result in a successful JA episode. In the current study if the behavior became a successful episode, the duration of this episode was recorded. If this behavior was not followed by the partner's response, then a miss was recorded.

***RJA-gaze behaviors*.** Toddler RJA-gaze behaviors were defined as a toddler clearly shifting their attention to follow a mother's eye gaze towards a toy (Tasker, 2012). A tally of these behaviors was recorded.

A toddler needed to show a marked head turn (as defined as a 45 degree to 90 degree turn) or noticeable shift of eye gaze towards the object the mother was looking at to rate the behavior as a RJA-gaze behavior (Tasker, 2012). Following both Mundy (2003) and Tasker (2012), RJA-gaze behavior was not coded if the toddler already was looking in the direction of their mother's gaze or if it was not clear that either the mother or toddler changed their gaze to look at a new object.

RJA-point behaviors. Toddler RJA-point behaviors were defined as a toddler clearly shifting their attention to follow a mother's point or show of an object (Tasker, 2012). A tally of these behaviors was recorded. A point and a show are defined below.

Maternal pointing is defined as a clear expression of the index finger (when the

index finger was extended and all other fingers were bent towards the palm of the hand) towards a toy or object (Tasker, 2012). Pointing may occur with or without concurrent eye contact between the dyad (Tasker, 2012). When pointing and eye contact occurred concurrently, this study, following Tasker (2012), considered pointing to trump any eye-gaze.

Maternal showing was defined as the mother lowering a toy toward their toddler's face while looking at their toddler. The object needed to be presented for at least one to two seconds. Waving or shaking objects also were coded as a show.

IJA-gaze behavior. These behaviors included the toddler making eye contact with the caregiver or the toddler "alternating" their attention between their mother and a toy (Tasker, 2012). A tally of these behaviors was recorded.

Eye contact was operationally defined as a toddler gazing at their mother's eyes while the toddler was touching an object. Just gazing at the mother without the toddler touching a toy is not sufficient and was not coded (Tasker, 2012). In addition, if toddler's gazing at the mother was produced from the mother's dialogue or movement, this was not coded (Tasker, 2012).

Alternating behavior was defined as the toddler alternating eye contact between an object and their mother (Tasker, 2012). This only requires two behaviors (which occurred back to back from the toddler): first, looking at an object and second, shifting their gaze from the object to their mother (Tasker, 2012). The toddler alternating their gaze to their mother must occur within two seconds of the toddler looking at the object (Tasker, 2012).

IJA-point behaviors. These behaviors included the toddler pointing and showing

their mother a toy. The operational definitions of toddler pointing and showing were equivalent to the definitions discussed above for maternal pointing and showing. The only difference was that the toddler, not the mother, initiated the behavior. A tally of these behaviors was recorded.

Successful JA Episodes.

All JA behaviors were defined in terms of the toddler's behavior not the mother's behavior. Episodes were defined in terms of both partners because an episode, by definition, is dyadic. Both the number and duration of JA episodes were recorded. For an episode to occur, both the mother and the toddler engage together in order to establish an episode.

Joint attention episodes were considered successful when: (a) a JA incitation behavior occurs (b) either the mother or the toddler responses to this bid (verbal or nonverbal) within 5 seconds and the response lasts for at least 3 seconds, (c) both the mother and the toddler continue to focus on the object, or one another. (Tasker, 2012). A JA episode was considered *terminated* when mother, toddler, or both mother and toddler elicited a termination act and remained off topic for more than 5 seconds (Tasker, 2012). Termination acts included focusing on a new object or action, or showing disinterest in the current focus through behaviors. Disinterest was defined as yawning, looking away, moving away from the interaction, focusing on a different object (Tasker, 2012). It is important to note that both a termination act and staying off topic for 5 seconds are needed for an act to be terminated. It is often the case that a toddler could for example, yawn during a JA episode, but if that yawn is not accompanied by 5 seconds of being off topic, the JA episode was continued and was not considered terminated (Tasker, 2012).

JA episode types. These successful joint attention episodes were divided into four mutually exclusive types: RJA-gaze, RJA-point, IJA-gaze, and IJA-point. For an episode to have been coded, it must have met the above criteria for being "successful" and must have begun with the corresponding type of behavior (i.e., a IJA-gaze episode must have began with a successful response to a IJA-gaze behavior, a IJA-point episode must have began with a successful response to a IJA-point behavior, and so on and so forth). The frequency and duration of each type of JA episode were recorded.

JA misses. A miss was defined as the occurrence of JA behavior that did not become a successful JA episode. Misses were summed across all JA types and tally of misses was recorded.

Coding Manual Adaption. For this project, one additional adaptation of the coding system was implemented and was thought to be feasible. The adaptation included coding JA behaviors and episodes in real time through second-by-second coding rather than creating overall frequency measures. Tasker and Schmidt (2007) emphasize that there are "hits" and "misses" in joint attention and that these behaviors could occur simultaneously, which made it easily adaptable for second-by-second coding. Observers entered codes for each participant in each dyad (mother and toddler) independently in real time, yielding two synchronized streams of continuous events. Every behavior was coded either as present (1) or absent (0) during each second of the video-taped interaction. The coders followed the same operational definitions from Tasker's 2012 manual, but coded them in real time as opposed to collecting frequencies. Although this data has a time dimension, real time measures were collapsed into overall duration summary scores for this study, which will be described further below.

Reliability. To ensure initial reliability with the coding system, the graduate student sought guidance from the first authors of the coding system and was considered reliable with the system when she was able to reliably (.8) code a training video. The graduate student then trained the undergraduates in the system. The undergraduates were considered reliable coders when they were able to achieve reliability of .8 with the graduate student (master) coder. To maintain reliability throughout the project, coders met for regular weekly meetings and coded sections of videos together, discussed questions about coding, and made coding rules when needed.

Following Landis and Koch's (1997) and Halgreen's (2012) guidelines, inter-rater reliability was determined using Fleiss' Kappas. Results indicated almost perfect agreement (the highest level of agreement outlined by Landis & Koch, 1997 and Halgeen 2012) with Fleiss Kappas all .95 or higher for this study. The Fleiss Kappas for each individual JA variable were as follows: RJA-gaze behavior was .98, RJA-point behavior was 0.96, IJA-gaze behavior was .96, IJA-point behavior was .98, RJA-gaze episodes was 0.97, RJA-point episode was 0.96, IJA-gaze episode was 0.95, and IJA-point episode was 0.97.

Data Analysis

It is well demonstrated that a potential confound when studying VLBW samples may include lower socioeconomic status (Bhutta, 2002). Following a long line of literature, SES was measured by maternal education and was controlled for in all analyses (Desai & Alva, 1998; Caldwell, 1979).

Differences in joint attention behaviors and episodes by birth weight group were examined using a two-way analysis of covariance (ANCOVA). A series of ANCOVAs

were conducted on each type of JA behavior and each type of JA episode. Each ANCOVA was conducted using the grouping variable (VLBW versus NBW) as a predictor of each of the JA measures. SES (measured by maternal education) was included as a categorical covariate to control for differences in SES between mothers. Because there were no hypothesized interactions between the grouping variable and SES, the interaction terms were not included in any of the models. Univariate tests were conducted separately for each dependent variable to understand the nature of potential differences.

CHAPTER 3: RESULTS

Preliminary Results

General demographic means by birth weight group are summarized in Table 1. Prior to running the ANCOVAS, a set of t-tests and chi-squared analyses were conducted to ensure that the VLBW and NBW cohorts did not significantly differ on any toddler or caregiver key demographic variables, except for weight (see Table 1). This ensured that findings of this study were not confounded by any of the demographic variables. For the toddlers, the results indicated that there were no significant differences in the ethnic makeup (X^2 (2) = 8.84, p=.18), gender (X^2 (2) = 0.078, p=.78), or age (t=1.39, p=.24) of the two cohorts. For mothers, the results indicated no group differences in the ethnic make-up (X^2 (2) = 7.80, p=.25) or age (t=.274, p=.60). For maternal education the chi-square results suggests there was not a statistical difference in education level between birth weight groups, but this difference was almost significant (X^2 (2) = 9.179 p=.12). There was a significant difference between maternal marital status by birth weight group (X^2 (2) = 13.579, p=.01). Table 2 shows the means and standard deviations of the JA

behavior frequencies as well as the JA episode frequencies and durations by birth weight group.

Aim 1: Joint Attention Behaviors.

Figure 1 shows a summary of all JA behaviors by birth weight group.

RJA-gaze behaviors. As shown in Figure 3, there was no significant difference between birth weight groups on toddler RJA-gaze behaviors ($F(1,51)= 1.40$, p=.274). Toddlers born VLBW and toddlers born NBW did not differ in the amount of following eye gaze of their mother towards toys.

RJA-point behaviors. As shown in Figure 4, there was a significant difference between birth weight groups on RJA-point behaviors ($F(1,51)= 6.398$, p=.003). Toddlers born VLBW displayed fewer responses to their mother's pointing or showing of objects than did toddlers born NBW and their mothers.

IJA-gaze behaviors. As shown in Figure 5, there was a significant difference between birth weight groups on toddler IJA-gaze behaviors ($F(1,51)= 3.267$, p=.047), such that contrary to expectation, toddlers born VLBW displayed more eye gazing towards toys or objects to bid for their mother's attention than did toddlers born NBW and their mothers.

IJA-point Behaviors. As shown in Figure 6, there was no difference between birth weight groups on toddler IJA-point behaviors ($F(1,51)= 0.717$, p=.493). Toddlers did not differ by birth weight group in the amount of pointing and showing toys or objects to bid for their mother's attention.

Aim 2: Joint Attention Episodes.

JA Misses. The analyses indicated no significant effects or trends of birth weight on JA misses ($F(1,51)= 0.971$, p=.386)

Given that misses were infrequent for both VLBW and NBW dyads (M=.65 for VLBW dyads and M=1.0 for NBW dyads), this led to no differences in the mean number of joint attention behaviors and the mean number of joint attention episodes (See Table 2).

RJA-gaze episodes. As shown in Figure 7 and contrary to expectation, s no significant difference was found between birth weight groups on RJA-gaze episodes ($F(1,51)= 1.653$, p=.202).

RJA-point episodes. As shown in Figure 8, there was a significant difference between birth weight groups on RJA-point episodes ($F(1,51)= 6.794$, p=.012) such that, as expected, toddlers born VLBW spent less time engaging in successful joint attention episodes with their mothers, indicated by mothers showing or pointing to an object and toddlers responding, across the free-play interaction than toddlers born NBW and their caregivers.

IJA-gaze episodes. As shown in Figure 9, there was a significant difference between birth weight groups on IJA-gaze episodes ($F(1,51)= 3.174$, p=.051) with the VLBW group engaging in more joint attention episodes that began by the toddler initiating through gazing or head turning.

IJA-point episodes. As shown by Figure 10, there was no significant difference between birth weight groups on IJA-point episodes ($F(1,51)= 2.062$, p=.45).

CHAPTER 4: DISCUSSION

Summary of Results

In a cohort of 18 month toddlers (VBLW: N=26; NBW: N=26) and their mothers, some aspects joint attention behaviors and episodes were similar, while others significantly differed by birth weight group. Specifically, in terms of RJA behaviors, contrary to expectation, no differences were found in the frequency of RJA-gaze behaviors, while as expected, RJA-point behaviors occurred less frequently for toddlers born VLBW compared with toddlers born NBW. For IJA behaviors, contrary to our hypotheses, IJA-gaze behaviors occurred *more* frequently for toddlers born VLBW than for toddlers born NBW, while no differences were found on the frequency of IJA-point behaviors. As hypothesized, there were no birth weight group differences for "missed episodes." It is important to note that almost all behaviors became episodes, (there were very few misses, averaging one per dyad), meaning that behaviors by themselves (outside of the context of episodes) very rarely occurred. Because almost all behaviors were in the context of episodes, there were parallel findings for joint attention behavior and episodes. Specifically, parallel to their referent behavior, RJA-point episodes occurred less frequently and IJA-gaze episodes occurred more frequently for toddlers born VLBW than for toddlers born NBW. No differences were found between birth weight groups on RJA-gaze and IJA-point episodes.

Birth Weight Group Differences in JA

JA "missed episodes." As expected there were no differences in JA "missed episodes" between birth weight groups. Interestingly, misses were very infrequent for both groups. This suggests that both mothers and toddlers (VLBW and NBW) were

sensitive to each other's bids for JA. This finding is consistent with past research suggesting that mothers of toddlers born VLBW tend to be highly responsive to their toddler (Salerni, Suttora, & D'Odorico, 2007).

RJA-gaze behaviors and episodes. Descriptively, RJA-gaze behaviors were relatively infrequent for both groups (means of 3 and 1 for VLBW and NBW, respectively). No birth weight group differences were found on toddler RJA-gaze behaviors when toddlers shifted their attention to their mother's gaze at a toy. There were parallel findings for RJA-gaze behaviors and episodes, such that there were no differences between birth weight groups.

Past research combined gaze and show behaviors and the current study is the first to our knowledge to examine these developmentally different forms of RJA behavior separately. It is possible that the mixed results from previous studies are due in part by studies not examining the different types of RJA behaviors separately, especially given that the current study found that RJA-gaze behaviors were infrequent for both groups. This is of particular importance given that gazing occurs much younger in development than pointing (Moll and Tomasello, 2007).

Past research examining RJA behaviors among toddlers born VLBW has been mixed, with some studies showing no difference in toddler RJA behavior between groups and other studies showing less frequency of this behavior among toddlers born VLBW compared to toddlers born NBW (Landry & Chapieski 1988; Gardner, Landry & Richardson, 1991). The current study fits with some of the past literature suggesting no differences in toddler RJA behavior between birth weight groups for this age group (18 months) (Landry & Chapieski 1988).

It is possible that these null findings for RJA-gaze behaviors and episodes can in part be explained by the low frequency of this behavior for both birth weight groups. For both toddlers born VLBW and their NBW counterparts, RJA-gaze episodes (eye gaze started by the mother) did not occur often, if ever, during free-play interaction. This interesting finding may have come to light because our study was one of the first to separate gaze from point behaviors . Although our finding is contrary to our hypotheses, this finding may be important because it suggests the possibility that in natural free-play interactions, mothers of toddlers may more often show or point to a toy rather than look or gaze at a toy to get their toddler's attention. Although the reason for this infrequency of RJA-gaze behaviors and episodes is unknown, we speculate that this could be because parents believe that showing and pointing is more developmentally appropriate for their toddler or because they have had more success with it. This hypothesis will need to be further explored by future studies in order to understand if this is a descriptive aspect of free-play interactions at this age. There is only one study, to our knowledge, with typically developing infants that explored maternal gazing separately from pointing. This study similarly found maternal showing/pointing to be more frequent than gazing (Bakeman and Adamson, 1984). Although there is limited literature directly exploring the frequency of maternal pointing rather than gazing to get the attention of their toddler, there is research to suggest that as infants become toddlers, more complex play interactions around toys emerge, including more advanced pretend play around 18 months (Jay and Most, 1981; Fein, 1981). Perhaps mother's pointing/showing instead of gazing to get the attention of their toddler is a product of increasing pretend play with mothers and toddlers during this developmental period.

RJA-point behaviors and episodes. RJA-point behaviors were more frequent for NBW dyads (m=9) than for VLBW dyads (m=1). This study found that toddlers born VLBW showed significantly less attention shifting towards their mothers, showing and pointing towards toys and objects (RJA-point), than did toddlers born NBW. Interestingly, toddlers born VLBW did not struggle with responding to mothers (or misses would have been higher), but rather this difference appears to stem from mothers of toddlers born VLBW displaying fewer bids for joint attention through showing and pointing than mothers of toddlers born NBW. Because of the low frequency of misses, parallel findings occurred for both behaviors and episodes.

In terms of RJA-point episodes, like RJA-point behaviors, this study found significant differences between birth weight groups. Toddlers born VLBW were less frequently engaged in interactions that began with their mothers showing/pointing to a toy than were toddlers born NBW. This furthers Gardner, Richardson, and Landry (1991)'s work to suggest that the nature of RJA differences among toddlers born VLBW might stem from fewer joint attention episodes that begin with the mother showing and pointing.

One hypothesis is that this finding that NBW dyads more frequently engaged in RJA-point behaviors and episodes than VLBW dyads may suggest that mothers of toddlers born VLBW do not bid as frequently for their toddlers' attention compared to mothers of toddlers born NBW. This birth weight group difference in RJA-point behaviors and episodes could be explained by "vulnerable child syndrome" in which mothers of toddlers born VLBW view and interact with their toddlers differently than mothers of NBW toddlers because of excessive parental anxiety and stress related to the

perceptions and stereotypes that their toddler is susceptible to medical problems (Perrin, West, Culley, 1989; Stern et al. 2006). There is extensive literature to suggest mothers of toddlers born VLBW engage in more negative interactions with their toddlers and are less actively engaged during interactions with their toddlers compared to NBW dyads (Cho et. al., 2004; Stern and Hildebrandt, 1986; Stern et al., 2000; Stern et al., 2006; Goldberg and DivVitto, 1995; Singer et al. 2003; Jarvis, Myers, Creasey, 1989; Schermann-Eizirik et al, 1997; Smith et al. 1996). The current study corroborates this hypothesis to a certain extent, finding that mothers of toddlers born VLBW less actively attempted to jointly attend around an object with their toddlers than did mothers of toddlers born NBW. However, this maternal behavior needs to be placed in the larger dyadic interactive context, as mothers of toddlers born VLBW engaged in fewer of these behaviors but engaged in more following of their toddler's JA lead (discussed later in IJA gaze findings). These findings highlight the importance of a mothers' role in joint attention interactions and suggest that mothers of toddlers born VLBW may interact differently with their toddlers than mothers of toddlers born NBW.

IJA-gaze behaviors and episodes. Descriptively, this study found that IJA-gaze behaviors were more frequent across groups than were IJA-point behaviors. This may suggest that 18 month olds may utilize IJA-gaze behaviors more frequently to bid for their mother's attention than IJA-point behaviors (which occurred less frequently).

The current study found, contrary to our prediction, that toddlers born VLBW showed significantly more IJA-gaze behaviors than did toddlers born NBW, but also found no difference in IJA- pointing behaviors. Parallel to their referent behaviors, IJ-gaze episodes significantly differed in frequency by birth weight group with toddlers born

VLBW engaging in more episodes than NBW controls, again contrary to our prediction. This data suggests that toddlers born VLBW initiated and engaged in more successful IJA-gaze episodes by gazing at toys than toddlers born NBW. This finding is interesting because there were very few misses for both VLBW and NBW dyads, suggesting mothers rarely missed their toddler's bid for their attention. This low level of misses may suggest that both mothers of VLBW and NBW toddlers are sensitive to their toddler's behavior.

Research involving IJA behaviors and episodes in a VLBW sample has been sparse and the data have been mixed. Two studies suggest that there were differences IJA behaviors, both combining gazing and pointing behaviors, with VLBW engaging in less of these behavior compared to NBW controls (De Schuymer et al. 2011; Landry, Schmidt, & Richardson, 1989). Another study suggests no differences in IJA episodes (gaze and point combined) between toddlers born VLBW with low medical risk and toddlers born NBW (Gardner, Landry, Richardson, 1991). The mixed results from the past literature could have been driven by these studies not examining gazing and pointing separately. This is especially true given that our findings suggest that only IJA-gaze (behaviors and episodes) significantly differed by group. If the current study had combined IJA episodes (gaze and point), significant group differences of IJA episodes may not have been identified.

Interestingly, our results revealed that toddlers born VLBW actually spend *more* time in IJA-gaze episodes as compared to NBW controls, which was contrary to expectation. One possible explanation for this finding is that VLBW dyads engage in more IJA-gaze behaviors and episodes than do NBW toddlers. This finding is contrary to

past research suggesting that mothers engage less with their toddlers born VLBW (Goldberg and DiVitto, 1995) and that IJA episodes either did not differ or were less frequent than NBW dyads (De Schuymer et al. 2011; Landry, Schmidt, & Richardson, 1989; Gardner, Landry, Richardson, 1991). This finding needs to be explored further.

While initially perplexing, the current study's finding that toddlers born VLBW engaged in *more* IJA-gaze behaviors and episodes compared with toddlers born NBW could potentially be explained by an alternative explanation: a product of coding system artifacts.

First, coding systems for joint attention often assume that various behaviors serve particular functions. Particularly with IJA-gaze behaviors and episodes, a toddler gazing at a toy is assumed to serve the function of eliciting social interaction from the mother (Tasker, 2012; Mundy et al., 2003). This infers intention when there are many other intentions that this behavior could imply, such as the toddler could be looking for reassurance from their mother, the toddler could be actively pursuing a toy to play with on their own without their mother, or many other plausible explanations. These different intentions, when anchored in the same observable behavior, are indistinguishable from each other. In contrast, the coding system assumes the toddler's behavior always serves a social function.

It is possible that the mother was sensitive to the toddler's behavior or interest in a toy and began to play with whatever the toddler was looking at or touching, making this JA episode one that was actually initiated *by the mother*. This is currently speculative and there is no past research suggesting this explanation, but it appear plausible given the assumption of the toddler's intention. Thus, in the present coding system, there is no way

to distinguish between a toddler bidding for mother's attention (what we code as IJA episode) or the mother sensitively responding to their toddler's behavior. It is possible that IJA, as coded by this study, is in fact mothers of toddlers born VLBW being more sensitive to their toddlers' behavior. This finding fits with our other birth weight group difference finding related to fewer RJA-gaze behaviors and episodes among toddler born VLBW and their mothers: if mothers of toddlers born VLBW are following their toddler's lead more often (more IJA-point behaviors and episodes), then they may be initiating fewer JA episodes themselves (fewer RJA-gaze behaviors and episodes). This alternative explanation fits with past findings that a number of studies of toddlers born NBW which suggest that the majority of JA episodes arise as a result of the mother monitoring the infant's line of gaze (Schaffer, 1984). This finding also would be consistent with past research suggesting that mothers of toddlers born VLBW tend to be highly responsive to their toddler and that there is lack of activity on the part of the infant/toddler (Salerni, Suttora, & D'Odorico, 2007). If this hypothesis about the nature of toddler IJA actually representing increased maternal sensitivity is accurate, this could suggest that mothers of VLBW toddlers provide relatively high levels of sensitive responsiveness to their toddlers.

Similarly, the low frequency of RJA-point behaviors by mothers of VLBW toddlers could be strength: evidence of maternal sensitivity. When placed into the larger dyadic context, mothers engaging in less pointing behaviors to elicit their toddler's attention, but more following of the toddlers initiations, this low frequency of the mother initiating could be a product of more frequently of following their toddler's initiations. If this hypothesis is correct, this suggests that mothers of toddlers born VLBW are more

sensitive to the toddler's behavior or interest in a toy, as evidenced by this low frequency of maternal initiation. This finding could be consistent with past research suggesting that mothers of toddlers born VLBW tend to be highly responsive to their toddler (Salerni, Suttora, & D'Odorico, 2007). If this maternal sensitivity can be shown to be linked to outcomes, this finding could have important implications for interventions. Interventions could focus on highlighting this sensitivity for mothers of toddlers born VLBW as strength in order to increase self efficacy.

IJA-point behaviors and episodes. The data from the current study suggests that there were no significant differences in IJA-point behavior and episode duration between birth weight groups. Similar to RJA-gaze episodes, it is possible that this null finding can be explained by the low frequency of IJA-point episodes for both birth weight groups. For both toddlers born VLBW and their NBW counterparts, IJA-point behaviors and episodes were very rare (m=1 for both groups for both behaviors and episodes).

This study suggests the possibility that in natural-play interactions, toddlers may gaze at a toy to begin interactions with their mother more often than they show or point to toys to begin interactions with their mother. Although the reason for this infrequency of IJA-point is unknown, this is still informative about the descriptive nature of mother-toddler interactions. It is possible that this low frequency of IJA-point behaviors and episodes may be a product of the developmental stage of these toddlers. In toddlers, gaze following ability has been consistently shown to develop before point following ability (Carpenter et al. 1998; Tomasello, 1995, Vaugh van Hecke et al., 2007) and multiple studies suggest that pointing and showing ability by toddlers does not develop until 14 to 18 months of age (Butterworth & Cochran, 1980; Tomasello, 2007). It is possible that the

low frequency of occurrence of IJA-point behavior is due to the fact that many of these toddlers may not have yet developed the ability to point or show towards toys.

Study Strengths

Most research on joint attention has focused on toddlers born NBW and utilized an experimental paradigm. This study is one of the few to examine joint attention behaviors and episodes with a VLBW sample, and this is the second study, to our knowledge, to examine these differences in the ecologically valid paradigm of the mother-toddler free-play interaction. Researching joint attention in this ecologically valid paradigm might have more applications for clinical work than the experimental paradigm.

In addition to being more ecologically valid, exploring episodes (rather than just behaviors) helped to elucidate the dyadic nature of these interactions. This study was one of the first to explore JA as episodes with a VLBW sample.

This study also highlights the difficulties in coding a dyadic level behavior in natural interaction. During observational coding of natural interactions, distinguishing the lines between different JA episodes and who actually initiates a JA episode are much less clear than coding systems created for experimental paradigms suggest. In short, the dyadic nature of JA behaviors and episodes leads to considerable coding confusion. More research is needed to better understand what current coding systems are actually measuring and how they map onto more nuanced forms of JA behaviors and episodes. Additional work is needed to help improve coding systems for natural interaction. One idea is to add eye tracking software and multiple camera angles so that coding gaze can be more precisely measured. Further adaptions to naturalistic coding of these JA interactions need to be considered in future research.

In addition, this study was the first to examine RJA and IJA among VLBW dyads divided into gazing and pointing (as these behaviors develop at different times for toddlers). This is an important strength to highlight because prior studies with VLBW samples have examined only RJA and IJA with both gaze and point combined. Exploring these forms of JA separately is important because past research with toddler born NBW suggest that infants and toddlers evidence a developmental progression in abilities such that infants as young as 6 months can follow eye gaze, but showing and pointing emerges later in development (Vaugh can Hecke et al., 2007), with pointing and showing (for both IJA and RJA) emerging in toddlers around 14 to 18 months of age (Moll and Tomasello, 2007). Similar to Van Hecke et al (2003)'s work with a NBW sample, the current study furthers the literature by including a VLBW sample to examine the different forms (gaze and point) of RJA and IJA episodes. Overall, our RJA behavior and episode findings are consistent with the literature and seem to suggest the possibility of greater maternal sensitivity for the VLBW group. Understanding the type of joint attention behavior (gaze or point) that drives these differences helps clarify the specific behaviors that that occurred less often for VLBW dyads.

Another strength of this study was that our sample was ethnically diverse and we controlled for SES. Mothers of toddlers born VLBW are more likely to be from a minority group and our study, and our VLBW participants included 68% ethnic minorities, comparable to nationally-based samples of toddlers born VLBW (Signh & Yu, 1996). However, our sample was not entirely representative because it lacked African Americans.

Limitations

Even though these findings are novel and interesting, a discussion of the limitations of the current study is warranted. A major limitation of this study, as well of all studies of joint attention, was the way in which the coding system operationalizes JA behaviors/episodes. It is difficult to operationalize a toddler's observable behaviors without assuming intention of the toddler's action or without coding the behavior itself as its function. This is particularly difficult for JA given the social nature of this construct. It is currently unclear how to code these behaviors without assuming intention of the toddler and further studies focusing on ways to improve the coding systems.

Another limitation is that this study was an in-depth analysis of the different types of JA behaviors and episodes and did not include whether these behaviors had a long-term impact on a toddler's developmental outcomes. Further studies should look at how JA episodes and behaviors affect long-term cognitive, executive functioning, and social abilities in toddlers born VLBW.

This study also did not take into consideration how each individual partner's behavior affected the other partner's behaviors at the level of the dyad. Future studies should focus on understanding how each social partner can casually affect the other partner's behavior during an interaction.

Concluding Statements

In spite of these limitations, the findings of this study are interesting and informative. By studying different forms (gaze and point) of both RJA and IJA behaviors and episodes, this study helped elucidate the nature of RJA and IJA episodes in both VLBW and NBW dyads. This study found RJA-point episodes to be more infrequent for

VLBW dyads, suggesting that this lower frequency may stem from mothers' of toddlers born VLBW bidding less for RJA-point episodes. These differences further support past research and further this literature by showing that this RJA deficit likely stems from mother's showing and pointing as opposed to eye gazing at a toy to initiated joint attention episodes. Interestingly, our study highlights that although this RJA difference between birth weight groups is often hypothesized to be a deficit, this may actually evidence that mothers of toddlers born VLBW are *more* sensitive to following their toddler in play. This sensitivity can be evidenced by of this lack of initiation of the mother, especially when taken into the larger context that mothers of toddlers born VLBW engaged with their toddlers to make more IJA-gaze behaviors (intentionally social or not) turn into more IJA-gaze episodes.

The finding that VLBW dyads may show more IJA-gaze episodes than toddlers born NBW may be due to a limitation of the coding system. If this hypothesis about the nature of these IJA behaviors is true, then mothers of toddlers born VLBW may be more sensitive to their toddler's behavior and may try to engage more with their toddler than NBW controls. In addition, the infrequency of JA "missed episodes" for the VLBW group also highlights and supports mothers of toddlers born VLBW as sensitive to their toddlers behavior.

These findings have promising implications for ways to target interventions, assuming JA behaviors can be linked to outcomes. These implications include bolstering and promoting self efficacy of what VLBW mothers are doing well, which includes being sensitive to and following their toddler's bid for attention and not overly bidding for their toddlers attention.

Future research should develop and test potential interventions around joint attention behaviors and episodes. Other possible future directions include examining the causal relationship between each partner's behaviors during a joint attention episode, and exploring joint attention's effects on future outcomes. Some research has looked at cognitive and language outcomes (DeSchuymer et al. 2011; Smith & Ulvind, 2003), but other outcomes such as social-emotional or theory of mind should be explored.

APPENDICES

Appendix A. Tables

Table 1. Toddler and Mother Demographics for Toddlers born VLBW and Toddlers born NBW

		VLBW (n=26) M (SD)	**NBW (n=26) M (SD)**
Toddler Age (months)		20(1.3)	19(1.7)
Toddler Birth Weight (grams)*		882(194.8)	3271(486.0)
Toddler Illness Severity**		24(22.3)	0(0)
Mother Age (years)		28(5.8)	26(5.4)
		VLBW (n=26) % (N)	**NBW (n=26) % (N)**
Toddler Ethnicity*			
	Hispanic	42(11)	65(17)
	White	34(9)	23(6)
	Native American	19(5)	11.5(3)
	African American	4(1)	0(0)
Mother Ethnicity			
	Hispanic	42(11)	65(17)
	White	34(9)	23(6)
	Native American	19(5)	11.5(3)
	African American	4(1)	0(0)
Mother Marital Status			
	Married	39%(10)	42%(11)
	Living with a partner	35%(9)	8%(2)
	Single	23%(6)	50%(13)
Mother Level of Education			
	Less than High School	15%(3)	30%(8)
	High School	50%(13)	50%(13)
	Associates	19%(5)	4%(1)
	Bachelors	15%(4)	11%(3)
	Graduate School	0%(0)	4%(1)

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

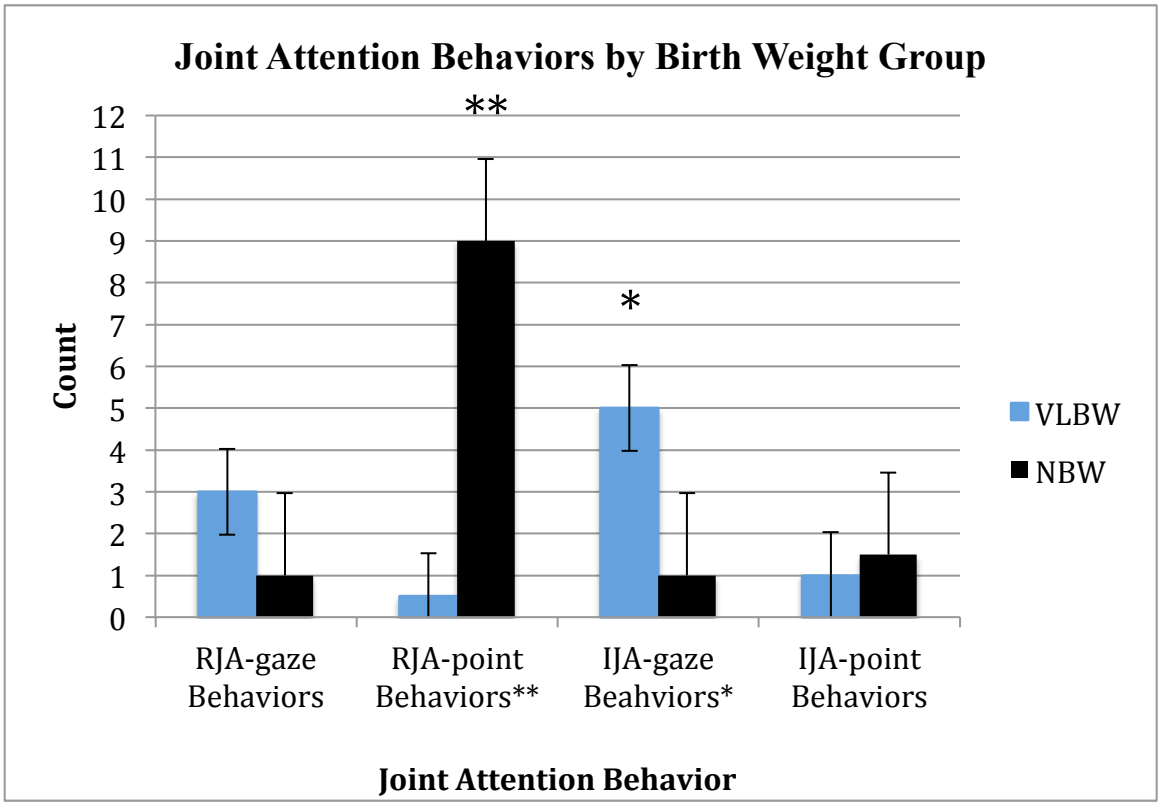
Table 2. Mean (Standard Deviation) Joint Attention Variables by Birth Weight Group

Joint Attention (JA) Variables	VLBW (n=26) M(SD)	NBW (n-26) M(SD)
JA Behaviors (count)		
RJA-gaze behaviors	3(2.03)	1(.74)
RJA-point behaviors**	0.5(0.76)	9(4.23)
IJA-gaze behaviors*	5(2.76)	1(1.12)
IJA-point behaviors	1(1.12)	1.5(1.83)
Misses (count)	1(1.4)	1(1.2)
JA Episodes (count)		
RJA-gaze episodes	3(4.1)	1(.72)
RJA-point episodes**	0.6(2.3)	9(4.20)
IJA-gaze episodes*	5(2.2)	1(1.09)
IJA-point episodes	1(1.2)	1(1.4)
JA Episodes (duration)		
RJA-gaze episodes	6(2.6)	4(1.2)
RJA-point episodes**	60(15.1)	251 (17.2)
IJA-gaze episodes*	125(49.7)	64(40.5)
IJA-point episodes	65(10.2)	60(18.6)

RJA= Responding Joint Attention
IJA= Initiated Joint Attention
* $p < .05$
** $p<.01$

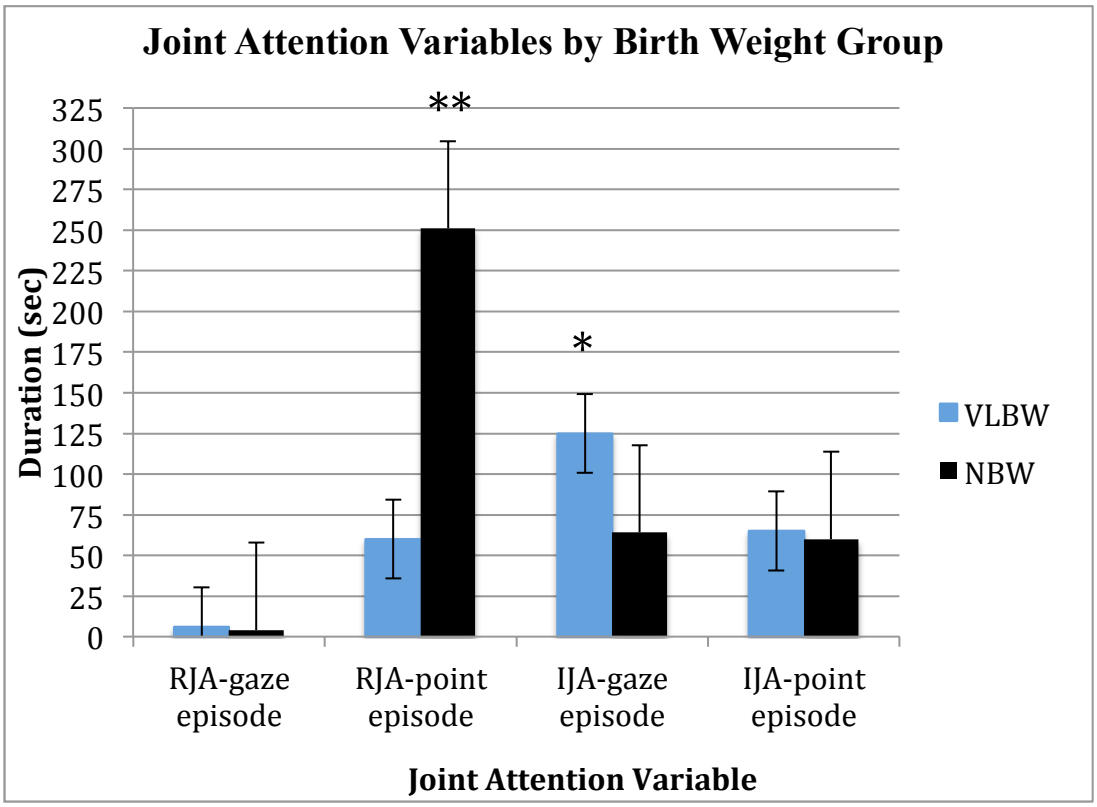
Appendix B. Figures.

Figure 1. Joint Attention Behaviors by Birth Weight Group



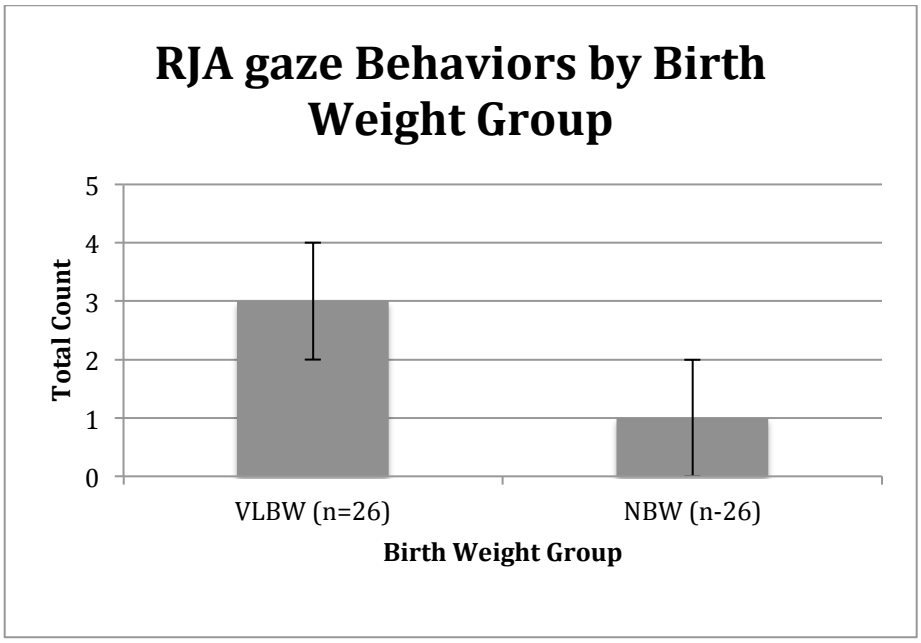
RJA= Responding Joint Attention, IJA= Initiated Joint Attention
*p < .05 level
**p<.01 level

Figure 2. Joint Attention Episodes by Birth Weight Group



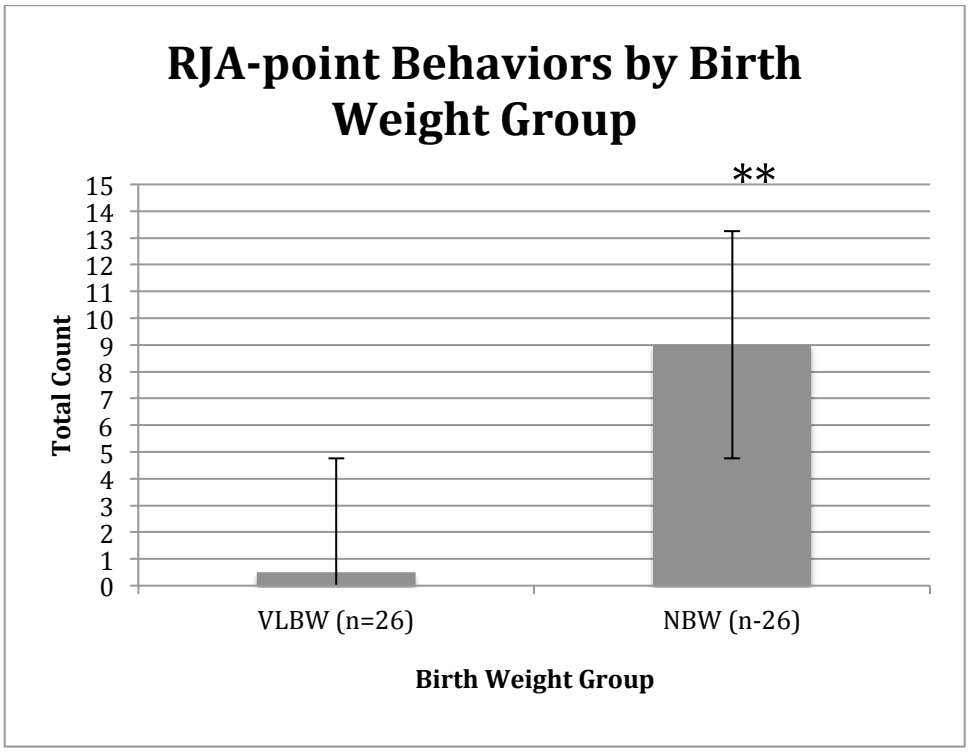
RJA= Responding Joint Attention, IJA= Initiated Joint Attention
* p < .05
**p<.01

Figure 3. RJA-gaze behaviors by Birth Weight Group



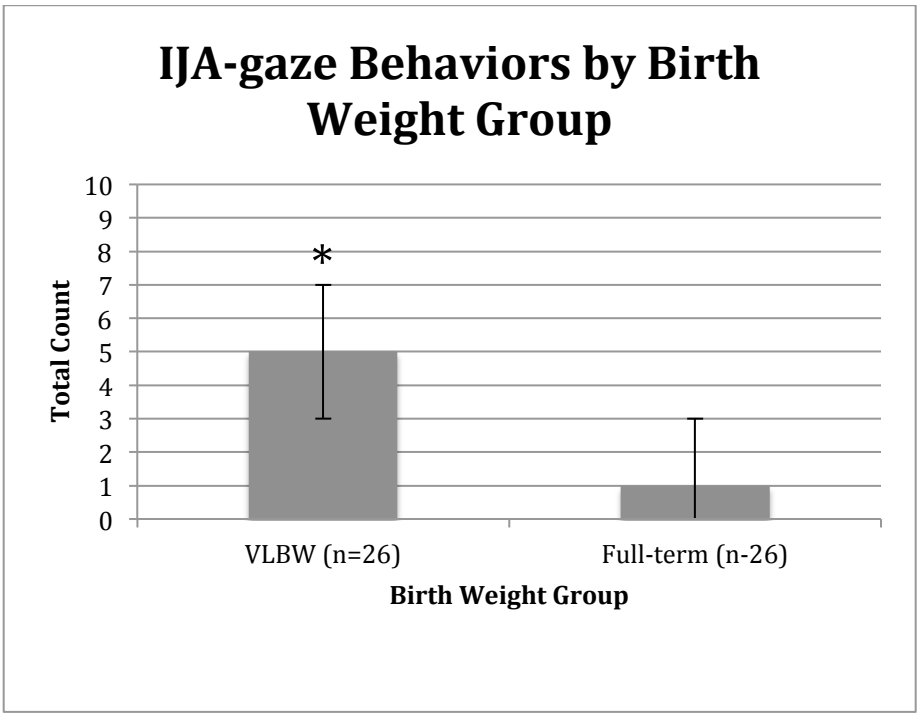
RJA= Responding Joint Attention
* p < .05
**p<.01

Figure 4. RJA-point behaviors by Birth Weight Group



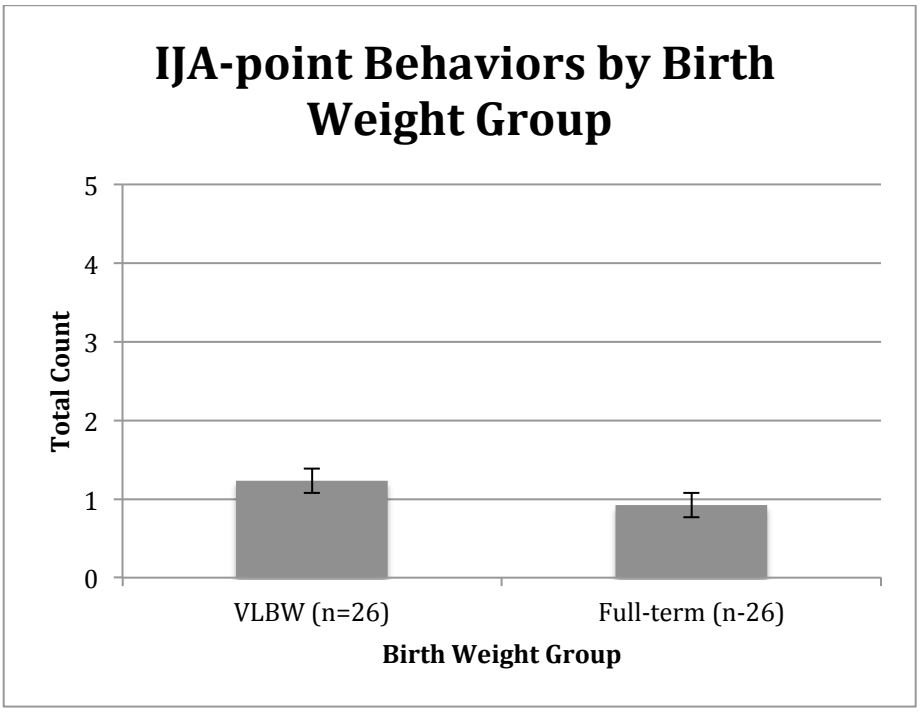
RJA= Responding Joint Attention
*p < .05
**p<.01

Figure 5. IJA-gaze Behaviors by Birth Weight Group



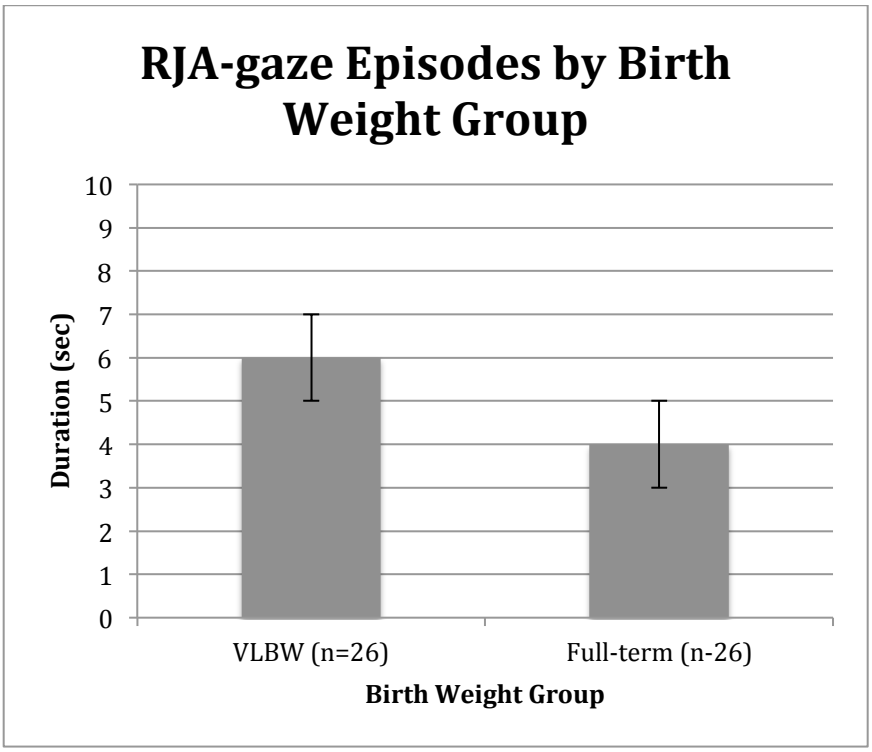
IJA= Initiated Joint Attention
*p < .05
**p<.01

Figure 6. IJA-point Behaviors by Birth Weight Group



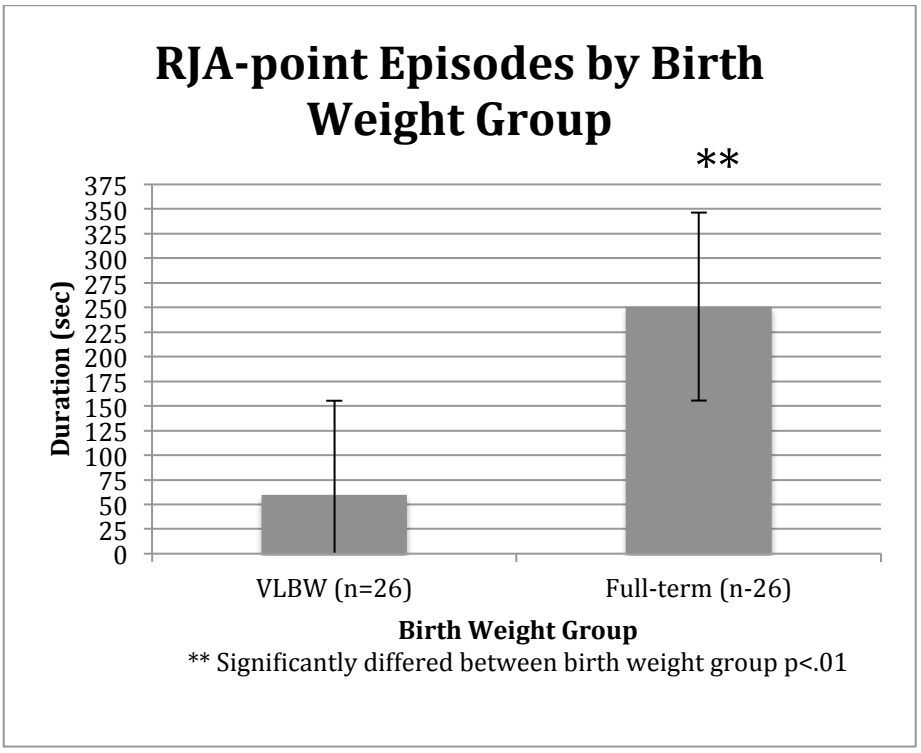
IJA= Initiated Joint Attention
*p < .05
**p<.01

Figure 7. RJA-gaze Episodes by Birth Weight Group



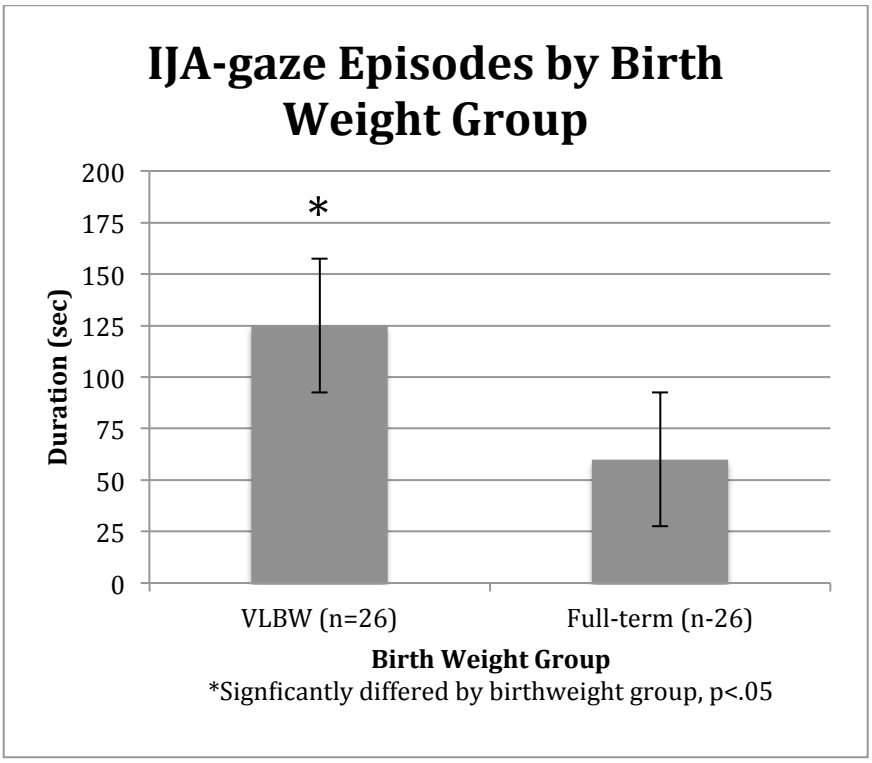
RJA= Responding Joint Attention
*p < .05
**p<.01

Figure 8. RJA-point episodes by Birth Weight Group



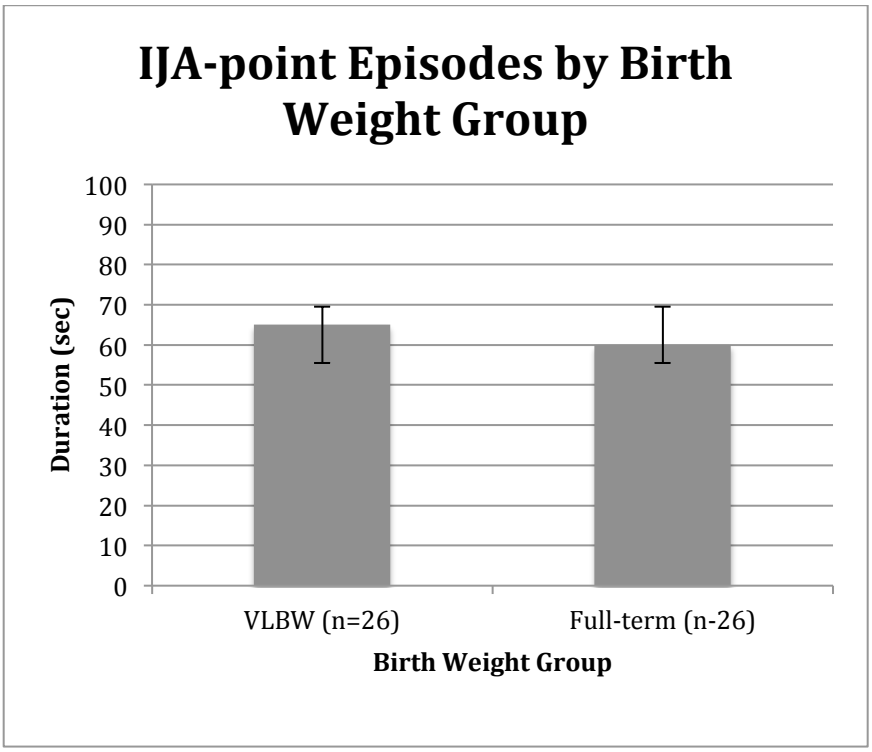
RJA= Responding Joint Attention
*p < .05
**p<.01

Figure 9. IJA-gaze episodes by Birth Weight Group



IJA= Initiated Joint Attention
*p < .05
**p<.01

Figure 10. IJA-point episodes by Birth Weight Group



IJA= Initiated Joint Attention
*p < .05
**p<.01

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