JOINT ATTENTION DURING EARLY MEALTIMES AND THE INFLUENCE OF WEANING STYLE

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by
TAYLOR G. MARTIN

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APPROVED BY:

Amy Galloway
Chairperson, Thesis Committee

Lisa Emery
Member, Thesis Committee

Reagan Breitenstein
Member, Thesis Committee

Rose Mary Webb
Chairperson, Department of Psychology

Marie Hoepfl, Ed.D.
Interim Dean, Cratis D. Williams School of Graduate Studies

Abstract

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Taylor G. Martin
B.S., University of South Carolina
M.A., Appalachian State University

Chairperson: Amy Galloway

Baby-led weaning is an emerging alternative to traditional complementary feeding that may have beneficial effects for language development. However, little is known about how the parent-child interactional processes that occur during feeding contribute to development. Early feeding interactions may present important opportunities for infants to engage in joint attention, a preverbal communicative skill that is related to early language development, and these dyadic processes may be affected by weaning methods that place differing task demands on the parent and the infant. This study quantifies, for the first time, the amount of joint attention that 6- to 12-month-old infants engage in during mealtimes, and evaluates self-feeding as a predictor of total joint attention and infant-initiated joint attention. Video recordings of infant mealtimes were coded for self-feeding and joint attention, and hierarchical regression was used to evaluate the relationships between self-feeding and joint attention variables, as well as how these relationships change with age. We found significant amounts of joint attention occurring during mealtimes at all ages included in our study. While self-feeding did not predict engagement in total joint attention in our study, we did find that self-feeding was a significant predictor of

infant-initiated joint attention. Future research should continue to explore the impacts of feeding practices on language development, as well as the utility of mealtimes for joint attention interventions.

Keywords: joint attention, complementary feeding, baby-led weaning

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Joint Attention During Early Mealtimes and the Influence of Weaning Style

As many as three to four percent of US children aged three and above struggle with language disorders (Black et al., 2015), placing language difficulties among the most prevalent special educational needs (Lindsay & Strand, 2016). Furthermore, in 2012, only 66.8% of US children with language difficulties received intervention services, with female children and ethnic minorities less likely to receive interventions than white, male children (Black et al., 2015). Considering these numbers, along with findings that language difficulties in childhood predict adverse outcomes in education, employment, and even social domains later in life (Conti-Ramsden & Durkin, 2012; Yew & O'Kearney, 2013), it is no surprise that many parents and researchers alike are concerned with how to give children the best start possible when it comes to language development. One way that this can be accomplished is by focusing on the development of preverbal communicative skills, such as joint attention.

Improving joint attention has become an intervention target for children at risk of language difficulties, such as children with autism spectrum disorder (ASD). These interventions have been largely effective in improving children's joint attention (Murza et al., 2016) and language skills (Drew et al., 2002; Girolametto et al., 1994; Kasari et al., 2008). As of now, joint attention has been studied almost exclusively in the context of play interactions, to the exclusion of other contexts that may present important opportunities for infants to practice their developing joint attention skills. The present study will investigate the potential of mealtimes as important joint attentional contexts, as well as whether complementary feeding method influences the joint attention that infants experience during early mealtimes.

Complementary Feeding Approaches

Complementary feeding refers to the process by which infants are gradually introduced to

foods other than breastmilk or infant formula in order to meet their expanding nutritional needs (World Health Organization, 2003). In traditional complementary feeding, infants are usually spoon-fed pureed foods by a caregiver, gradually transitioning to foods of a thicker texture and beginning to participate in feeding themselves toward the end of the first year (Seaman et al., 1996). Alternatively, baby-led weaning (BLW) is an emerging approach to complementary feeding characterized by allowing the infant to feed itself, offering the child "finger foods" rather than purees, and feeding the infant in the context of family meals from the initiation of complementary feeding (Rapley & Murkett, 2008).

Although formal research on the prevalence of BLW has not been conducted, the approach has anecdotally experienced a recent increase in popularity (Brown & Lee, 2011), with a corresponding rise in research devoted to the topic. The majority of the research to date has focused on the method's implications for nutrition and eating behavior, with observational research suggesting that BLW may lead to better self-regulation of food intake, decreased risk of obesity, and lower food fussiness (Brown & Lee, 2015), possibly due to BLW affording the child increased autonomy in the feeding process, which contributes to increased satiety responsiveness (Brown & Lee, 2013).

More recent research has investigated whether a baby-led approach to complementary feeding has implications for cognitive development. Presumably, BLW infants are exposed to the experiences of chewing and handling solid foods earlier than traditionally weaned infants; these experiences may benefit early cognitive development. In fact, there is support for a link between chewing and cognition. Studies of adults have shown that, in the short term, chewing during lab tasks results in improved attentional focus and shorter reaction times (Allen & Smith, 2015; Wilkinson et al., 2002). Developmentally, mouse studies have found that compared to mice fed

on a soft diet, mice fed on a hard diet exhibit superior performance on memory tasks and have higher levels of brain-derived neurotrophic factor (BDNF), which plays a role in learning and memory by supporting synapse formation (Yamamoto et al., 2008; Yamamoto & Hirayama, 2001).

Early studies have found positive associations between a BLW style and measures of language development (Webber et al., 2021). Two primary pathways to impact have been suggested in the previous literature: increased usage of fine motor and oral motor skills and increased prevalence of family mealtimes. Feeding infants chunks of solid foods rather than purees requires them to practice more complex oral-motor movements during feeding (Cichero, 2016). Alcock (2006) found that oral-motor scores are positively associated with measures of expressive language at 21 months. Thus, the experience of eating solid foods from an earlier age may better prepare infants for the physiological demands of spoken language. Allowing infants to feed themselves rather than spoon-feeding them also introduces increased gross-motor and fine-motor demands, as infants must practice the hand-eye coordination necessary to grasp food and bring it to their mouths. Accordingly, Addessi et al. (2021) recently found an association between self-feeding and crawling at an earlier age. Advancements in motor skills may allow infants to access a broader range of opportunities to stimulate the development of language skills (Iverson, 2010). Regarding family mealtimes, the prevalence of family meals is related to language skills in childhood, perhaps because it exposes children to a broader and richer range of language usage compared to other contexts (Snow & Beals, 2006). Webber et al. (2021) found that participation in family meals mediated the positive relationship between BLW and language production and comprehension.

The theoretical bases for the above studies have focused mainly on the infant's individual experiences during feeding and their relevance to cognition. In many ways, language is both a cognitive and a social phenomenon, but dyadic interactions within the early feeding context have yet to be investigated in terms of their relationship to communicative development. There is a need for empirical evaluation and characterization of the parent-child interactions that occur during traditional and baby-led weaning to further understand whether and why the two approaches may result in differing developmental outcomes. The present study will focus on one such interaction, joint attention, and whether self-feeding, as emphasized in the BLW approach, predicts differences in joint attention during feeding.

Joint Attention Development

Joint attention is a behavioral state in which two individuals are focusing on the same object or event and are aware of their shared focus (Baldwin, 1995). From birth and for the first several months of life, infants primarily attend to social stimuli and engage in dyadic interactions (Morton & Johnson, 1991; Trevarthen, 1979). At this point, their attention is largely externally driven by the properties of environmental stimuli; that is, their attention is "captured" by novel or interesting stimuli rather than intentionally directed (Hendry et al., 2016). Infants first begin to exercise control over their attention by disengaging from the most environmentally salient stimuli and shifting to other targets at 4 months of age (Johnson et al., 1991), and improvements in this ability continue to dominate the development of attentional control until around 9 months (Hendry et al., 2016). Accordingly, towards the midpoint of the first year, infants increasingly expand their attention to include the world of objects (Kaye & Fogel, 1980); this may be due to the infant's increased ability to disengage from the highly salient stimuli of faces, which are often accompanied by movement and sound. Once this object-directed shift occurs, infants

gradually begin to participate in triadic interactions, in which interactions with objects become integrated into dyadic social interactions (Bakeman & Adamson, 1984). Infant behaviors that characterize triadic interactions include following the eye gaze of an adult, shifting their own gaze between an object and the adult, and using gestures, including pointing and showing, to share their experience of an object with an adult (Carpenter et al., 1998). It is within these interactions that joint attention occurs. This developmental transition is described by Trevarthen and Hubley (1978) as a shift from primary intersubjectivity, in which the infant is aware of their *own* experience of an external entity, to secondary intersubjectivity, in which the infant is aware that they are *sharing* the experience of an object or event with another person.

An infant's capacity for joint attention in the first year of life is related to early language development (Carpenter et al., 1998; Morales et al., 2000). It has been suggested that joint attention presents an enhanced opportunity for language development because the caregiver's verbalizations are more likely to be associated by the infant to the joint focus of attention, which aids the infant in labeling objects and acquiring the meanings of words (Harris et al., 1996). Bruner (1975) proposed that caregivers exhibit specific behaviors and create structured situations to facilitate the infant's ability to follow into the caregiver's line of attention. This aids in the establishment of a shared frame of reference that allows infant and caregiver to be "on the same page" before spoken language is understood. Language that is used by the caregiver within this shared framework can then be mapped on to the infant's existing understanding of the situation. The behaviors that caregivers exhibit to create ideal contexts for language development are called *scaffolding,* as they represent structural supports for the infant to expand upon their existing communicative abilities (Bruner, 1983). Specific scaffolding behaviors identified by

Bruner include creating simple, repetitive routines that are affectively positive and afford clear roles for caregiver and infant.

Joint attention interactions can be divided into two distinct types—those initiated by the caregiver and those initiated by the child (Akhtar & Gernsbacher, 2007)—and different developmental capabilities are required for each. To respond to a caregiver's bid for joint attention, infants must recognize the communicative signals of an adult and be able to follow their gaze, while the child must generate their own communicative signals to initiate joint attention (Zampini et al., 2015). Skills associated with initiating joint attention tend to emerge later than those required to respond to joint attention (Carpenter et al., 1998). Both initiating and responding to joint attention are related to language development (Ulvund & Smith, 1996); however, propensities for these different social skills may correspond with differing language capabilities. Mundy and Gomes (1998) observed that initiating joint attention predicted more variance in expressive language capabilities, while responding to joint attention predicted more variance in receptive language. Additionally, allowing the child to direct the focus of joint attention, which occurs when the child initiates joint attention, is related to increased word learning in older infants compared to adults directing the infant's attention; this has been demonstrated both experimentally and observationally (Dunham et al., 1993; Tomasello & Farrar, 1986; Tomasello & Todd, 1983). A caregiving style characterized by following, rather than directing, the child's focus of attention during play has also been related to higher scores on measures of focused attention and broad cognition (Bono & Stifter, 2003). Thus, joint attention experiences which allow the child increased agency and independence may benefit developing language and cognition.

Joint Attention and Complementary Feeding

The structure of early feeding interactions seemingly lends itself to triadic interactions, as the key elements are the infant, the caregiver, and food, which represents a potential object of joint engagement. Early feeding routines meet Bruner's (1975) description of parental scaffolding: simple, repetitive routines that are affectively positive and provide a clear role structure for infant and caregiver. Of course, the degree to which the feeding routines of individual infant-caregiver dyads meet these criteria will vary, but these scaffolding behaviors are consistent with the responsive complementary feeding practices laid out in Engle's Care Initiative manual (1997), which are recognized by UNICEF as best practices for infant feeding. These practices specifically include developing a consistent feeding routine, minimizing distractions during feeding, and using a warm affective style of interacting with the infant. Feeding responsively may be pulling "double duty" in the feeding interaction, encouraging proper nutrition and a healthy relationship with food while also providing scaffolding for infants to practice and hone their emerging communicative abilities.

Joint attention experiences may be particularly salient in the complementary feeding period. The WHO (2003) recommends initiating complementary feeding at 6 months and considers the complementary feeding period to extend from then until 2 years of age. Giving an estimate of the typical age of emergence for joint attention is difficult, as this term is often used to refer to the whole complex of behaviors associated with triadic interactions, and these behaviors emerge at different times throughout the first 2 years of life (Carpenter et al., 1998). However, gaze following within mother-infant interactions can be observed reliably and is related to later language development by 6 months (Morales et al., 2000), and gaze shifting, which is thought to evidence "true" joint attention, or secondary objectivity, is thought to emerge

between 8 and 10 months in most infants and to experience the most significant increases in prevalence between 9 and 12 months of age (Carpenter et al., 1998). This indicates that the first six months of the complementary feeding period are also an important developmental window for joint attention.

Current Study

As of yet, joint attention has been studied almost exclusively in naturalistic play interactions and standardized lab tasks. Despite the theoretical connections outlined above, there has been no systematic investigation of joint attention processes during early feeding interactions. Additionally, it is unknown how weaning method may impact those processes. The differing task demands placed on the infant and caregiver in traditional and baby-led weaning may result in differing levels of infant initiation of joint attention. In traditional weaning, the parent may initiate more instances of joint attention, as they must present each bite of food to the child and draw the child's attention to the food in order to get them to eat. In contrast, baby-led weaning may encourage the infant to initiate more instances of joint attention, as the food is placed before the infant, who chooses which piece of food he or she will engage with and thus is given more opportunities to direct the parent's attention, drawing them into a joint attention interaction. Regarding overall joint attention, the influence of self-feeding may be less straightforward. Infants who are self-feeding become more able to feed themselves independently with age (Engle et al., 2000), requiring less parental involvement. Thus, in older infants, self-feeding may predict less joint attention overall.

The primary aims of the current study are 1) to quantify the joint attention states that occur within feeding interactions during the first six months of the complementary feeding period, 2) to analyze how the quantities of these joint attention states change with age, and 3) to

determine whether self-feeding, as emphasized in baby-led weaning, predicts levels of infant-initiated and overall joint attention during mealtimes. Specifically, age and self-feeding will be evaluated as predictors of both infant-initiated and overall joint attention. We hypothesize that both age and self-feeding will positively predict infant-initiated joint attention. However, for overall joint attention, we anticipate an interaction between self-feeding and age in which overall joint attention decreases with age at high levels of self-feeding.

Methods

Participants

Fifteen mothers and their 6- to 12-month-old infants were recruited nationally through Facebook as well as through family-oriented organizations local to the Boone, NC area and Watauga County birth records. Inclusion criteria were mothers over the age of 18 whose infants were in the desired age range and had begun solid feeding. Infants with genetic, physical, or developmental conditions that may impair cognitive development or eating behavior, as well as infants born prior to 37 weeks' gestation, were excluded from the study.

Mothers were 33.3 (*SD* = 4.06) years old on average. The sample was highly educated, with most mothers (*n* = 13) reporting some post-secondary education. Nearly half of the sample (*n* = 6) had a graduate degree, while five mothers had a 4-year degree, two had a 2-year degree, and two had a high school diploma. Most of the sample was employed (*n* = 12), working an average of 24.6 hours per week (*SD* = 17.4). The sample was predominantly Caucasian (*n* = 11).

Infants were an average of 8.87 (*SD* = 1.76) months old. There was a relatively equal number of male (*n* = 8) and female (*n* = 7) infants in the sample. Five of the infants were first and only children, with the remaining infants having one (*n* = 7) or two (*n* = 3) older siblings. All infants were reported to live with both of their parents in their primary home.

Procedure

Interested participants contacted the research team via email and answered screening questions before providing informed consent. Participants then scheduled an appointment to complete an observation of a typical mealtime for their infants via Zoom video conference. After scheduling, participants were sent detailed instructions for completing the observation, including using a cell phone or laptop computer with a camera to capture the mealtime, placing the filming device in as unobtrusive a location as possible, providing a clear, direct view of the infant and the primary caregiver, and feeding the infant as they normally would without attending to the camera. When participants joined the Zoom conference, the researcher confirmed that the camera angle and audio input was sufficient, then instructed the mothers to feed their infants as they normally would and to let them know when the mealtime was concluded. The researcher then turned off their audio and video and recorded the video observation to a secure hard drive. Recordings concluded once the mothers indicated that the mealtime was over.

After completing the mealtime observation, participants were sent a short online questionnaire via Qualtrics, asking about maternal and infant demographics, as well as infants' early development and experiences with solid foods. Upon completion of the study, participants were compensated via electronic gift cards to the amount of $12 for the mealtime observation and $3 for the online survey.

Measures

Online Survey

Demographics. Maternal education was measured by the education scale of the Hollingshead Index (Hollingshead, 1975). Maternal ethnicity, age, parity, and employment status (hours per week spent working outside the home) were also collected. The only infant

demographics collected were gender, age in months, birth order, gestational age at birth, weight at birth, and a free response question regarding salient health problems. Finally, participants were asked to describe who else lives in the infant's primary home, besides the infant and themselves.

Early Experiences with Solid Foods. Participants were asked about their child's first experiences with solid foods: at what age solids were first introduced, the type of food that was offered (purees or whole/chunked foods), and how the child was fed (by parent via utensil, self-fed, or a combination of the two). Participants were also asked about their current practices for feeding their infants solid foods: what percent of their child's meals they are responsible for, what percent of their infant's foods are family foods (the same food as eaten by the rest of the family), what percent of their infant's foods are pureed as opposed to whole or chunked foods, and what percentage of the time they feed their infant as opposed to letting their infant feed themselves.

Mealtime Observation

Self-feeding. Self-feeding was coded from the video submissions by recording the number of times that the infant attempted to self-feed versus the number of times the parent attempted to feed the infant. Self-feeding attempts were operationalized as the child bringing a quantity of food to its own mouth and attempting to eat it, whether by hand or using a utensil, regardless of whether the child actually succeeded in consuming the food. However, if the infant merely mouthed or sucked on their hand or a utensil that did not contain any food, a self-feeding attempt was not recorded. Parent-feeding attempts were operationalized as the parent bringing a quantity of food to the infant's mouth and the infant attempting to eat it, again regardless of the presence or absence of utensils and whether the child succeeded in consuming the food or not. However, if the infant rejected the attempt by turning away from the food or refusing to open

their mouth, a parent-feeding attempt was not counted. If the parent loaded food onto a utensil and then handed it to the infant, and the infant brought the food to their own mouth, a self-feeding attempt was recorded. A third category, joint-feeding, was created to describe feeding attempts in which infants grabbed on to the utensil once the parent had already brought it to the infant's mouth. The self-feeding score for each infant was obtained by calculating the ratio of attempted self-feeds to the total number of attempted feeds, such that a score of 1 indicates a child that only self-feeds, while a score of 0 indicates a child that is entirely parent-fed.

Joint Attention. Joint attention during feeding was coded from the mealtime observations via a coding scheme originally developed by Bakeman and Adamson (1984) and modified by Zampini et al. (2015). This scheme divides infant-caregiver interactions into eight exhaustive categories: not codable (child is not clearly visible or it is otherwise impossible to ascertain what the child is doing), disengagement (the child is not involved with any person or object), observation of others' actions, interactions with a person (without involvement of an object), interaction with objects (without involvement of another person), passive attention (involvement of a child and another person with an object, but the child is unaware or inconsiderate of the other's involvement), attention getting (wherein the child is attempting to draw another person's attention to an object, but the person does not respond), and joint attention (the child is interacting with both an object and another person, as evidenced by eye gaze, communicative vocalizations, or gestures). Joint attention is further divided into "joint attention follow focus" and "joint attention propose focus," which for the purpose of this study will be referred to as "responding to joint attention" and "initiating joint attention," respectively. Responding to joint attention describes an interaction in which the adult proposes the point of focus using communicative signals and the child responds appropriately, shifting their focus to

the object proposed by the adult. The most common behavior considered to indicate responding to joint attention was gaze alternation between the mother's face and the proposed object of focus. Initiating joint attention describes an interaction in which the child proposes the focus using communicative signals of their own and the adult directs their attention accordingly. The most common behaviors considered to indicate initiating joint attention were communicative gestures, such as holding an object in the hand and extending it towards the mother, accompanied by some acknowledgement of the mother, such as vocalization or eye gaze oriented to the mother's face.

Mealtime observation videos were coded in 5-second intervals according to the category that filled the majority of the interval, due to the note of Zampini et al. (2015) as to the difficulty of determining exact starting and ending points for each behavioral state. Coding began during the interval in which the infant was first presented with food, and terminated either when all food had been removed from the infant's vicinity or when the mother indicated that the meal was over. Ratios were calculated for each category relative to the total number of 5-second intervals coded in the feeding session to provide a score for each behavioral state. The primary measures derived from this coding scheme for this study were total joint attention (ratio of joint attention intervals to total intervals) and proportion of initiating joint attention (ratio of initiating joint attention intervals to total joint attention intervals).

Inter-rater Reliability. Reliability for feeding coding was established by having two coders rate four of the video submissions. Considering the total number of each of the three types of feeding attempts recorded, percent agreement between the two coders ranged from 91% to 100%. For joint attention coding, four of the video submissions were double-coded. Cohen's kappa ranged from 0.44 to 0.55, indicating moderate agreement (Landis & Koch, 1977).

Results

Preliminary Analyses

Descriptive statistics and correlational analyses were performed in Jamovi (The Jamovi Project, 2021; R Core Team, 2021) to describe the sample's complementary feeding practices and observed mealtime dynamics.

Complementary Feeding

First Experiences with Solid Foods. Infants in our sample were first introduced to solid foods at 5.80 months of age (*SD* = 0.92) on average. Most mothers reported providing their infants with pureed food as their first solid food (*n* = 11), with the remainder giving whole or chunked foods (*n* = 4). Most mothers reported exclusively spoon-feeding their infants during their first exposure to solid foods (*n* = 10), while others reported a mix of spoon-feeding and self-feeding (*n* = 4), and one mother reported allowing their infant to exclusively feed themselves.

Current Complementary Feeding Practices. Mothers reported being responsible for an average of 79.9% of their infants' meals (*SD* = 19.0%), indicating that most mothers were primary caregivers; none of the mothers indicated being the one to feed their infant less than 50% of the time. On average, mothers reported feeding their infants the same food as eaten by the rest of the family 50.8% of the time (*SD* = 37.7%), feeding their infants pureed food (as opposed to whole or chunked foods) 57.4% of the time (*SD* = 41.6%), and spoon feeding their infants (as opposed to letting them feed themselves) 59.2% of the time (*SD* = 35.4%).

Mealtime Observations

Descriptive Statistics. Recorded mealtimes varied substantially in length, with the shortest meal lasting 4.5 minutes and the longest lasting 39.25 minutes. The average mealtime observation was 19.18 minutes long (*SD* = 9.88). Mealtime duration was not correlated with self-

Table 1

Descriptive Statistics for Self-feeding and Engagement States during Mealtime Observations

	Age Range			
Behavior	6 to 8 months *n* = 6 *M (SD)*	8 to 10 months *n* = 4 *M (SD)*	10 to 12 months *n* = 5 *M (SD)*	Full sample *n* = 15 *M (SD)*
Self-feeding	0.18 (0.29)	0.32 (0.47)	0.87 (0.11)	0.45 (0.42)
Disengagement	0.23 (0.20)	0.20 (0.17)	0.04 (0.03)	0.16 (0.17)
Observation	0.11 (0.11)	0.10 (0.11)	0.12 (0.06)	0.11 (0.09)
Interaction with person	0.08 (0.06)	0.09 (0.07)	0.11 (0.08)	0.09 (0.07)
Interaction with object	0.11 (0.15)	0.24 (0.16)	0.38 (0.09)	0.23 (0.18)
Passive attention	0.28 (0.11)	0.23 (0.15)	0.11 (0.06)	0.21 (0.13)
Attention getting	0.00 (0.01)	0.00 (0.00)	0.02 (0.02)	0.01 (0.01)
Total joint attention	0.18 (0.11)	0.14 (0.13)	0.22 (0.11)	0.18 (0.11)
Responding to joint attention	0.17 (0.09)	0.14 (0.13)	0.14 (0.08)	0.15 (0.09)
Initiating joint attention	0.01 (0.02)	0.00 (0.00)	0.08 (0.04)	0.03 (0.04)
Non-codable	0.00 (0.01)	0.00 (0.00)	0.00 (0.01)	0.00 (0.01)

Note: Figures reported are ratios—for self-feeding, number of self-feeding events to total feeding events; for engagement states, number of state intervals compared to total intervals.

feeding, age, or any of our joint attention outcome variables (see Appendix A). For eight of the mother-infant dyads, no one else was present during the mealtime; for the remainder, siblings and/or the infant's other parent were also present. Average self-feeding scores and the average proportion of the mealtime spent in each behavioral engagement state are reported in Table 1. These figures are provided for the full sample, as well as broken down into two-month age brackets to demonstrate how mealtime interactions may change with age.

Associations Between Age, Self-feeding, and Engagement States. Bivariate correlations were conducted between infant age, self-feeding score, and the relative time spent in each engagement state during the mealtime observation (Appendix A). Age and self-feeding

Table 2

Kruskal-Wallis Comparisons for Self-feeding and Engagement States Between Age Groups

Behavior	χ^2	*p*	ε^2
Self-feeding	6.96	0.031	0.50
Disengagement	5.69	0.058	0.41
Observation	0.32	0.854	0.02
Interaction with person	0.66	0.719	0.05
Interaction with object	5.95	0.051	0.42
Passive attention	5.66	0.059	0.40
Attention getting	4.33	0.115	0.31
Total joint attention	0.95	0.622	0.07
Responding to joint attention	0.38	0.827	0.03
Initiating joint attention	10.64	0.005	0.76
Non-codable	1.79	0.409	0.13

Note: df = 2

were strongly and positively correlated, $r(13) = .75$, $p = .001$. Age was also positively correlated with time spent interacting with objects, $r(13) = .72$, $p = .003$, attention getting, $r(13) = .55$, $p = .034$, and initiating joint attention, $r(13) = .84$, $p < .001$. Age was negatively correlated with passive attention, $r(13) = -.70$, $p = .004$, and disengagement, $r(13) = -.55$, $p = .034$. Self-feeding score was positively correlated with interaction with objects, $r(13) = .85$, $p < .001$, and initiating joint attention, $r(13) = .68$, $p = .006$, while it was negatively correlated with passive attention, $r(13) = -.63$, $p = .011$, and disengagement, $r(13) = -.81$, $p = <.001$.

Differences in Self-feeding and Engagement States by Age Group. Kruskal-Wallis analyses were performed to determine which behaviors differed in prevalence between the three age groups (Table 2). Age group differences were found in self-feeding, $\chi^2 = 6.96$, $p = 0.031$, disengagement, $\chi^2 = 5.69$, $p = 0.058$, passive attention, $\chi^2 = 5.66$, $p = 0.059$, and initiating joint attention, $\chi^2 = 10.64$, $p = 0.005$. Dwass-Steel-Critchlow-Filgner pairwise comparisons were

performed to further describe the differences between age groups. For self-feeding score, there was no difference between the 6 to 8 month group and the 8 to 10 month group, $W = 0.68$, $p = 0.881$, or the 8 to 10 month group and the 10 to 12 month group, $W = 1.74$, $p = 0.436$, but the 6 to 8 month group engaged in significantly less self-feeding than the 10 to 12 month group, $W = 3.96$, $p = 0.014$. For disengagement, there was no difference between the 6 to 8 month group and the 8 to 10 month group, $W = -0.60$, $p = 0.905$, or the 8 to 10 month group and the 10 to 12 month group, $W = -2.08$, $p = 0.306$, but the 6 to 8 month group spent a significantly greater proportion of mealtimes disengaged than the 10 to 12 month group, $W = -3.36$, $p = 0.046$. For passive attention, there was no difference between the 6 to 8 month group and the 8 to 10 month group, $W = -1.21$, $p = 0.670$, or the 8 to 10 month group and the 10 to 12 month group, $W = -1.73$, $p = 0.439$. However, 6- to 8-month-olds engaged in significantly more passive attention than 10- to 12-month-olds, $W = -3.36$, $p = 0.046$. For initiating joint attention, there was no difference between the 6 to 8 month group and the 8 to 10 month group, $W = -1.72$, $p = 0.443$, but 6- to 8-month-olds engaged in significantly less initiating joint attention than 10- to 12-month-olds, $W = 3.70$, $p = 0.024$, and 8- to 10-month-olds engaged in significantly less initiating joint attention than 10- to 12-month-olds, $W = 3.62$, $p = 0.028$.

Main Analyses

Covariates

Bivariate correlations were run between demographic variables and self-feeding score, total joint attention, initiating joint attention, and responding to joint attention to detect possible covariates for our regression model (see Appendix B). Demographic variables investigated were maternal age, hours of employment, percent of meals responsible, number of siblings, infant weight, and age of introduction of solid foods. Maternal age was positively correlated with

responding to joint attention, $r(13) = .53$, $p = .042$. All other correlations were not statistically significant. Kruskal-Wallis analyses were conducted to test for a relationship between maternal education level and our predictor and criterion variables; no significant differences were found between education levels in terms of self-feeding, total joint attention, initiating joint attention, or responding to joint attention.

Predictors of Total Joint Attention

Hierarchical Regression. To assess the relationships between self-feeding, age, and total joint attention during feeding, a hierarchical regression was performed on the outcome variable of total joint attention (Table 3). For this analysis, the predictor variables of infant age and self-feeding were centered in order to reduce any multicollinearity introduced by the inclusion of the interaction term in the final model. Since maternal age was found to correlate with responding to joint attention, this variable was entered in Block 1. Infant age was entered in Block 2, self-feeding scores in Block 3, and the interaction term for age and self-feeding in Block 4. This was done in order to determine whether self-feeding predicts variation in joint attention over and above the variance accounted for by demographic factors and infant age. Assumption checks on the final model indicated little to no concern with multicollinearity ($VIF_{maternal\ age} = 1.28$; $VIF_{infant\ age} = 4.13$; $VIF_{self-feeding\ score} = 3.29$; $VIF_{infant\ age*self-feeding\ score} = 1.88$).

In Block 1, maternal age did not contribute significantly to the model, $F(1, 13) = 4.64$, $p = .051$, accounting for 26.3% of the variance in total joint attention. The addition of infant age in Block 2 only accounted for an additional 4.8% of variance, which was not statistically significant, $F(1, 12) = 0.83$, $p = .379$. Adding self-feeding score in Block 3 explained an additional 3.0% of the variance, which was not a statistically significant change in R^2 compared to Block 2, $F(1, 11) = 0.51$, $p = .491$. Finally, adding the interaction term for infant age and self-

Table 3

Summary of Hierarchical Regression for Predictors of Total Joint Attention

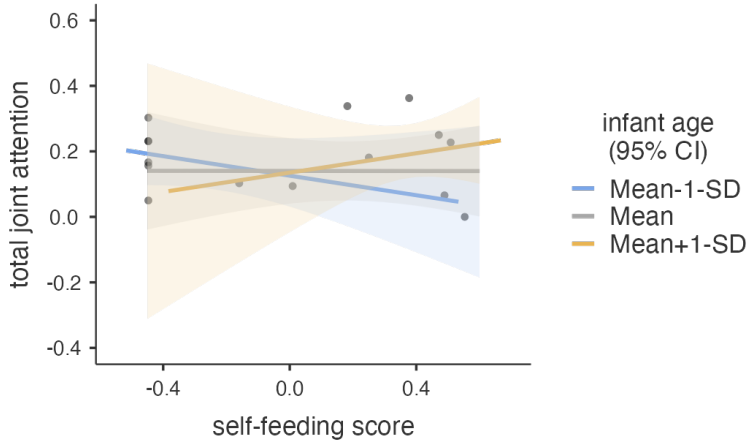
Variable	Estimate	β	SE	t	p	R	R^2	ΔR^2
Block 1						0.51	0.26	
Intercept	-0.27		0.21	-1.27	.227			
Maternal age	0.01	0.51	0.01	2.15	.051			
Block 2						0.56	0.31	0.05
Intercept	-0.27		0.21	-1.26	.233			
Maternal age	0.01	0.51	0.01	2.14	.054			
Infant age	0.01	0.22	0.01	0.91	.379			
Block 3						0.58	0.34	0.03
Intercept	-0.23		0.22	-1.04	.320			
Maternal age	0.01	0.47	0.01	1.88	.087			
Infant age	0.03	0.42	0.02	1.12	.285			
Self-feeding	-0.07	-0.27	0.10	-0.71	.491			
Block 4						0.65	0.42	0.08
Intercept	-0.39		0.26	-1.52	.159			
Maternal age	0.02	0.61	0.01	2.23	.050			
Infant age	0.00	0.04	0.03	0.09	.932			
Self-feeding	0.00	0.00	0.11	-0.01	.995			
Infant age * self-feeding	0.08	0.58	0.07	1.17	.268			

Note: $N = 15$

feeding accounted for an additional 8.0% of the variance; however, this change in R^2 was not significant, $F(1, 10) = 1.38$, $p = .268$. In the final model, none of our predictors contributed significantly to the model. However, maternal age, $\beta = 0.61$, $p = .050$, fell just short of significance, and the interaction between age and self-feeding, while not significant, had a comparable standardized estimate in terms of its relation to total joint attention, $\beta = 0.58$, $p = .268$. Neither self-feeding, $\beta = 0.00$, $p = .995$, nor infant age, $\beta = 0.04$, $p = .932$, predicted total joint attention. The final model accounted for 42.1% of the variance in total joint attention

Figure 1

Simple Slopes for the Relationship Between Self-Feeding and Total Joint Attention as Moderated by Infant Age



but was not significant, $F(4, 10) = 1.82$, $p = .202$.

Exploratory Simple Slopes Analysis. While the regression model could not support the presence of an interaction between infant age and self-feeding, since the standardized estimate for the interaction term indicated some relationship, the Jamovi module GAMLj (Gallucci, 2019) was used to perform an exploratory simple slopes analysis to further describe the nature of a potential interaction effect (Figure 1). The relationship between self-feeding and total joint attention was not significant at any level of age.

Predictors of Proportion of Initiating Joint Attention

Hierarchical Regression. The results of the hierarchical regression on proportion of initiating joint attention are reported in Table 4. Maternal age was again added in Block 1, followed by infant age in Block 2, and self-feeding in Block 3. While we did not predict an interaction between infant age and self-feeding, we included the interaction term in Block 4 in the model as an exploratory analysis. Because of this, the centered versions of infant age and self-feeding were again used. Assumption checks on the final model indicated little to no

Table 4

Summary of Hierarchical Regression for Predictors of Proportion of Initiating Joint Attention

Variable	Estimate	β	SE	t	p	R	R^2	ΔR^2
Block 1						0.01	0.00	
Intercept	0.13		0.49	0.26	.802			
Maternal age	0.00	0.01	0.01	0.05	.964			
Block 2						0.88	0.78	0.77
Intercept	0.12		0.24	0.49	.635			
Maternal age	0.00	0.02	0.01	0.12	.907			
Infant age	0.09	0.88	0.01	6.15	< .001			
Block 3						0.94	0.88	0.10
Intercept	0.14		0.19	0.77	.459			
Maternal age	-0.00	0.01	0.01	0.07	.943			
Infant age	0.05	0.43	0.02	2.31	.044			
Self-feeding	0.26	0.55	0.09	2.92	.015			
Block 4						0.97	0.94	0.06
Intercept	-0.18		0.18	-1.00	0.345			
Maternal age	0.01	0.16	0.00	1.61	0.142			
Infant age	0.02	0.12	0.02	0.92	0.380			
Self-feeding	0.32	0.69	0.07	4.60	0.001			
Infant age * self-feeding	0.13	0.52	0.05	2.92	0.017			

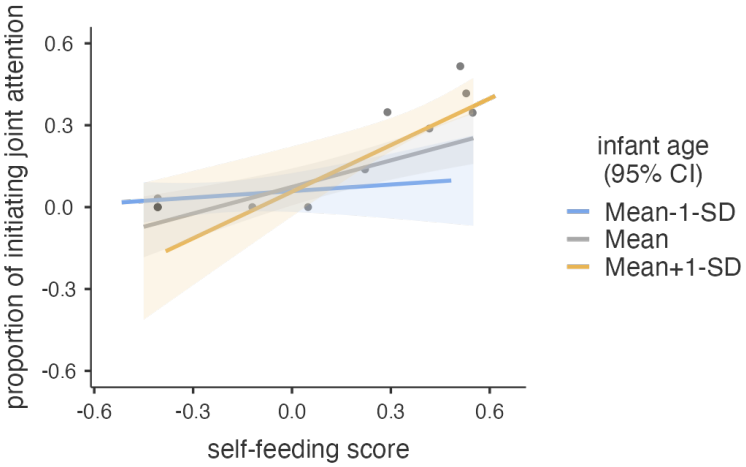
Note: $N = 15$

concern with multicollinearity ($\text{VIF}_{maternal\ age} = 1.38$; $\text{VIF}_{infant\ age} = 4.21$; $\text{VIF}_{self-feeding\ score} = 3.25$; $\text{VIF}_{infant\ age*self-feeding\ score} = 1.95$).

In Block 1 of the regression model, maternal age was not a significant predictor of proportion of initiating joint attention, $F(1, 12) = 0.00$, $p = .964$, accounting for 0.0% of the variance. Adding infant age in Block 2 resulted in a significant increase in R^2 between the two models, $F(1, 11) = 37.79$, $p < .001$, accounting for an additional 77.5% of the variance. Adding self-feeding in Block 3 also significantly increased the predictive power of the model,

Figure 2

Simple Slopes for the Relationship Between Self-Feeding and Proportion of Initiating Joint Attention as Moderated by Infant Age



$F(1, 10) = 8.51$, $p = .015$, accounting for an additional 10.4% of the variance. In Block 3, self-feeding score, $\beta = 0.55$, $p = 0.015$, was the strongest predictor of proportion of initiating joint attention, followed by infant age, $\beta = 0.43$, $p = .044$. Maternal age, $\beta = 0.01$, $p = .943$, did not contribute significantly to proportion of initiating joint attention.

When the interaction between self-feeding and infant age was entered in Block 4 to explore a potential moderation effect, there was a significant increase in variance explained, $\Delta R^2 = 0.06$, $F(1, 9) = 8.53$, $p = .017$. In this model, maternal age, $\beta = 0.16$, $p = 0.142$, and infant age, $\beta = 0.11$, $p = 0.380$, did not significantly predict proportion of initiating joint attention, while self-feeding, $\beta = 0.69$, $p = 0.001$, and the interaction term, $\beta = 0.52$, $p = 0.017$, were significant predictors. Overall, this model explained 93.7% of the variance in proportion of initiating joint attention, $F(4, 9) = 33.73$, $p = <.001$.

Exploratory Simple Slopes Analysis. Since the exploratory addition of the interaction term between self-feeding and age was significant in our regression model, we performed a simple slopes analysis for the relationship between self-feeding and proportion of initiating joint

attention at different levels of age (Figure 2). Overall, the relationship between self-feeding and proportion of initiating joint attention is positive and is seen to increase in magnitude as age increases. When age is at one standard deviation below the mean, the relationship between self-feeding and proportion of initiating joint attention is not significant, $B = 0.08$, $p = 0.398$. At mean age levels, there is a moderate, positive relationship between self-feeding and proportion of initiating joint attention, $B = 0.32$, $p = 0.001$. When age is at one standard deviation above the mean, there is a strong, positive relationship between self-feeding and proportion of initiating joint attention, $B = 0.57$, $p = 0.001$.

Discussion

The purpose of this study was to quantify the joint attention that infants experience during mealtimes in the first six months of the complementary feeding period, as well as investigate whether self-feeding predicts overall and infant-initiated joint attention. We hypothesized that self-feeding and age would interact to predict total joint attention such that the relationship between self-feeding and total joint attention decreases with age. For initiating joint attention, we hypothesized that self-feeding would positively predict the proportion of joint attention that was infant-initiated. Overall, our results provided partial support for our hypotheses.

Complementary Feeding Approach

Participants described currently using a wide range of feeding approaches with their infants. However, most participants reported either a weaning style that matched a strict definition of traditional weaning (completely spoon-fed with purees, with family foods rarely or never served) or were somewhere in the middle, with very few participants reporting adherence to a strict BLW style (very little spoon feeding or purees, with mostly family foods served). In

fact, based on the classification system used by Brown and Lee (2011), only one of our participants would be classified as "BLW." Furthermore, regarding first experiences with solid foods, only one mother reported her infant being entirely self-fed from the very beginning of complementary feeding. Despite this, we observed high levels of self-feeding in several mealtime observations, with over ¼ of infants in our sample having self-feeding scores of over 90%. This may suggest that while many parents incorporate aspects of BLW into their infant's feeding routines, comparatively few parents adhere to a strict definition of BLW. Future research with a larger and more representative sample should investigate the prevalence and usage of BLW in the United States.

Joint Attention During Mealtimes

On average, infants in our sample spent 18% of intervals during mealtime observations engaging in joint attention. The majority of this was responding to joint attention (15%), while initiating joint attention was a comparative rarity (3%). The vast majority of initiating joint attention was observed in the 10 to 12 month group, with most infants from 6 to 10 months exhibiting no initiating joint attention at all. This is consistent with research on joint attention during play interactions; Carpenter et al. (1998) found that the mean age of emergence of communicative gestures, a crucial skill for initiating joint attention, was 10.7 months. However, responding to joint attention was distributed relatively equally between age groups. Since responding to joint attention made up the majority of joint attention we observed, this resulted in no observed differences in the amount of total joint attention experienced between age groups. This is contrary to the findings of Carpenter et al. (1998) and Bakeman and Adamson (1984), both of whom found a significant increase in time spent in joint attention during play from 9 to 12 months of age. These researchers concluded that infant developmental and maturational

factors allow them to become more skilled in engaging in joint attention with age; therefore, some factor (or combination of factors) in the feeding situation may be counteracting the infant's increased social capabilities to prevent an increase in joint attention during mealtimes with age.

We suggest that differences in maternal goals—and, subsequently, behavior—across contexts underlies this effect. During playtime, the mother's central goal is to engage with her infant to and facilitate the infant's engagement with objects in the environment. During mealtimes, the central goal is presumably for the infant to eat a sufficient amount of food. Engagement with the child and facilitation of the child's engagement with food may be strategies that mothers use to encourage eating, particularly at young ages, but as the infant grows and begins to feed themselves independently, mothers may use these strategies less and less, due to a perceived lack of necessity and perhaps even out of fear of distracting the child from eating by initiating social interactions. Thus, while the child's ability to respond to a parent's bid for joint attention increases with age, the number of bids that the parent makes during mealtimes decreases, holding the overall amount of joint attention static. Competing social and nutritional goals may limit the potential utility of mealtime contexts in joint attention interventions; however, it is also possible that social and nutritional goals can be advanced together, rather than facilitating one at the expense of the other. Future research should investigate whether encouraging parents to engage their infants in joint attention during feeding is effective at increasing joint attention, and whether prioritizing social development as a mealtime goal has a detrimental impact on the child's food intake.

It is difficult to directly compare our estimates of the amount of joint attention occurring during mealtimes to estimates of joint attention prevalence during play interactions, because we used an interval coding scheme, while many studies quantifying joint attention during play

attempted to record the exact amount of time that infants spent in joint attention. Therefore, our percentage estimates are likely to be inflated compared to theirs, since joint attention only needed to fill the majority of the 5-second interval to be classified as such, rather than the entire interval. However, based on the comparisons that can be made, it seems as though joint attention was more prevalent during the mealtimes we observed compared to play interactions observed in other studies. Carpenter et al. (1998) found that 9-month-old infants engaged in an average of 13 seconds of joint attention during a 10-minute play interaction with their mothers, equating to 2.2% of the total interaction time. In our 8 to 10 month age group, infants engaged in joint attention during an average of 14% of intervals in the mealtime observation. Bakeman and Adamson (1984) found that 12-month-old infants engaged in joint attention for 3.6% of their play interactions; the 10 to 12 month age group in our study engaged in joint attention for an average of 22% of intervals during mealtime observations.

There are several potential explanations for why joint attention may be more prevalent during the mealtimes in our study compared to play interactions observed in Carpenter et al. (1998) and Bakeman and Adamson (1984). For one, the play interactions in these studies took place in a laboratory setting with lab-owned toys, while our mealtime observations took place in the infant's typical mealtime environment. Bringing infants into a novel environment and giving them access to novel objects may have decreased their interest in and attention to their mothers during play, with infants preferring to independently explore the unfamiliar toys available. Hunter et al. (1983) found that infants spend more time visually fixated on novel toys compared to familiar ones, providing some support for this suggestion. Additionally, based on Carpenter's description of the laboratory setup for play interactions, no less than 10 separate toys were available for each mother-infant dyad to interact with, and infants were largely free to move

about the room as they wished. In our feeding observations, far fewer objects were available in the infant's immediate environment, and every single infant was constrained to a high-chair or similar infant seat while eating. These environmental differences may reduce opportunities for infants to become distracted, making it easier for mothers to engage infants in joint attention during mealtimes compared to play.

Engagement States, Age, and Self-Feeding

While our primary focus in this study was joint attention, Kruskal-Wallis analyses and bivariate correlations allowed us to explore how all engagement states and feeding behaviors in our coding scheme changed with age. Unsurprisingly, we found that self-feeding score was positively correlated with infant age and was significantly higher in older age groups. This is consistent with an understanding of the complementary feeding period as a gradual process by which infants transition from being parent-fed to feeding themselves independently (Engle et al., 2000).

Infant age was negatively correlated with passive attention in our study, and older age groups had fewer passive attention intervals during their mealtimes. In their study of joint attention during play interactions, Bakeman and Adamson (1984) found that the amount of time spent in passive attention did not differ substantially between 6 and 12 months of age. This would suggest that the successive decrease in passive attention observed in our study is a result of an element unique to the feeding environment. Decreased engagement of parents as children gain more independence in feeding seems to be a likely factor. Younger infants tend to rely more on parental involvement for feeding, so their parents are more likely to be attending to the food that the child is engaging with. Additionally, while Kruskal-Wallis analyses did not find a difference in time spent interacting with objects between age groups, there was a positive

correlation between age and interaction with objects. Thus, the passive attention that is lacking at older ages due to a decrease in cooperative feeding may have been replaced by the child's independent exploration of foods. Supporting this, we also found that self-feeding was negatively correlated with passive attention and positively correlated with interaction with objects.

We also found a negative correlation between self-feeding and disengagement, indicating that infants with higher self-feeding scores spent less of the mealtime disengaged and more time engaging with people or objects. This may be due to parent-fed infants having less access to objects to explore during mealtimes. It is possible that this association is influenced by the third variable of age; Bakeman and Adamson (1984) found that infants spent significantly less time disengaged during play as they aged, reflecting a maturation of their attentional processes. Accordingly, we also found a negative correlation between age and disengagement in our study, albeit of a smaller magnitude than the relationship between disengagement and self-feeding. Therefore, it seems likely that both self-feeding and age influence an infant's tendency to become disengaged during mealtimes.

Predictors of Total Joint Attention During Mealtimes

Due to our small sample size, our regression analyses were severely underpowered. This likely contributed to difficulty in reaching statistical significance in our results. Therefore, results will also be discussed in terms of effect size. However, these results should be interpreted with extreme caution and not regarded as confirmatory, but rather as observed trends that may provide direction for future research.

In our final regression model for joint attention, none of our variables significantly predicted total joint attention. However, maternal age was just over the significance threshold, accounting for 26.3% of the variance in total joint attention when entered in the first block of the

model. A potential pathway for the contribution of maternal age to joint attention may operate through maternal responsiveness. Previous studies of infant language development have found that maternal age is positively correlated with responsiveness (Bornstein et al., 2020). Landry et al. (2006) defines responsiveness as consisting of contingent responses to infant behavior, positive emotionality, supporting infant focus of attention, and high-quality language input. The connections between responsiveness, particularly the factor of supporting infant focus of attention, and joint attention are self-evident and have also been empirically demonstrated. Using eye-tracking during parent-child play interactions, Suarez-Rivera et al. (2019) found that parent speech and physical interaction with the object of the child's attention during a joint attention episode was associated with significantly longer joint attention episodes. This suggests that responsive behaviors are associated with more time spent in joint attention during parent-child interactions. Furthermore, Hodges et al. (2013) developed a scale to assess caregiver responsiveness during feeding (Responsiveness to Child Feeding Cues Scale; RCFS) and noted that, in the sample used to develop the instrument, maternal general responsiveness and child visual attention were significantly correlated. Future research should investigate whether the relationship between maternal age and joint attention is robust, as well as the possible mediating influence of responsiveness.

Neither infant age nor self-feeding contributed significantly to the regression model when added in Blocks 3 and 4, respectively. When the interaction term was added in Block 4, the standardized regression coefficient for both individual variables dropped to practically zero. While the contribution of the interaction term did not reach significance, the standardized regression coefficient indicated a contribution comparable to that of maternal age. The exploratory simple slopes analysis, while not statistically significant, does reveal a trend toward

interaction (Figure 1). The relationship between self-feeding and joint attention is negative at one standard deviation below the mean age (7.11 months of age), practically zero at the mean age (8.87 months), and positive at one standard deviation above the mean age (10.63 months).

While we predicted an interaction effect, the interaction trend that we observed was in the opposite direction than we hypothesized. We reasoned that even when children were mostly self-fed, mothers would be more attentive and involved in feeding when children were younger and less engaged when children were older, resulting in decreased joint attention for older, self-fed children. However, it may be that self-feeding results in less parental involvement at both ages. Potentially, early in the complementary feeding period (6 to 8 months), when infants have less well-developed attentional and communicative skills, joint attention is primarily enabled by parental scaffolding behaviors. Thus, a feeding approach that emphasizes independence results in less joint attention at younger ages. Meanwhile, older infants (10 to 12 months) have developed the skills to engage in joint attention with less parental support, allowing them to take advantage of the increased engagement and access to objects afforded by self-feeding and giving rise to a positive relationship with joint attention.

Predictors of Proportion of Initiating Joint Attention During Mealtimes

In contrast to our findings regarding total joint attention, maternal age did not predict proportion of initiating joint attention. This supports the notion that the ability to initiate joint attention is more dependent on the developmental maturation of the child, while responding to joint attention is highly dependent on maternal factors, such as scaffolding behaviors and responsiveness. Put simply, infants cannot respond to joint attention unless mothers initiate it, but this restriction does not apply to initiating joint attention.

Accordingly, in our final regression model, infant age and self-feeding contributed to the variance in proportion of initiating joint attention. Age only contributed through the interaction term between age and self-feeding, while self-feeding continued to make a unique contribution to the variance even when the interaction term was entered. The interaction between self-feeding and age followed the pattern observed in our regression on total joint attention, with the relationship between self-feeding and proportion of initiating joint attention becoming more positive with age. There was no relationship between self-feeding and proportion of initiating joint attention at younger ages, a moderate positive relationship at mean ages, and a strong relationship at older ages. Infants at the younger end of our age range were seemingly too young to have developed the necessary skills for initiating joint attention, and thus could not take advantage of the increased access to objects afforded by self-feeding. It appears that, once infants have developed the communicative skills to initiate joint attention, those with higher levels of self-feeding initiate a greater proportion of joint attention experiences during mealtimes.

Limitations

The sample size of this study, while comparable to other observational studies of joint attention, was quite small, limiting our ability to perform confirmatory analyses and to reach statistical significance in our observed effects. Our sample was also highly homogeneous, with mostly white, highly educated mothers who were primary caregivers and lived with the child's other parent. Therefore, our results may not generalize across demographics and family structures. Future research should attempt to replicate our findings in a larger and more diverse sample.

Infant developmental factors are likely to influence their capacity to engage in joint attention, and parental perception of the child's developmental readiness for solids and self-

feeding likely influences parental choice of feeding method. Due to the cross-sectional nature of this study, direction of causality cannot be inferred. However, this study is valuable to establish that there are in fact differences in joint attention during feeding episodes according to feeding method before attempting to establish causality or control for all relevant factors.

This study uses self-feeding to measure one aspect of BLW. Other measures of baby-led weaning in the research literature also include the factors of feeding the infant solids rather than purees and feeding the infant in the context of family meals (Rapley & Murkett, 2008). These factors may also influence joint attentional interactions during feeding. Feeding solids may introduce a wider variety of "objects" (pieces of food) available to the infant and parent with which to jointly engage (as opposed to a single jar of baby food and a utensil), while the presence of multiple family members during feeding may recruit both the infant and the caregiver's attention away from one another. Future research on differences between traditional and baby-led feeding interactions should incorporate these aspects of BLW.

Experimental control during the mealtimes observed in this study was low. Mealtime characteristics, such as length, time of day, and other individuals present, were highly variable, introducing several factors that may have confounded our results. However, it was determined that a more ecologically valid paradigm should be prioritized in this study. We wanted to determine how much joint attention was naturally occurring during mealtimes in an infant's day-to-day life, rather than how much we might observe under experimentally-imposed conditions. We argue that the former information is crucial in evaluating whether parent-based joint attention interventions should place a higher emphasis on mealtime contexts. Future studies should investigate whether joint attention can be influenced by manipulating mealtime characteristics, particularly self-feeding. This type of experimental study has the potential to

expand on the current, more exploratory study, and establish a causal role for self-feeding in joint attention during mealtimes.

Conclusion

Overall, our findings must be interpreted cautiously due to the small sample size of our study and exploratory nature of some of our analyses. However, our results provide some indication that self-feeding may discourage joint attention during mealtimes at the very beginning of the complementary feeding period (6 to 8 months), but it appears to encourage joint attention at older ages (10 to 12 months). Future research should explore this relationship with a larger sample size to determine whether this is a true effect, as our sample size was insufficient to demonstrate statistical significance. Despite the possibility that more self-feeding at the beginning of the complementary feeding period could discourage joint attention, joint attention may still underlie some of the potential benefits of BLW for language development that have been found in early studies (Webber et al., 2021). While Morales et al. (2000) found relationships between joint attention and language outcomes as early as 6 months of age, other research has suggested that joint attention does not significantly predict later language skills until toddlerhood (Carpenter et al., 1998). Thus, reduced joint attention during mealtimes from 6 to 8 months may have no detrimental impact on language, while increased joint attention during mealtimes from 10 to 12 months may have a positive effect.

Additionally, self-feeding appears to promote initiating joint attention over responding to joint attention, particularly at older ages (8 to 12 months). More opportunities to initiate joint attention may encourage infants' developing expressive communication (Mundy & Gomes, 1998), as well as benefit overall word learning more so than responding to joint attention, as the

infant is directing the focus of attention (Dunham et al., 1993; Tomasello & Farrar, 1986; Tomasello & Todd, 1983).

Our results also indicate that infants in the first six months of the complementary feeding period engage in significant amounts of joint attention during mealtimes, perhaps even more so than during playtime. This supports the possibility that an increased emphasis on mealtime contexts in joint attention interventions may be effective at increasing gains in joint attention skills. Future research should compare joint attention and language outcomes from early interventions that focus solely on playtime contexts compared to those that include specific instruction on how to structure mealtimes to encourage joint attention.

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Appendix A

Correlations Between Age, Self-feeding, Engagement States, and Observation Length

		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1. Infant age	*r*	-											
	p	-											
2. Self-feeding	*r*	.748*	-										
	p	.001	-										
3. Disengagement	*r*	-.548*	-.807*	-									
	p	.034	<.001	-									
4. Observation	*r*	.084	.388	-.678*	-								
	p	.765	.152	.006	-								
5. Interaction with person	*r*	.196	.358	-.289	.296	-							
	p	.484	.190	.296	.285	-							
6. Interaction with object	*r*	.719*	.854*	-.734*	.457	.163	-						
	p	.003	<.001	.002	.087	.562	-						
7. Passive attention	*r*	-.695*	-.633*	.507	-.412	-.523*	-.696*	-					
	p	.004	.011	.054	.127	.046	.004	-					
8. Attention getting	*r*	.549*	.494	-.498	.395	-.043	.563*	-.458	-				
	p	.034	.061	.059	.145	.879	.029	.086	-				
9. Responding to joint attention	*r*	-.141	-.348	.110	-.316	-.183	-.508	.148	-.321	-			
	p	.616	.204	.697	.251	.513	.053	.597	.243	-			
10. Initiating Joint attention	*r*	.842*	.676*	-.516*	-.047	.246	.432	-.525*	.545*	.140	-		
	p	<.001	.006	.049	.868	.378	.108	.044	.036	.619	-		
11. Total joint attention	*r*	.221	-.024	-.116	-.290	-.058	-.260	-.086	-.054	.915*	.527*	-	
	p	.429	.934	.681	.294	.838	.349	.761	.847	<.001	.044	-	
12. Observation length	*r*	.240	.478	-.556*	.201	.137	.331	.032	.164	-.158	.315	.242	-
	p	.390	.071	.031	.473	.625	.229	.909	.560	.574	.253	.385	-

Note: $N = 15$, $*p < .05$

Appendix B

Correlations Between Predictor/Outcome Variables and Demographic Variables

		Self-feeding score	Total joint attention	Responding to joint attention	Initiating joint attention	Maternal age	Hours of work per week	Percent of meals responsible	Number of siblings	Infant weight (ounces)	Age of introduction to solid foods
Self-feeding score	*r*	-									
	p	-									
Total joint attention	*r*	-.024	-								
	p	.934	-								
Responding to joint attention	*r*	-.348	.915*	-							
	p	.204	<.001	-							
Initiating joint attention	*r*	.676*	.527*	.140	-						
	p	.006	.044	.619	-						
Maternal age	*r*	-.146	.513	.531*	.140	-					
	p	.605	.051	.042	.620	-					
Hours of work per week	*r*	.127	-.257	-.158	-.300	.004	-				
	p	.625	.355	.575	.277	.989	-				
Percent of meals responsible	*r*	.122	.029	-.091	.265	-.001	-.655*	-			
	p	.665	.918	.746	.341	.997	.008	-			
Number of siblings	*r*	-.164	.183	.183	.064	.323	-.724*	.387	-		
	p	.559	.513	.513	.821	.240	.002	.154	-		
Infant weight (ounces)	*r*	-.186	.280	.396	-.148	.172	.269	.035	-.036	-	
	p	.508	.313	.144	.599	.539	.333	.902	.899	-	
Age of introduction to solid foods	*r*	-.194	-.016	-.027	.018	.158	-.679*	.616*	.613*	-.360	-
	p	.488	.956	.925	.951	.574	.005	.014	.015	.188	-

Note: $N = 15$, $^*p < .05$

Appendix C

Participant Consent Form

APPALACHIAN STATE UNIVERSITY

CONSENT FORM

INFANT FEEDING RESEARCH STUDY

Researchers:

Taylor Martin: Master's Candidate, Primary Investigator, participant contact person
(email: martintg3@appstate.edu)

Amy Galloway: Professor of Psychology, faculty advisor

Researchers Statement:
We are asking you and your child to participate in a research study. This form gives you information to help you decide whether or not to be in the study, such as the purpose of study; the procedures, risks, and benefits of the study; how we will protect the information we will collect from you; and how you can contact us with questions about the study or if you feel that you have been harmed by this research. Please read it carefully. You should ask any questions you have about the research and, once they are answered to your satisfaction, you can decide whether or not you want to be in the study. Being in the study is voluntary, and even after you agree to participate, you can change your mind and stop participating at any time without losing any benefits from the University to which you may be entitled.

PURPOSE OF THE STUDY

The goal of this study is to learn more about parent-child mealtime interactions during the infant's first several months of eating solids (approximately 6 to 12 months of age).

STUDY PROCEDURES

This study involves completing a short online questionnaire and completing an observation of a typical mealtime with your infant via video chat. The questionnaire will ask for demographic information about yourself (age, education, etc.) and your infant (age, weight, etc.), information about your child's first experience with solid foods, and your child's involvement with childcare. You may refuse to answer any question on this survey. The feeding session will be recorded by establishing a secure Zoom connection between yourself and a researcher, and you will then proceed to feed your infant as normal while the researcher records audio and video of the mealtime to a protected university hard drive. The amount of time necessary to complete the study, including survey completion and the mealtime observation, is expected to be around 1 hour and will not exceed 3 hours.

RISKS, STRESS, AND DISCOMFORTS

Identifiable data (email addresses for community-recruited participants, video recordings) will be collected for the purposes of this study. This presents the risk that confidentiality may be breached and the information that you have provided over the course of this study may be accessed. Please see “Protection of Research Information” for the measures that we will take to minimize the risk of a breach of confidentiality.

BENEFITS OF THE STUDY

This study will provide insight into multiple aspects of infant development and may result in findings that can lead to improvements in early intervention strategies for children with developmental disabilities. You will not receive individual benefit from participating in this study.

PROTECTION OF RESEARCH INFORMATION

Data collected for the purposes of this study is confidential and will be kept in university-protected storage. Video observations completed via Zoom will be kept secure by requiring a unique passcode for access to the meeting. All data will be kept indefinitely. Unless you consent to having your videos shared (see end of form), video recordings will not be shared with entities outside of the research team. Government or university staff sometimes review studies such as this one to make sure they are being done safely and legally. If a review of this study takes place, your identifiable data may be examined.

USING YOUR DATA IN FUTURE RESEARCH

The information that we obtain from you for this study might be used for future studies without getting additional permission from you. For internal use by this research team, we will not remove anything that might identify you from the information and specimens. For collaboration with external research teams, deidentified data (information collected during the study that cannot be linked to you) may be shared. This means that while coded data collected from your video may be shared with other research teams, the video itself will not be shared, unless you provide specific permission for us to do so at the end of this form.

RESEARCH-RELATED HARMS

By signing this document, you are not waiving any legal rights that you have to act against Appalachian State University for harm or injury resulting from negligence of the University or its investigators. If you experience any harm or distress related to this study, please contact the primary investigator.

COMPENSATION

For community-recruited participants, upon completion of the feeding observation, you will be compensated with a $12 Amazon gift card, which will be sent to the email address you provided to the research team. Upon completion of the survey, you will receive an additional $3 gift card in the same manner.

YOUR RIGHTS AS A RESEARCH PARTICIPANT

Your participation in this research is completely voluntary. If you choose not to participate, there will be no penalty and you will not lose any benefits or rights you would normally have.
If you choose to take part in the research, you can change your mind at any time and stop participating. If you agree to participate but decide later that you don't want to be in this study, please contact the primary investigator. If you have questions or concerns about your rights as someone taking part in research, please contact the Appalachian State University Office of Research Protections at **828-262-2692** or **irb@appstate.edu**.

IRB Approval Date: 11/03/2021
Expiration Date: N/A

Subject's statement

By signing below, I volunteer myself and my child for this study and agree that:

- The purpose and procedures of the study have been explained to me;
- I have been informed of the risks of participation;
- The study is voluntary, I do not have to participate, and I can withdraw at any time;
- I have been given (or have been told that I will be given) a copy of this consent form to keep.
- I have had the opportunity to ask questions, and was able to get all of my questions satisfactorily answered;
- If I have questions later about the research, or if I have been harmed by participating in this study, I can contact one of the researchers listed on the first page of this consent form.

Sharing of video recordings (please initial on the appropriate line):

I consent to my videos being shared outside the research team for the purposes of collaboration with other research teams, conference presentations, etc. _____

Do not share my videos with entities outside of the research team _____

Participation in future research (please initial on the appropriate line):

I consent to being contacted with inquiries about participation in future studies _____

Do not contact me to inquire about participation in future studies _____

Printed name of subject Signature of subject

Date_____

Appendix D

Demographic and Infant Feeding Questionnaire

I. Demographic Information

1. Participant ID #: ____
2. Your current age (years): ____
3. Your highest level of education:
    a. Some high school
    b. Graduated high school
    c. Technical or vocational school
    d. Some college
    e. 2-year degree
    f. 4-year degree
    g. Graduate degree
4. Your ethnicity (Please select all that apply)
    a. Native American
    b. Asian
    c. Black or African American
    d. Hispanic or Latinx
    e. Native Hawaiian or Pacific Islander
    f. White
    g. Mixed race
    h. Don’t know
    i. Prefer not to answer

5. Are you currently employed?
    a. No
    b. Yes
6. If so, how many hours per week do you currently work?
    a. _____ hours/week

II. General Questions About Your Child

7. Your child's current age (in months and weeks): ____
8. Your child's sex:
    a. M
    b. F
9. Birth order:
    a. Only child
    b. 1st child
    c. 2nd child
    d. 3rd child
    e. Other (please specify: ____)
10. Number of siblings living in the child's primary household:
    a. None
    b. 1
    c. 2
    d. 3
    e. More (please specify: ___)

11. Who else lives in the child's primary household, besides the child, the child's siblings, and yourself? (Select all that apply)
    a. The child's other parent
    b. The child's stepparent
    c. Other relatives/extended family (insert number: __)
    d. Non-relatives, such as family friends or roommates (insert number: __)
    e. Other (please describe: __)
12. Was your child born on their due date?
    a. Yes
    b. No
    c. Don't remember/don't know
13. If not, how many days/weeks early or late?
    a. ____ days early ____ weeks early
    b. ____ days late ____ weeks late
    c. ____ don't remember/don't know
14. How much did your child weigh at birth?
    a. ____ pounds ____ ounces
    b. ____ don't remember/don't know
15. Infant health problems, if any (please describe):
    a. _____

III. Questions About Your Child's Weaning

16. When did your child have his/her first solid food (in addition to breastmilk or formula)?
    a. ____ months _____ weeks

b. ____ don't remember/don't know

17. What type of food did you first offer your child?
    a. Pureed baby-food or baby rice cereal
    b. Whole or chunked food
    c. Don't remember/don't know
18. Did you feed your child with a utensil or allow him/her to self-feed his/her first food?
    a. Utensil-fed
    b. Self-fed
    c. Both
    d. Don't remember/don't know
19. What percent of your child's meals are you responsible for (that is, how often are you the person feeding your child)?
    a. Sliding scale, 1-100
20. What percentage of your infant's solid foods are family foods (the same food eaten by the rest of the family, whether in the same form or blended/mashed)?
    a. Sliding scale, 1-100
21. What percentage of your infant's solid foods are pureed (as opposed to whole or chunked foods)?
    a. Sliding scale, 1-100
22. When your infant eats solid foods, what percentage of the time do you feed them with a spoon or fork (as opposed to feeding themselves)?
    a. Sliding scale, 1-100

Vita

Taylor Gwendolyn Martin was born in Greenville, South Carolina, USA, to John and Paula Martin. She graduated summa cum laude from Southside Christian School in May 2015 and subsequently attended the Honors College at the University of South Carolina. In 2019, she graduated with a Bachelor of Science degree in Biology, along with minors in Chemistry and Psychology. She spent the following year working as a psychometrician at a psychological testing practice, where she developed an interest in child development. In the autumn of 2020, she accepted a research assistantship in Experimental Psychology at Appalachian State University and began pursuing a Master of Arts degree, which was conferred in August 2022.

Ms. Martin completed a year-long teaching assistantship at Appalachian State and now hopes to teach her own Research Methods in Psychology course. She is an avid gardener and resides in Columbia, South Carolina, with her partner and their vast assortment of animal friends.