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MOTHERS' USE OF GESTURES AND THEIR RELATIONSHIP TO CHILDREN'S LEXICAL PRODUCTION

This study examines the relationship between mothers' use of gestures and the lexical production of their children, measured in a joint book-reading task. Fifteen mother-child dyads participated, all monolingual native speakers of Mexican Spanish. Children were boys and girls with typical development, aged 48 months. Each reading session was videotaped and analyzed to calculate the gestural production of mothers and the lexical production of children. The results showed a significant positive correlation between the number of mothers' gestures and the number of distinct words used by the children. Mothers' gestural communication was related to the size of the vocabulary children produced in joint book-reading.

Keywords: gestures, deictic, lexical production, joint book-reading

Mothers' Use of Gestures and Their Relationship to Children's Lexical Production

Gestures are defined as movements of the hands or arms produced while people are speaking (McNeill, 1992). The hands are symbolic instruments that perform movements synchronized with speech, and hand gestures have been regarded as elements that convey semantic information (McNeill, 1992) and play a significant role in communication (Bavelas et al., 2002). They reveal a concept of the mind (Kendon, 2007) that is not always expressed, or cannot be expressed, through words (Bavelas et al., 2002; De Ruiter et al., 2012; Goldin-Meadow, 2000; Özçalışkan et al., 2014). Gestures and speech coexist and can reveal different semantic aspects of a single underlying cognitive representation that form an integrated system (Bavelas & Chovil, 2000, 2006; McNeill, 1992; McNeill & Duncan, 2000).

McNeill (1992) distinguishes four types of gestures according to their referential value: deictic, iconic, metaphoric, and beat. Deictic gestures are movements that point to, show, offer, give, or request an object (Capirci et al., 1996); typically, these gestures are made with the fingers, but any extensible object or other part of the body (e.g., head, nose, chin) can be used (Haviland, 2000; Krauss et al., 2000; McNeill, 1992). Iconic gestures represent an object, event, or action (McNeill, 1992), and are direct representations that take the place of an object or experience and reveal meaning related to the semantic content of speech (Holler & Beattie, 2002, 2003; Kita, 2000; McNeill, 1992; McNeill & Levy, 1982). Metaphoric gestures represent abstract ideas (McNeill, 1992) and present abstract concepts as physical objects, such as when a speaker refers to a concept like "peace" and represents it as a delimited and spatially localized object (McNeill, 1985). Beat gestures, also called baton gestures, are movements that follow the rhythm of speech; they have no discernible meaning and are typically in/out or up/down movements whose semiotic value is linked to their pragmatic content (McNeill, 1992). Deictic and conventional gestures—which McNeill (1992) also refers to as emblems—are commonly used in interactions between mothers and children (Iverson et al., 1999). Conventional gestures are movements inserted in a social routine whose meaning is culturally established, such as waving the hand to communicate "goodbye" (Iverson et al., 1999; Rodrigo et al., 2006). Fewer metaphoric and beat gestures have been reported in interactions between mothers and children than in interactions between adults (Bekken, 1989).

Gestures predict the appearance of linguistic milestones (Goldin-Meadow, 2015; Kuhn et al., 2014): children who produce more gestures at an early age produce more words in the course of their development (Sauer et al., 2010), and the use of gestures in early childhood (e.g., at 11 months of age) significantly advances the onset of children's first words (Colonnese et al., 2010; Goodwyn et al., 2000). Moreover, the production of gesture-word combinations predicts the onset of infants' production of two-word utterances (Iverson & Goldin-Meadow, 2005). Gestures are considered a tool in children's cognitive growth as a way

for children to explore ideas that can be difficult for them to express in speech (Goldin-Meadow, 2009; Wall, 2006). Gestures propel children to the next step in language development because they reduce cognitive load; they offer children a cognitively easier communicative tool to express or think about complex ideas (Goldin-Meadow, 2000; Özçalışkan et al., 2017).

Several studies have demonstrated that infants' use of gestures fulfills functions that precede, facilitate, and complement language development (Acredolo & Goodwin, 1988; Goodwyn et al., 2000; Volterra et al., 2005). Gestures have communicative functions with underlying symbolic and cognitive processes (Capone & McGregor, 2004). However, their meaning and functions change depending on children's communicative needs, their cognitive development, and the social context. Representational gestures, for example, decline in relation to an increase in verbal production (Iverson et al., 1994), and iconic gestures accompany speech (Nicoladis et al., 1999). Parents play an important role as models of gestural production (Acredolo & Goodwin, 1988); the gestural behavior of parents not only serves as a model for children but it is also related to their production and verbal comprehension. The evolution of gestural production and comprehension is maintained throughout children's development (Goldin-Meadow, 2000); changes in communicative function and meaning, thus, depend largely on children's experience in communicative interactions.

Parents use gestures when they interact and communicate with their children (Acredolo & Goodwyn, 1988; Özçalışkan & Dimitrova, 2013); they employ multimodal communicative behavior (e.g., speech and gestures) which is adapted to children's language abilities. Iverson et al. (1999), for example, found that mothers adapted their gestural production to their children's development. Although diverse explanations have been offered for these adaptations (e.g., O'Neill et al., 2005), we believe that these parental modifications are adjusted to children's abilities in order to facilitate their learning (Grimminger et al., 2010). With this hypothesis in mind, our study analyzed the role of gestures in mothers' communication directed to their children. Our aim was to observe whether there is a developmental relationship between maternal gestures and children's verbal language in the Mexican Spanish-speaking population. This phenomenon also needs to be studied in other languages in order to know whether the relationship is universal or specific to the cultural context.

A high positive correlation has been found between mothers' production of gestures and children's production of gestures and vocabulary size. For example, Iverson et al. (1999) reported a significant correlation between Italian mothers' deictic gesture production (specifically, pointing gestures) and children's vocabulary size at 16 months, but not at 20 months, in joint play and at meal or snack time. These authors also reported that mothers' gestural production at 16 months predicted children's word production (word tokens) at 20 months. Similarly, Pan et al. (2005), in an observational study of free interactions, found that children whose mothers made more pointing gestures showed faster vocabulary growth than other children.

Parents provide gestural models that influence children's vocabulary development (Özçalışkan & Dimitrova, 2013). Rowe and Goldin-Meadow (2009) reported that parents of higher socioeconomic status (SES) use more gestures to communicate with their children with a broader range of meaning (that is, more gesture types with different meanings) than their low-SES counterparts. Infants with high-SES parents use more gestures at 14 months of age than those with low-SES parents, and these differences could explain the effect of SES on the size of vocabulary in both groups at the time of starting school (54 months of age). In another study, Rowe et al. (2008) found that parents' gestural production is also indirectly related to their infants' late vocabulary development. They observed that infants' gestural production at 14 months of age is a predictor of their vocabulary size at 42 months of age. Similarly, Igalada et al. (2015) showed that production of simultaneous gesture-speech combinations by Spanish-speaking infants during controlled social interactions at 12 months of age predicted language development at 18 months. The data obtained supported the idea that deictic (pointing) gestures synchronized with speech are related to later language development, specifically with respect to vocabulary and morphosyntax.

Based on the observation that parents modified multimodal communication directed to their children, Grimminger et al. (2010) analyzed modification by mothers and its relation to children's lexical development. They examined the gestures of German-speaking mothers interacting with their 22- to 24-month-old children in a task-oriented dialogue, dividing them into two groups: those with typically developing children and those with late-talking children. The mothers of late-talking children used more deictic gestures than those with typically developing children; in general, the mothers of late-talking children produced significantly more gestures, and significantly more spoken words accompanied by a gesture, than the other group. Mothers thus adjusted their gestural production according to children's verbal abilities.

The relationship of gesture with verbal comprehension is of particular interest around the age of four years. Studies demonstrate the extent to which gestures often reinforce a message or transmit information not expressed by spoken words (Greenfield & Smith, 1976; Özçalışkan & Goldin-Meadow, 2005; Zukow-Goldring, 1996). In this regard, it is very likely that parents' gestures can facilitate understanding of a message addressed to their children (Rowe et al., 2008; Stanfield et al., 2013). Stanfield et al. (2013) found that this comprehension emerges when children begin to produce gesture-speech combinations (at the age of three years). Four-year-old children scored a larger number of correct answers in a task to measure understanding of the meaning of gesture-speech combination than three-year-olds, who, in turn, scored higher than two-year-olds; the study found that four-year-old children have a greater ability to extract meaning from gestures not expressed by words. We believe that the study of children at this age is important because their greater comprehension of gesture-speech combination allows us to observe its implications on their expressive vocabulary.

If gestures facilitate the verbal comprehension of children, it is possible that they will show better communicative competence in a dyadic interaction. Misunderstandings about the referential meaning of a word are reduced if, for example, parents indicate an object with a deictic gesture (Zukow-Goldring, 1996). Gesture-speech combination provides children with the most complete message (Özçalışkan & Dimitrova, 2013) and ensures greater comprehension (Cook & Goldin-Meadow, 2006). If mothers communicate meaningful content through both, gesture and speech modalities, in which a gesture reinforces the oral message or adds information to it (Greenfield & Smith, 1976; Özçalışkan & Goldin-Meadow, 2005), they can provide children with more significant elements (a richer communicative scenario) to build the messages in dyadic interaction.

Joint book-reading encourages communicative interaction and reveals the richness of the communicative strategies used by both parents and children (Arias, 2014). Studies have found that in this activity, mothers use large vocabularies, stimulate interaction with their children by asking questions, and use social regulatory speech less frequently (Jones & Adamson, 1987; Lewis & Gregory, 1987). It has also been observed that when the attention of both, mother and child, is focused on the book, the particular features of “mothers’ speech” appear, which promote language acquisition (Dunn et al., 1977) and early expressive language development (Farrant & Zubrick, 2011; Trivette et al., 2010). Ard and Beverly (2004) found that joint book-reading promotes vocabulary acquisition, especially of nouns and verbs. Observing dyadic interactions with 48-month-old children who perform this narrative activity daily could add to our understanding of its dynamics (Rossmanith et al., 2014), and, in particular, the role played by mothers’ multimodal communicative behavior. We focus on showing how these multimodal communication strategies are linked to the child’s communication development.

Children at the age of 48 months already have a vocabulary size of at least 50 to 100 words (Bates et al., 1994; Galván & Alva, 2007; Jackson-Maldonado et al., 1993) whose acquisition is associated with multiple factors (D’Odorico et al., 2001; Golfield & Reznik, 1990). Our study analyzes whether mothers’ gestures play an important role in children’s lexical production by examining their production of gestures when they interact with their children in a joint book-reading task. Although by this age children have acquired a considerable number of words with which to communicate, maternal gestures might continue to have an influence on their communicative development as their communication skills become more complex. We analyze children’s lexical production with attention to grammatical categories that illustrate the complexity of their discourse and its association with their mother’s production of gestures.

Mothers’ multimodal communication and children’s lexical production have been analyzed during free play and free interactions (e.g., Iverson et al., 1999; Pan et al., 2005); however, little is known about their relationship in the context of joint book-reading. Murphy (1978) studied deictic gestures during joint book-reading in 32 mother-child dyads. Using microanalytic techniques,

she described how these dyads use pointing gestures, and found that pointing is a routine behavior that has different functions according to the infant's age. More recently, Rohlfing et al. (2015) compared mothers' nonverbal behavior with their children in joint book-reading and in free play. As expected, the longitudinal data from 18 mother-child dyads showed that children pointed significantly more often during reading than in play, meaning that mothers varied their gestural behavior according to the context. They also confirmed that when infants were 14 months old, maternal gestural behavior correlated positively with receptive and productive vocabulary, as measured by the ELFRA language survey (a standardized parental report about the words their child produces or comprehends).

The relationship between mothers' gestures and children's speech in book-reading interactions has also been examined by Lavelli et al. (2015), who analyzed the frequency and types of gestures produced by mothers of 45 Italian preschool children with specific language impairment (SLI) during shared book-reading, comparing them with mothers of typically developing children, and the potential effectiveness on children's responsiveness of those gestures-accompanying speech. Children with SLI and their mothers used more bimodal utterances (speech with gesture), than mothers and their typically developing children. Sequential analysis showed that the use of gestures by mothers in the SLI group had a significant probability of being followed by children's initiatives. This may indicate that the mothers are able to tune their communicative behavior to their children's linguistic limitations, though the authors also raise the intriguing possibility of influence in both directions.

Our interest in the current study was to observe whether mothers' gestures in joint book-reading are related to children's word production in the cultural and linguistic context of Mexican Spanish. The study of gestures in a shared context allows us to observe how multimodal communication operates in the highly coordinated activity of book-reading. It is known that communities and cultural groups share ways of gesturing that differentiate them from other groups or cultures (Kendon, 1995), that is, that there are cultural differences in the form and meaning of gestures (Kendon, 2004). Although specific gestures consistently convey specific kinds of meaning, their use in interaction is part of a complex, shared communication system whose meaning also depends on context (Kendon, 2017; McNeill, 1992). To avoid reductionism, we must consider variables such as the type of interactive task and the participants involved in the interaction.

Analysis of the relationship between mothers' gestural behavior and children's language development will help us to describe the emergence of lexical production in Spanish-speaking children as a discursive feature involved in particular contexts. While previous studies have shown that mothers adjust their communicative behavior to infants' language development, we consider the possibility of a bidirectional process in a dyadic interaction of interactive communication through joint book-reading. Our study hypothesized a positive

correlation between the use of mothers' gestures and the number of words produced by children in a joint book-reading task. We identified the grammatical category produced most often by the children and whether the production of this category was also associated with their mothers' gestural production. We also predicted a relationship between mothers' deictic gestures and the grammatical categories produced by their children.

Method

Participants

Twenty mother-child dyads participated in the study. All were videotaped; five dyads were excluded from analysis because the participants moved in a way that located their gestures outside the camera range (e.g., they held the book in a position that hid the movement of their hands), or they held the book in a way that prevented them from performing gestures. The children were 48 months of age ($M = 48.3$; $SD = 0.55$), boys ($n = 8$) and girls ($n = 7$) with typical development. According to parental reports, they had no serious prenatal, perinatal, or postnatal problems, and no visual impairment or hearing problems. Their verbal abilities were evaluated with the Wechsler Preschool and Primary Scale of Intelligence III, Verbal IQ subscale (Wechsler, 2013). The mean Verbal IQ was 30.73 ($SD = 5.43$), and a Shapiro-Wilk test indicated the normality of the data, suggesting that the group was homogeneous with respect to verbal ability. Mothers and children were both monolingual native speakers of Mexican Spanish. Mothers had an average of 15.87 years of formal education ($SD = 1.76$) and an average age of 33.6 years ($SD = 6.87$).

Data Collection

The mothers were given instructions for the joint book-reading task and provided written informed consent to be video-recorded in this activity. They answered a sociodemographic questionnaire (Alva & Arboleda, 1992) which included questions about children's date of birth, condition at birth, and medical history, as well as relevant data about the mother. All of these activities were carried out in a single session, in a child-friendly laboratory room with a table and comfortable seats for the participants and ample space for movement.

The book used in the joint book-reading session was *Frog on His Own* (Mayer, 1973), which presents a series of 24 illustrations without words, and is specifically addressed to children aged 48 months. It has been used in previous studies on gestures and language (e.g., Kuhn et al., 2016; O'Neill & Holmes, 2002). No researchers were present in the laboratory room while the participants performed the narrative task. Following instructions, the mother first told the child a story based on the book's illustrations. Then she asked the child to tell a story. Children were not encouraged to imitate the mother. The instructions were as follows: "We will give you an illustrated book without any words.

Please tell your child a story based on the illustrations, and when you have finished, give your child the book and ask them to tell you a story. When you have both finished telling your stories, open the door of the laboratory room to signal that you are done.” Each joint book-reading session was videotaped with a camera.

We placed no time restrictions on the task, but we chose videos for analysis within a range to avoid the influence of time as an interference variable: the dyadic interactions used for this analysis had an average duration of 13.21 minutes ($SD = 3.2$). The joint book-reading task limited the communicative behavior of the participants, directing it toward the elements presented in the book, such as the characters and the actions they perform; thus, the task itself provided a control for both gestural and lexical production. We recognize that gestural and lexical production of the participants can be the result of different factors, but we also believe that joint book-reading is a space of meaning and action that emerges through dyadic interaction (see Rossmanith et al., 2014).

Coding and Analysis of Data

An analysis of the videos was performed to calculate the gestural production of the mothers and the lexical production of mothers and children for each of the 15 dyads. The analysis was divided into two parts: 1) the mother's turn, in which she told her story based on the illustrations in the book; and 2) the child's turn, in which they told a story. In the first part, the approaches to identification and categorization of McNeill (1992) were used to analyze the mothers' gestures. Gestures were classified into one of McNeill's four categories: deictic (e.g., extending the index finger to point to an object), iconic (e.g., both hands forming a spherical figure to represent a ball), metaphoric (e.g., both hands forming a spherical figure to represent fear), or beat (e.g., a hand moving up and down), or as conventional gestures whose meaning was culturally established (e.g., waving the hand with the palm extended to communicate “hello”) (Iverson et al., 1999; Rodrigo et al., 2006). It should be emphasized that only gestures performed in conjunction with speech, that is, gesture-speech combinations, were taken into account, based on the criteria of McNeill (1992). As previously noted, gesture-speech combinations can offer children a more complete message because gestures reinforce the oral message or add information (Özçalışkan & Goldin-Meadow, 2005). Gesture coding was carried out by two trained coders working independently, whose reliability was demonstrated by their 90% agreement on gesture identifications (Appendix A provides a detailed description of the coding process).

To measure the children's and mothers' lexical production, a full transcript of the recordings was prepared and incorporated into a database. When coders had difficulty understanding and transcribing a word, it was noted as unintelligible. After a review of the transcription, the children's and mothers' lexical production was coded by word types (the different words produced, which constitute the

breadth of the child's vocabulary) and word tokens (the total number of words produced, including repeated words). These measures of verbal production were coded based on the grammatical categories used by Alva (2004) in studies of vocabulary among Mexican children: nouns, verbs, adjectives, adverbs, articles, pronouns, prepositions, interjections, and conjunctions (Appendix B provides a description of these categories). This coding was also performed by two trained coders, whose agreement was 87%; discrepancies in classification were reviewed by a third coder. Word types and word tokens were thus calculated in general and for each grammatical category.

The total number of mothers' gestures and the total production for each gestural category were calculated, along with the total number of children's word types and tokens, and the number of word types and tokens for each grammatical category. In order to obtain a broader view of the mothers' communicative behavior, their lexical production was also taken into account (the transcription also allowed us to calculate the total number of mothers' word types and tokens). The most frequently produced gestures and grammatical categories were identified. Finally, a correlation analysis was carried out to identify the relationship between the mothers' gestures and the lexical production of their children, and a linear regression analysis was performed to determine the impact of gestures on the children's lexical production. Although it has been shown that mothers adjust their gestural behavior to children's verbal abilities (Grimminger et al., 2010), we believe there is the possibility of a bidirectional process (Lavelli et al., 2015) in the joint book-reading task, that is, the possibility that mothers' gestures also affect the expressive vocabulary of their children (Özçalışkan & Dimitrova, 2013). For this reason, we carried out linear regression analysis with this directionality: to show that mothers' gestural production also affects children's lexical production.

Results

The aim of this study was to identify the relationship between the gestural production of mothers and the lexical production of their children in a joint book-reading task. The first analytical step was to examine the 15 mothers' communicative behavior (gestural and lexical production) during the task. We obtained the total number of gestures produced by mothers when they interacted with their children and classified them into five categories. The mean total production was 61.27 gestures (*min* = 5, *max* = 105, *SD* = 30.63): 48.60 (*SD* = 26.22) were deictic, 9.40 (*SD* = 10.40) iconic, 0.07 (*SD* = 0.26) metaphoric, 2.47 (*SD* = 3.07) beat, and 0.73 (*SD* = 0.70) conventional (see Figure 1).

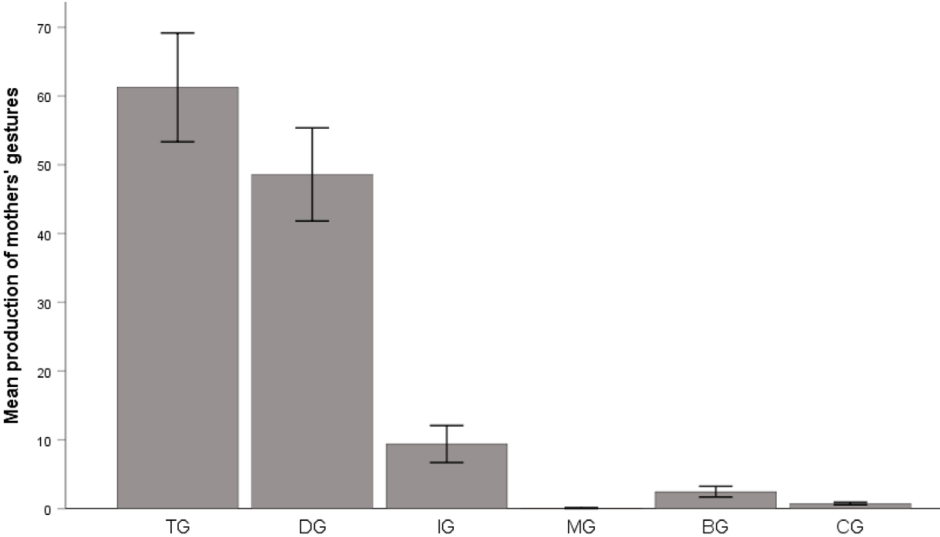


Figure 1 Mean Production of Mothers' Gestures

Note. Total gestures (TG), deictic gestures (DG), iconic gestures (IG), metaphoric gestures (MG), beat gestures (BG), and conventional gestures (CG). Error bars represent ± 1 SE.

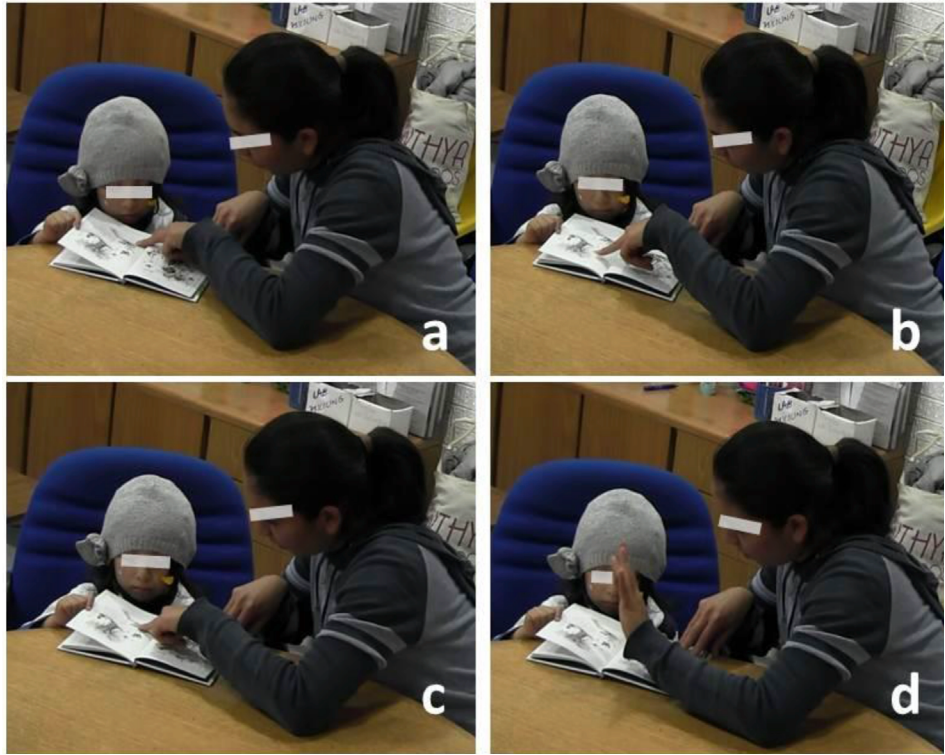


Figure 2 Dyadic Interaction in a Joint-Book Reading Task

Figure 2 shows a mother performing deictic gestures (a, b, and c) while telling a story based on the images of the book. When the mother said “La rana se quedó ahí en el río, con los mosquitos y las mariposas” [The frog stayed there in the river, with the mosquitoes and butterflies], she gestured three times, pointing to images of the river, the mosquitoes, and the frog. She also used a conventional gesture while saying “La rana le dice adiós niño” [The frog says goodbye, little boy]. This gesture of “goodbye” is used in social routines: she closes and opens her palm (d).

Figure 3 shows another example in which a mother produces a deictic gesture. The girl listens to the story her mother tells and looks at an image in the book (a). When the mother uses a deictic gesture, a movement of the index finger to point to an image and says at the same time “Le llegó otra ranita; acá, acá mira” [Another little frog came up to him; here, here, look], the girl directs her gaze to that image (b).



Figure 3 Dyadic Interaction in a Joint-Book Reading Task

The mothers' lexical production was analyzed with two purposes: a) to identify a possible relationship between the mothers' gestural production and their lexical production, and b) to analyze whether the mothers' lexical production was correlated with children's lexical production. The mean total of the mothers' production was 259.87 word types ($SD = 52.14$) and 812.87 word tokens ($SD = 289.56$). The word types most frequently produced were verbs ($M = 105.73$, $SD = 27.55$), followed by nouns ($M = 53.33$, $SD = 13.90$) and adverbs ($M = 25$, $SD = 6.68$). The most frequently produced tokens were also verbs ($M = 182.60$, $SD = 70.83$), followed by nouns ($M = 131.20$, $SD = 37.27$) and conjunctions ($M = 90.40$, $SD = 49.20$).

A correlation analysis was carried out to examine the relationship between the mothers' gestures and their lexical production. There were significant correlations between the total number of gestures and production of word types ($r = 0.523$, $p < 0.05$), and between the mothers' years of education and production of word types ($r = 0.579$, $p < 0.05$). No relationship was found between the mothers' gestural production and their years of education. That is, mothers who

showed greater production of different words also produced more gestures, and lexical production was associated with years of education.

The next step was to analyze the children's lexical production. After coding and analyzing the transcription, the total number of words in each grammatical category was identified. Table 1 presents the mean production of each grammatical category for word types and word tokens. Verbs were the word type most frequently produced, followed by nouns and adverbs. Nouns were the most often produced tokens, followed by verbs and articles. These results indicate that children produced a greater number of different verbs than other grammatical categories ($X^2(8) = 102.394$, $p < 0.05$). They also produced a larger number of noun tokens: that is, of the total number of words including repeated words, nouns were the most produced ($X^2(8) = 79.726$, $p < 0.05$). Non-significant differences were found between girls and boys in lexical production (word types: $t(15) = .139$, $p = .892$; word tokens: $t(15) = 1.387$, $p = .189$), where boys presented slightly more word types (117.75 ± 28.92) than girls (115.57 ± 31.96), and girls more word tokens (407.86 ± 154.23) than boys (310 ± 118.73).

Table 1 Mean Production of Word Types and Word Tokens: Children's Lexical Production

	Total	Nouns	Verbs	Adjs.	Advs.	Arts.	Prons.	Preps.	Conjs.	Interjs.	Unintell.
Word Types	116.73	28.47	40.13	8.47	11.13	5.33	8.13	4.53	4.47	5.20	.87
SD	29.28	10.92	12.42	3.42	3.46	1.50	1.92	1.30	1.54	2.40	.52
Word Tokens	355.57	66.47	63.53	21.53	35.60	51.53	36.67	15.13	49.00	8.67	7.53
SD	140.71	35.11	23.05	17.90	10.41	32.05	15.49	9.76	27.83	7.38	6.97

Note. The column Total represents the total number of word types and word tokens. The other columns indicate the number of word types and word tokens by grammatical category.

A correlation analysis was carried out to examine the relationship between the mothers' communicative behavior (linguistic and gestural) and the children's lexical production. We examined whether the mothers' gestures in the joint book-reading task had any relationship to children's lexical production in that activity. Specifically, we analyzed the relationship between deictic gestures (the category most produced by mothers) and the grammatical categories most produced by children (nouns and verbs). We also explored the mothers' lexical production (the grammatical categories they produced most often) and its relationship with the children's lexical production (word types and word tokens) (see Table 2). The results showed a significant correlation between the number of mothers' gestures and the number of word types their children produced; however, no relationship

was found between the mothers' gestures and the number of word tokens. A correlation analysis was also carried out to assess the relationship between specific gestural categories and the breadth of the children's vocabulary (word types). A significant correlation was found between deictic gestures and the number of word types. A greater number of gestures produced by mothers, particularly deictic gestures, was thus associated with a greater production of different words by their children (see Figure 4).

Table 2 Correlation Between Mothers' Gestural and Lexical Production and Children's Lexical Production

Mothers' communicative behavior	Children's lexical production					
	Word types			Word tokens		
	Total	Nouns	Verbs	Total	Nouns	Verbs
Gestural production	.535*	.501	.582*	.327	.081	.598*
Deictic gesture	.530*	.518*	.576*	.238	.109	.549*
Lexical production (Word types)	.399	.504	.501	.251	.125	.456
Nouns	.565*	.728**	.590*	.245	.172	.569*
Verbs	.260	.242	.408	.216	-.016	.356

Note. * $p < 0.05$ and ** $p < 0.01$.

Next, the relationship between the mothers' gestures and the grammatical categories of words produced by their children was analyzed. A significant correlation was found between the mothers' gestures and the total number of different verbs the children produced, as well as between the deictic gestures and the number of different verbs. Likewise, a significant correlation was found between the mothers' gestures and the children's verb tokens (the total number of verbs produced, including repeated words), as well as between the deictic gestures and verb tokens.

Regarding the mothers' lexical production, the results showed a significant correlation between the number of different nouns produced by the mothers and the number of word types produced by the children, as well as between the number of mothers' and children's different nouns. In addition, a relationship was found between the number of mothers' different nouns and children's different verbs, and between the mothers' different nouns and the children's verb tokens. However, no relationship was found between the mothers' lexical production (number of word types and number of word tokens) and the children's lexical production. Thus, the mothers' gestural and lexical production (different nouns) was associated with the lexical production of their children, specifically with verb production (different verbs and verb tokens).

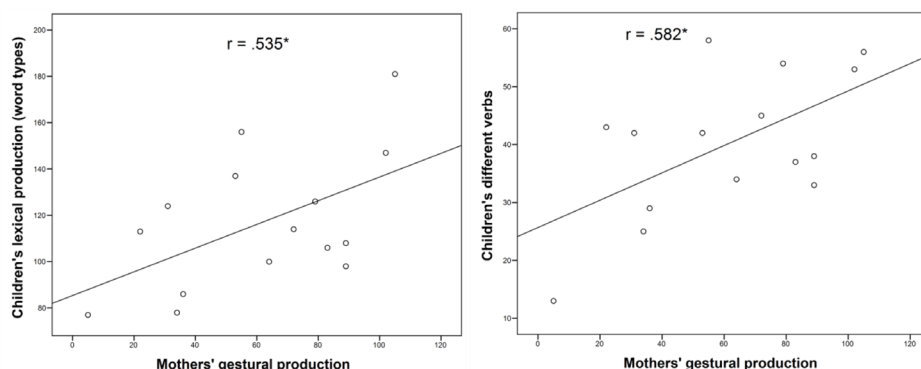


Figure 4 Scatter Plots Showing Relationship Between Mothers' Gestural Production and (i) Children's Lexical Production and (ii) the Number of Children's Different Verbs

A linear regression analysis was carried out to further analyze the effect of the number of mothers' gestures on their children's lexical production. The total number of mothers' gestures (all categories) had a significant impact on children's word type production: $\beta = .535$, $p < 0.05$. The production of gestures (total number) explained 28.6% of the variance in the breadth of the children's vocabulary (word types) ($F(1, 13) = 5.216$, $p < 0.05$). The linear regression analysis showed that the total number of gestures had a significant effect on the number of different verbs children produced: $\beta = .582$, $p < 0.05$. The total number of gestures produced by the mothers explained 33.8% of the variance in the production of different verbs by their children ($F(1, 13) = 6.652$, $p < 0.05$). Deictic gestures produced by the mothers also had a significant effect on their production of different verbs: $\beta = .576$, $p < 0.05$. The production of deictic gestures by the mothers explained 33.1% of the variance in their children's production of different verbs ($F(1, 13) = 6.441$, $p < 0.05$). All of these results show that gestures may have an effect on children's lexical production.

Discussion and Conclusions

The aim of this study was to analyze the relationship between mothers' gestures and the lexical production of their four-year-old children in a joint book-reading activity. The gestures used by the mothers in our joint book-reading task had an impact on their children's type of lexical production. We demonstrated that mothers' use of gestures was associated with the number of different words that children used (word types) but not with how much children spoke in interaction (word tokens). A possible explanation of this finding is that mothers' gestures are a tool in children's cognitive growth (Goldin-Meadow, 2009) that is linked to the use of children's lexical repertoire. Mothers' gestures contribute to the richness of vocabulary in joint book-reading; that is, they are not related to the simple production of words, but to the complexity of their lexical production.

Our results also showed that mothers' lexical production (different nouns) was associated with their children's lexical production. However, our study suggests that the gestural production also accompanies mothers' speech directed to their children, and it is related to children's verbal production, a finding similar to that of Iverson et al. (1999).

When they interact with their children, parents change their communication strategies, using both speech and gestures that are different from those they use when interacting with adults (Özçalışkan & Dimitrova, 2013). The current study found that mothers used a greater number of deictic gestures than other types in interaction with their children in a joint book-reading task. The nature of this task, where the book is available to illustrate the characters and other referents in the story, is a plausible explanation for this finding. These results are also consistent with studies that have reported the prevalence of such gestures in interaction between mothers and children (Iverson et al., 1999; Murphy, 1978; Özçalışkan & Goldin-Meadow, 2005) and others that found more frequent use of deictic gestures by mothers in joint book-reading (e.g., Lavelli et al., 2015; Rohlfing et al., 2015). It has been shown that in mother-child interactions, mothers make less use of complex gestures and show a preference for simple gestures, such as deictic ones, indicating that they adjust their communication to their children's abilities. This same gestural behavior occurred in the dyadic interactions of joint book-reading with the Mexican Spanish-speaking mothers; their communicative behavior is thus consistent with that of other populations. Following the definition of gesture in McNeill (1992), we analyzed only gesture-speech combinations, because these provide children a more complete message than gesture alone, with two pathways: movement and word (Özçalışkan & Goldin-Meadow, 2005). Although an effect of language on gesture-speech combinations has already been seen (e.g., Özçalışkan et al., 2018), our findings suggest that the relationship between the mothers' gestures and their children's lexical production is a feature of development which occurs in different cultural contexts within specific languages. Our results add evidence to the continuing debate about the universality of gesture. Analyzing silent gestures produced without speech could identify the role of communicative hand movement and provide insight into the universality of gesture in activities like joint book-reading.

Studies have found that when communicative interactions take place between mothers and infants in joint attention to a book, mothers' speech has particular discursive features that encourage their children's language development (Ard & Beverly, 2004; Dunn et al., 1977; Farrant & Zubrick, 2011; Trivette et al., 2010). These studies have focused on the dyadic interactions of joint book reading with infants younger than those examined here. We have shown that deictic gestures are part of the communication strategies between mothers and children at the age of four: our study also confirms that deictic gestures are still favored in joint book reading interactions with children of this age. This finding raises the question of why mothers prioritize deictic gestures in this context. One explanation could

be that gestures serve different functions, depending on the type of speech with which they are used, the context, and their specific communicative purpose. Rohlfing et al. (2015) found that the use of deictic gestures in joint book reading can serve, for example, to attract attention to objects, to elicit the names of objects, to indicate the components of a picture, or to emphasize certain aspects of an object. In other words, it is possible that deictic gestures are complex communicative strategies, both semantic and pragmatic. Our results indicate that deictic gestures are also associated with the breadth of children's vocabulary. Joint book reading is an activity that supports learning processes, especially with picture books (Kümmerling-Meibauer et al., 2015; Temple & Snow, 2003). The very nature of this task implies that participants were carrying out strategies of joint attention (Kümmerling-Meibauer et al., 2015) with various communicative functions. Future work should extend this study with a broader analysis of these communicative functions.

We analyzed the relationship between mothers' years of education and their lexical and gestural production and found no association with gestural production. However, their gestural production was associated with a greater breadth of lexical production, which was in turn related to their years of education. Years of education represent one measure of parental socioeconomic status, but it would be useful to evaluate the association of other socioeconomic factors with the gestural production of Spanish-speaking mothers.

Studies have suggested that children have a tendency to acquire more nouns than verbs in speech (e.g., Dhillon, 2010; Bornstein et al., 2004; Jackson-Maldonado et al., 1993). Our findings, however, showed a greater production of verbs than nouns in the production of word types. Although a slightly greater production of nouns was found in the production of word tokens, the same tendency was found in the production both of verbs and nouns. The finding in the case of word tokens may be evidence that verbs are linked to nouns, because verbs require arguments to enrich their meaning (Chapman et al., 1992; Michael et al., 2012). Overall, the distinctiveness of these findings about lexical production is associated with a pragmatic context (Rengifo, 2015) in which the communicative interaction between mothers and their children takes place (see Choi, 2000 and Goldfield, 1993). That is to say, the situation of the joint book-reading led to a greater production of verbs than nouns, as well as a balanced production of noun and verb tokens. Specifically, actions predominate in a narrative discourse because they are the principal element of a story; without the actions of the characters, there is no story (see Greimas & Courtés, 1982). Most of the word tokens (redundant words) were nouns, but verbs were the grammatical category in which children showed a greater breadth of vocabulary. According to Karmiloff and Karmiloff-Smith (2001), the production of verbs implies deeper processing than nouns. Verbs are more complex because they involve both semantic and syntactic information (Bassano, 2000). Other studies have shown that joint book-reading enables the

acquisition of verbs—both their production and their comprehension—especially when adults use interactive strategies to comment on the reading and ask children questions (Ard & Beverly, 2004). Although lexical production is the result of several factors, our study allows us to recognize the role played by the maternal gesture in the complex cognitive and interactive processes for producing verbs in joint book-reading. The production of article word tokens, which was also relatively large, indicates the way in which children carry out lexical production according to the rules of their language: nouns in Spanish are generally accompanied by the articles that indicate gender and number (Hernanz & Brucart, 1987; Leonetti, 1999).

Our research design does not allow us to verify that gestures favor the process of learning words (Capone & Saks, 2015; De Villiers & Zukow-Goldring, 2010), but we can show that gestures affect the production of words (and of specific word types). The linear regression analysis shows that mothers' gestural production has an effect on children's lexical production, especially of verbs, when they interact in joint book-reading. Mothers' gestures and children's verbal production are interactive communicative mechanisms that emerge in correspondence in such dyadic interactions. Thus, this finding clearly demonstrates the importance of mothers' gestural production in children's lexical development. A limitation of this study is that we did not analyze the children's gestures. It would have been interesting to observe the communicative role of their gestures in the interaction of joint book-reading.

Although it has been shown that mothers modify their multimodal communication according to children's lexical development, Lavelli et al. (2015) have theorized about the possible existence of a bidirectional process. Although our data does not allow us to imply a causal relationship, we identified that the multimodal communicative behavior of mothers is linked to the lexical richness of their children. Our finding suggests a possible two-way correspondence in the communicative behaviors between mothers and their children. Such a correspondence would have implications in the educational field, where these interactive routines are carried out daily.

There are some limitations inherent in the design of our study. One is that since the scope of our study only allowed us to assess the nature of lexical production located in and limited by a specific task, we can only suggest that in this communicative situation, mothers' gestures could provide support for greater comprehension (Rowe et al., 2008; Stanfield et al., 2013) of a story or information. Another limitation became apparent after observing how the design of the task—in which mothers held the book with one or both hands—could have inhibited their gestural production or limited their production to deictic gestures. It would be useful to know what would happen if the mothers did not use the book. Finally, we did not study father-child dyads; it would be useful to know whether the phenomena studied are different in the interactions between fathers and children.

To our knowledge, this is the first time a joint book-reading task has been used to measure the relationship between mothers' gestural production and children's lexical production in Spanish-speaking participants. Observing the dynamics of the interactions in the joint book-reading task allowed us to demonstrate that mothers' gestures play an important role in this type of task because they are associated with children's lexical production. This link between mothers' gestures and children's lexical production is an example of how mothers and children construct meaning together in this type of task.

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APPENDIX A

Gesture Coding

The coding of gestures was performed as follows:

1. The observation of video recordings was segmented into intervals of 10 seconds. The researchers watched the videos of the joint book-reading as many times as necessary to determine the number and types of gestures in this lapse of time.
2. After confirming the simultaneity of a gesture-speech combination, the gesture type was coded. One or more gestures could emerge in this lapse of time.
3. The coding was recorded in a table which specified the total number of mothers' gestures and the types of gestures in every 10-second interval during mothers' telling of stories in the joint book reading task.
4. Gestures were coded according to the four categories identified by McNeill (1992) – deictic, iconic, metaphoric, or beat – or as conventional gestures (Iverson et al., 1999; Rodrigo et al., 2006). Deictic movements were those that pointed either at a physical or an imaginary referent that was present in discourse but not physically in the context (a type of gesture also known as abstract pointing). Although conventional gestures may appear without speech, only those appearing in combination with speech were considered.
5. The coding of the gestures was performed independently by two trained researchers, who agreed on approximately 90% of the coding. Discrepancies in coding were corrected in a joint review of the data.

APPENDIX B

Grammatical Category Coding

Children's lexical production and mothers' lexical production were coded based on the following grammatical categories:

1. Nouns. The names of objects, events, and living things were coded as nouns. This category included common, generic, or individual names, as well as adjectives used as nouns, and verbs used as subjects of a sentence. For this categorization, two-word names that refer to a single referent were considered a single name.
2. Verbs. Words expressing the state, essence, or actions of the subject of a sentence were coded as verbs. Phrasal verbs were considered as a single unit.
3. Adjectives. Words modifying nouns of a sentence, including ordinal modifiers, quality modifiers, or state modifiers were coded as adjectives. Nouns used as adjectives were included in this classification, as well as words that modify the subject of a sentence.

4. Adverbs. Modifiers expressing circumstances of time, place, mode, affirmation, and negation of a verb, adjective, or adverb were coded as adverbs.
5. Articles. Words which are determiners of nouns and indicate gender and number were coded as articles. Elements that indicate the subject upon whom the action falls were categorized as articles (e.g., *por la*, *de la*, and similar).
6. Pronouns. Words substituting for a noun previously mentioned, and which have no meaning in themselves, including personal pronouns, relative pronouns, and interrogative pronouns, were coded as pronouns.
7. Prepositions. Words linking any element of the sentence with its complement were coded as prepositions.
8. Conjunctions. Words logically linking two or more elements of a sentence, as well as words linking a premise with its conclusion, were coded as conjunctions.
9. Interjections. Words or verbal expressions which lack syntactic value, but have semantic content, commonly associated with speakers' emotions, were coded as interjections. Expressions that are social conventions with no syntactic function were included.