The link between early iconic gesture comprehension and receptive language

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Abstract

Children comprehend iconic gestures relatively later than deictic gestures. Previous research with English-learning children indicated that they could comprehend iconic gestures at 26 months, a pattern whose extension to other languages is not yet known. The present study examined Turkish-learning children's iconic gesture comprehension and its relation to their receptive vocabulary knowledge. Turkish-learning children between the ages of 22- and 30-month-olds ($N = 92$, $M = 25.6$ months, $SD = 1.6$; 51 girls) completed a gesture comprehension task in which they were asked to choose the correct picture that matched the experimenter's speech and iconic gestures. They were also administered a standardized receptive vocabulary test. Children's performance in the gesture comprehension task increased with age, which was also related to their receptive vocabulary knowledge. When children were categorized into younger and older age groups based on the median age (i.e., 26 months–the age at which iconic gesture comprehension was present for English-learning children), only the older group performed at chance level in the task. At the same time, receptive vocabulary was positively related to gesture comprehension for younger but not older children. These findings suggest a shift in iconic gesture comprehension at around 26 months and indicate a possible link between receptive vocabulary knowledge and iconic gesture comprehension, particularly for children younger than 26 months.

Keywords. Iconic gesture comprehension, receptive vocabulary, individual differences

The link between early iconic gesture comprehension and receptive language

Children can comprehend speakers' messages conveyed by speech and gesture in the first year of development (Morford & Goldin-Meadow, 1992). However, gesture comprehension at this age is mostly limited to deictics, indicating a referent with the index finger or the whole hand (e.g., pointing at a ball to indicate a ball). Most children begin comprehending others' iconic gestures (e.g., moving the hand toward the mouth as if eating with a spoon or using an index finger to outline an object's shape) between the ages of 2 and 3 years (Hodges et al., 2018; Namy et al., 2004; Stanfield et al., 2014). English-learning children show a noticeable increase in both iconic gesture production and comprehension at around 26 months which is also referred to as the "iconic spurt" (Namy et al., 2004; Özçalışkan & Goldin-Meadow, 2011; Özçalışkan et al., 2014). Thus far, research has predominantly focused on English-learning children, and little is known about the developmental trajectory of iconic gesture comprehension in other languages. The present study investigates whether Turkish-learning children show a similar trend in iconic gesture comprehension as their English-learning peers and whether it relates to children’s receptive vocabulary, as early gesture and speech have a developmental continuity (Volterra et al., 2017).

Children’s comprehension of iconic gestures

Iconic gestures reflect the affordances of referents as such they vary based on their referents, such as entities and actions (Kendon, 2004; McNeill, 1992). Given the transparent relation between the representative hand form and the referent, one may posit that recipients are primed to more readily comprehend iconic gestures. However, previous research on iconic gesture comprehension demonstrated that English-learning children can understand iconic gestures beginning around 2-3 years of age, which is later than comprehending deictic gestures

(Dimitrova et al., 2017; Hodges et al., 2018; Namy et al., 2004; Stanfield et al., 2014; Striano et al., 2003). The late emergence of children's iconic gesture comprehension may indicate an age transition towards a major cognitive shift that facilitates linking the properties of referents and iconic gestures (Tolar et al., 2008). Alternatively, young children might not be able to benefit from the visual cues provided by iconic gestures due to their limited language skills (Özer & Göksun, 2020). Yet, the specific mechanisms that underlie this age-related change remain elusive.

Iconic gesture comprehension has a steep developmental trajectory. For instance, while 26-month-old English-learning children solely associate iconic gestures with referents (e.g., hopping gesture for the rabbit) and not arbitrary gestures (e.g., dropping gesture for the rabbit), 18-month-olds can associate both iconic and arbitrary gestures with their referents (Namy et al., 2004). Striano and colleagues (2003) showed that 26-month-olds could choose a referent presented by an iconic gesture without training about the association before the task, while 20-month-olds could not. In another study, Stanfield and colleagues (2014) administered a speech + gesture comprehension task to 2- to 4-year-olds and found that children understood the message presented by iconic co-speech gestures by age 3. While most children aged 3-4 comprehended iconic gestures, only a small number of the 2-year-olds (i.e., ranging between 24-28 months) could give correct responses, with comprehension increasing with age.

The subtype of iconicity is another dimension that influences children's iconic gesture comprehension. For example, Hodges and colleagues (2018) found that 2-year-olds have difficulty understanding iconic gestures that convey information about the physical features of objects (e.g., cupped hands held apart to show the shape of a ball), yet they can understand iconic gestures depicting actions related to those objects (e.g., flapping downward-facing open palms to show flying) with relative ease. By age 3, however, they can comprehend both types of iconic gestures. In another study, Glasser and colleagues (2018) tested 3- to 4-year-old English-speaking children's iconic gesture comprehension about events, in which they presented children with gestures that depicted different components of a motion event (i.e., path or manner of motion). They found that 4- but not 3-year-olds could understand iconic gestures depicting different components of a motion event, suggesting that children comprehend iconic gestures about events later than those depicting the entities.

In sum, earlier work that examined iconic gesture comprehension in children –mostly with English learners– suggested that children understand iconic gestures between ages 2 and 4, showing earlier comprehension of iconic gestures conveying information about objects (ages 2-3) than the ones about events (age 4). More specifically, children might begin to comprehend iconic gestures at 26 months (Namy et al., 2004), at around the same time that they begin to produce iconic gestures (Özçalışkan & Goldin-Meadow, 2011). However, there has been no prior investigation into the developmental pattern of iconic gesture comprehension in Turkish-learning children. To this end, we aim to investigate whether Turkish-learning children aged between 22 and 30 months exhibit a similar trend as their English-learning peers.

Furthermore, most of this earlier work focused on group differences, using child age as a categorical variable without exploring variability among individuals within the same age range. Therefore, our explanation for why some children do not comprehend iconic gestures is constrained by age-related factors only for English learners. No work has yet examined other factors that could explain individual differences in iconic gesture comprehension. One possible factor that drives individual variation in young children’s iconic gesture comprehension might be verbal ability, as speech and gesture form integrated systems during language development, and children might rely on their verbal resources to interpret gestures (Kartalkanat & Göksun, 2020; Momsen et al., 2020).

Children's iconic gesture comprehension and its link to vocabulary knowledge

Early gestures predict upcoming changes in speech (i.e., the onset of first words children produce; Iverson & Goldin-Meadow, 2005; Özçalışkan et al., 2017; Rowe et al., 2008). However, the link between gesture and speech in language comprehension (i.e., receptive vocabulary) remains relatively understudied. Previous work mostly focused on gesture production, which indicated a tight link between speech and gesture during language learning (for meta-analyses, see Colonnesi et al., 2010; Kirk et al., 2022). For example, a longitudinal study found that gesture use at 14 months was a significant predictor of vocabulary size at 42 months of age (Rowe et al., 2008). There was also a positive link between earlier (10-18 months) gesture-plus-word combinations and later (17-34 months) two-word utterances (Iverson & Goldin-Meadow, 2005; Özçalışkan & Goldin-Meadow, 2005; 2010). In another study, Capirci and colleagues (2005) observed children longitudinally from 10 to 23 months of age and found a high semantic overlap between children's corresponding actions to their later gesture use and word production. That is, the relation between gesture and speech has a developmental continuity, which occurs through early actions (Volterra et al., 2017). The systematic link between gesture production and language development raises the possibility of a similar strong link between gesture comprehension and early vocabulary, particularly for young children.

Some limited work suggests a positive association between iconic gesture comprehension and children's language skills. For example, Kartalkanat and Göksun (2020) demonstrated that 5-year-old children with higher expressive language skills measured by

TEDİL (Güven & Topbaş, 2015), Turkish adaptation of TELD-3 (Hresko et al., 1999), benefited more from the experimenter's iconic gestures than other children with relatively lower expressive language skills during the encoding of the narrative. This study suggests that verbal resources might be integral to interpreting co-speech iconic gestures as children with higher verbal resources comprehend iconic gestures better than those with relatively lower verbal resources. However, whether and how receptive language explains variability in young children's comprehension of iconic gestures before and after they comprehend them still remains unexplored.

Given earlier work that showed that producing verbs is related to iconic gesture production (Özçalışkan et al., 2014), a similar association could also be observable between receptive vocabulary and iconic gesture comprehension. Comprehending iconic gestures involves a cognitively demanding process that requires matching visual and verbal information (Tolar et al., 2008), a demand that also becomes evident in iconic gesture production (Özçalışkan & Goldin-Meadow, 2011). Building on this, compared to older children, younger children who have less mature cognitive abilities might depend more on their linguistic knowledge, such as vocabulary knowledge, to understand iconic gestures. Using verbal resources is related to iconic gesture comprehension (Özer & Göksun, 2020) and creates an individual variation that might be necessary to interpret gestures in preschoolers (Kartalkanat & Göksun, 2020). Hence, young children's early comprehension of iconic gestures can be related to their receptive vocabulary knowledge.

The present study

The current study aims to examine Turkish-learning children's iconic gesture comprehension and whether and how it relates to their receptive vocabulary. We focused on children learning Turkish between the ages of 22 and 30 months. We used the Turkish-modified version of the iconic gesture comprehension task originally developed by Stanfield et al. (2014), in which participants were asked to match an experimenter's iconic gesture with speech (e.g., "I am eating" + hold cupped hands together as if holding a sandwich) to a correct referent (i.e., sandwich) in a forced-choice task (e.g., a sandwich vs. a bowl of soup). We also assessed children's receptive vocabulary knowledge with the Turkish Expressive and Receptive Language Test (TIFALDI-R)– Receptive subtest (Berument & Güven, 2010).

We first asked whether iconic gesture comprehension would increase with age, particularly with an upward trend after 26 months, as previously observed in English-learning children's iconic gesture development (Namy et al., 2004; Özçalışkan & Goldin-Meadow, 2011). We chose 26 months as the cut-off point, which corresponded to the typical age of English-learning children's initial spurt in understanding and producing iconic gestures (Namy et al., 2004; Özçalışkan & Goldin-Meadow, 2011; Özçalışkan et al., 2014). We therefore compared children younger than 26 months to those 26 months and older in the Turkish-modified version of the iconic gesture comprehension task (Stanfield et al., 2014). Building on previous literature (Namy et al., 2004; Özçalışkan et al., 2014), we expected that children aged 26 months and older would perform above chance level while children aged younger than 26 months would not, in the iconic gesture comprehension task. We also predicted that children older than 26 months would perform better in the gesture comprehension task than those younger than 26 months, following a pattern akin to children learning English (Namy et al., 2004).

Given our limited understanding of the possible link between iconic gesture comprehension and children's vocabulary development, particularly in young children, we also examined this link in our study. The increasing pattern in children's performances in iconic gesture comprehension as they age indicates their enhanced understanding of communicative acts and intentions by others (Namy et al., 2004; Stanfield et al., 2014). In addition to group comparisons based on age (i.e., 26 months, the typical age at which the initial iconic gesture spurt occurs for English-learning children; Özçalışkan et al, 2014), investigating whether and how children differ in their performances within groups before and after 26 months could potentially reveal what drives early iconic gesture comprehension. Considering that production of first words and gestures are closely linked very early in development (Capirci et al., 2005; Goldin-Meadow, 1998; Iverson & Goldin-Meadow, 2005; Özçalışkan et al., 2017), we examined the role of receptive vocabulary knowledge on iconic gesture comprehension. We predicted an overall positive correlation between receptive vocabulary and iconic gesture comprehension. We next asked whether the shift in iconic gesture comprehension would be differentially linked to children's receptive vocabulary before and after age 26 months. Following this, we expected an interaction between children's age and receptive vocabulary in speech and iconic gesture comprehension. That is, we predicted that children's receptive vocabulary knowledge would be positively related to their iconic gesture comprehension in the younger (< 26 months) but not the older (≥ 26 months) age group, as younger children might rely more on their linguistic knowledge (i.e., knowledge of words) to comprehend iconic gestures.

Methods

Participants

The final sample consisted of 92 monolingual Turkish-learning children[1] who are learning Turkish as their native language and who do not have any developmental or neurological disorders. The children ranged in age between 22 and 30 months of age (M = 25.6 months, SD = 1.6), including 51 girls (M = 25.7 months, SD = 1.7) and 41 boys (M = 25.5 months, SD = 1.4). The power analysis, based on linear regression analysis with a power of .97 and a small effect size of .20, suggested that 91 participants would be needed to detect significant correlations between iconic gesture comprehension and receptive vocabulary knowledge. Koç University's Institutional Review Panel for Human Subjects approved the study (Protocol no: 2018.118.IRB3.083).

We initially recruited 98 monolingual Turkish-learning children between 22 and 30 months of age. Three children were excluded due to health issues (n=2) or exposure to two languages (n=1). The sample thus consisted of 95 typically developing monolingual Turkish-learning children between 22 and 30 months of age (M = 25.6 months, SD = 1.6), including 51 girls. Of the 95 participants, 3 additional children were excluded because they did not participate in the gesture comprehension task. In addition, 13 children did not perform the receptive vocabulary task due to either disengagement or being sleepy. Thus, we had a total of 80 participants aged between 22 and 30 months who performed both the gesture comprehension and receptive vocabulary tasks (M = 25.6 months, SD = 1.6). Therefore, we included 92 participants in the gesture comprehension analysis and 80 participants in the

[1] There were 24 preterm children in the dataset. Preterm children did not differ from full-term children in age, iconic gesture comprehension, and receptive vocabulary, all *ts* < 0.93 and *ps* > .35. Thus, we merged preterm and full-term children for further analyses.

correlational analysis. Outlier analyses did not yield outliers exceeding the threshold of ±3 standard deviations for the variables. Children were given a book as a gift for their participation, and parents' transportation expenses were compensated.

Measures and Procedure

Children were tested in a quiet setting in a research laboratory. After parents completed the consent procedures, each child participated in two tasks, one testing gesture comprehension and the other measuring receptive vocabulary.

Gesture Comprehension Task. We used the Turkish-adapted version of a gesture comprehension task originally developed by Stanfield et al. (2014). The task consisted of six test trials, presented in four randomly created counterbalanced orders. Table 1 shows all stimuli pairs used in this task. In each trial, the child was presented with a pair of pictures showing two different objects (e.g., a grilled cheese sandwich vs. a plate of baked beans) with a verbal description that matched both pictures (e.g., "I am eating") and an iconic gesture that matched only one of the pictures (e.g., closing the hand as if holding a spoon and moving towards the mouth to represent eating baked beans with a spoon). Then, the child was asked to choose the correct picture among two options (e.g., 'What did I eat?') by pointing to the picture. All responses were recorded and later tallied for a total gesture comprehension score for each child (score range = 0-6).

Table 1

Stimuli pairs for the gesture comprehension task

Item #	Speech	Gesture	Object Choice
Gesture 1	"I am eating"	A. Scooping with closed fist towards mouth B. Moving cupped palms with fingers in U-shape	A.  B. 
Gesture 2	"I am drinking"	A. Tilting right closed fist to mouth B. Tilting right hand in a C-shape to mouth	A.  B. 
Gesture 3	"I am playing"	A. Moving C-shaped hand, palm down, back and forth B. Moving both flat hands with palms down back and forth	A.  B. 
Gesture 4	"I am opening"	A. Rotating extended semi-cupped right hand while moving it towards the body B. Placing touching palms in front of body and opening them	A.  B. 
Gesture 5	"I am throwing"	A. Moving claw-shaped right hand with palm up away from body B. Moving right hand away from body with index finger and thumb touching, palm up	A.  B. 
Gesture 6	"I am putting on"	A. Moving both closed fists with palms towards head down from top of head to ear level B. Closed fist right hand makes two circles around neck	A.  B. 

Receptive Vocabulary Measure. We tested children's receptive vocabulary with the Turkish Expressive and Receptive Language Test (TİFALDİ)–Receptive subtest (Berument &

Güven, 2010), a standardized assessment of 2- to 12-year-old children's vocabulary scores. This study only used the receptive subtest, which included 80 test items. For each test item, the participant was presented with a word and asked to point to the picture that best matched the word's meaning among a choice of 4 pictures. All responses were video recorded and later tallied for each child's total receptive comprehension score (score range = 0-80). As aforementioned (p. 10), only 80 out of 92 children completed this task.

Data Analyses

To determine whether children showed age-related changes in their iconic gesture comprehension with an iconic shift occurring at 26 months, we divided children into younger (< 26 months, N = 42, *M* = 24.2 months, *SD* = 0.98) vs older (≥ 26 months, N = 50, *M* = 26.8 months, *SD* = 0.95) age groups, and compared gesture comprehension scores with an independent t-test. We followed up this analysis by comparing performance with respect to chance level (i.e., 3 correct answers out of 6 questions), separately in each age group. We also conducted an independent t-test to investigate whether younger and older age groups had different receptive vocabulary scores.

We conducted correlational analyses to determine whether children's iconic gesture comprehension would correlate with their receptive vocabulary scores and age. To further examine whether children's iconic gesture comprehension would relate differently to their receptive vocabulary scores before and after age 26 months, we conducted a hierarchical linear regression to investigate the concurrent relation between iconic gesture comprehension and receptive vocabulary knowledge and whether the relation between iconic gesture comprehension and receptive vocabulary would differ between younger and older age groups by adding the interaction term 'age group x receptive vocabulary' to the model.

Results

Preliminary analyses

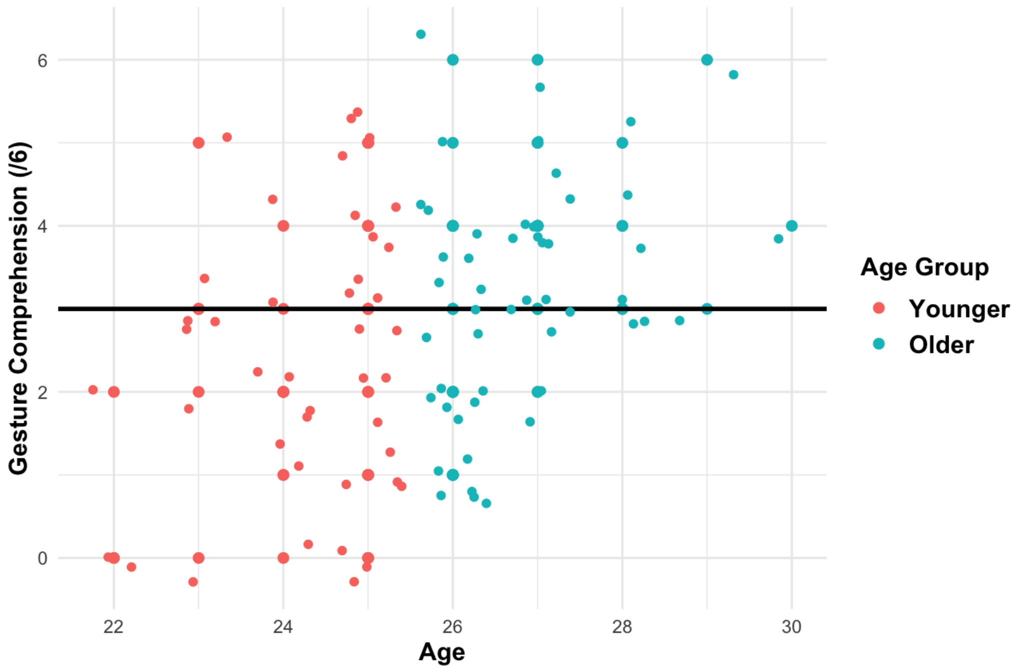
We first conducted a series of independent sample t-tests to analyze whether age, receptive vocabulary knowledge, and performances in iconic gesture comprehension differed based on sex. We found no effect of sex in any of the outcome variables (all *t*s < .71 and *p*s > .48). We, therefore, collapsed across child sex for all the remaining analyses.

Age-related changes in children's comprehension of iconic gestures

Comprehension of iconic gestures improved with age, marking a significant difference between the younger (< 26 months) and the older children (≥ 26 months), t (90) = -2.90, p = .005, d= 0.61. As can be seen in Figure 1, younger children understood fewer gestures (red dots; M = 2.36, SD = 1.59) than older children (blue dots; M = 3.24, SD = 1.33). Even though children showed some individual variability in their scores, the younger children performed significantly below the chance level, t (41) = -2.62, p = .012, d = 0.18, while the older age group performed at the chance level, t (49) = 1.27, p = .21, d = -.404. Children's age also positively correlated with their iconic gesture comprehension score, r (90) = .41, p < .001.

Figure 1

Gesture comprehension scores of younger (red dots, ages < 26 months) and older (blue dots, ages (≥ 26 months) children; the straight line indicates chance level performance, set at 3 out of max possible comprehension score of 6 (each dot denotes an individual child).



Age group differences in receptive vocabulary knowledge

We compared younger and older children's receptive vocabulary and found that older children had higher receptive vocabulary scores (M = 21.73, SD = 10.19) than the younger ones (M = 14.86, SD = 9.22), t (78) = 3.13, p = .002, d = .70.

Relations among children's age, receptive vocabulary, and iconic gesture comprehension

We ran first-order correlations to test the relations between children's age, receptive vocabulary knowledge, and iconic gesture comprehension scores. Children's age positively correlated with their receptive vocabulary, r (78) = .43, p < .001. There was also a positive correlation between receptive vocabulary and iconic gesture comprehension, r (78) = .30, p = .007.

Does comprehension of iconic gestures relate differently to receptive vocabulary at younger vs. older ages?

We conducted a hierarchical linear regression analysis using iconic gesture comprehension as the outcome variable and age group (younger vs. older children) and receptive vocabulary scores as predictors (see Table 2). We added the age group in the first step, receptive vocabulary scores in the second step, and the interaction between the age group and receptive vocabulary scores in the third step. Figure 2 presents model statistics. The model in the first step significantly explained 7% of the total variance, F (1,78) = 6.81, p = .011. Adding receptive vocabulary in the second step significantly improved the model, ΔR^2 = .05, F (1,77) = 4.19, p = .044, with the model in the second step explaining 11% of the total variance, F (2,77) = 5.64, p = .005. In the final step, adding the interaction term between the age group and receptive vocabulary scores also improved the model significantly, ΔR^2 = .05, F (1,76) = 4.12, p = .046. The model in the third step significantly explained the 14% of the total variance, F (3,76) = 5.29, p = .002. In the final step of the model, age group was a significant predictor, β = 1.75, p = .009. The older age group was associated with higher iconic gesture comprehension (M = 3.25, SE = 0.21) compared to the younger age group (M = 2.72, SE = .24). Receptive vocabulary was also a significant predictor, β = 0.07, p = .005. However, the main effect of receptive vocabulary was further qualified by an interaction with the age group, β = -0.07, p = .046 (see Figure 2). In the younger age group, higher receptive vocabulary was associated with higher gesture comprehension (β = 0.07, p = .017), F (1,34) = 6.28, p = .017. In the older age group, however, receptive vocabulary did not predict iconic gesture comprehension (β = 0.007, p = .70), F (1,42) = 0.15, p = .70.

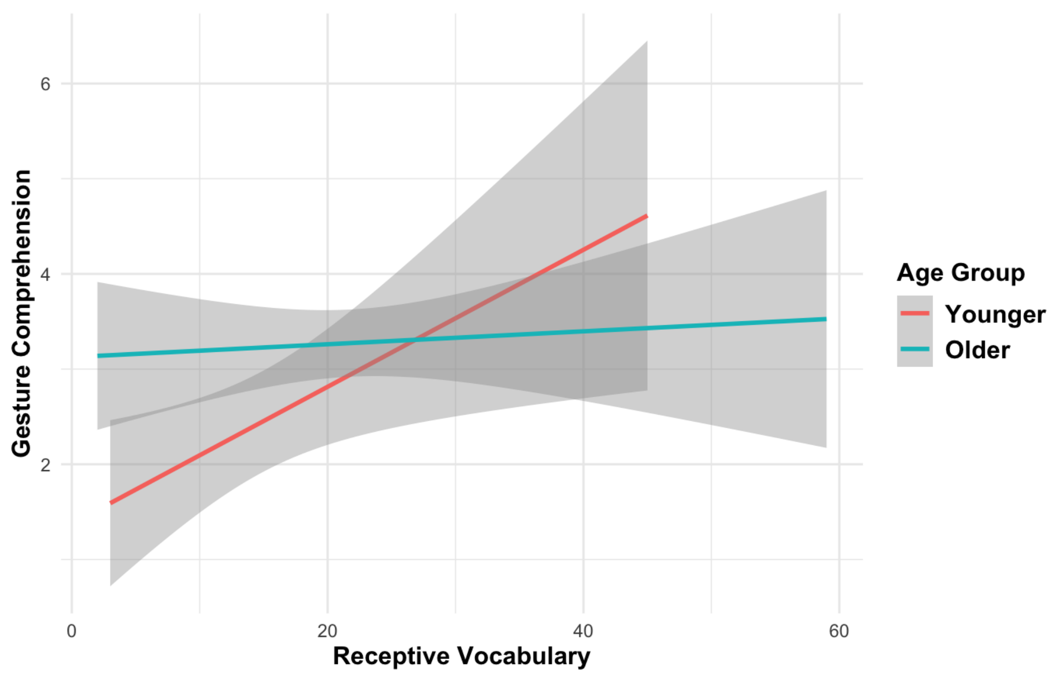
Table 2

Model statistics for the regression analysis, with gesture comprehension as the outcome

Step	Predictors	*β*	*SE*	*t*	*p*	R^2	ΔR^2
1						.07	
	Age group	0.83	0.32	2.61	.011*		
2						.11	.05
	Age group	0.60	0.33	1.83	.072		
	Receptive vocabulary	0.03	0.02	2.05	.044*		
3						.14	.05
	Age group	1.75	0.65	2.69	.009*		
	Receptive vocabulary	0.07	0.02	2.89	.005*		
	Age group * Receptive vocabulary	-0.07	0.03	-2.03	.046*		

Figure 2

Distribution of gesture comprehension scores (max possible score = 6) by younger (red line ages < 26 months) and older (blue line, ages ≥ 26 months) children in relation to receptive vocabulary scores; shaded gray areas indicate the score range at each age group).



Discussion

The present study examined the developmental trajectory of iconic gesture comprehension and the role of receptive vocabulary knowledge in 22- to 30-month-old Turkish-learning children's iconic gesture comprehension. We investigated two questions. First, we asked whether children's performances on iconic gesture comprehension would increase with age, specifically examining whether there would be an iconic gesture comprehension shift at 26 months in Turkish-learning children. We next asked whether children's receptive vocabulary knowledge would be associated with their iconic gesture comprehension as a source of individual variability in verbal resources, after controlling for age.

Our results showed that the iconic gesture comprehension of Turkish-learning children improved with age, reflecting patterns similar to their English-learning peers with a notable change around 26 months (Namy et al., 2004; Özçalışkan & Goldin-Meadow, 2011). In particular, children at or older than 26 months showed better iconic gesture comprehension than children younger than 26 months. This suggests that comprehending iconic gestures might be explained by age-related maturation, signifying a global developmental shift around 26 months of age.

It is important to note here that in our study, children younger than 26 months performed below chance whereas children older than 26 months performed at chance levels. This finding is in fact similar to earlier research with English-learning children, who also failed to reliably match the information in iconic gestures with the relevant pictures before age 3 (Stanfield et al., 2014). Namy et al. (2004) indicated that children could map iconic gestures with objects at 26 months, when asked to match an iconic gesture with a real object. Different from this earlier work, in our study, adapted from Stanfield et al. (2014), the iconic gestures were produced with speech (I am eating + hold cupped hands together as if holding a sandwich), and the child was tasked with not only grasping the multimodal integration of speech and gesture but also matching the gesture to a picture – not a real object. Thus, the task demands of our experiment was greater as compared to earlier work (Namy et al., 2004), likely resulting in chance level performance in iconic gesture comprehension even by age 26 months.

Why do iconic gestures appear later in language learners' repertoires than their first words and pointing gestures in both production and comprehension? Due to the dual-representational aspects of iconic gestures, children must attend to visual and verbal representations of a co-speech gesture (Tolar et al., 2008). More specifically, children need to match information represented in two different modalities- verbal and visual- simultaneously to comprehend speakers' messages. Moreover, the underlying reason for the iconic gesture comprehension change at 26 months might be related to domain-general development in children's representational thinking and relational thinking, which mainly occurs after age 2 (Özçalışkan & Goldin-Meadow, 2011). In addition, since iconic gestures depict speakers' messages by hand forms idiosyncratic to each gesturer, young children might not be able to process them based on their prior knowledge, contrary to their experiences while understanding pointing gestures that only have one single form (i.e., extended index finger to a referent). These results are not in line with those of a previous study on the early use of iconic gestures in Turkish. Furman and colleagues (2014) showed that Turkish-learning children begin to use action-related iconic gestures for motion events from 19 months onwards, potentially due to the early use of verbs in their speech. However, the present study examined children's ability to integrate information from gestures with speech in comprehension, which is challenging and might require more time to develop than the mere use of iconic gestures.

Second, we investigated the association between children's receptive vocabulary knowledge and their performances on the iconic gesture comprehension task. In line with our expectations, iconic gesture comprehension scores were significantly correlated with children's receptive language. Our findings further support the claims that gesture and speech are integrated systems that develop together and that verbal resources might be important to interpret and process co-speech iconic gestures, particularly at the early ages (Goldin-Meadow, 1998; Özçalışkan et al., 2014; Volterra et al., 2017). This is also consistent with previous findings. For example, preschoolers with higher expressive vocabulary scores benefit more from observing iconic gestures during spatial tasks than children with lower expressive vocabulary scores (Kartalkanat & Göksun, 2020).

Our further analyses indicated that receptive vocabulary knowledge only contributed to iconic gesture comprehension performance for children younger than 26 months. Contrary to the gesture-as-a-compensation-tool account (Özer & Göksun, 2020), our findings suggest that children with higher receptive vocabulary knowledge comprehend speakers' iconic gestures better than children with lower receptive vocabulary knowledge. In addition, contrary to the findings on pointing gestures the production of which precede children's first words (Iverson & Goldin-Meadow, 2005; Özçalışkan et al., 2017), younger children might need better verbal resources to process information from others' iconic gestures during communication than older ones. In fact, earlier research showed that iconic gestures did not precede but were produced on average 7 months after children's first relational words (e.g., verbs; Özçalışkan et al., 2014), suggesting that it might function differently than deictic gestures in children's early language development. These findings indicate that young children might attend speakers' hand gestures, particularly iconic ones, more when they have a critical amount of verbal capacity not only in production, but possibly on comprehension. As such, receptive vocabulary knowledge might be one of the precursors of individual differences in early multimodal language comprehension. Children with more vocabulary knowledge might better process the visual semantic information expressed in gestures. For example, the experimenter's co-speech gesture (e.g., "I am drinking" while tilting hand in C-shape to mouth as if holding a glass) might be more relevant for the child when one has a vocabulary for the coffee cup.

Our study also presents some limitations. One such limitation is the lack of a non-linguistic measure of cognitive development to investigate domain-general processes that may contribute to the development of iconic gesture comprehension around the age of 26 months. As mentioned earlier, representational and relational thinking are important aspects to consider in shaping the developmental trajectory of iconic gesture comprehension. Future studies that investigate the link among domain-general mechanisms, verbal resources, and iconic gesture comprehension in a longitudinal study can provide a more extended account of developmental changes in iconic gesture comprehension in young children

In conclusion, our study showed that children's age was related to their iconic gesture comprehension. Similar to the English-learning children in Stanfield et al. (2014), Turkish-learning children in our sample (all younger than 3 years) performed at or below chance levels. In addition, children aged 26 months or older performed better than younger children, suggesting an upward developmental trajectory in iconic gesture comprehension. This finding provides valuable insights into the development of iconic gesture comprehension in a language other than English, also marking a significant shift in comprehension of such gestures at around 26 months of age. More importantly, children's receptive vocabulary knowledge was correlated with their iconic gesture comprehension. However, this relation was evident only for children who were younger than 26 months. One implication of this finding could be that for young children, who do not yet have a fully developed gesture-speech integration ability, verbal resources might be necessary to understand the gestures that accompany speech. Our findings thus suggest that comprehension of iconic gestures might follow a different trajectory than that of pointing gestures–a pattern akin to the production of these types of gestures (Özçalışkan et al., 2014), with children relying more on verbal resources (i.e., words) to grasp the meaning of such iconic gestures.

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