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ORIGINAL PAPER

Parental Speech and Gesture Input to Girls Versus Boys in Singletons and Twins

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Abstract
Children show sex differences in early speech development, with girls producing a greater number and variety of words at an earlier age than boys (Berglund et al. in Scand J Psychol 46(6): 485–491, 2005)—a pattern that also becomes evident in gesture (Butterworth and Morisette in J Reprod Infant Psychol 14(3): 219–231, 1996). Importantly, parents show variability in how they produce speech when interacting with their singleton sons vs. daughters (i.e., Cherry and Lewis in Dev Psychol 12: 278–282, 1976; Leaper et al. in Dev Psychol 34: 3–27, 1998). However, it is unknown whether the variability in speech input extends to different twin dyads or becomes evident in gesture input. In this study, we examined parental gesture and speech input to 35 singleton (19 boys, 16 girls) and 62 twin (10 boy–boy, 9 girl–girl, and 12 girl–boy dyads) Turkish children (age range = 0;10–3;4) in parent–child interactions. We asked whether there is evidence of sex (girls vs. boys) or group (singletons vs. twins) differences in parents' speech and gesture production, and whether these differences also become evident in different twin dyads (girl–girl, boy–boy, girl–boy). Our results, based on parent-child interactions, largely showed no evidence of sex or dyad-composition difference in either parent speech or gesture, but evidence of a group difference in gesture, with the parents of singletons providing a greater amount, diversity, and complexity of gestures than parents of twins in their interactions. These results suggest that differences in parent input to singletons vs. twins might become evident initially in gesture.

Keywords Parent speech · Parent gesture · Twin children · Sex differences · Turkish

Introduction

Singleton children show sex differences in early speech and gesture development—with an advantage for girls (e.g., Berglund et al. 2005; Butterworth and Morrisetta 1996). Sex differences also become evident in twin children (Day 1932), particularly pronounced for boy–boy twin dyads who lag behind both girl–girl twin dyads and boy or girl singletons in early speech development (e.g., Garitte et al. 2002)— a pattern that has not yet been

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examined for gesture. One likely explanation for the observed sex (boy vs. girl), group (singleton vs. twin), and dyad composition (boy–boy, girl–boy, girl–girl) differences could be the parental speech and gesture input that children receive at the early ages. Research on parental speech and gesture input to boys vs. girls in singleton vs. twin dyads remains nonexistent, and studies on parental speech input to boys vs. girls present largely inconclusive results (e.g., Leaper et al. 1998; Laflamme et al. 2002). In this study, we focus on the gestures and speech produced by parents of three groups of 1- to 3-year-old fraternal twins (boy–boy, girl–boy, girl–girl) in comparison to the gestures and speech produced by parents of 1- to 3-year-old boy vs. girl singletons—all native Turkish speakers. We ask whether we can find evidence of sex (boy vs. girl), group (singleton vs. twin), and dyad composition (boy–boy, girl–boy, and girl–girl) differences in the speech and gestures parents provide to their children. The findings will expand our understanding of the importance of parental verbal and nonverbal input that can help boost language and gesture development of singleton and twin children.

Sex Differences in Singleton and Twin Children's Early Speech and Gesture Production

Speech

Singletons show sex differences in their early speech production, with an advantage for girls (Hyde and Linn 1988; Kimura 1998). Girls not only produce their first words (Maccoby 1966) and first sentences (Ramer 1976; Özçalışkan and Goldin-Meadow 2010) earlier than boys; they also develop larger vocabularies (Eriksson et al. 2012; Huttenlocher et al. 1991) and produce a more complex and more diverse set of sentences (Tse et al. 2002) compared to boys of the same age.

Twins lag behind singletons—with an average time lag of 3 months—in their early speech development, producing fewer number and variety of words (Conway et al. 1980; Day 1932; Hay et al. 1987; Rutter and Redshaw 1991; Rutter et al. 2003; Savić 1980); and this gap expands as children grow older (Day 1932; Rutter et al. 2003). Twin children also start to produce their first sentences later than singletons (Rice et al. 2014), and they lag behind singletons in the complexity and diversity of the sentences that they produce (Conway et al. 1980; Davis 1937; Day 1932; Rutter et al. 2003). Similar patterns were also found in studies examining languages other than English (i.e., Turkish), showing that twins lag behind singletons in terms of their vocabulary (age 2;5; Gücüyener et al., 2011) and morphological development (ages 2;0–3;0; Ketrez 2016, 2017).

Importantly, dyad composition also has an effect on language development in twins, with girl–girl twins outperforming boy–boy twins (Day 1932). In an earlier study with 1;6-year-old twin dyads, Hay et al. (1987) showed that boy–boy twins lagged behind girl–girl twins, showing a 6-to-8-month difference in their expressive and receptive vocabulary and syntax development. Likewise, other studies with 2;0-year-old twins (along with singletons) using parent report of child vocabulary (CDI; Fenson et al. 2000) showed that boy–boy twins had smaller vocabularies compared to girl–girl twins (Galsworthy et al. 2000; Rice et al. 2014). Similar patterns were also found with twin children's vocabulary at slightly later ages (2;0–5;0), in spontaneous parent-child interactions (Day 1932). An earlier study with older Turkish twin children (5;0) showed that boy–boy twins attained lower receptive vocabulary scores (T-PPVT; Katz et al. 1974) than girl–girl twins at comparable ages (Gücüyener et al. 2011–but see also Ozturk et al. 2021 for an exception that showed comparable word production between girl–girl vs. boy–boy twins at the younger ages; i.e., 0;10–3;4). The female advantage for vocabulary in girl–girl twins has also been shown for early sentence production. Day (1932) found that 2;0- to 5;0-year-old girl–girl twins showed greater diversity and complexity in the sentences that they produced than boy–boy twins in parent-child interactions. Similar patterns were also observed with older children (ages 5;6–9;6; Davis 1937).

Compared to several studies that largely showed a female advantage in same-sex twin dyads, only a few studies examined mixed-sex twin dyads, with largely inconclusive results. Galsworthy et al. (2000) found that 2;0-year-old girl–girl twins had significantly higher vocabulary scores than boy–boy and girl–boy twins of the same age. On the contrary, some other studies showed no evidence of a difference between girl–girl and girl–boy twins in their vocabulary (Garitte et al. 2002; Gücüyener et al. 2011; Ozturk et al. 2021). In summary, the female advantage in early spoken language development becomes evident not only for singleton children but also for twin children, who typically lag behind singletons in speech production. This, in turn, places boy–boy twins at a greater disadvantage than both singletons and other types of twin dyads in speech development because of the presence of two risk factors, namely being a boy and being a twin.

Gesture

At the early ages, children not only use speech, but also rely heavily on gesture to communicate with others (e.g., Bates et al. 1979). Previous work, with singleton samples, suggests a strong link between early gesture and speech. Children gesture before they produce their first words to communicate about referents (Acredolo and Goodwyn 1985, 1989; Bates 1976; Bates et al. 1979; Özçalışkan and Goldin-Meadow 2005a, 2006a; Özçalışkan et al. 2009); and these gestures predict emerging spoken language abilities (Butcher and Goldin-Meadow 2000; Iverson and Goldin-Meadow 2005; Özçalışkan et al. 2017; Özçalışkan and Goldin-Meadow 2005b, 2006a). Although limited, the existing research suggests a female advantage in early gesture production among singletons: girls tend to produce more gestures than boys at the early ages (ages 0;8–2;6; Eriksson and Berglund 1999; Fenson et al. 1994); girls also produce their first gestures about a month earlier than boys (Butterworth and Morisette 1996)— assessed by parent report.

Research on early gesture production in twins remains sparse. The one existing study (Ozturk et al. 2021) that examined patterns of gesture and speech production among 0;10–3;4 year-old Turkish twin children, compared to singleton children, showed that twins produced fewer gestures indicating a less diverse set of referents, compared their singleton peers—a pattern that closely mirrored their early vocabularies in speech.

After children produce their first gestures, followed by their first words, they continue using gestures in combination with words (i.e., gesture + speech). First, children start producing gesture + speech combinations where the information conveyed in gesture is the same as the information expressed in speech (e.g., complementary gesture + speech; "cookie" + point at cookie; Greenfield and Smith 1976; Masur 1983; Zinober and Martlew 1985). Shortly later, they start using gesture + speech combinations where gesture conveys unique information that is not present in speech (supplementary gesture + speech; "eat" + point at cookie). These gesture + speech combinations, in turn, predict the emergence of first sentences in speech (Iverson and Goldin-Meadow 2005; Özçalışkan and Goldin-Meadow 2005b, 2009; Özçalışkan et al. 2018). Importantly, girls produce gesture + speech combinations that convey sentence-like meanings (e.g., ride + point at bike) earlier than boys—a difference that predates differences in the onset of similar sentences in their speech (Özçalışkan and Goldin-Meadow 2010). There is, however, no research that has yet examined the applicability of this pattern to twin-children—with the exception of one study (Ozturk et al. 2021), which showed lack of a difference between twin and singleton children in their production of supplementary and complementary gesture + speech combinations.

In summary, girls exceed boys in their speech development, developing larger and more varied vocabularies and more complex speech at an earlier age—a pattern that largely becomes evident in their gestures. Twin dyads—particularly boy–boy twins—lag behind singletons in their early speech development, a pattern that might be true for their gestures and gesture + speech combinations as well.

Sex Differences in the Speech and Gestures Produced by Parents of Singleton and Twin Children

Speech

One of the best predictors of the typical range of variability in children's speech vocabulary is the verbal input that they receive from their parents (e.g., Ambridge et al. 2015; Hoff 2006; Huttenlocher et al. 1991, 2002, 2010; Liu 2014). Children who are exposed to a greater amount and variety of words from their parents show not only faster vocabulary growth, but also develop larger vocabularies than children who hear fewer words from their parents (Conway et al. 1980; Hart and Risley 1995; Huttenlocher et al. 1991). Parents also modify their speech when talking to their children (Hart and Risley 1995; Snow and Ferguson 1977): they use shorter phrases with simpler syntax and lexicon (Furrow et al. 1979), exaggerated intonation (Cooper et al. 1997), and more imperatives, interrogatives, and repetitions (Ninio 1983, 1984; Snow 1995), thus simplifying their speech input. At the same time, parents also gradually increase the complexity of the speech that they produce as their children grow older (Huttenlocher et al. 2007; Phillips 1973; Rondal 1980; Snow 1972), suggesting continued sensitivity to the changes in their children's spoken language trajectories.

Parents also differ in the amount and diversity of the speech that they provide to their sons vs. daughters. Some studies suggest an advantage for girls: Leaper et al. (1998) did a meta-analysis examining the amount of different types of talk (e.g., supportive vs. directive) mothers addressed to their daughters vs. sons across 41 studies covering an age span of 0;1–11;0; and showed that mothers produced more of each type of talk when interacting with their daughters than with their sons. Similar results were reported for younger children (ages 1;8–2;0): mothers talked more and used more complex speech with their daughters than with their sons in interactive play contexts (Cherry and Lewis 1976; Schaffer and Crook 1979). However, a few other studies, focusing mostly on younger children (ages 0;6–2;2), present contradictory evidence. For example, Laflamme et al. (2002), examining parent input to boys vs. girls (age 0;9) during free-play, showed that parents used more words with their sons than with their daughters, but these differences disappeared by the time children were 1;3. Huttenlocher et al. (1991) also found no evidence of a sex difference in maternal talk to girls vs. boys (ages 1;2–2;2) in semi-naturalistic parent-child interactions.

Earlier research on sex differences focused mainly on the amount and complexity of speech parents of singletons produce, leaving the diversity of the speech parents provide to their sons vs. daughters mostly unexamined. There is also scant research that examined differences in parent speech input to different dyads of twin children or to twin children compared to singleton children. The only two existing studies (age 2;5; Lytton et al. 1977; ages 1;3–1;9; Tomasello et al. 1986), both focusing on the relation between the amount of parent talk and child vocabulary in twin children during parent-child interactions, suggested that maternal speech serves as a critical predictor of vocabulary development in twin children—but neither study has examined sex differences.

Gesture

Parents frequently gesture when talking to their children. However, we know relatively less about nonverbal input compared to verbal input. Previous work with singleton children show that parents modify their gesture input to match the communicative needs of their children (Iverson et al. 1999; Özçalışkan and Goldin-Meadow 2005a, 2006b, 2011; Özçalışkan et al. 2018; Shatz 1982), mirroring the pattern found in their speech. Parents produce simpler gestures (i.e., pointing) when they are interacting with their children, and a majority (99.8%) of these gestures come with speech (i.e., gesture + speech combinations; Baumann et al. 2019; Bekken 1989; Iverson et al. 1999; Özçalışkan and Goldin-Meadow 2005a; Özçalışkan et al. 2018). Parents also mostly use simpler types of gesture + speech combinations, namely complementary combinations where gesture conveys the same information as speech ("look at the chair" + point at the chair) than the relatively more complex supplementary gesture + speech combinations (i.e., gesture *clarifies* speech as in: "look at this" + point at the chair, or gesture *adds* new information to speech; e.g., "sit" + point at the chair) at the early ages (Baumann et al. 2019; Iverson et al. 1999; Özçalışkan and Goldin-Meadow 2005a, 2006b; Özçalışkan et al. 2018), suggesting further attunement to the communicative needs of their children.

Research suggests that parents' use of gesture might both provide models and also facilitate children's use of gestures, which, in turn, help children learn new words. For example, parents who gesture more, have children who gesture more as well, showing a tight link between child and parent gesture (Iverson et al. 1999; Namy et al. 2000; Rowe 2000). In an earlier longitudinal study following children from 1;2 to 2;10, it was shown that parents' gesture use at 1;2 was related to child gesture use at 1;2, which, in turn, predicted child vocabulary at 2;10 (Rowe et al. 2008). The positive relation between parent gesture and child vocabulary has been shown in other studies as well, with parent gesture predicting the size (Iverson et al. 1999) or acquisition rate of early vocabularies in speech at the early ages (1;0–3;0; Pan et al. 2005). Similarly, when parents were explicitly asked to use iconic gestures (e.g., flapping arms for bird flying) in addition to words when communicating with their young children, children used more gestures at 1;0 and also showed greater vocabulary gains in speech at 2;0 (Acredolo and Goodwyn 1989). The findings from these studies thus suggest that parent gesture input can influence child spoken language development in at least two substantial ways. First, parents' gestures can directly influence the comprehension of parental speech that accompanies these gestures. Second, the gestures parents produce can indirectly affect the child's subsequent language development by influencing the child's gesture production (see Özçalışkan and Dimitrova 2013, for a review).

Compared to numerous studies examining parent speech and gesture input to singletons, there is little research that examines sex differences in early gesture input to either singletons or twins. The one existing study suggests that parents of singletons might be comparable in the amount of co-speech gestures that they produce when speaking to their daughters vs. sons, but only for gestures that convey additional information not found in speech (e.g., "look what I have" + point at the toy; Özçalışkan and Goldin-Meadow 2010). There are, however, studies that show differences in coordinated joint engagement with mothers of singleton vs. twin children. As shown in earlier work (Stafford 1987; Thorpe et al. 1991, 2003), twin children receive less joint attention and directed speech and engage in shorter conversations with their parents compared to singletons, resulting in less involved interactions with their parents. There are also more interruptions during parent-child interactions among twins compared to singletons (Clark and Dickman 1984). We know that gesture plays a vital role in coordinated joint engagement— with pointing and show gestures (e.g., hold up a toy) showing positive correlations with coordinated joint engagement and subsequent language development (Bakeman and Adamson 1986; Brooks and Meltzoff 2008; Butterworth 2003; Colonnesi et al. 2010; Lock 1978; Tomasello et al. 2007). As such, differences in joint engagement might result in differences in the amount of gesture input children receive from their parents.

In sum, research shows that parental verbal input plays an essential role in both singleton and twin children's spoken language development—a pattern that has been shown to be true for nonverbal input for singleton but not yet for twin children. At the same time, research remains largely inconclusive about sex differences in parents' speech towards their daughters vs. sons; and there is no work that examines patterns of parent verbal input to twin children in different twin-dyads. Research in gesture is even sparser, with no existing work examining either sex or dyad composition differences in parental gesture input to children at the early ages.

Current Study

Previous research, based mainly on singletons, suggests that parent speech and gesture input play an important role in child's spoken language development. While some studies show inconclusive findings on sex differences in parental verbal input to singleton children (e.g., Leaper et al. 1998; Huttenlocher et al. 1991), there is no work exploring these patterns in twin children. At the same time—particularly given the importance of parental gesture input in children's vocabulary development—we do not yet know whether parents show sex differences in the gestural input that they provide to their singleton and twin children. In this study, we take these findings one step further by examining differences in both speech and gesture input that parents provide, based on child sex and dyad composition. We have two questions. First, we focus on *sex differences* and ask whether parents differ in the way they gesture and speak to their boys vs. girls and whether these patterns extend to parents of boy–boy vs. girl–girl twins. Based on inconclusive findings on sex differences in the way parents speak to their daughters and sons (e.g., Cherry and Lewis 1976; Huttenlocher et al. 1991), we predict that parents of girls— singleton or twin—will either produce greater or similar amount, diversity, and complexity of speech as parents of boys. Based on earlier findings that showed lower rates of joint engagement in parents of twins than in singletons (i.e., Stafford 1987; Thorpe et al. 2003), we expect that parents of singletons will produce a greater amount, diversity, and complexity of speech than parents of twins. We expect gestures to follow the patterns observed in speech, based on earlier work that has shown close integration between parent gesture and speech (Iverson et al. 1999; Özçalışkan and Goldin-Meadow 2005a; Özçalışkan et al. 2018).

Second, we focus on *dyad composition* and ask whether parental gesture and speech production is influenced by the dyad composition of the twin children (boy–boy, girl–boy, girl–girl). Given the lack of previous work on parent input to different twin dyads, we rely on previous results in singletons. Accordingly, we expect that parents of girl–girl twins will use either greater or similar amount, diversity, and complexity of speech compared to parents of girl–boy or boy–boy twins. We expect gestures to follow the same patterns as speech, based on earlier work that shows close integration between parent gesture and speech (Özçalışkan and Goldin-Meadow 2005a; Özçalışkan et al. 2018).

Method

Participants

The participants included the parents of 35 singletons (19 boys and 16 girls) and 31 fraternal twin dyads (10 boy–boy, 9 girl–girl, 12 girl–boy), all native Turkish speakers. All but 6 of the parents were mothers. The six remaining parents included either both the mother and father ($n=5$),[1] or only the grandmother ($n=1$). The sample of the study comes from a previously collected larger study that focuses on morpho-syntactic development of children learning Turkish (Ketrez 2014). The children in this study were selected so that they were comparable in age: there were no reliable age differences between the two groups of singletons and two groups of same-sex twins, $F(3, 69)=0.81$, $p=.49$, $\eta p^2=0.03$, or the three groups of twin dyads, $F(2, 59)=0.72$, $p=.49$, $\eta p^2=0.02$, at the time of our observations. Only a few of the parents (8/66) had an additional older child, the distribution of which was comparable across the five groups ($\text{singleton}_{boy}=3$, $\text{singleton}_{girl}=2$, $\text{twin}_{boy\text{–}boy}=1$, $\text{twin}_{girl\text{–}girl}=1$, $\text{twin}_{girl\text{–}boy}=1$); none of these siblings were present during the parent-child play. Parents were also comparable in age (Parent_{range} = 30;4–32;8; see Table 1)[2] and education: most of the participants in each group had either a university (56–100%) or a high school degree (10–37%). Participants for the original study were recruited through web platforms and foundations serving twin and singleton families in the greater metropolitan Istanbul area.

Table 1 The mean ages (*SD*) of children and their parents in years; months

	Singletons		Twins		
	Boy	Girl	Boy–Boy	Girl–Boy	Girl–Girl
Child	1;7 (0;5)	1;7 (0;5)	1;9 (0;8)	2;0 (0;6)	1;10 (0;8)
Parent	30;7 (3;3)	30;4 (2;2)	30;4 (3;6)	32;8 (3;5)	32;4 (5;4)

SD = standard deviation

[1] In the recordings where both mother and father were present, they took turns while interacting with their children; we therefore included input across the two parents. The co-presence of mother and father during the interaction was equally distributed across all 5 groups, with $n=1$ per group.

[2] The age of the grandmother was not recorded.

Data Collection

Parents were provided with several toys (i.e., farmhouse with hidden animals, animal puzzle) and asked to play with their children as they would in their everyday interactions for 10–15 minutes. The parent-child play included the singleton child and parent for singletons and both of the twin children and the parent for twins, with the goal to attain a sample of parent-child interaction that approximated children's natural home environment. The mean length of the interactions across groups was 12 minutes ($SD=4.93$); it also varied across families, largely based on how long the parent-child participants wanted to play with the toys.[3] All interactions were video recorded. Informed consent was obtained prior to any data collection from all participants included in this study.

Data Transcription and Coding

Speech

All parent speech was transcribed, using Codes for Human Analysis Transcript (CHAT) system (CHILDES; MacWhinney 2000) from video-records by native Turkish speakers trained in speech transcription. Sounds that were used to refer to an object, property of an object, or an event (e.g., "kedi" = cat, "güzel" = pretty), onomatopoetic (e.g., "hav hav" = woof woof), and conventionalized evaluative sounds (e.g., "vay" = wow) were treated as words, following earlier work (Özçalışkan et al. 2017), and further coded for morphemes, following Ketrez and Aksu-Koç (2020). Speech transcripts were divided into utterances, defined as a sequence of words that were preceded and followed by a change in conversational turn, intonation, or pause, following the CHAT system guidelines (MacWhinney 2000).

Gesture

All gestures produced by each parent were coded by coders trained in gesture coding. Gesture was defined as a communicative hand or body movement that did not involve direct manipulation of an object (e.g., moving a toy truck back and forth) or a ritualized game (e.g., patty cake), following earlier work (Özçalışkan and Goldin-Meadow 2005a; Özçalışkan et al. 2017). The gestures produced by each parent were further coded for gesture diversity and gesture complexity. Gesture *diversity* referred to the diversity of parent's vocabulary in gesture, namely the number of different referents each parent indicated in gesture (e.g., point at cat vs. point at dog vs. point at the table). Gesture *complexity* referred to the complexity of the gesture form (i.e., gesture type) and the complexity of the informational relation gesture held to the accompanying speech (i.e., gesture + speech relation type). Gesture type included the simpler *deictic gestures* that indicated referents (e.g., point at the cat) and *conventional* gestures that conveyed culturally-prescribed meanings (e.g.,

[3] The mean length of interaction varied by group, Msingletons $=10.06$ ($SD=4.31$) vs. Mtwins $=14.32$ ($SD=4.65$), $F(1, 64)=14.95$, $p<.001$, but not by sex, Mgirls $=12.40$ ($SD=5.65$) vs. Mboys $=10.97$ ($SD=4.31$), F(1, 52) $=1.12$, $p=.29$, or by twin dyad type, Mtwin boy–boy $=13.40$ ($SD=3.41$), Mtwin girl–girl $=15.78$ ($SD=6.16$), Mtwin boy- girl $=14.00$ ($SD=4.39$), $F(2, 28)=0.65$, $p=.53$.

headshake), along with the relatively more complex iconic gestures that conveyed characteristic actions or features associated with objects (e.g., flapping arms to convey flying). Gesture + speech relation type included the simpler complementary gesture + speech combinations (i.e., gesture conveys the same information as speech; "kediye bak" = look at the cat + point at cat) and the relatively more complex supplementary gesture + speech combinations (i.e., gesture clarifies or adds new information to speech; e.g., "oraya bak" = look over there + point at top of cabinet; "ne istersin?" = what do you want? + point at cat').

For twins, we did not differentiate which of the twin children the parent's communicative effort was directed at, mainly because both children were present during the interaction with equal access to parent's verbal and gestural input; and in majority of the cases, it was ambiguous which of the two twin children was being addressed by the parent. We, therefore, treated parents' verbal and gestural input as directed at both children in a twin dyad.

Reliability

We assessed reliability for gesture coding by two trained independent coders blind to the hypotheses of the study, who each coded a randomly selected 20% of the video-records for gesture detection, gesture diversity, gesture type and gesture + speech relation type, separately in each of the five groups. Agreement between coders was 89%, $\kappa = 0.96$ ($\text{Parents}_{\text{GIRL}} = 92\%$, $\text{Parents}_{\text{BOY}} = 91\%$, $\text{Parents}_{\text{BOY–BOY}} = 83\%$, $\text{Parents}_{\text{GIRL–GIRL}} = 95\%$, $\text{Parents}_{\text{GIRL–BOY}} = 86\%$) for the identification of the gestures; 95%, $\kappa = 0.95$ ($\text{Parents}_{\text{GIRL}} = 95\%$, $\text{Parents}_{\text{BOY}} = 100\%$, $\text{Parents}_{\text{BOY–BOY}} = 92\%$, $\text{Parents}_{\text{GIRL–GIRL}} = 95\%$, $\text{Parents}_{\text{GIRL–BOY}} = 92\%$) for assigning meaning to gesture (i.e., gesture diversity); 98%, $\kappa = 0.98$ ($\text{Parents}_{\text{GIRL}} = 99\%$, $\text{Parents}_{\text{BOY}} = 100\%$, $\text{Parents}_{\text{BOY–BOY}} = 95\%$, $\text{Parents}_{\text{GIRL–GIRL}} = 100\%$, $\text{Parents}_{\text{GIRL–BOY}} = 97\%$) for the classification of gestures into types; and 95%, $\kappa = 0.94$ ($\text{Parents}_{\text{GIRL}} = 91\%$, $\text{Parents}_{\text{BOY}} = 95\%$, $\text{Parents}_{\text{BOY–BOY}} = 90\%$, $\text{Parents}_{\text{GIRL–GIRL}} = 100\%$, $\text{Parents}_{\text{GIRL–BOY}} = 97\%$) for the classification of gesture + speech combinations into types.

Scoring

Speech

We assessed the number of words and number of different words each parent produced.[4] We used number of words as a measure of *speech amount*, number of different types of words (e.g., "kedi" = cat vs. "köpek" = dog) as a measure of *speech diversity*, and the mean length of utterance in morphemes (i.e., MLU) as a measure of *speech complexity*. We treated words with the same stem but with derivational morphemes (e.g., "şarkı" = song vs. "şarkıcı" = singer) as different words. Words with the same stem but with inflectional morphemes (e.g., "şarkı" = song vs. "şarkılar" = songs) were treated as the same word.

[4] For the 5 parent-child interactions where both parents were present, we tabulated speech production across the two parents.

Gesture

We assessed the number of gestures and the number of different gesture referents produced by each parent. We used the number of gestures as a measure of *gesture amount*, and the number of different referents conveyed in gesture (e.g., point at cat vs. point at dog) as a measure of *gesture diversity*. We also used the type of gesture (deictic, conventional, iconic) and gesture + speech combination (complementary, supplementary) as a measure of *gesture complexity*: iconic and conventional gestures and supplementary gesture + speech combinations were considered as more complex than deictic gestures and complementary gesture + speech combinations, following earlier work (Özçalışkan and Goldin-Meadow 2005a).[5] Parents produced very few iconic gestures (23 instances across 5 groups); therefore, we excluded iconic gestures from all analyses.

Analysis

We investigated sex and group differences in the amount, diversity, and complexity of speech and gestures parents produced when interacting with their singleton (boys and girls) and twin (boy–boy and girl–girl) children, using two-way ANOVAs with child sex (boy vs. girl) and group (singleton vs. twin) as between-subjects factors, separately for the amount, diversity, and complexity of parents' speech and gesture production. We then investigated dyad composition differences in the speech and gestures parents produced when addressing their twin children with a set of one-way ANOVAs—with the type of twin-dyad (boy–boy, girl–boy, girl–girl) as a between-subject factor, separately for the amount, diversity, and complexity of speech and gesture production. In all analyses, we used parent's production of speech and gesture per minute of interaction to control for variability in the duration of parent-child play interaction across different child-parent pairs. The only exception was speech complexity as measured by the mean length of utterance (i.e., MLU), which we computed by dividing the number of morphemes per utterance by the total number of spoken utterances for each parent. We transformed gesture and speech scores that were not normally distributed using log10 or square root transformation, as appropriate, and used transformed scores in our analyses.[6]

[5] For the 5 parent-child interactions where both parents were present, we tabulated gesture production across the two parents.

[6] We conducted all analyses first with the whole sample, and then with a reduced sample by excluding the 5 parent-child interactions ($n = 1$/group) in which both parents were present. The pattern of results remained identical; we therefore only reported the results based on the whole sample.

Table 2 Speech production of parents of singleton and same-sex twin children

	Singletons		Twins	
	Girl	Boy	Girl–Girl	Boy–Boy
$M_{\text{speech amount per minute}}(SD)$	46.56 (13.66)	54.39 (19.72)	45.26 (14.67)	50.46 (18.18)
$M_{\text{speech diversity per minute}}(SD)$	11.43 (4.26)	14.88 (5.99)	10.89 (3.20)	11.69 (4.46)
$M_{\text{speech complexity}}(SD)$	4.61 (1.34)	5.39 (1.40)	4.80 (0.83)	5.51 (1.54)

M = mean; *SD* = standard deviation

Results

Do Parents of Singletons and Same-sex Twins Talk and Gesture Differently to their Sons and Daughters?

Speech

Parents talked similarly to their singleton and twin boys and girls. As can be seen in Table 2, parents did not show an effect of child sex for either the amount (i.e., number of word tokens, $F(1, 50) = 1.80$, $p = .19$, $\eta p^2 = 0.04$), diversity (i.e., number of word types, $F(1, 50) = 2.36$, $p = .13$, $\eta p^2 = 0.05$), or complexity (i.e., MLU, $F(1, 50) = 3.80$, $p = .06$, $\eta p^2 = 0.07$) of their speech production. Similarly, parents' speech did not differ by group (singleton vs. same-sex twin dyad) either for amount, $F(1, 50) = 0.29$, $p = .60$, $\eta p^2 = 0.01$, diversity, $F(1, 50) = 1.80$, $p = .19$, $\eta p^2 = 0.04$, or complexity, $F(1, 50) = 0.17$, $p = .68$, $\eta p^2 = 0.00$. There was also no interaction between sex and group for either the amount, $F(1, 50) = 0.07$, $p = .79$, $\eta p^2 = 0.001$), diversity, $F(1, 50) = 0.91$, $p = .34$, $\eta p^2 = 0.02$, or complexity, $F(1, 50) = 0.01$, $p = .93$, $\eta p^2 = 0.00$, of parents' speech production (see Table 2).

Gesture

Turning next to gesture, we found that parents showed no effect of sex for the amount of gesture production, $F(1, 50) = 0.04$, $p = .84$, $\eta p^2 = 0.001$. However, they showed an effect of sex for the diversity of meanings they conveyed in gesture, $F(1, 50) = 4.76$, $p = .03$, $\eta p^2 = 0.09$, with parents of boys gesturing about a greater diversity of referents (e.g., point at rooster vs. point at cow) than parents of girls. Parents also showed an effect of group for both the amount, $F(1, 50)$. $= 7.22$, $p = .01$, $\eta p^2 = 0.13$, and diversity, $F(1, 50) = 4.28$, $p = .04$, $\eta p^2 = 0.08$, of gesture production. Overall, parents of singletons produced a greater amount and diversity of gestures than parents of twins. However, there was no interaction between sex and group for either the amount, $F(1, 50) = 2.32$, $p = .13$, $\eta p^2 = 0.04$, or the diversity, $F(1, 50) = 1.35$, $p = .25$, $\eta p^2 = 0.03$, of gesture use (See Fig. 1a, b).

Turning next to complexity of gesture, and beginning with *gesture types*, we found an effect of gesture type, $F(1, 50) = 123.07$, $p < .001$, $\eta p^2 = 0.71$, and group, $F(1, 50) = 6.65$, $p = .01$, $\eta p^2 = 0.12$, *but* no effect of sex, $F(1, 50) = 0.01$, $p = .92$, $\eta p^2 = 0.00$. Parents produced greater number of deictic than conventional gestures; and parents of singletons produced more of each type of gesture than parents of twins. There was also an interaction between gesture type and group, $F(1, 50) = 8.34$, $p = .01$, $\eta p^2 = 0.14$, with greater production of deictic ($p < .05$)—but not conventional ($p = .53$) gestures—by parents of singletons compared to

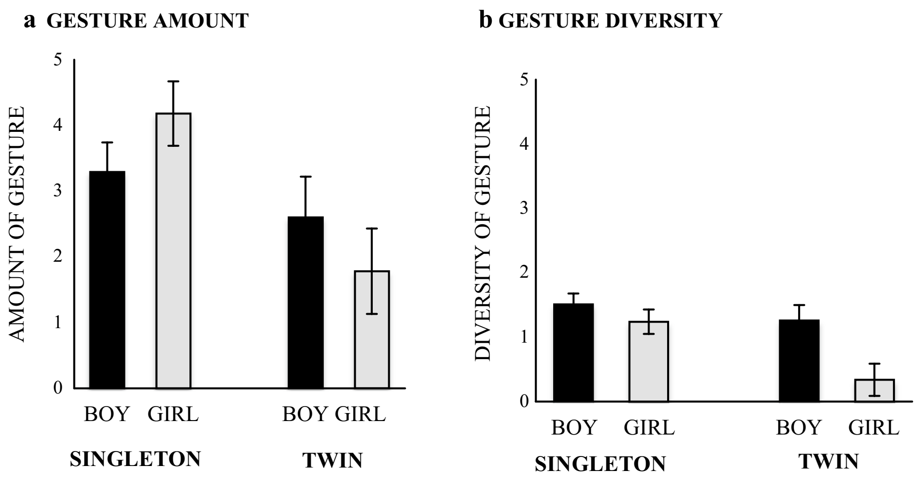

Fig. 1 Mean amount (**a**) and diversity of gestures (**b**) produced per minute by parents of boys and girls for singletons and twins (error bars represent standard error)

parents of twins. There was *no interaction* between gesture type and sex, $F(1, 50)=0.32$, $p=.57$, $\eta p^2=0.01$, or between gesture type, sex, and group, $F(1, 50)=0.73$, $p=.40$, $\eta p^2=0.01$.

Next looking at complexity in terms of gesture + speech combinations, we found no effect of gesture + speech combination type, $F(1, 50)=3.45$, $p=.07$, $\eta p^2=0.07$, or sex, $F(1, 50)=0.06$, $p=0.81$, $\eta p^2=0.001$, *but* we found an effect of group, $F(1, 50)=6.58$, $p=.01$, $\eta p^2=0.12$, with parents of singletons producing more gesture + speech than parents of twins. None of the two-way interactions: gesture + speech type by sex, $F(1, 50)=1.73$, $p=.20$, $\eta p^2=0.03$, gesture + speech type by group, $F(1, 50)=1.52$, $p=.22$, $\eta p^2=0.03$, or three-way interactions: gesture + speech type, sex, and group, $F(1, 50)=0.68$, $p=.42$, $\eta p^2=0.01$ was significant (see Fig. 2a, b).

In summary, parents did not show sex or group differences in the amount and complexity of the speech that they provided to their children. They, however, showed some sex and group differences in the amount and diversity of their input gestures. Parents of boys gestured about a greater variety of referents in gesture than parents of girls; and parents of singletons produced greater amount and diversity of gestures and greater amount of gesture + speech combinations than parents of twins. All parents, however, relied predominantly on the simpler deictic gestures, using them both to reinforce ("koyun" = sheep + point at sheep) or to supplement ("Tavşan ne yiyor?" = What is the rabbit eating? + point at the carrot) what they convey in speech.

Do Parents Talk and Gesture Differently to their Twins in Different Dyads?

Speech

We next examined the patterns of speech and gesture for parents in each of the three twin dyads (boy–boy, girl–girl, boy–girl). As can be seen in Table 3, parents of twins in the three groups did not differ in either the amount, $F(2, 28)=0.55$, $p=.58$, $\eta p^2=0.04$, diversity, $F(2, 28)$ 0.11,

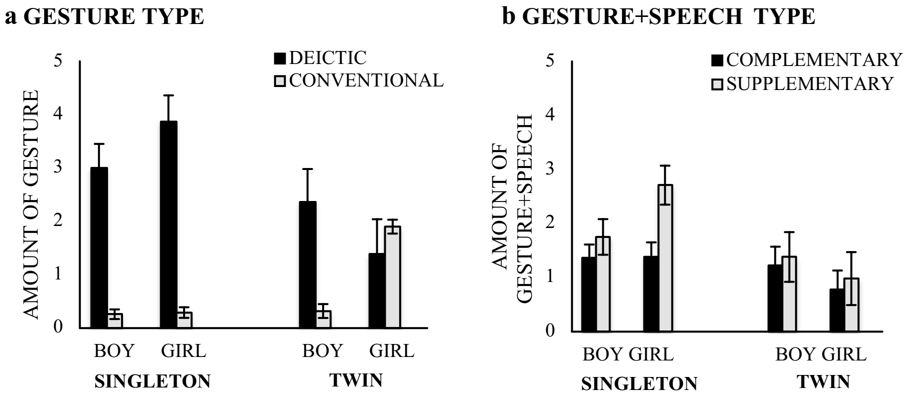

Fig. 2 Mean number of different types of gestures (**a**) and gesture + speech combinations (**b**) produced per minute by parents of boys and girls for singletons and twins (error bars represent standard error)

$p = .89$, $\eta p^2 = 0.01$, or complexity, $F(2, 28) = 1.06$, $p = .36$, $\eta p^2 = 0.07$, of the speech that they provided to their children.

Gesture

The parents' patterns of gesture production remained similar to the patterns in their speech. Parents of twins in the three dyad types (boy–boy, girl–girl, boy–girl) did not differ in either the amount, $F(2, 28) = 0.59$, $p = .56$, $\eta p^2 = 0.04$ (see Fig. 3a) or the diversity, $F(2, 28) = 2.35$, $p = .11$, $\eta p^2 = 0.14$ (see Fig. 3b), of the gestures that they produced when interacting with their children.

Next, turning to complexity of gesture, and beginning with *gesture type*, we found an effect of gesture type, $F(1, 28) = 50.40$, $p < .001$, $\eta p^2 = 0.64$, but no effect of dyad-composition, $F(2, 28) = 0.50$, $p = .61$, $\eta p^2 = 0.03$, or gesture type by dyad composition interaction, $F(2, 28) = 0.60$, $p = .56$, $\eta p^2 = 0.04$. Parents produced greater amount of deictic than conventional gestures across the three twin dyads (see Fig. 4a). The pattern was different for complexity as indexed by gesture + speech combinations. As can been seen in Fig. 4b, parents' gesture + speech combinations showed no main effect of combination

Table 3 Speech production of parents of twins

	Girl–Girl	Boy-Boy	Girl–Boy
$M_{\text{speech amount per minute}}$ (SD)	45.26 (14.67)	50.46 (18.18)	54.28 (23.25)
$M_{\text{speech diversity per minute}}$ (SD)	10.89 (3.20)	11.69 (4.46)	11.40 (3.45)
$M_{\text{speech complexity}}$ (SD)	4.80 (0.83)	5.51 (1.54)	4.93 (0.99)

M = mean, SD = standard deviation

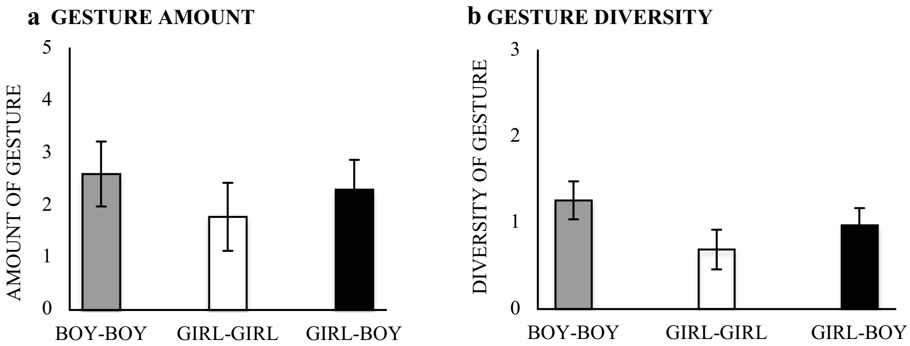

Fig. 3 Mean amount (**a**) and diversity of gestures (**b**) produced per minute by parents of boy- boy, girl–girl, and girl–boy twin dyads (error bars represent standard error)

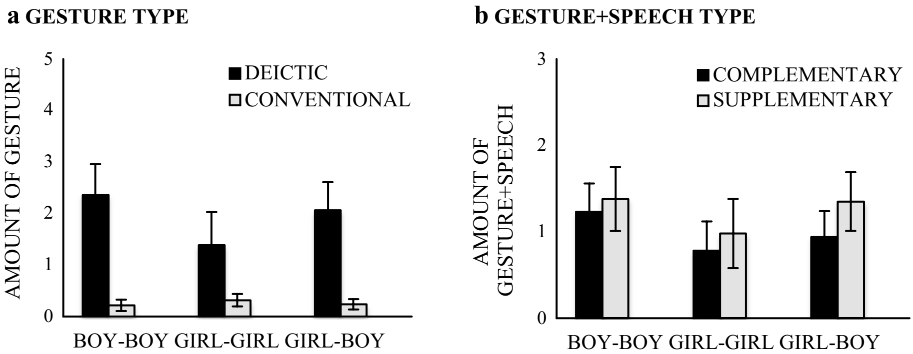

Fig. 4 Mean number of different types of gestures (**a**) and gesture + speech combinations (**b**) produced per minute by parents of boy–boy, girl–girl, and girl–boy twins (error bars represent standard error)

type, $F(1, 28) = 1.63$, $p = .21$, $\eta p^2 = 0.06$, dyad composition, $F(2, 28) = 0.55$, $p = .58$, $\eta p^2 = 0.04$, or interaction between gesture + speech type and dyad composition, $F(2, 28) = 0.54$, $p = .59$, $\eta p^2 = 0.04$.

In sum, parents of the three twin dyads showed similarities in the amount, diversity, and complexity of the speech and gestures that they produced, with no group differences. Parents relied largely on the relatively simpler deictic gestures, regardless of type of dyad; they also used the two types of gesture + speech combinations at similar rates when communicating with their twin children in the three dyads (see Table 4 in "Appendix" for overall correlations between measures of gesture and speech production of parents across all groups).

Discussion

In this study, we examined parents' speech and gesture production towards their singleton and twin children. We observed 35 parents of singletons (16 girls, 19 boys) and 31 parents of twins (10 boy–boy, 12 girl–boy, 9 girl–girl) and asked whether parents showed sex, group, or dyad composition differences in their speech and gesture input to their children. We found no sex differences in speech and gesture, except for gesture diversity where parents of boys indicated a greater diversity of referents in gesture than parents of girls. We observed no evidence of group differences (singleton vs. twin) in speech, but we found differences in the amount, diversity, and complexity of gestures parents produced, with an advantage for parents of singletons compared to parents of twins. In addition, we found no dyad-composition differences (boy–boy, girl–boy, girl–girl) in either the amount, diversity, or complexity of speech and gestures parents provided to their twin children, showing that parents of children in each twin dyad used similar amount and variety of speech and gestures.

First looking at *sex differences* (boy vs. girl), in contrast to some of the earlier work (Cherry and Lewis 1976; Schaffer and Crook 1979), our study found no difference in the way parents talked to their daughters vs. sons. Similar to speech, we also found no sex differences in the amount and complexity of the gestures parents produced. However, we found that parents of boys indicated a more diverse set of meanings in gesture than parents of girls. One possible factor that could explain this difference could be the child's own gesture production. We know from previous work that boys lag behind girls in their language development (Berglund et al. 2005); as such, boys might rely on gesture more than girls to communicate. However, an earlier study (Ozturk et al. 2021) that examined the speech and gestures produced by the children of the parents in our study showed no evidence of sex differences in children's production of either gesture or speech—suggesting that the greater diversity of meanings conveyed in the gestures produced by parents of boys is not likely an outcome of the patterns observed in children's own production of gestures. Our findings also showed no sex differences in the types of gesture + speech combinations parents used. This finding further supports earlier work, which showed that caregivers produced comparable numbers of gesture + speech combinations when addressing their daughters vs. sons (Özçalışkan and Goldin-Meadow 2010).

It is important to note that most of the earlier work that showed differences in parental input to girls vs. boys was from studies published in the 1970s, several decades before our study, which showed no evidence of such a difference. One possibility might be that there have been changes in parental behavior due to societal practices that encourage less pronounced gender stereotypes. At the same time, however, recent work that has focused largely on the content of the parental talk addressed to sons vs. daughters (either by mothers or fathers) has suggested that parents still communicate with their children in gender-stereotypical ways, using more talk about emotions with their daughters and more talk about achievements with their sons (e.g., Aznar and Tenenbaum 2014; Mascaro et al. 2017).

Turning next to *group differences* (singleton vs. twin), our results showed that parents of singletons and twins produced similar amounts, diversity, and complexity of speech while interacting with their singleton and twin children—a finding in contrast with our prediction as well as earlier work on speech production (e.g., Conway et al. 1980). We know from previous research that there are more interruptions during parent-child interactions in twins compared to singletons (Clark and Dickman 1984), which adversely affects the amount of parent attention and speech production in twin dyads (Lytton et al. 1977; Thorpe et al. 2003). However, most of this earlier work that showed group differences in speech focused on older children (ages 1;8–9;0). In contrast, the children in our study were relatively young and were not yet producing much speech. This, in turn, might have influenced rates of speech production among parents, resulting in differences in the speech input provided to singletons vs. twins. Turning to gesture, however, we found that parents of singletons used a greater amount and diversity of gestures, relying primarily on the less complex deictic gestures. We also found that parents of singletons produced more gesture + speech combinations than parents of twins. There might be several reasons for this difference. One possible explanation could be the difficulties in coordinated joint engagement in a twin dyad. We know from earlier work that coordinated joint engagement and gesture are positively related (e.g., Brooks and Meltzoff 2008); and since parents of twins need to divide their attention, there might be less participation of joint engagement in a twin dyad (Butler et al. 2003; Stafford 1987; Tomasello et al. 1989; Tomasello et al. 1986). Earlier research, in fact, showed that mothers are five times more likely to participate in coordinated joint engagement with one of the twins instead of both of them at the same time (Aldrich et al. 2015), affecting the quantity and quality of interaction each child receives in a twin dyad (Rutter et al. 2003). The differences in joint engagement thus might explain the lower production of gestures and gesture + speech combinations by the parents in twin dyads. A second possible explanation could be the effect child's gesture production might have on the parent's gesture production. In line with earlier work that has shown positive correlations between parent and child gesture production (e.g., Namy et al. 2008; Rowe et al. 2008), the greater amount of gesture input provided to singleton than to twin children in our study might also be an outcome of differences in children's own gesture production. In fact, earlier work (Ozturk et al. 2021) that examined the children of the current sample of parents provided evidence for this possibility—with less frequent use of gestures that also conveyed a less diverse set of meanings among twins compared to singleton children.

Turning last to *dyad composition differences* in twin dyads (boy–boy vs. girl–girl vs. boy–girl), we found more similarities than differences. The parents did not differ in either the amount, diversity, or complexity of the speech that they used with their children in each of the three twin dyads—a pattern that also extended to their gestures. It is important to note here that our sample size for the comparison of the three types of twin dyads was relatively modest, which in turn, might have influenced our power in detecting reliable differences. Importantly, however, parents primarily used the relatively simpler deictic gestures when communicating with their children, in line with earlier work (Bekken 1989; Iverson et al. 1994; Özçalışkan and Goldin-Meadow 2005a; Özçalışkan et al. 2018). One reason why parents used deictic gestures more could be that they might be mimicking the gestures their children produce—a pattern that we indeed did observe in the gestures produced by the children of the parents in an earlier study (Ozturk et al. 2021). We know that children tend to use deictic gestures at the early ages because such gestures provide them with an easy tool to refer to an object before they know the word for it (Iverson and Goldin-Meadow 2005; Özçalışkan et al. 2017, 2018). Deictic gestures are more transparent than both iconic and conventional gestures because the latter types of gestures convey relational concepts, which might be cognitively more challenging for young children (Özçalışkan et al. 2014; see also Dimitrova et al. 2017; Hodges et al. 2018; Stanfield et al. 2014 for a similar pattern in gesture comprehension). In addition, research shows that more complex representational skills might be necessary to produce iconic gestures, though these abilities usually do not begin to emerge until children are 2- to 3-years-old (DeLoache 2004; Lillard 1993). Given that parents modify their gesture to adjust to the communicative needs of their children (Iverson et al. 1999; Özçalışkan and Goldin-Meadow 2005a, 2011; Özçalışkan et al. 2018), they themselves also used very few iconic and conventional gestures, but instead relied primarily on deictic gestures. At the same time, the study design might have also encouraged parents to produce a greater number of deictic gestures as well, given that it involved one-on-one interactions around a set of objects available in the immediate environment.

While we found differences in the complexity of gestures parents used—with a preference for the simpler deictic gestures—there was no difference in parents' production of different gesture + speech combination types. Parents, regardless of group (twin vs. singleton) or child sex (boy vs. girl), produced similar amounts of both the simpler complementary and the more complex supplementary gesture + speech combinations. Our findings are inconclusive with other research findings that showed that parents produced a greater amount of complementary gesture + speech combinations than supplementary combinations (Baumann et al. 2019; Özçalışkan and Goldin-Meadow 2005a; Özçalışkan et al. 2018). One reason that our findings might be different from earlier work could be that we treated supplementary gestures as either adding ("nerede?" = "where?" + point at barn door; 10%) or disambiguating ("inek burada" = cow is here + point at barn door; 49%) the information conveyed in speech. In fact, if we leave out the combinations where gesture disambiguated a pronominal referent in speech, then complementary combinations ("inek" = cow + point at cow) indeed become one of the most common type of gesture + speech combinations (41%) parents used in our study as well.

One limitation of our study was the relatively wide age range of the participants: children in our study ranged in ages from 0;10 to 3;4, which is a time period where children go through two important milestones in speech (i.e., first words, first sentences)—with gesture signaling the emergence of these milestones in speech (Iverson and Goldin-Meadow 2005; Özçalışkan and Goldin-Meadow 2005b, 2010; Özçalışkan et al. 2017, 2018). However, earlier research suggests that even though children go through rapid changes in speech and gesture use between ages 1–3, parental speech and gesture input remains relatively stable across this age span (e.g., Özçalışkan et al. 2018; Rowe et al. 2008; see also Furrow et al. 1979; Gleitman et al. 1984 for similar results on speech). We, therefore, believe that the age range—which was similar in each of the five groups—had relatively little effect on parents' production of gesture and speech. In fact, when we examined parents' gesture and speech production separately for the younger (0;10−2;1) vs. older (2;2–3;4) children in our sample, we found the same patterns of production for the parents of younger vs. older group as we did for the whole sample, further suggesting that the range of child age had no reliable effect on parents' gesture and speech production.

In summary, our study—as the first of its kind—shows that parents' production of speech and gesture remains largely similar when communicating with their sons vs. daughters or with their twin children in different dyad types (girl–girl, boy–boy, boy–girl). Our results also suggest that parents might be providing models for their children for the types of gestures and gesture + speech combinations, with more predominant use of the relatively simpler deictic gestures and frequent use of complementary gesture + speech combinations. Our findings also show differences—with greater parental gesture input to singletons than to twins—a pattern that mirrors the gesture production of the children in previous work (Ozturk et al. 2021). As such, our findings have the potential to inform parent-focused nonverbal communicative strategies to alleviate difficulties twin children might face in early language development.

Appendix

See Table 4.

Table 4 Correlational matrix for parents' speech and gesture production (significant correlations are in bold)

	S_ amount	S_ diversity	S_ complexity	G_ amount	G_ diversity	G_ deictic	G_ conventional	G+S_ complementary	G+S_ supplementary
S_amount	1								
S_diversity	**.53****	1							
S_complexity	0.17	0.16	1						
G_amount	0.23	0.14	−0.17	1					
G_diversity	**.35****	**.36****	**.27***	**.62****	1				
G_deictic	0.17	0.10	−0.18	**.98****	**.58****	1			
G_conventional	**.32****	0.16	0.03	0.10	0.17	−0.09	1		
G+S_complementary	**.35****	**.36****	0.20	**.66****	**.75****	**.60****	**.27***	1	
G+S_supplementary	0.03	−0.01	**−0.40****	**.86****	**.31***	**.88****	−0.12	**.25***	1

**$p < .001$, *$p < .01$; 2-tailed; G: gesture, G+S: gesture+speech, S: speech

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