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Empirical Article

Self-feeding and communicative development from 12 to 24 months of age: An observational study

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Abstract

This study examined the relations between independent eating and communicative development, both concurrently and longitudinally, using observational methods. In total, 182 Italian mother–infant pairs (M_{age} = 12.33; 48% females; 100% White) participated from 2020 to 2023. Infants' gestures, vocalizations, and self-feeding episodes were coded during mealtimes at 12 months. Mothers reported on language development at 12, 18, and 24 months. Self-feeding was concurrently and positively associated with infants' use of deictic gestures and simple vocalizations during the meal. Notably, self-feeding at 12 months was positively related to sentence production reported by mothers at 24 months (but not to parent-reported vocabulary size at 12, 18, or 24 months). The results suggest potential language benefits from allowing infants an active role during the mealtime.

Keywords infants, self-feeding, language, communication, child-directed speech

Lay summary

The present study investigates how 12-month-old infants' independent eating relates to their communication development over the first 2 years of life. The research involved 182 infants and used direct observations during family meals, along with parent-reported assessments of fine motor skills and language abilities. Results showed that infants who ate more frequently independently at 12 months produced a significantly higher number of vocalizations and gestures during meals at that age and exhibited better sentence production at 24 months. For the first time, such associations were found adopting a multimethod approach and a longitudinal design. The findings of this study suggest that encouraging autonomous eating may support both motor and communicative development.

Mealtime serves as a rich context for various developmental opportunities, allowing infants to engage in meaningful social interactions and practice motor skills, especially when encouraged to eat independently (Addessi et al., 2021; Carruth & Skinner, 2002). Eating independently is a key milestone in the first 2 years of life, with complementary feeding usually beginning between 6 and 12 months, introducing solid foods gradually after a period of exclusive milk feeding (Nantel & Gingras, 2023). Recent evidence suggests that complementary feeding methods encouraging self-feeding, rather than spoon-feeding, are associated with enhanced language development in 8- to 24-month olds (Farrow et al., 2025; Webber et al., 2021). Free to use their hands, infants can explore objects in various ways, potentially advancing their understanding of object properties and forming word categories (West & Iverson, 2017). Moreover, as motor skills develop, so do gestures such as pointing, which are important pre-linguistic

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tools that facilitate communication and word learning (Iverson & Goldin-Meadow, 2005) and predict later vocabulary growth (Rowe & Goldin-Meadow, 2009). The reciprocal influences between new motor and language acquisitions underline the relevance of developmental cascades, where changes in one domain influence development in others (Thelen & Smith, 1994). However, the potential role of motor skills fostered through self-feeding in supporting infants' gestural communication remains largely unexplored. It remains unknown whether the pathways to self-expression and self-regulation in these domains are independent or developmentally linked.

The main aim of the present study was to explore the concurrent and longitudinal associations between the ability to eat independently and gestural and vocal communication in a sample of 12- to 24-month-old infants. Drawing on prior findings (e.g., Farrow et al., 2025; Webber et al., 2021) and building upon the theoretical and empirical framework of the dynamic systems perspective (Fogel & Thelen, 1987; Iverson, 2021; Smith, 2013; Thelen & Smith, 1994), we hypothesized that 1-year-old infants more engaged in self-feeding would produce a higher number of communicative acts during the meal than infants eating independently less frequently. Moreover, we expected cascading effects on infants' communicative skills 1 year later (Iverson, 2021), depending on the opportunities provided for infants to exercise independent eating in the course of the first and second year of life.

Infants' self-feeding

Infantstypically achieve the ability to eat independently by the end of the second year of life, following a complementary feeding period. This milestone is fundamental, as it plays a crucial role in the self-regulation of feeding behavior, with lasting effects on nutritional intake and body weight (Schwarzenberg et al., 2018). In industrialized societies, the "parent-led weaning" (PLW) approach gradually transitions infants from pureed food on a spoon to finger foods, and eventually to family foods (e.g., Addessi et al., 2021). Over the last 15 years, the increasing popularity of "baby-led weaning" (BLW; Rapley & Murkett, 2008) has promoted infants' independent eating, allowing them to autonomously consume finger foods, participate in family meals, and set the pace and the amount of food eaten from the beginning of the weaning period (e.g., Brown et al., 2017). Similarly, "on-demand complementary feeding" (od-CF, "alimentazione complementare a richiesta") in Italy encourages waiting for infants to signal interest in food and sharing family meals (Buglioni et al., 2017; Piermarini, 2002). Both BLW and od-CF are based on the idea that 6-month-old infants are active partners in self-regulating nutrient intake, as they are during breastfeeding.

Studies indicate that infants introduced to solid foods through self-feeding approaches, such as BLW, tend to develop more advanced oral-motor and fine-motor skills compared with those fed with traditional spoon-feeding methods. For instance, Campeau et al. (2021) concurrently examined whether adopting the BLW approach led to better developmental outcomes, including fine-motor skills, in 10- to 14-month olds. The authors found that infants weaned through BLW exhibited better fine-motor skills compared with those exposed to PLW. This can be attributed to the increased opportunities for infants to explore and manipulate food independently, fostering motor development (Daniels et al., 2015). Indeed, eating independently is a complex goal-directed activity that involves executing coordinated fine-motor sequences during daily meals. Each action may have its own difficulties and interruptions, and the infant has to maintain attention and motivation toward the overall goal of the sequence in order to fulfill the ultimate goal of eating. During their daily mealtime routines, infants have the opportunity to exercise and practice for weeks these complex sequences of fine-motor skills in order to become proficient in eating independently.

Through the lens of the dynamic systems perspective, mealtimes may be considered a dynamic context where motor development, object manipulation, and interaction with the social environment converge, shaping infants' skills, and abilities (Smith, 2013). In particular, the repeated practice and refinement of motor skills during self-feeding can contribute to broader domains, including language development (Farrow et al., 2025; Iverson, 2021; Webber et al., 2021).

Potential contribution of self-feeding to communicative development

Extensive longitudinal research highlights that the first year of life is crucial for the developmental transition in mother–infant communication, evolving from dyadic face-to-face interactions to triadic joint object engagement (Bakeman & Adamson, 1984; Tomasello & Carpenter, 2007). In mother–infant interactions, dyadic person engagement declines between 6 and 18 months of age, while coordinated joint engagement increases (Bakeman & Adamson, 1984). By the end of their first year, infants gradually employ deictic gestures, including pointing, showing, offering, and requesting, as well as vocalizations in triadic interactions during routines to communicate with a social partner on objects of mutual interest in the environment (Bates et al., 1975, 1979). When children also engage in gaze alternation between the adult and the object, and persist in their efforts by repeating the gesture when their communicative attempts are unsuccessful, these actions have been identified as intentional social acts (Camaioni et al., 2004; Franco & Butterworth, 1996; Golinkoff, 1986).

Pointing, extensively studied in longitudinal observational and experimental studies, emerges with a clear communicative function in typically-developing infants at around 12 months of age, often in combination with vocalizations, initially for requesting and later also for sharing interest and providing information (Camaioni et al., 2003, 2004; Liszkowski et al., 2006). Additionally, Franco and Butterworth (1996) identified a developmental shift from looking after pointing to looking before gesture execution, emerging at around 16 months of age. This shift denotes a new sophisticated appreciation of the social requirements for the successful use of pointing, referred to as social awareness. This awareness would imply some knowledge of the psychological processes in the social partner and a clear intentional use of joint attention. Soon after the emergence of the use of deictic gestures—between 12 and 15 months of age—typically developing children begin to use representational, or symbolic, gestures (Caselli, 1990; Iverson et al., 1994). These gestures serve not only to direct others' attention and behavior, but also to represent specific referents, and their meaning does not change depending on the context (e.g., the child claps hands meaning "bravo" when she finishes eating).

Representational gestures first appear in imitation games, social routines, and in joint pretend-play episodes (Caselli, 1983). Deictic and representational gestures, along with early vocalizations, are associated with later vocabulary development, "bridging" the transition from pre-symbolic to symbolic communication (Camaioni et al., 2004; Iverson et al., 1994; Sansavini et al., 2010). Single lexical items frequently appear first in gestural language rather than in speech (Iverson & Goldin-Meadow, 2005), and the gestural vocabulary at 18 months of age predicts the verbal vocabulary at 42 months (Rowe & Goldin-Meadow, 2009).

In the same developmental period, children also acquire a repertoire of vocalizations to express their communicative intentions. These word-like sounds can be used alone or accompanied by gestures as signals for communicative purposes (Bates et al., 1975). Some studies have highlighted similarities between production in the gestural and the vocal modalities, showing how the two modalities start developing in parallel and undergo a similar process of gradual decontextualization (e.g., Bates et al., 1979; Iverson et al., 1994). Later on, however, gestures tend to decline in use whereas words increase progressively. Transitional vocal forms such as "protowords" have also been identified: these are onomatopoeic and idiosyncratic sounds that convey conventional meanings for a particular mother–child dyad (Halliday, 1975).

There is evidence that early vocalizations can provide an avenue of later vocabulary acquisition and a marker for lexical delay. Furthermore, some developmental progressions have been identified, such as increased volume of early vocalizations at 6 months (Camp et al., 1987), increased phonetic complexity of babbling (D'Odorico et al., 2011), and consistent use of specific consonants, called Vocal Motor Schemes (McCune & Vihman, 2001). According to McCune and Vihman (2001) , early vocal production may play a critical role in word learning, as through vocal practice infants establish sensory-motor couplings between their articulatory routines and the words to which they are exposed.

Emerging evidence suggests that self-feeding practices may play a role in both motor and language development during infancy, though findings remain limited and somewhat mixed. For instance, Addessi et al. (2021) found that infants aged 6–12 months who were spoon-fed less frequently began to crawl earlier, suggesting a possible association between baby-led weaningapproaches and earlier achievement of motor milestones. However, spoon-feeding was not related to the age of first word production. In contrast, Webber et al. (2021) found that children who more frequently ate unaided at the onset of the complementary feeding period showed more advanced language comprehension and production between 8 and 24 months of age. Moreover, this association was mediated by the prevalence of offering the child family foods, suggesting that both motor and social aspects of feeding may support language development. Similarly, Farrow et al. (2025) observed that the percentage of self-feeding was positively correlated with the total number of infant vocalizations produced during the meal (without distinguishing between types of vocalizations). Overall, these findings indicate that while self-feeding may not have a role in the onset of first words, it could support later vocabulary growth and facilitate earlier motor development, linking domains that have been extensively studied separately. Longitudinal studies are needed to determine the direction of these relations and better understand changes over time.

Current study

The literature indicates that, by the end of the first year, infants can eat independently and use gestures and vocalizations to communicate with social partners (e.g., Camaioni et al., 2004; Nantel & Gingras, 2023). Family meals provide a unique social context for studying the interrelation between pathways to independent eating and communicative development. Indeed, infants learn to manipulate food in conventional ways, recognize specific foods represented by words, and can observe the eating behaviors of others (e.g., Adi-Bensaid et al., 2022). Nonetheless, there is still a gap in research examining the reciprocal influences between these important achievements.

In the present observational study, we examined the relations between infants' independent eating skills and their gestural and vocal communication, both concurrently (at 12 months of age) and longitudinally (at 18 and 24 months of age), when the transition to symbolic communication occurs. We propose that infants with greater autonomy in eating will demonstrate heightened proficiency in gestural and vocal communication, as the motor skills involved in self-feeding may promote language development. Beyond the theoretical implications, this research has practical relevance, as it can inform evidence-based recommendations for new parents, promoting positive pathways for infants as they transition to independent eating and develop their communicative and linguistic skills.

Method

Participants

Participants were 182 infants (48% females; 100% White) recruited from medical services, daycare centers, and social media networks. The inclusion criteria were the following: (i) being born after the 37th gestational week, (ii) not having congenital abnormalities or neurological deficits, and (iii) being exposed to Italian as the primary language. Video recordings of infants' meals were conducted when they were 12 months of age. Of the original sample of 195 infants, 13 were excluded for the following reasons: 10 families dropped out in this phase of the study, 1 infant had an intestinal virus causing a loss of appetite (and thus it was not possible to record the meal), 1 family requested to participate by completing only questionnaires, with no video recordings, and 1 infant showed psychomotor delay as reported by the parents. Parental socioeconomic status (SES) was primarily upper class, as determined by parents' education level (89% of mothers and 59.9% of fathers had at least a university degree). The present study complied with the APA Ethical Guidelines and was approved by the Ethics Committees of the Department of Dynamic and Clinical Psychology and Health Studies of Sapienza University of Rome (Prot. n. 0000315, April 14, 2020 and n. 0001209, December 15, 2020) and by the National Research Council of Italy (prot. n. 00721482019, October 18, 2019 andprot. n. 0028810, April 23, 2021).

Procedure

This study was part of a broader research project, titled "SPOON" Project—Svezzamento e SviluPpO cOgNitivo, which focused on the association between complementary feeding approach and

development in children aged 4–24 months. We obtained written consent from both parents to remotely record infants' meals and collect parent-report questionnaires. For one child, the parents provided written consent to publish a frame of their infant during the mealtime in this scientific article. Specifically, around the age of 12 months ($M = 12.33$, $SD = 0.51$), we scheduled online appointments with parents, using the platforms Skype or JitsiMeet, to record meals in a typical home setting. Families were instructed not to alter the usual procedure of a typical meal and were asked to position the recording device, preferably a laptop with a webcam, in front of the infant but out of her reach, to capture all upper-body movements. If feasible, families were also asked to frame part of the surroundings with the webcam to gather information about the people present during the meal and to whom or what the infant's gestures and vocalizations were directed. The experimenter was usually able to provide feedback and, if necessary, request small adjustments to the frame just before the meal began. We used the OBS Studio software for recording and the ELAN software to analyze the video recordings, employing a coding scheme we devised (see "Measures" for further details). At 12 months of age, we also coded mothers' child-directed speech during the meal as a control measure and administered parent-report questionnaires to collect demographic information, as well as data on infants' fine-motor skills and language abilities. Mothers completed online questionnaires using electronic devices, preferably laptops or tablets, within 1 month before or after infants turned 12 months old. Mothers provided information on their infants' language development again when infants were 18 ($N = 176$, $M = 18.37$, $SD = 0.51$) and 24 months of age ($N = 176$, $M = 24.29$, $SD = 0.67$). Further details are reported below.

Measures

Observational measures during meals

Infants' gestures and vocalizations

Building upon the coding scheme developed by Camaioni et al. (2003) and Bellagamba et al. (2022) for children's communicative acts, we elaborated a coding scheme designed to capture infants' gestures and vocal acts. With this aim, we initially outlined the guidelines to code the gestures and vocal acts.

Gestures: we coded gestures only when they had a communicative function, specifically when the child either gazed at the communicative partner or accompanied the gesture with systematic vocalization and a coherent facial expression. In the gestural modality, gaze at the partner is required, since perceptual access is necessary for communication to continue. We counted gestures with a long duration as single gestures unless the child moved their arm backward and forward again. In this case, the gesture was counted twice. A gestural communicative act was coded whenever it occurred. Actions and gestures that did not meet the criteria outlined above were not coded (e.g., when the infant raised her arms without gazing at the communicative partner or vocalizing). As a special case, when a gesture was not accompanied by a gaze toward the communicative partner but was produced as an answer to a request or comment, it was still considered communicative (e.g., when a child replies to the mother—who asks if they want more of a certain food—by shaking their head to say "no" without looking at her). If the infant was out of frame at any point during the recording, gestures were not coded.

Vocal acts: a vocal act always had a communicative function since, in the auditory modality, a communicative partner can hear a child's vocalization even without perceptual access to the child. A vocal communicative act was coded whenever it occurred. Vocalizations were coded only if they could be clearly attributed to the infant.

The coding scheme for infants' deictic and referential gestures is detailed in Table 1. Figure 1 provides an example of the deictic pointing gesture produced by an infant during the meal.

The coding scheme of infants' vocal acts included four categories:

1. Simple vocalizations: These are vocalic or syllabic sounds. They may or may not be accompanied by a gesture. If they were, both simple vocalization and gesture were assigned codes. Examples: "mmm," "eh," "ah."

Table 1 List of infants' deictic and referential gestures observed during the meal.

Deictic gestures		
Pointing	Showing	Giving or offering a non-food object
Giving or offering food	Requesting	Taking or receiving
Referential gestures		
Shaking head to say "no"	Moving head to say "yes"	Shaking index finger or hand to stop, refuse or deny
Waving hands to say "bye-bye"	Clapping hands to say "bravo"	Putting index finger to lips to say "silence" or "be quiet"
Touching cheek with index finger to say "good"	Showing hands to say "all-gone"	Pretending to telephone
Pretending to comb	Making gesture of hitting something	Pretending to drive a car
Hugging and patting a doll	Making the movement of a vehicle (e.g., car, train)	Flapping hands to say "bird" or "plane"
Sending a kiss using the hand's palm	Showing a number with fingers	Showing muscles to say "how strong"
Pretending to pour juice or other liquid by bending closed hand with thumb down	Folding hands together to pray	Blowing with lips for food that is hot
Pretending to wash hands by rubbing them	Pretending to brush teeth with finger	Pretending to sleep (hands toward the face)
Moving hands on the mouth to request a napkin		

Figure 1 A frame of an infant pointing at an object in the surrounding area during the meal, recorded at 12 months of age.

2. Proto-words: These are onomatopoeic and idiosyncratic sounds with specific meanings for a particular mother–child dyad. They are associated with specific referents through iconic or figurative relations. Examples: "bau" (dog), "meow" (cat), "brum" (car), "ahm" or "gnam" in reference to food.
3. Words: A word is linked to a particular referent through an arbitrary sound-meaning relation. Examples: "mamma" (mummy), "papà" (dad), "no."
4. Word combinations: This category includes a combination of more than two words. Example: "Chi è?" (Who is that?).

Self-feeding

We computed the total number of self-feeding episodes that occurred throughout the meal according to the Family Mealtime Coding Scheme (Farrow et al., 2025; Haycraft & Blissett, 2008). These episodes encompassed events in which infants independently brought food to their mouth, using either their hands or cutlery (e.g., a spoon). Then, we divided the number of self-feeding episodes by the overall count of feeding episodes, including both events when infants ate independently and when they were fed by an adult. This allowed us to obtain the proportion of self-feeding during the meal.

Mothers' child-directed speech

As indicated by various studies, mealtimes serve as a fertile environment for child-directed speech, with caregivers giving instructions, offering encouragement, and labeling objects and actions, all activities that have been found to promote infants' language development (Zimmerman et al., 2019). Remarkably, research also indicates that caregivers employ a notably greater number of labels in their speech when infants manipulate objects (West & Iverson, 2017). Therefore, to account for the potential confounding role of child-directed speech during the meal in our analyses, we elaborated a coding scheme designed to capture the utterances and words that mothers directed toward the infants during the meal, adapting the coding scheme created by Weisleder and Fernald (2013) for adults' communicative acts. We did not encompass all other communicative acts that mothers did not direct toward the targeted infant. In order to code the mothers' speech, we first delineated the definition of an "utterance" in accordance with West and Iverson (2017) and Pan et al. (2005), as presented below.

Utterance definition: "An utterance is defined as any sentence of words preceded and followed by silence, a change in conversational turn, or a change in intonational pattern" (West & Iverson, 2017, p. 193). Moreover, "A verbal utterance is bounded by grammatical closure, a pause of more than 2 s, or transition in the speaker" (Pan et al., 2005, p. 767).

Therefore, a single utterance was coded any time mothers produced a sequence of words with a pause before and after, when someone else interrupted their speech, or when there was a change in intonation. In some cases, when mothers uttered several words without any pause or change of intonation, to determine whether a sentence comprised one or multiple utterances, mothers' actions that accompanied the verbal act were considered. Specifically, if a unique action accompanied the verbal act, one single utterance was coded (e.g., feeding the child while saying "How good, that is good"). On the contrary, if the grammatical function changed, the sentence was divided into two or more utterances, mainly when a question was followed immediately by an assertion (e.g., "Is that good?"—"Good!"). However, even though a single action spanned the entire sentence, factors defining the concept of utterance (e.g., the presence of silence) and the grammatical function of the verbal act (e.g., an interrogative sentence or an imperative sentence) played a more prominent role, determining whether the sentence should remain a single utterance or be divided into multiple utterances. We counted the number of utterances and single words mothers directed at infants during the meal.

Three undergraduate students participated in training sessions led by an expert coder to acquire proficiency in using the coding scheme and the ELAN software. The training involved examining the coding scheme and the operation of ELAN in the initial phase. In the subsequent phase, the undergraduates conducted a trial coding to address uncertainties collaboratively with the expert coder. After all coders independently and blindly coded the same six video recordings for intercoder reliability assessment, any disagreements were discussed and rectified before proceeding to code the remaining video recordings. Corrections were made based on a consensus agreement among the expert coder, the undergraduate students, and the study's principal investigators. To measure the level of agreement on children's communicative acts (i.e., gestures and vocalizations) between each independent coder and the expert coder, we calculated the Cohen's kappa after the final round of coding. The average agreement was 0.94. Specifically, the k values for the three coders were 0.98, 0.96, and 0.89, respectively. To measure the level of agreement on the number of maternal utterances of child-directed speech, we calculated the Spearman's correlations. For all independent coders, there was a perfect correlation with the expert coder ($r_s = 1$).

From the coding of the videos, we calculated the total number of the following events: (i) infants' gestures and vocalizations, (ii) mothers' child-directed utterances, and (iii) mothers' child-directed words. Then, we derived rates by dividing the frequency of each variable by the duration of each meal.

Observational measures during meals

Parent-report questionnaires

Infants' language abilities

Mothers completed the Italian short forms of the MacArthur–Bates Communicative Development Inventory (MCDI-SF): Words & Gestures and Words & Sentences (Fenson et al., 2000)—Il Primo Vocabolario del Bambino: Gesti e Parole, Parole e Frasi (Caselli et al., 2015). The Words and Gestures form, assessing early language abilities in children aged 0–17 months, including vocabulary comprehension, productive vocabulary, and gestures, was completed when infants were 12 months old. Mothers identified words understood and produced by their infants from a list of 100, along with the gestures produced from a set of 18. The Words and Sentences form, investigating productive vocabulary and sentences production in children aged 18–36 months, was completed when children were 18 and 24 months old. Specifically, mothers indicated the words their children produced and whether they could pronounce sentences (0 = *unable to produce sentences*, 1 = *able to produce sentences*). At 18 months, 57 children (32.8%) could produce sentences, whereas at 24 months of age 146 children (84.4%) were able to produce sentences, as reported by mothers.

Infants' fine-motor skills

We administered the Developmental Profile—3 (DP3; Alpern, 2007) when infants were 12 months old to assess psychomotor development. Although detailed findings on the motor domain will be presented in a separate manuscript (Focaroli et al., in preparation), this study focused on obtaining a measure of infants' fine-motor skills, as more advanced object manipulation abilities have been shown to be related to language development (Bates et al., 1979; Iverson, 2021). From the DP3 motor scale, we selected two items related to fine-motor skills (i.e., "Turning the pages of a book" and "Stacking three cubes"). These two items provide information about infants' motor behavior in contexts other than mealtime (i.e., reading books and playing with cubes). This additional measure of fine-motor skills, independent from observations during meals, is important as it supports a multi-informant, multi-method approach. Mothers rated these items on a 2-point scale (0 = *no*, 1 = *yes*), indicating whether they observed the target behavior in their child. Then, we computed a composite score for fine-motor skills, ranging from "0" to "2" (0 = *no behavior exhibited*, 1 = *only one behavior exhibited*, 2 = *both behaviors exhibited*). As reported by mothers, 43 infants (24.4%) displayed both behaviors, obtaining a score of "2"; 90 infants (51.1%) exhibited only one behavior, obtaining a score of "1"; and 43 infants (24.4%) did not show any behavior, receiving a score of "0."

Sociodemographic characteristics

To ensure our study was comprehensive and grounded in the relevant literature, we collected data on various aspects of infants and their families. The variables included have been identified in previous research as significant for language development. Specifically, we gathered information about infants' gender (0 = *boy,* 1 = *girl*), presence of siblings (0 = *single child*, 1 = *at least one sibling*), duration of exclusive breastfeeding in months, attendance at daycare (0 = *not attending daycare,* 1 = *attending daycare*), pacifier usage during the day (0 = *not using the pacifier,* 1 = *using the pacifier*), number of hours of daily pacifier use, weaning type (BLW = *baby-led weaning*; PLW = *parent-led weaning*; Mixed = *combined weaning approach led by the child and the parent*), mothers' level of education (0 = *education lower than university level*; 1 = *at least a university degree*), and the number of weekly working hours for mothers. Based on prior studies, we expected to find significant positive effects on language development for girls (e.g., Eriksson et al., 2012), single children (Steelman et al., 2002), and infants who were breastfed longer (e.g., Weigel et al., 2011), attended daycare centers (e.g., Burchinal et al., 2000), did not use a pacifier (e.g., Barca et al., 2020), and had mothers with a higher education level (e.g., Fernald et al., 2013).

Data analysis

We conducted a preliminary exploration of the descriptive statistics of the study variables, providinga qualitative description of the observational variables, and verifyingwhether our MCDI questionnaire scores were comparable to typical developmental trajectories. Next, we performed a series of confirmatory regression analyses to evaluate whether and how self-feeding was associated with variables denoting infants' communication (i.e., deictic and referential gestures, simple vocalizations, proto-words, and words) produced during the meal at 12 months of age, and language assessed through the MCDI at 12, 18, and 24 months of age (i.e., vocabulary comprehension, productive vocabulary, and actions and gestures at 12 months old; productive vocabulary and sentence production at 18 and 24 months old). To account for the possibility of inflated Type I error due to multiple comparisons, we applied a Bonferroni correction to adjust the alpha-level (alpha-level adjustment approach). Specifically, the adjusted alpha-level threshold for significance was obtained dividing the experiment-wise alpha-level (0.05) by the number of comparisons made within each outcome set, including gestures (deictic and referential), vocalizations (simple vocalizations, protowords, and words), and MCDI's variables within each age point (12, 18, and 24 months). In all regression analyses, we controlled for the effect of potentially confounding variables, which have been found to be significantly related to infants' language development in prior research: gender, mothers' child-directed speech and education level, attending a daycare center, presence of siblings, number of months of exclusive breastfeeding, using a pacifier (number of hours per day), and fine-motor skills. The continuous independent variables were scaled and the binary independent variables were effect-coded. We used SPSS 26 to conduct the descriptive statistics, whereas we used STATA 16 to perform the regression analyses.

Results

Preliminary analyses

Descriptive statistics showed that mothers worked an average of 25 h per week ($M = 25.08$, $SD = 16.76$) and that they exclusively breastfed their children for ∼4 months ($M = 4.17$, $SD = 2.47$). Moreover, 75 infants (41.8%) had at least one sibling, 74 infants (41.8%) attended a daycare center (with missing data for 5 infants), and 83 infants (46.1%) used a pacifier during the day (with missing data for two infants). In detail, infants used a pacifier for about

1 h per day on average ($M = 0.92$, $SD = 1.59$). The duration of meals ranged from a minimum of 4.05 to a maximum of 64.97 min ($M = 20.88$, $SD = 10.30$). Finally, 65 mothers (35.7%) reported using a BLW method, while 54 (29.7%) reported using a PLW approach, and 59 (32.4%) reported using a mixed method (with missing data for four infants). Table 2 shows the descriptive statistics of the key study variables.

Referring to infants' gestures produced during the meal, we observed that 173 infants (95%) exhibited deictic gestures and 148 infants (81.3%) displayed referential gestures. Moreover, we found that the "Taking or receiving" gesture was produced by the greater number of infants ($N = 141$, 77.5%), followed by the "Requesting" gesture, produced by 136 infants (74.7%), the "Pointing" gesture ($N = 133$, 73.1%), the "Giving or offering a non-food object" gesture ($N = 84$, 46.1%), the "Giving or offering food" gesture ($N = 72$, 39.6%), and the "Showing" gesture ($N = 51$, 28%). In terms of average gesture frequencies per minute during the meal, infants pointed at something ~0.39 times per min ($M = 0.39$, $SD = 0.48$), requested something 0.27 times per min ($M = 0.27$, $SD = 0.34$), received something 0.21 times per min ($M = 0.21$, $SD = 0.27$), offered food 0.09 times per min ($M = 0.09$, $SD = 0.18$), offered something other than food 0.07 times per min ($M = 0.07$, $SD = 0.014$), and showed something 0.03 times per min ($M = 0.03$, $SD = 0.07$). Therefore, the gestures more frequently used by infants during meals were pointing, requesting, and receiving, while offering (food or anything else) and showing were used much less often.

Regarding infants' vocalizations, 181 infants (99.4%) produced simple vocalizations, 71 infants (39%) enunciated proto-words, 80 infants (43.9%) pronounced words, and only 1 infant (0.1%) combined words. The most frequently used words during the meal were "mamma" ("mummy"), produced by 44 infants (24.2%), "no," produced by 27 infants (14.8%), and "pappa" ("food"), produced by 17 infants (9.3%).

Moreover, 149 infants (81.9%) engaged in self-feeding during the meal at least once and, on average, self-feeding was practiced 0.49 times per min during a single meal ($M = 0.49$, $SD = 0.37$).

Finally, as for the utterances and words directed by mothers to the infants during the meal, we observed that, on average, mothers pronounced around nine utterances per min ($M = 9.15$, $SD = 5.58$) and ~25 words per min ($M = 25.58$, $SD = 16.58$).

Our MCDI questionnaire scores are consistent with the normative data, indicating that the language development of the infants in our sample aligns with typical developmental trajectories. In particular, at 12 months, the mean vocabulary comprehension score and the mean productive vocabulary score were 34.9 and 2.48, respectively, both falling between the 50th and the 75th percentiles in the normative sample (score ranges: 29–44 and 2–5, respectively); the mean actions and gestures score was 7.87, falling between the 25th and 50th percentiles (score range: 6–8). At 18 months, the mean productive vocabulary score was 19.95, which fell between the 25th and 50th percentiles (score range: 10–23). Finally, at 24 months, the mean productive vocabulary score was 53.80, also between the 25th and 50th percentiles (score range: 41–77).

Table 2 Descriptive statistics of the study variables.

	N	*M*	*SD*	Range
Infants' self-feeding	182	0.49	0.37	0.00–1.00
Infants' gestures				
Deictic gestures	182	0.93	0.80	0.00–4.29
Referential gestures	182	0.34	0.44	0.00–2.97
Total number of gestures	182	1.40	0.98	0.00–4.57
Infants' vocalizations				
Simple vocalizations	182	3.55	2.17	0.00–10.20
Proto-words	182	0.10	0.33	0.00–2.94
Words	182	0.12	0.27	0.00–1.88
Words combinations	182	0.01	0.09	0.00–1.22
Total number of vocalizations	182	3.79	2.34	0.00–12.99
Child-directed speech				
Mothers' utterances	182	9.15	5.58	0.00–24.39
Mothers' words	182	25.58	16.58	0.00–78.85
MCDI at 12 months of age				
Vocabulary comprehension	179	34.90	23.77	0.00–100.00
Productive vocabulary	179	2.48	4.10	0.00–34.00
Actions and gestures	179	7.87	2.88	0.00–16.00
MCDI at 18 months of age				
Productive vocabulary	174	19.95	18.08	0.00–77.00
MCDI at 24 months of age				
Productive vocabulary	173	53.80	26.53	1.00–100.00

Note. The infants' self-feeding variable is a proportion (i.e., number of self-feeding episodes divided by total number of feeding episodes). All other observational variables are rates (i.e., occurrences divided by meal duration).
MCDI = MacArthur-Bates Communicative Development Inventory.

Concurrent relations with observed infants' communication at 12 months of age

We performed a series of linear regressions with infants' communication variables (i.e., deictic gestures, referential gestures, simple vocalizations, proto-words, and words) as dependent variables. The independent variable for all regressions was the proportion of self-feeding, along with potential confounding variables as covariates (i.e., gender, mothers' child-directed speech and education level, attending a daycare center, presence of siblings, number of months of exclusive breastfeeding, using a pacifier, and fine-motor skills). The continuous independent variables were mean-centered and scaled, whereas the binary independent variables were effect-coded. All regressions are presented in Tables 3 and 4. The significant relations are also illustrated in the text below.

Associations with infants' gestures during meals

The regression with infants' deictic gestures as the dependent variable was significant ($R^2 = 0.14$, $F(9,162) = 3.54$, $p < .001$) and revealed positive effects of self-feeding and mothers' child-directed utterances. Specifically, a 1 SD increase from the mean in the proportion of self-feeding and in the rate of mothers' child-directed utterances corresponded to a 0.16 increase in the rate of deictic gestures in both cases. All other effects were nonsignificant.

The regression with referential gestures as the dependent variable was significant ($R^2 = 0.25$, $F(9,162) = 6.31$, $p < .001$) and

Table 3 Linear regression analyses with infants' gestures as dependent variables.

Variable	*Coeff*	*Robust SE*	95% CI *LL*	95% CI *UL*	*t*	Actual *p*	Bonferroni corrected *p*
DV = deictic gestures							
Self-feeding	0.161	0.06	0.04	0.28	2.66	.009	$p < .05$
Mothers' child-directed utterances	0.157	0.05	0.05	0.26	3.01	.003	$p < .05$
Gender	0.131	0.06	0.01	0.25	2.21	.029	ns
Mothers' education level	0.035	0.10	−0.16	0.23	0.35	.726	ns
Daycare attendance	0.114	0.06	−0.00	0.23	1.96	.052	ns
Presence of siblings	−0.004	0.06	−0.12	0.11	−0.07	.941	ns
Exclusive breastfeeding	−0.114	0.06	−0.24	0.01	−1.79	.075	ns
Pacifier use	−0.028	0.05	−0.13	0.08	−0.51	.608	ns
Fine-motor skills	0.082	0.06	−0.03	0.20	1.42	.159	ns
Intercept	0.926	0.10	0.73	1.12	9.42	<.001	
R^2			.14***				
DV = referential gestures							
Self-feeding	−0.044	0.03	−0.11	0.02	−1.41	.162	ns
Mothers' child-directed utterances	0.191	0.03	0.13	0.25	6.22	<.001	$p < .05$
Gender	0.019	0.03	−0.04	0.07	0.69	.493	ns
Mothers' education level	−0.025	0.05	−0.12	0.07	−0.52	.602	ns
Daycare attendance	0.105	0.03	0.04	0.17	3.19	.002	$p < .05$
Presence of siblings	0.032	0.03	−0.03	0.09	1.10	.272	ns
Exclusive breastfeeding	−0.043	0.03	−0.11	0.02	−1.31	.192	ns
Pacifier use	−0.035	0.02	−0.08	0.01	−1.54	.125	ns
Fine-motor skills	0.039	0.03	−0.02	0.09	1.39	.165	ns
Intercept	0.394	0.05	0.30	0.49	8.27	<.001	
R^2			.25***				

Note. The actual *p*-values before Bonferroni correction and significant effects after Bonferroni correction ($p < .05$) are reported; ns = not significant. ***$p < .001$.

showed that mothers' child-directed utterances and infants' daycare attendance had significant positive effects. In particular, a 1 SD increase from the mean in the rate of mothers' child-directed utterances corresponded to a 0.19 increase in the rate of referential gestures. Furthermore, infants attending daycare centers exhibited a 0.10 increase in the rate of referential gestures compared with the average score of 0.39. All other effects were nonsignificant, including the proportion of self-feeding, which did not relate to a higher rate of referential gestures.

Associations with infants' vocalizations during meals

The regression with infants' simple vocalizations as the dependent variable was significant ($R^2 = 0.14$, $F(9,162) = 2.29$, $p < .05$) and indicated positive effects of self-feeding and mothers' child-directed utterances. In particular, a 1 SD increase from the mean in the proportion of self-feeding and in the rate of mothers' child-directed utterances translated into increases of 0.38 and 0.73, respectively, in the rate of simple vocalizations. All other effects were nonsignificant.

The regression with proto-words as the dependent variable was not significant ($R^2 = 0.08$, $F(9,162) = 0.73$, $p = .680$) and no significant effects emerged for any of the independent variables, including the proportion of self-feeding, which was not associated with therate of proto-words.

The regression with words as the dependent variable was not significant ($R^2 = 0.15$, $F(9,162) = 1.51$, $p = .148$). However, a significant effect of mothers' child-directed utterances was found. Specifically, a 1 SD increase from the mean in the rate of mothers' child-directed utterances corresponded to an increase of 0.06 in the rate of words produced by infants during the meal. All other effects were nonsignificant, including the proportion of self-feeding, which was not related to therate of words.

Concurrent and longitudinal relations with mother-reported language at 12, 18, and 24 months of age

We performed a series of linear regressions with infants' MCDI continuous variables at 12 months (i.e., vocabulary comprehension, productive vocabulary, and number of actions and gestures) and at 18 and 24 months (i.e., productive vocabulary) as the dependent variables. Additionally, we conducted logistic regressions using the MCDI dichotomous variables at 18 and 24 months (i.e., sentence production). In all models, the independent

Table 4 Linear regression analyses with infants' vocalizations as dependent variables.

Variable	*Coeff*	*Robust SE*	95% CI *LL*	95% CI *UL*	*t*	Actual *p*	Bonferroni corrected *p*
DV = simple vocalizations							
Self-feeding	0.385	0.16	0.07	0.70	2.44	.016	$p < .05$
Mothers' child-directed utterances	0.734	0.19	0.36	1.11	3.90	<.001	$p < .05$
Gender	−0.064	0.17	−0.40	0.27	−0.37	.709	ns
Mothers' education level	0.009	0.25	−0.49	0.50	0.04	.972	ns
Daycare attendance	−0.015	0.17	−0.35	0.32	−0.09	.929	ns
Presence of siblings	−0.123	0.18	−0.48	0.23	−0.69	.492	ns
Exclusive breastfeeding	0.077	0.17	−0.25	0.40	0.47	.640	ns
Pacifier use	−0.088	0.16	−0.40	0.22	−0.56	.579	ns
Fine-motor skills	0.110	0.16	−0.21	0.43	0.67	.503	ns
Intercept	3.472	0.24	2.99	3.95	14.20	<.001	
R^2			.14*				
DV = proto-words							
Self-feeding	0.023	0.02	−0.02	0.06	1.16	.246	ns
Mothers' child-directed utterances	0.058	0.03	−0.00	0.12	1.91	.058	ns
Gender	−0.032	0.03	−0.09	0.03	−1.06	.292	ns
Mothers' education level	0.050	0.02	0.00	0.10	2.00	.047	ns
Daycare attendance	−0.029	0.02	−0.07	0.02	−1.25	.212	ns
Presence of siblings	−0.022	0.03	−0.07	0.03	−0.85	.396	ns
Exclusive breastfeeding	0.057	0.03	0.00	0.11	1.99	.048	ns
Pacifier use	−0.022	0.02	−0.05	0.01	−1.42	.157	ns
Fine-motor skills	0.031	0.02	−0.01	0.08	1.34	.182	ns
Intercept	0.055	0.02	0.02	0.09	3.23	.002	
R^2			.09				
DV = words							
Self-feeding	0.002	0.02	−0.04	0.04	0.08	.938	ns
Mothers' child-directed utterances	0.065	0.02	0.02	0.11	2.63	.009	$p < .05$
Gender	0.019	0.02	−0.02	0.06	0.94	.347	ns
Mothers' education level	0.027	0.02	−0.02	0.07	1.26	.210	ns
Daycare attendance	0.023	0.02	−0.02	0.06	1.13	.261	ns
Presence of siblings	−0.003	0.02	−0.04	0.03	−0.14	.888	ns
Exclusive breastfeeding	0.023	0.02	−0.02	0.06	1.16	.248	ns
Pacifier use	−0.020	0.01	−0.05	0.01	−1.56	.121	ns
Fine-motor skills	0.031	0.02	−0.01	0.07	1.44	.151	ns
Intercept	0.105	0.02	0.07	0.144	5.28	<.001	
R^2			.09				

Note. The actual *p*-values before Bonferroni correction and significant effects after Bonferroni correction ($p < .05$) are reported; ns = not significant. *$p < .05$.

variable was the proportion of self-feeding. For the outcomes at 12 months, we included the following covariates: gender, mothers' child-directed speech and education level, attending a daycare center, presence of siblings, number of months of exclusive breastfeeding, using a pacifier, and fine-motor skills. For the outcomes at 18 and 24 months, we additionally controlled for infants' total gestures and total vocalizations during the meal at 12 months, to account for individual differences in early communicative abilities based on direct observation. The continuous independent variables were mean-centered and scaled, whereas the binary independent variables were effect-coded. The results are presented in Tables 5–7. The significant relations are also illustrated in the text below.

Twelve months of age

The regression with the MCDI's vocabulary comprehension score at 12 months of age as the dependent variable was significant ($R^2 = 0.15$, $F(9,162) = 3.89$, $p < .001$) and revealed a significant positive association with the fine-motor skill score and a negative association with the presence of siblings. Specifically, a 1 SD

Table 5 Linear regression analyses with infants' MCDI scores at 12 months as dependent variables.

Variable	*Coeff*	*Robust SE*	95% CI *LL*	95% CI *UL*	*t*	Actual *p*	Bonferroni corrected *p*
DV = MCDI comprehension at 12 months							
Self-feeding	−0.512	1.84	−4.14	3.12	−0.28	.781	ns
Mothers' child-directed utterances	2.816	1.79	−0.71	6.35	1.58	.117	ns
Gender	1.477	1.68	−1.83	4.79	0.88	.380	ns
Mothers' education level	−3.578	3.63	−10.75	3.59	−0.99	.326	ns
Daycare attendance	−3.386	1.74	−6.83	0.06	−1.94	.054	ns
Presence of siblings	−4.490	1.62	−7.69	−1.29	−2.77	.006	$p < .05$
Exclusive breastfeeding	1.534	1.81	−2.04	5.11	0.85	.399	ns
Pacifier use	−1.033	1.79	−4.58	2.51	−0.58	.566	ns
Fine-motor skills	5.179	1.69	1.84	8.51	3.07	.003	$p < .05$
Intercept	36.376	3.59	29.29	43.46	10.14	<.001	
R^2			.15***				
DV = MCDI productive vocabulary at 12 months							
Self-feeding	−0.058	0.37	−0.79	0.68	−0.16	.876	ns
Mothers' child-directed utterances	−0.051	0.35	−0.74	0.64	−0.14	.886	ns
Gender	−0.151	0.31	−0.76	0.46	−0.49	.625	ns
Mothers' education level	0.377	0.37	−0.35	1.11	1.02	.308	ns
Daycare attendance	−0.346	0.28	−0.90	0.21	−1.23	.219	ns
Presence of siblings	−0.414	0.29	−0.99	0.16	−1.41	.159	ns
Exclusive breastfeeding	−0.165	0.38	−0.92	0.59	−0.43	.666	ns
Pacifier use	−0.664	0.28	−1.22	−0.11	−2.35	.020	ns
Fine-motor skills	0.410	0.29	−0.16	0.98	1.42	.158	ns
Intercept	2.087	0.34	1.42	2.76	6.16	<.001	
R^2			.06				
DV = MCDI actions and gestures at 12 months							
Self-feeding	0.186	0.21	−0.23	0.61	0.88	.381	ns
Mothers' child-directed utterances	−0.014	0.21	−0.44	0.41	−0.06	.949	ns
Gender	0.721	0.22	0.28	1.16	3.24	.001	$p < .05$
Mothers' education level	−0.356	0.34	−1.04	0.32	−1.04	.302	ns
Daycare attendance	−0.222	0.23	−0.67	0.23	−0.98	.330	ns
Presence of siblings	0.350	0.22	−0.09	0.79	1.56	.121	ns
Exclusive breastfeeding	−0.027	0.22	−0.46	0.41	−0.12	.903	ns
Pacifier use	−0.306	0.22	−0.74	0.13	−1.39	.167	ns
Fine-motor skills	0.538	0.22	0.11	0.97	2.48	.014	$p < .05$
Intercept	8.221	0.36	7.52	8.92	23.12	<.001	
R^2			.13**				

Note. The actual *p*-values before Bonferroni correction and significant effects after Bonferroni correction ($p < .05$) are reported; ns = not significant. **$p < .01$, ***$p < .001$.

increase from the mean in the fine-motor score corresponded to a 5.18 increase in the number of words understood. Moreover, single children exhibited a 4.49 increase in the number of words understood, compared with the average score of 36.38. All other effects were nonsignificant, including the proportion of self-feeding, which was not related to thenumber of words understood by infants.

The regression with the MCDI's productive vocabulary at 12 months of age as the dependent variable was nonsignificant ($R^2 = 0.06$, $F(9,162) = 1.29$, $p = .246$), and none of the study variables was significantly related to the outcome, including self-feeding.

The regression with the MCDI's number of actions and gestures at 12 months of age as the dependent variable was significant ($R^2 = 0.13$, $F(9,162) = 2.55$, $p = .009$) and revealed significant positive effects of the fine-motor skill score and gender. A 1 SD increase from the mean in the fine-motor score corresponded to a 0.54 increase in the number of actions and gestures produced. Moreover, girls showed a 0.72 increase in the number of actions and gestures produced, compared with the average score of 8.22.

Table 6 Linear regression analyses with infants' MCDI productive vocabulary at 18 and 24 months as dependent variables.

Variable	*Coeff*	*Robust SE*	95% CI *LL*	95% CI *UL*	*t*	Actual *p*	Bonferroni corrected *p*
DV = MCDI productive vocabulary at 18 months							
Self-feeding	−0.697	1.64	−3.93	2.54	−0.43	.671	ns
Mothers' child-directed utterances	−0.982	1.50	−3.95	1.99	−0.65	.515	ns
Gender	1.532	1.46	−1.36	4.42	1.05	.297	ns
Mothers' education level	0.218	2.69	−5.10	5.54	0.08	.936	ns
Daycare attendance	0.206	1.49	−2.75	3.16	0.14	.891	ns
Presence of siblings	−1.275	1.48	−4.20	1.65	−0.86	.390	ns
Exclusive breastfeeding	−0.375	1.49	−3.32	2.57	−0.25	.802	ns
Pacifier use	−1.575	1.30	−4.13	0.98	−1.22	.226	ns
Fine-motor skills	2.486	1.35	−0.18	5.15	1.84	.068	ns
Infants' total gestures during the meal	1.851	1.74	−1.59	5.29	1.06	.289	ns
Infants' total vocalizations during the meal	1.422	1.74	−2.01	4.86	0.82	.415	ns
Intercept	19.963	2.63	14.77	25.16	7.59	<.001	
R^2			.07*				
DV = MCDI productive vocabulary at 24 months							
Self-feeding	1.729	2.35	−2.91	6.37	0.74	.463	ns
Mothers' child-directed utterances	2.695	2.23	−1.71	7.10	1.21	.229	ns
Gender	0.450	2.16	−3.83	4.73	0.21	.836	ns
Mothers' education level	2.432	3.85	−5.17	10.04	0.63	.528	ns
Daycare attendance	2.498	2.13	−1.72	6.71	1.17	.243	ns
Presence of siblings	−1.409	2.14	−5.64	2.82	−0.66	.512	ns
Exclusive breastfeeding	0.487	2.13	−3.72	4.69	0.23	.819	ns
Pacifier use	−4.634	1.86	−8.30	−0.97	−2.50	.014	$p < .05$
Fine-motor skills	2.960	2.10	−1.20	7.12	1.41	.161	ns
Infants' total gestures during the meal	3.226	2.60	−1.91	8.36	1.24	.216	ns
Infants' total vocalizations during the meal	0.942	2.19	−3.38	5.27	0.43	.667	ns
Intercept	51.529	3.83	43.96	59.10	13.45	<.001	
R^2			.12**				

Note. The observational independent variables (i.e., infants' gestures and vocalizations) during the meal at 12 months are rates (occurrences divided by meal duration). The actual *p*-values before Bonferroni correction and significant effects after Bonferroni correction ($p < .05$) are reported; ns = not significant. **$p < .01$; *$p < .05$.

MCDI = MacArthur-Bates Communicative Development Inventory.

We did not find any other significant effect, including self-feeding, which did not relate tothe number of actions and gestures produced by infants, as reported by mothers.

Eighteen months of age

The regression analysis with the MCDI's productive vocabulary at 18 months of age as the dependent variable was significant ($R^2 = 0.07$, $F(11,153) = 1.89$, $p = .045$). However, none of the study variables was significantly related to the outcome, including self-feeding at 12 months, which was not related to thenumber of words produced by infants at 18 months, as reported by mothers.

The logistic regression analysis with the MCDI's sentence production score at 18 months of age as the dependent variable was only marginally significant ($\chi^2(11) = 18.48$, $p = .071$). None of the study variables was significantly related to the outcome, including self-feeding at 12 months, which was not related to theability to produce sentences at 18 months.

Twenty-four months of age

The regression with the MCDI's productive vocabulary score at 24 months of age as the dependent variable was significant ($R^2 = 0.12$, $F(11,154) = 2.35$, $p = .010$), showing a negative effect of the use of a pacifier during the day when infants were 12 months old. Specifically, a 1 SD increase from the mean in the hours of use of the pacifier at 12 months corresponded to a 4.63 decrease in the number of words produced at 24 months. We did not find any other significant effect for the other variables, including self-feeding at 12 months, which was not related to the number of words produced at 24 months.

The logistic regression with the MCDI's sentence production score at 24 months of age as the dependent variable was

Table 7 Logistic regression analyses with infants' MCDI sentence production at 18 and 24 months as dependent variables.

			95% CI				
Variable	***Odds Ratio***	***Robust SE***	***LL***	***UL***	***Z***	**Actual *p***	**Bonferroni corrected *p***
DV = MCDI sentence production at 18 months							
Self-feeding	0.853	0.17	0.58	1.26	−0.79	.427	ns
Mothers' child-directed utterances	0.755	0.17	0.48	1.19	−1.22	.224	ns
Gender	1.194	0.22	0.83	1.71	0.97	.332	ns
Mothers' education level	1.315	0.38	0.74	2.33	0.94	.347	ns
Daycare attendance	1.472	0.28	1.01	2.14	2.03	.042	ns
Presence of siblings	0.953	0.19	0.65	1.40	−0.25	.806	ns
Exclusive breastfeeding	0.758	0.15	0.51	1.12	−1.40	.161	ns
Pacifier use	0.780	0.15	0.53	1.14	−1.28	.202	ns
Fine-motor skills	1.412	0.27	0.97	2.05	1.81	.070	ns
Infants' total gestures during the meal	1.227	0.25	0.82	1.84	1.00	.319	ns
Infants' total vocalizations during the meal	1.366	0.27	0.92	2.02	1.56	.119	ns
Intercept	0.381	0.11	0.21	0.68	−3.26	0.001	
R^2			0.10				
DV = MCDI sentence production at 24 months							
Self-feeding	2.006	0.52	1.20	3.35	2.67	.008	$p < .05$
Mothers' child-directed utterances	1.381	0.40	0.78	2.45	1.10	.272	ns
Gender	0.981	0.25	0.59	1.63	−0.07	.942	ns
Mothers' education level	0.451	0.26	0.14	1.43	−1.36	.175	ns
Daycare attendance	1.327	0.36	0.78	2.27	1.04	.301	ns
Presence of siblings	1.160	0.33	0.66	2.03	0.52	.603	ns
Exclusive breastfeeding	0.831	0.24	0.47	1.46	−0.64	.522	ns
Pacifier use	0.694	0.14	0.47	1.02	−1.87	.061	ns
Fine-motor skills	1.002	0.28	0.58	1.73	0.01	.994	ns
Infants' total gestures during the meal	1.335	0.59	0.56	3.18	0.65	.514	ns
Infants' total vocalizations during the meal	1.437	0.44	0.78	2.63	1.17	.241	ns
Intercept	15.565	9.40	4.76	50.87	4.54	<.001	
R^2			0.17*				

Note. The actual *p*-values before Bonferroni correction and significant effects after Bonferroni correction ($p < .05$) are reported; ns = not significant. *$p < .05$.
MCDI = MacArthur-Bates Communicative Development Inventory.

significant ($\chi^2(11) = 23.32$, $p = .016$), revealing a significant positive effect of the proportion of self-feeding during the meal at 12 months of age. This means that a 1 SD increase from the mean in the proportion of self-feeding at 12 months corresponded to a 2.01-fold probability of producing sentences at 24 months. All other effects were not significant.

Discussion

This study is the first in the literature to investigate whether 12-month-old infants with greater independent eating skills exhibit more advanced gestural and linguistic abilities, implementing both observational and parent-reported measures. We specifically examined whether infants' self-feeding, observed at 12 months of age, was (i) concurrently related to their gestural and vocal communication, both through meal observation and a parent-reported questionnaire and (ii) longitudinally related to their language abilities, as reported by mothers at 18 and 24 months, when the transition to symbolic communication occurs.

The results revealed that 12-month-old infants who self-fed more frequently during the mealtime were also more likely to produce deictic gestures and simple vocalizations for communicative purposes than infants who ate independently less often, even after controlling for potential confounding variables (i.e., gender, mothers' child-directed speech and education level, exclusive breastfeeding, presence of siblings, daycare attendance, pacifier use, and fine-motor skills). The importance of independent eating for infant's communicative development is further suggested by a significant association between an independent measure of fine-motor skills, measured through the DP3 questionnaire, and language comprehension and gesture production assessed through the MCDI at 12 months. It might be argued that infants who are more involved in self-feeding, actively using their hands and focusing on the actions required to eat, would be expected to produce fewer gestures and vocalizations. This could be because they devote less time and attention to activities other than eating, primarily using their hands and mouth for mastering self-feeding. According to this view, vocalizing or gesturing and self-feeding

would be in competition since the mouth or the hand would need to be used to perform both actions. However, the results from our study suggest a different developmental relation between eating and communicative development, since infants with more control over their food intake produced a higher rate of deictic gestures and vocal acts. At times, infants engaged in self-feeding also had to move the spoon from the hand they were using at that moment to the other hand in order to make a gesture for communicative purposes (see Figure 1), showing coordination of bimanual activity and fine-motor skills. Noteworthy, in BLW, infants assume an active role, being encouraged in taking initiative, freely manipulating different types of food with their hands or utensils, and setting the amount and the pace of food eaten, while eventually vocalizing between one bite and another (Brown et al., 2017; Buglioni et al., 2017). This may promote episodes of joint attention on food during interactions with others and enhance the understanding of new labels referring to food or objects that may be present on the table. These results align with recent evidence reporting positive associations between a BLW style and different developmental outcomes (Addessi et al., 2021; Campeau et al., 2021; Farrow et al., 2025; Webber et al., 2021). Unlike prior research relying on cross-sectional designs and/or parental reports, our work implemented observational measures and adopted a longitudinal design, strengthening the robustness of these findings.

Consistent with the view that motor development and the acquisition of language influence each other reciprocally during the first 2 years of life (Thelen & Smith, 1994), we argue that infants who have more opportunities to manipulate food and use fine-motor skills to eat independently during meals may have advantages in their communicative development. In particular, infants with independent eating skills at 12 months may also show advanced gestural and vocal communication, as both self-feeding and communication involve the use of hands, whether to eat or to communicate with others in the here-and-now context. Parents may have more opportunities to label the food that the child has selected and the actions that the child is performing, eventually commenting on the infant's achievements and facial expressions when tasting a new food. Moreover, the BLW method, starting at 6 months of age, encourages daily engagement in the manipulation of food and goal-directed activities with the hands, and later with culturally-specific eating utensils. This practice helps infants exercise fine-motor skills (e.g., pincer grasp, eye-hand coordination; Carruth & Skinner, 2002). As evidenced by Smith (2013), the way infants interact with objects may play a crucial role in their ability to learn and name those objects. Specifically, actions such as handling and manipulating objects help the visual system develop shape-based categories, which in turn facilitate learning the names of objects. From this perspective, infants who eat unaided more frequently may benefit from practicing motor skills, such as reaching for food, manipulating it, and eventually tasting it. This creates increased opportunities for caregivers to follow in, comment on, and provide verbal labels—that expand infant's understanding of words—and nonverbal assistance on the actions the infant is attempting to achieve, which can be pivotal for communicative development.

In this respect, our results are well supported by a rich literature showing the critical role of maternal contingent talk in response to children's communicative attempts at 1 year of age. Contingent talk (i.e., maintaining and labeling the infant's focus of attention) appears to be especially effective for infants under 18 months, who have limited capacities to interpret others' communicative intentions (Baldwin, 1991). Olson and Masur (2015) found that mothers of 13-month olds respond differently to infants' early gestural bids than they do to early non-gestural bids (i.e., vocalizations, words, gaze to mother and to object), and reported that mother's responses to infants' pointing especially facilitated their later vocabulary acquisition. Using a randomized controlled trial design, McGillion et al. (2017) allocated parents of 142 eleven-month-olds either to a low-intensity intervention to promote contingent talk or to a matched intervention to promote health. Results showed that it is possible to increase caregiver contingent talk and that this is effective in promoting vocabulary growth for lower SES infants, at least in the short term. It is noteworthy that, in our sample, self-feeding was significantly associated with the production of deictic gestures and vocalizations, but not with referential gestures or production of words. Deictic gestures and vocalizations refer to concrete objects that are present in the here-and-now context of the child; thus, they are closely tied to the immediate environment in which they are produced. They also typically appear earlier in infant development compared with referential gestures and symbolic words (Iverson et al., 1994). It is therefore possible that infants who engage more in self-feeding may encounter more opportunities to use deictic gestures and simple vocalizations to make requests and to indicate objects or events around them that are relevant to their immediate needs and experiences, creating new opportunities for exchanges, negotiations, and repairs (Golinkoff, 1986). In a different context and routine, such as playtime, we might expect that referential gestures and words, which are employed to communicate about a specific referent in a decontextualized, symbolic manner (Iverson et al., 1994), could be utilized to a greater extent and be more appropriate.

Importantly, our longitudinal analyses showed that self-feeding abilities, directly observed at 12 months during the meal, were significantly and positively related to sentence production at 24 months, as reported by mothers. This suggests that the ability to eat independently can have cascading effects on combinatory language development 1 year later. Early acquisitions in self-feeding practices may reorganize, in the daily context of the meal, the child's behavior, marking a complex and dynamic process, where early skills lay the foundation for later abilities (Thelen & Smith, 1994). Indeed, self-feeding requires infants to develop fine-motor skills, hand-eye coordination, and the ability to manipulate objects effectively (Carruth & Skinner, 2002). These motor skills are not isolated but are intertwined with other cognitive processes, such as attention, imitation, and visual object recognition, which contribute to the development of language (Smith, 2013). Both the abilities to manipulate real-life objects and to combine words into sentences share a common underlying skill, namely the capacity to establish connections, whether between tangible items (e.g., food) or abstract concepts (e.g., words). For instance, a child who uses her hands to eat, thus being free to squeeze, beat, or mash the food, may gain more opportunities to learn about the properties of those items, form representations of what they see, taste, and interact with, and understand the causal relations between them (Clark, 2003). We argue that increased physical interactions with the world can lead to a deeper understanding of causal links between objects, which, in turn, may support the development of more complex linguistic structures to express them.

However, contrary to our expectations, self-feeding at 12 months was not related to vocabulary size at 12, 18, and 24 months, as reported by mothers. Based on previous evidence (Farrow et al., 2025; Webber et al., 2021), we hypothesized that self-feeding would be positively related, both concurrently and longitudinally, to the number of words infants were able to produce. However, our study differs in methodology from previous research. Webber et al. (2021) relied on parental reports of complementary feeding practices, whereas our study employed an observational measure of self-feeding. Additionally, Farrow et al. (2025) used exclusively observational measures to examine both infant self-feeding and total vocalizations (without a distinction between possible subcategories, such as simple vocalizations, protowords, and words) and did not correlate parent-report MCDI variables with observed self-feeding measures, as we did in the present study. These methodological differences limit the direct comparison between studies and could account for variation in the results. Furthermore, it is possible that the impact of the motor activities involved in self-feeding on general vocabulary acquisition was overshadowed by other factors occurring during the meal, likely more relevant for the acquisition of new words. For example, self-feeding typically occurs within the context of family meals, in which social interactions with caregivers and family members may play an important role in supporting vocabulary growth (Webber et al., 2021). These interactions, involving joint attention and verbal prompting from different conversational partners, were not specifically addressed in our study but are important aspects that warrant further exploration. Future research should consider examining these contextual factors, as they may explain the variability in language development observed in relation to self-feeding.

Finally, we found some interesting relations between the covariates and primary variables. Infants exposed to a greater number of mothers' utterances during meals exhibited significantly more gestures, vocalizations, and words compared with infants whose mothers produced fewer utterances, indicating a significant impact on infants' gestural and vocal production at 12 months. These findings are consistent with a growing body of work showing that children's exposure to language predicts their linguistic and neurocognitive outcomes (Romeo et al., 2018; Weisleder & Fernald, 2013). Particularly notable is the association with gestures, which is an innovative aspect of our study as previous research has primarily focused on infants' vocal production. This enhances the role of gestures as fundamental in supporting communicative development and word learning (Iverson & Goldin-Meadow, 2005). Furthermore, attending daycare centers was significantly related to communicative development, with infants attending daycare centers exhibiting more referential gestures at 12 months, in comparison to infants not attending daycare centers. This aligns with findings from other studies highlighting the positive impact of structured opportunities and stimulating environments offered by daycare centers (e.g., Burchinal et al., 2000) and childcare programs (e.g., Weigel et al., 2011) on infants' cognitive and language development. The presence of siblings was associated with lower language comprehension in infants at 12 months, as reported by mothers. It has been suggested that having siblings may influence the first stages of children's communicative development and, as the number of siblings increases with closer spacing between them, this disadvantage enlarges (Steelman et al., 2002). Parents have limited resources and amount of time that they can dedicate to the care of their offspring, so with the arrival of a sibling in the family the available time is divided among the children present. Especially for very young infants, the time parents have available to specifically focus on them during face-to-face interaction can indeed have a direct impact on their communicative development. Finally, infants using the pacifier during the day at 12 months scored lower in productive vocabulary at 24 months. Despite limited scientific evidence (e.g., Barca et al., 2020), it is reasonable to assume that prolonged pacifier use during the day may limit infants' engagement in early speech sounds and expressive communication.

Strengths, limitations, and future directions

The present study, to the best of our knowledge, was the first to implement a multi-method approach and a longitudinal design in order to examine the associations between independent eating and communicative development within the first 2 years of life. Recent studies have highlighted positive associations between infant self-feeding practices and developmental milestones, including earlier crawling associated with low spoon-feeding frequency (Addessi et al., 2021), improved fine-motor skills in infants exposed to a BLW approach (Campeau et al., 2021), and advanced language development linked to more frequent unaided eating at the onset of the complementary feeding period (Farrow et al., 2025; Webber et al., 2021). However, research in this area is still limited, and the present study makes a valuable contribution to the existing literature. On the one hand, our multi-method approach, integrating parent-report questionnaires and observational measures, provided a robust and comprehensive examination of the relations between infants' self-feeding and communication. On the other hand, our longitudinal design offered insights into the directionality of the observed effects and facilitated the exploration of whether and how infants' self-feeding could influence communicative development. Moreover, in the Italian "on-demand complementary feeding method" (e.g., Piermarini, 2002), parents are encouraged to let infants participate in the meal since the beginning of the complementary feeding period, and infants learn how to eat by observing other participants and by imitating their specific manners while eating. Previous studies have highlighted the importance of observational learning to increase the acceptance of a non-preferred or novel food (e.g., Addessi et al., 2005), but its role during family meals deserves further investigation.

While our study has notable strengths, it also presents limitations. First, there was a homogeneity issue concerning mothers' high education level, potentially restricting the generalizability of our results. Future research should include a more heterogeneous sample, encompassing different socioeconomic backgrounds, to enhance the applicability of the findings to a broader population and to better identify possible SES differences in the study variables. Moreover, despite the multi-method approach employed, questionnaires about infants' language development and fine-motor skills were exclusively completed by mothers to ensure consistency in reporting. The inclusion of multiple perspectives in future research could improve the validity of the collected data, as different caregivers may observe and report on different aspects of the infant's behavior and development.

Notwithstanding the above limitations, the overall positive associations between self-feeding and communicative abilities suggest that interventions promoting autonomous eating may contribute to improved communicative skills. Professionals could consider incorporating strategies that encourage self-feeding in their programs, recognizing this practice as a potentially influential factor in the development of both fine-motor skills and communicative abilities. Furthermore, the picture emerging from our results is that the development of feeding during ontogeny is not a solitary activity, and that the milestone of independent feeding is part of our social cognitive skills and develops within a social context and in concert with communicative abilities. In this light, it is remarkable that we observed many infants (72 infants, corresponding to 39.6% of the sample) offering their own food to other participants during the meal, a gesture that has been viewed as prosocial and altruistic in the developmental literature (Barragan et al., 2020). It becomes evident that autonomous feeding is not merely a physiological process but is deeply embedded within the infant's social and cultural context.

Data availability

The data necessary to reproduce the analyses presented here are not publicly accessible. The analytic code necessary to reproduce the analyses presented in this paper is not publicly accessible. The materials necessary to attempt to replicate the findings presented here are not publicly accessible. The analyses presented here were not preregistered.

Author contributions

Giulia Pecora (Conceptualization, Data curation, Investigation, Writing— original draft, Writing—review and editing), Francesca Bellagamba (Conceptualization, Methodology, Project administration, Resources, Supervision, Writing— original draft, Writing—review and editing), Valentina Focaroli (Investigation), Melania Paoletti (Investigation), Mariarosaria Ciolli (Investigation), Elisa Iaboni (Investigation), Noemi Palladino (Investigation), Alice Di Prete (Data curation), Claire Farrow (Conceptualization, Methodology, Writing—review and editing), Laura Shapiro (Methodology), Amy T. Galloway (Conceptualization, Methodology, Writing—review and editing), Flavia Chiarotti (Formal analysis), Corinna Gasparini (Investigation), Barbara Caravale (Methodology), Serena Gastaldi (Data curation), and Elsa Addessi (Conceptualization, Formal analysis, Methodology, Project administration, Resources, Supervision, Writing— original draft, Writing—review and editing) All authors have read and agreed to the published version of the manuscript.

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Conflicts of interest

None declared.

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