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Parental sensitivity and family conversation: A naturalistic longitudinal study with both mothers and fathers across three time-points in early infancy

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Abstract

Parental verbal sensitivity is known to promote child language skills, but few studies have considered: (a) links between global (i.e., verbal, behavioral, and affective) measures of parental sensitivity and infant-initiated conversations, an important precursor to language development; (b) whether maternal and paternal sensitivity show similar links with infant-initiated conversation; or (c) the transactional role of infant conversation for later parental sensitivity. Addressing these gaps, this study of 186 British first-time parents (93 families) examines the developmental dynamics between parental sensitivity and infant communication across the first year of life. We explore; (i) the role of maternal and paternal sensitivity (assessed during structured home observations at 4 months post-partum) for parent-infant conversational interactions at 7 months (indexed by day-long naturalistic recordings), and (ii) whether these mother-infant and father-infant conversations at 7 months shape maternal and paternal sensitivity at 14 months (also assessed via structured home observations). For both male and female infants, maternal (but not paternal) sensitivity at 4 months predicted infant vocalisations and conversational initiation at 7-months. By contrast, neither index of infant talk predicted maternal or paternal sensitivity at 14 months. Together these findings refine understanding of theoretical models of social development and suggest new possibilities for future research.

KEYWORDS
conversation, fathers, infant, interaction, mothers, sensitivity

1 | INTRODUCTION

Parental sensitivity, defined as the ability to notice, interpret, and respond in a timely and appropriate manner to children's verbal, emotional or behavioral signals (Ainsworth et al., 1974), is associated with infant attachment security, self-regulation, language skills, and behavioral/emotional adjustment (Cooke et al., 2022; Madigan et al., 2019; Rodrigues et al., 2021; Verhage et al., 2016). According to attachment theory (Bowlby, 1969), sensitive responding to infants' secure-base and safe-haven

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needs provides a blueprint for future social interactions by enabling infants to form an internal working model of caregivers as available, and themselves as effective within relationships. From a socio-cultural standpoint (Vygotsky, 1987), parent sensitivity sets the stage for dialogue and interaction and ensures children receive the optimal level of support to foster their learning and social skills. Importantly, both theoretical frameworks highlight the importance of caregiver responses to infants' early behaviors for social and linguistic development (Hoff, 2006).

Maternal sensitivity in specific contexts (i.e., verbal sensitivity to infant verbalizations) has been linked to early language outcomes, but fathers remain overlooked and little is known about how broader measures of sensitivity (i.e., contingent responses to a range of verbal and non-verbal infant cues) predict infants' initiation of (proto)conversations. Furthermore, the transactional nature of relationships dictates that both parents and infants shape conversational dynamics over time (Sameroff, 2009; Sameroff & Chandler, 1975). Addressing these gaps, the current longitudinal study aims to examine: (i) the role of early maternal and paternal sensitivity at 4 months of age for parent-infant conversational interactions, assessed at 7 months using naturalistic long-form audio recordings in the home, and (ii) whether parent-infant conversations at 7 months shape later maternal and paternal sensitivity at 14 months of age.

Key Findings

1. Maternal (but not paternal) sensitivity at 4-months predicts infant proto-conversations and frequency of infant vocalizations at 7-months.
2. The frequency of infant-initiated conversations at 7 months does not subsequently predict later maternal or paternal sensitivity at 14 months.
3. Similar patterns of associations were evident for parents of daughters and sons.

Statement of relevance

Attachment theory suggests contingent parent responses to infant cues shape children's social development. This study is novel in assessing the transactional links between maternal and paternal sensitivity and infants' conversational pre-cursors. These findings suggest that alongside verbal sensitivity, broader sensitivity – including behavioral and emotional responsiveness – may also foster infant's initiation of conversation and expectations of contingent responding from parents. Demonstrating the equivalence of these associations for mothers and fathers and parents with male and female infants supports the universality of theoretical assumptions.

1.1 | Parent sensitivity and early infant conversations

Caregivers' appropriate responses to their infants' verbal, emotional, and behavioral signals foster infants' expectations of contingent, sensitive caregiving (Paavola et al., 2006). From as early as 8 weeks of age, infants prefer interacting with a stranger who displays the same level contingency to smiles and vocalizations (i.e., verbal and non-verbal responses) as their mother (Bigelow & Rochat, 2006). Very young infants are also active participants in social interactions, initiating conversational turns with their caregivers (Gratier et al., 2015). For example, a small ($n = 12$) but exceptionally rich study that involved 12 fortnightly 30-min lab-based observations of unstructured play from 8 to 14 months showed that mothers' sensitive responses to infant vocalizations in the previous months—rather than their overall rate of responding to bids—predicted infants' subsequent mother-directed vocalizations, (Gros-Louis et al., 2014). Longitudinal evidence using day-long recordings from 122 families between 9 and 24 months of age also points to the importance of early parent-infant conversational turns for later child language acquisition (Donnelly & Kidd, 2021). Indeed, studies using long-form audio recordings of family talk have shown that the frequency of parent-infant conversational turns predicts children's language outcome, over and above effects of total adult talk in the home (Romeo et al., 2018; Salo et al., 2022; Zimmerman et al., 2009). Meta-analytic findings also demonstrate close links between the home language environment and child language outcomes (Madigan et al., 2019).

Together, the above studies provide some evidence to suggest that caregiver interactions provide the foundation through which infants come to understand, expect, and engage in contingency in their communicative interactions. Studies of sensitivity and contingent responding in the context of verbal interactions with infants highlight the importance of contingent verbal caregiving responses to infant's communication for later child language development (e.g., Salo et al., 2022; Tamis-LeMonda et al., 1996). For example, in a study of 40 mother-infant dyads filmed at home in 10-min free play sessions at 9- and 13-months of

age, maternal sensitivity, measured via an aggregate of verbal responses at 9 months of age predicted infant language comprehension at 13 months, even when prior infant language performance was considered (Baumwell et al., 1997; see also Tamis-LeMonda et al., 2001).

Unfortunately, the preoccupation with child language outcomes may have unduly narrowed the focus on parental sensitivity to infant verbal cues. As noted above, parental sensitive responding also involves contingent and appropriate responses to infants' affective and behavioral cues. For example, contingent mother smiles predict the frequency of infant social bids during a stressful interaction (i.e., during the Still Face paradigm, Mcquaid et al., 2009). Appreciating the range of ways in which parents display sensitivity may therefore advance our understanding of infants' developing social competencies, and their early motivation to initiate conversations with their caregivers.

Transactional models of relationships (Osher et al., 2020; Sameroff, 2009; Sameroff & Chandler, 1975) suggest that infant conversational bids elicit further sensitive responding. That is, infants can be seen as joint controllers in the "interaction engine" of social development (Levinson, 2016). As such, parental sensitivity is more likely in the context of an infant who frequently initiates conversation with their parents. Transactional links between parental sensitive responding and children's developing social competence have been documented in early and middle childhood (e.g., Blume et al., 2022; Guo et al., 2023). These patterns of associations also apply to early parent-infant interactions. For example, in a sample of 259 mother-infant dyads, infant negative emotionality at 6 months was negatively associated with maternal sensitivity at 14 months, which in turn was associated with reduced infant negative emotionality at 26 months (Bailes & Leerkes, 2023). However, the extent to which these transactional models apply to links between parenting and early communicative skills in infancy remains to be tested. Extending the developmental scope of prior empirical work, the current study tests whether these transactional patterns are evident in conversational precursors during infancy.

1.2 | Interaction Patterns for mothers and fathers

Parental sensitivity is widely recognized as a key parenting construct (Mesman, 2021), but our understanding of this construct is limited by the disproportionate focus on mother-infant rather than father–infant relationships (Dykas & Smiler, 2022). A meta-analysis of results from 93 studies published between 1983 and 2020 using observed measures of maternal and paternal sensitivity across childhood (3–180 months) found both a small but significant average between-parent difference, with mothers showing more sensitivity than fathers ($d = -.27$) and an effect of publication year, such that this contrast is smaller in more recent studies (Deneault et al., 2022). Further, maternal and paternal sensitivity show similarly sized associations with measures of children's later language and adjustment (e.g., Deneault et al., 2021; Mills-Koonce et al., 2015). What is not known, however, is whether children's conversational skills are equally associated with maternal and paternal sensitivity.

Recent work highlights the transactional nature of associations between both mother and father conversation and children's later language skills (Pancsofar, 2020), as well as between maternal positive parenting and children's later behavior. For example, in a study of 173 Irish families, Girad et al. (2017) reported that toddler social competence at 18 months showed positive longitudinal associations with maternal warmth at 24 months, which in turn was associated with higher toddler social competence at 36 months. Sensitivity is conceptually distinct from warmth, as parents can respond promptly and appropriately to infant distress without displaying positive affect (Mesman & Emmen, 2013); nevertheless, findings highlight the dynamic, reciprocal and across-domain nature of mother-infant interactions. Developmental ecological systems theories (e.g., Cabrera et al., 2014; Volling et al., 2019) also acknowledge the transactional and dynamic nature of father–child interactions, but these longitudinal models have received little empirical testing (Palkovitz, 2020), particularly during infancy. In the current study, we therefore compared the strength of associations between mothers' and fathers' home-based observations of parental sensitivity to verbal and non-verbal cues and infant talk.

1.3 | Parent interactions with infant daughters and sons

Child gender may also affect parents' sensitivity, but existing findings are mixed. Some studies report that parental sensitivity is greatest within mother–daughter dyads and lowest within father–son dyads (Hallers-Haalboom et al., 2017; Lovas, 2005; Siqveland et al., 2022), while others report that fathers are as sensitive as mothers toward sons, but less sensitive than mothers when interacting with daughters (Schoppe-Sullivan et al., 2006). Finally, some research suggests greater *within-couple similarity* in parental responsiveness towards infant sons than daughters (Deschênes et al., 2014, but see also Roggero et al., 2023).

There is similarly inconsistent evidence on whether infant girls and boys differ as communicative partners

during dyadic interactions. Between 2 and 5 months of age, girls display longer vocalizations than boys, and boys are less likely than girls to end a turn-taking sequence during vocal interaction with mothers (Gratier et al., 2015). Other studies show differences between maternal and paternal talk to infants, between maternal talk to sons compared with daughters and between male and female infants' vocalization frequency between birth and 7 months of age (Johnson et al., 2014). However, infants' social smiles and bids do not differ by infant gender during the Still-Face paradigm (McQuaid et al., 2009). Given these inconsistencies, in the current study we sought to test whether associations between parental sensitivity and child conversation vary by child gender.

1.4 | The current study

Meta-analytic work demonstrates positive associations between sensitivity narrowly defined as parental contingent verbal responses to their infant and later social, behavioral, and linguistic outcomes (Cooke et al., 2022; Madigan et al., 2019). However, few empirical studies have examined either the role of early global parental sensitivity for later infant vocalizations and initiated conversations, or whether they predict later parental global sensitivity. To address this gap, the current multi-method longitudinal study followed 186 first-time parents from 93 families across three time-points between 4- and 14-months. The 4- and 14-month time-points involved traditional manual coding of parent sensitivity in the home and at 7 months of age infant-initiated conversational turns were captured via day-long audio recordings using the Language ENvironment Analyses recorder and software (LENA, 2018).

Our overall aim was to examine the developmental dynamics between parental sensitivity and infant communication across the first year of life, with analyses guided by three sets of questions. Our first set of questions concerned the specificity of reciprocal links between parental sensitivity and infant talk. Here, we assessed both the frequency of vocalizations and those that elicited a response from the caregiver (i.e., initiated conversational turns). For both mothers and fathers, we expected: (a) early parental sensitivity to predict infant-initiated conversational turns rather than overall frequency of infant vocalizations, and (b) infant-initiated conversations (rather than overall vocalizations) to predict later parental sensitivity.

Our second and third sets of questions concerned similarities and differences between results across parent and child gender. Given the absence of decisive data, we adopted an exploratory approach, aimed at refining conceptual understanding of parent sensitivity as well as transactional links between parent and child outcomes.

2 | METHOD

2.1 | Participants

This study reports on a subsample of 93 families with infants of the right age who took part in three time-points of a multi-method longitudinal study of child development recruited in 2014 and 2015 (New Fathers and Mothers Study, see Hughes et al., 2018). Families were recruited via antenatal clinics, ultrasound scans, and parenting fairs in the East of England, alongside a local maternity unit (for more information see Fink et al., 2020). Given the overall aims of the New Fathers and Mothers study, participants were required to: (i) be cohabiting first-time mothers and fathers, (ii) be expecting delivery of a healthy singleton baby, (iii) plan to speak English as a primary language with their child, and (iv) have no history of severe mental illness or substance misuse. On average, fathers were 33.54 years old ($SD = 5.96$ years, range: 21–50 years) and mothers were 31.99 years old ($SD = 4.42$ years, range: 20–45 years) at the birth of their baby. Most mothers and fathers had a university degree (74% and 65%, respectively) and were predominantly Caucasian (91.4% and 92.5%, respectively).

At Time 1 infants were on average 4 months old ($M_{age} = 4.16$ months, $SD = .50$, range: 3–6 months, 45 (48%) girls), with 80% of infants visited at home within 14 days of 4 months of age. 92 families (87 mothers and 83 fathers) completed the Still Face paradigm with their infant to assess parental sensitivity. Of those families ($n = 79$) where both mother and father completed the Still Face paradigm, 82% were conducted on separate days.

When infants were 6 months old ($n = 93$), they were mailed a LENA device to be worn on a typical day when both mothers and fathers were home. Given this directive, there was more variability in infant age at Time 2 ($M_{age} = 6.87$ months, $SD = 1.09$, range: 5–9 months), however 85% of infants were between 6 and 8 months of age when the LENA recording day took place. On average there were 3.2 months between T1 and T2 (SD = 1.17 months, range: 1–6 months), with 85% of infants completing the LENA recording between 1.7 and 4.8 months after T1.

At Time 3, a subset of families ($n = 22$) could not be followed up because they were recruited via a more limited funding stream; one additional family remained in the larger study but did not complete the sensitivity observations, as such 71 families (69 mothers and 67 fathers) were followed up when infants were 14 months old ($Mage = 14.35$ months, $SD = .54$, range: 13.1–16.0). The time between T2 and T3 was on average 6.7 months ($SD = 1.20$

months, range: 3.6–9 months) and between T1 and T3 was on average 10.10 months (SD = .55, range: 8.8–11.32 months). Compared with families that were followed up (n = 71), families that were not followed up (n = 22) at Time 3 did not differ with respect to child gender, $\chi^2(2) = .175$, $p = .675$, father education, $\chi^2(2) = 2.69$, $p = .107$, or earlier mother or father sensitivity, $ts(85) < .788$, $p > .433$. However, there was a significant difference in mother education level, such that those followed up at Time 3 were more likely to have a post-secondary school qualification than those not followed up, $\chi^2(2) = 5.585$, $p = .018$.

Power analyses with G*Power ($\alpha = .05$) show even the sample size at Time 3 (n = 71) provides over 80% power to detect an effect size of .30 (Cohen, 1992).

2.2 | Procedure

All procedures in the current study were approved by the National Health Service Research Ethics Committee (London Bloomsbury), and parental consent was provided at each time-point of the study. Demographic information about parental highest level of education, ethnicity and age were collected from mothers and fathers prior to the birth of their infant. At 4 and 14 months of age (Time 1 and 3), families were visited in their home and mothers and fathers were observed separately interacting with their infants (alongside other tasks not relevant to the current study). When infants were 7 months of age (Time 2), LENA devices were mailed to consenting families. Families were requested to select a day for recording when both mothers and fathers were present and represented a typical day in their infant's routine.

2.3 | Measures

2.3.1 | Sensitivity

Filmed observations of each parent-infant dyad during home visits at Times 1 and 3 were coded for maternal and paternal sensitivity. Graduate-level coders were trained by a leading expert in the field on an international set of training videos of observations from the same time points and observational contexts.

At Time 1, families were visited once or twice at home, with each parent separately completing the Still-Face paradigm with their infant. The five-minute Still Face paradigm consists of three episodes; (i) the baseline where the parent and infant (who is seated in front of the parent) interact as normal for two minutes, (ii) the Still Face where the parent ceases interaction and adopts a neutral face for one minute, and (iii) the reunion where normal face-to-face interaction is resumed for a further two minutes (Tronick et al., 1978). Across both the baseline and reunion episodes, sensitivity, defined as appropriately following infant cues (based on gaze direction, vocalization) was coded using a 4-point global scale; 0 = virtually no sensitivity, 1 = minimal or low sensitivity, 2 = mixed or moderate sensitive, 3 = predominantly high sensitivity (Mesman et al., 2013; Miller et al., 2002). Reliability was established on 20% of the samples, mean sensitivity ICC = .73.

At 14 months, parents were observed playing with their infant on the floor during a 4-min Don't Touch paradigm, which comprised two episodes: (i) the challenge, which involved the parent asking the child not to touch a set of attractive toys, and (ii) free play, where children were permitted to play with the toys and their parent. Sensitivity was only coded during the free play episode at 14 months to mirror as much as possible the context of reunion after challenge in the Still Face paradigm. Each parent completed the observation with their 14-month-old separately, with a minimum of 60 min between each observation. The order of the visits was counterbalanced between parents, such that an equal number of mothers and fathers completed the observation first. Each video was coded by a trained coder using the Ainsworth Sensitivity Scales (1974). Mothers' and fathers' sensitivity was based upon parents' awareness, interpretation, and appropriate and timely response to their infant's signals (i.e., gaze direction, vocalizations), rated on a 9-point global scale, with 5 anchor points (e.g., 1 = highly insensitive, 3 = insensitive, 5 = inconsistently sensitive, 7 = sensitive, 9 = highly sensitive). Inter-rater reliability was acceptable (14 months: .70 < ICC < .91). In accordance with best practice for each time-point (Mesman & Emmen, 2013), different sensitivity coding schemes were used for the different contexts (4 months and 14 months) and so z-scores for sensitivity at each time-point were created to enable direct comparisons.

2.3.2 | Infant vocalizations and initiated conversational turns

The number of infant vocalizations and initiated conversational turns were recorded using the LENA hardware (LENA, 2018). The recorder, worn by the infant, recorded on average 15.42 hours (SD = 1.47, range: 5.50–16 h) of child vocalizations across a single day. Parents were able to choose the day of recording and were asked to record only when both mothers and fathers were home with their infant (for more information on the proportion of male and female voices across the course of the day see (Fink et al., 2020)). Overall, 92% of 5-min segments across the

TABLE 1 Descriptive statistics for study variables for full sample and separately for families with sons and daughters.

		Total sample			Boys ($n = 48$)	Girls ($n = 45$)		
		N	*M* (SD)	Range	*M* (SD)	*M* (SD)	*t*	Cohen's *d*
4-months	Mother sensitivity	87	1.71 (.79)	0–3	1.54 (.77)	1.87 (.79)	1.96	.42
	Father sensitivity	83	1.56 (.87)	0–3	1.39 (.93)	1.60 (.86)	1.14	.25
7-months	Infant vocalizations (hour)	93	155.52 (66.90)	19.87–401.75	166.27 (74.74)	144.06 (55.94)	−1.61	.34
	Infant-initiated conversation (hour)	93	10.68 (3.97)	1.55–22.07	10.94 (4.37)	10.40 (3.52)	−.66	.14
14-months	Mother sensitivity	69	5.94 (1.58)	2–9	5.56 (1.68)	6.36 (1.37)	2.18*	.53
	Father sensitivity	67	5.55 (1.64)	2–8	5.63 (1.64)	5.47 (1.67)	−.40	.10

*$p < .05$.

TABLE 2 Summary of bivariate correlations between study variables.

		1.	2.	3.	4.	5.	6.
4-months	1. Mother sensitivity	–					
	2. Father sensitivity	.10	–				
7-months	3. Infant vocalizations (hour)	.25*	−.06	–			
	4. Infant-initiated conversation (hour)	.22*	−.08	.80**	–		
14-months	5. Mother sensitivity	.07	.01	.13	.16	–	
	6. Father sensitivity	−.15	.26*	−.05	.10	.09	–

*$p < .05$,
**$p < .01$.

day included mother talk, 73% included father talk and 71% included both mother and father talk.

LENA software extracts: (i) the total frequency of infant vocalizations, and (ii) the frequency of infant-initiated conversational turns. Infant vocalizations comprise any speech-like sounds produced by the infant, for example, babbles and pre-speech communicative sounds involving proto-phonemes. Infant vegetative sounds (e.g., breathing or digestion sounds) or emotional reactions to the environment (e.g., crying, screaming) were not counted as child vocalizations. Infant-initiated conversational turns were any infant vocalizations that were followed by an adult utterance within 5 s. An hourly rate of infant vocalizations and infant-initiated conversational turns were used in the analysis as recordings were of different lengths. Given the range of ages for Time 2 it is important to highlight that infant age on the day of recording was not associated with rate of infant vocalizations or infant-initiated conversational turns, $r(93) < .13$, $p > .206$.

2.3.3 | Analysis plan

Bivariate associations across study variables were examined using Pearson correlations for the full sample, and then separately for families with sons and families with daughters. Two path models, one for mothers and one for fathers, were constructed in M*plus* (Muthén & Muthén, 1998–2019) to evaluate the extent to which parental sensitivity both predicts and is predicted by infant vocalizations and initiated conversation. Later sensitivity was regressed onto earlier sensitivity in both maternal and paternal models. Missing data was only imputed for the predictor in the models (i.e., 4-month maternal and paternal sensitivity data) as suggested by Enders (2022).

3 | RESULTS

3.1 | Descriptive statistics and correlations between key study variables

Table 1 presents descriptive statistics for key study variables. There was no significant difference in any study variable as a function of infant gender except for maternal sensitivity at 14 months (mothers with daughters were modestly more sensitive than mothers with sons). Within families, there was no significant difference between maternal and paternal sensitivity at either 4 months, $t(78) = .76$, $p = .449$, Cohen's $d = .09$, or 14 months, $t(65) = 1.86$, $p = .067$, Cohen's $d = .23$.

Table 2 presents bivariate associations across study variables for the full sample. Overall correlations show a significant positive association between maternal but not

TABLE 3 Bivariate correlations between study variables separately by infant gender, boys below the diagonal.

		1.	2.	3.	4.	5.	6.
4-months	1. Mother sensitivity	–	.18	.41**	.30	−.06	−.16
	2. Father sensitivity	.01	–	−.16	−.16	.04	.30
7-months	3. Infant vocalizations (hour)	.20	.02	–	.76**	−.09	.09
	4. Infant-initiated conversation (hour)	.19	−.02	.83**	–	−.07	.32
14-months	5. Mother sensitivity	.05	−.02	.31	.33	–	.06
	6. Father sensitivity	−.14	.23	−.15	−.05	.13	–

**$p < .01$.

paternal sensitivity at 4 months of age and later infant vocalizations and infant-initiated conversation turns. However, neither infant vocalization nor initiated conversational turns at 7 months was associated with later parental sensitivity at 14 months. Only paternal sensitivity was significantly correlated across 4 and 14-months of age. Examining correlations separately for families with sons and daughters (Table 3), showed that the association between 4-month maternal sensitivity and infant vocalizations and initiated conversations was only significant for mothers with daughters, whereas infant talk at 7 months was marginally associated with later (14 month) maternal sensitivity only for mothers with sons.

3.2 | Predictive associations between sensitivity and infant talk

Model 1a (see Figure 1) shows that maternal sensitivity at 4 months significantly predicted both infant vocalizations and infant-initiated conversations at 7 months of age, however, neither infant conversational turns nor infant vocalizations predicted later (14 months) mother sensitivity. For fathers, earlier sensitivity did not impact later infant talk, however a marginal role for infant-initiated conversational turns for later paternal sensitivity did appear, over and above the stability in paternal sensitivity between 4 and 14 months of age (see Model 1b; Figure 1).

We conducted a multi-group path model to estimate whether the association between sensitivity and infant talk differed by infant gender by comparing a model where paths for boys and girls were constrained to equality with a model in which paths could vary freely (Brown, 2015). The pattern of associations between sensitivity and infant talk did not differ across the two models, and constraining the models to equality did not significantly degrade model fit, $\Delta\chi^2(5) = 2.04$, $p > .05$. Thus, the association between sensitivity and infant talk appears equivalent for mothers with sons and mothers with daughters.

For fathers, the unconstrained model suggested that the role of infant-initiated conversations for later father sensitivity was significant for fathers with daughters (standardized coefficient = .41, $p = .031$) but not for fathers with sons (standardized coefficient = .20, $p = .456$). However, when the model was constrained to equality, this difference did not significantly degrade model fit, $\Delta\chi^2(5) = 2.69$, $p > .05$, suggesting that, overall, the association between sensitivity and infant talk is equivalent for fathers with sons and fathers with daughters.

3.3 | Sensitivity analyses

Two sensitivity analyses were then run to test that models were equivalent for families with higher compared with lower parental educational level, and when missing data for parental sensitivity at 4 months was not estimated. For mothers, a multi-group model was constructed for higher and lower maternal education and the unconstrained model was compared with a model constrained to equality. There was no difference in the pattern of associations between sensitivity and infant talk for mothers with higher compared to lower education, and there was no degradation of model fit when constraining models to equality, $\Delta\chi^2(5) = 1.60$. For father education, stability in sensitivity between 4 and 14 months emerged as significant in the lower education group (standardized coefficient = .58, $p = .011$) but not the higher educated group (standardized coefficient = .03, $p = .877$), however this difference did not significantly degrade model fit, $\Delta\chi^2(5) = 4.83$. Finally, no differences in the pattern of findings for the models emerged when estimating maternal and paternal sensitivity at 4 months compared to those models reported in Figure 1.

4 | DISCUSSION

The current study examined the interplay between sensitivity and infant-initiated conversations for both mothers

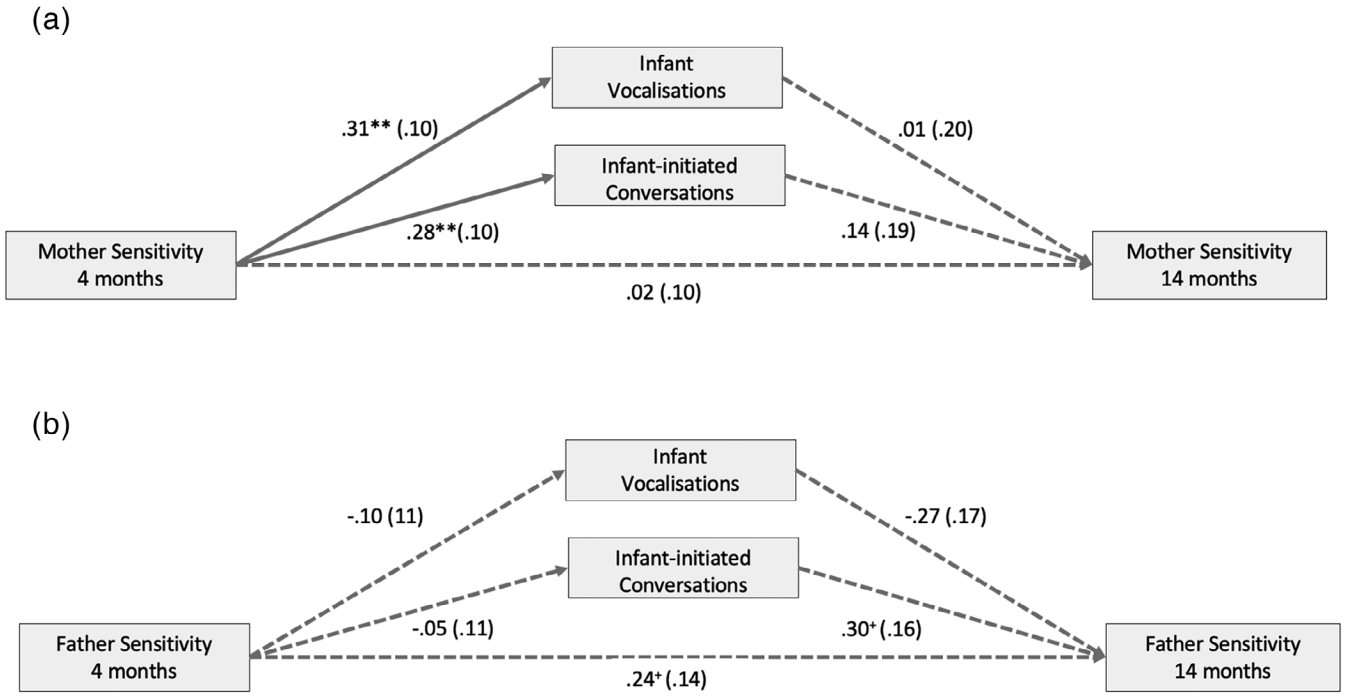

FIGURE 1 Standardized coefficients (standardized errors in parentheses) for the role of infant talk for maternal (a) and paternal (b) sensitivity. $+p < .10$, $*p < .05$, $**p < .01$.

and fathers, using a global index of parental sensitivity. Findings suggest that maternal (but not paternal) sensitivity sets into motion both infant proto-conversations and frequency of infant vocalizations. However, the frequency of infant-initiated conversations (or vocalizations) did not predict later parental sensitivity. Below we discuss the implications of these findings for our understanding of the transactional association between parental sensitivity and infant behaviors.

4.1 | Sensitivity and infant talk

Previous studies have established links between parent verbal sensitivity and infant vocalizations and conversational turns (e.g., Gros-Louis et al., 2014; Tamis-LeMonda et al., 2014). Extending this work, the current study used a day-long assessment of infant vocalizations and parental responses to show that global maternal sensitivity at 4 months is associated with both total infant vocalizations and infant vocalizations that elicit a parental response. In day-to-day interactions sensitivity therefore appears to manifest in terms of both infant behavior (i.e., frequency of vocalizations) and responsiveness to infant behavior. As meta-analytic work demonstrates that parent sensitivity is a stronger predictor of children's later receptive and expressive language than parental warmth (Madigan et al., 2019), further work is needed to assess whether conversational turns mediate the link between parent sensitivity and later child language.

However, neither total infant vocalizations nor the number of infant-initiated conversational turns at 7 months predicted mother or father sensitivity at 14 months. Several different factors may underpin this null finding. First, the developmental period between the measurement of infant talk at 7 months and parental sensitivity at 14 months is marked by not only the consolidation of the parent-infant relationship but also considerable emotional, linguistic, and cognitive gains. In many of our study families, this period was also a time of substantial changes in context as most mothers returned to paid work during this interval, a transition known to be accompanied by changes to everyday routine interactions and the introduction of new social influences (i.e., nursery staff and childminders). As such, infant talk is only one part of a constellation of skills, experiences, parent, child, and contextual characteristics that shape parental sensitivity going forward (c.f., Bornstein, 2016; Taraban & Shaw, 2018). Consistent with this emphasis on changes in family environments, maternal sensitivity was not stable over time; in contrast, paternal sensitivity was stable across the same period, perhaps reflecting their relatively stable roles as working parents.

In line with meta-analytic work with European samples (Deneault et al., 2022), our study showed similar levels of sensitivity in mothers and fathers. However, we did not find strong within-couple concordance in maternal

and paternal sensitivity. The next step is to understand the similarities and differences in the antecedents and consequences of maternal and paternal sensitivity (e.g., Lucassen et al., 2011), as our findings suggest that early individual differences in maternal rather paternal sensitivity shapes infant talk in the home. Questions remain regarding how paternal sensitivity shapes infant talk, especially in the context of the stability of sensitivity observed for fathers (but not mothers). For example, infant talk may be fostered by features of father–child interactions that are not typically considered sensitive by traditional coding schemes (e.g., more directive language; Pancsofar, 2020; more challenging and active play; Vallotton et al., 2020). Future work with non-hetero-normative families will also help refine conceptual understanding of this central parenting construct by disentangling caregiver role and gender (e.g., Ellis-Davies et al., 2022).

In addition to the lack of overall significant differences in key measures by parent gender or infant gender, our analyses showed equivalent associations between mothers' and fathers' sensitivity and infant talk for parents with sons and parents with daughters. These findings contrast with other longitudinal associations which differed by infant gender. For example, we have previously reported that, in this sample, gains in the theoretically related construct of mind-mindedness were stronger in the postpartum period for fathers (not mothers) with daughters and not sons (Foley et al., 2022) and that mothers with poorer relationships with their partners at 4 months postpartum spoke more to their sons but not daughters at 7 months (Fink et al., 2020). Meta-analytic studies have also examined whether parent and infant behaviors differ by infant gender (Endendijk et al., 2016); we hope that it will soon be possible to apply meta-analyses to test more nuanced questions surrounding whether transactional links between parent and infant behavior systematically differ by infant gender.

4.2 | Strengths and limitations

Two strengths of the current study set it apart from existing research in this field. First, including both mothers and fathers at all time-points enabled us to determine parental specificity in the role of sensitivity for infant talk. Overcoming challenges of recruiting fathers into infant research (Mitchell et al., 2007) therefore helps refine understanding of existing constructs as well as offer new approaches to theorizing fatherhood (Adamsons et al., 2022). Even though a subset of study families were not seen at the 14-month time-point, we still had a substantial number of families giving us over 80% power to detect small effect sizes. Second, we employed an unobtrusive wearable device to provide a window into a full day of the infants' linguistic environments.

Alongside these strengths, at least three limitations of the current study deserve note.

First, the sample comprised cohabiting English-speaking heterosexual couples and their first-born infants. Reflecting both the demographics of a university town and the prenatal timing of recruitment, most of the parents in this sample were highly educated and affluent, precluding investigation of the moderating role of socio-economic status for the link between sensitivity and infant talk. Here it is worth noting that links between child language acquisition and the quantity and quality of infants' language exposure (including the interactional nature of the home language environment) has been shown to vary with parental socio-economic status (Schwab & Lew-Williams, 2016). Furthermore, as most of the participants were White British, and all English-speaking, further research is required to test whether the dynamics of early family interactions differ across cultures and language. Relatedly, a further eligibility criteria, namely that all infants were first-borns, limits the generalizability of the current findings. Further work is therefore needed to examine if the results are similar for mothers and fathers with later-born infants.

Second, although previous studies (e.g., Gomez & Strasser, 2021; Zimmerman et al., 2009) have demonstrated that automated LENA ratings of the frequency of earlier parent-infant conversational predict children's language and socio-emotional outcomes, it is worth noting that the LENA algorithm defines a conversational turn as an adult verbal response within 5 seconds of an infant vocalization. As the latency between an infant-initiated vocalization and a parental vocal response is typically around 1 s (Nguyen et al., 2022), this generous 5-s window may well be too long to accurately estimate the gradient of sensitive parental response to infant overtures.

Third, while the sensitivity coding schemes used in this study were appropriate for their different contexts and developmental age, these schemes stemme from observations of mother-infant dyads. Highlighting this, findings from a study of 630 mothers and fathers followed across infancy indicate that a latent factor for fathers' sensitivity is more closely related to stimulation of development than responsiveness to cues (Mills-Koonce et al., 2015). This suggests that our coding of sensitivity may not capture dimensions of sensitivity that are particularly pertinent to fathers (Siew et al., 2021). This may help explain why only maternal sensitivity was related to later infant talk in this study. Finally, it should be noted that although parental sensitivity was equivalently defined at 4- and 14-months, the number of anchor points differed; we used standardized scores to correct for this contrast in our analyses, but

ratings of sensitivity may have been less nuanced at Time 1 coding than at Time 3.

To conclude, prior studies have shown that parents' ability to respond verbally to their child's vocal cues promotes linguistic competencies. The current naturalistic study of 93 families extended this evidence base by showing that for mothers at least, global sensitivity also predicts infant proto-conversations. However, infant's early conversational capacities did not shape later parental sensitivity. By combining the current study's observational and naturalistic methods we provide a window onto the dynamics of family life as well as an initial empirical examination of the transactional association between parenting and infant conversations.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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