Mother-child and father-child "serve and return" interactions at 9 months: Associations with children's language skills at 18 and 24 months

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Abstract

Infants learn language through the back-and-forth interactions with their parents where they "serve" by uttering sounds, gesturing, or looking and parents "return" in prompt (i.e., close in time) and meaningful (i.e., semantically relevant to the object of interest) ways. In a sample of 9-month-old infants (n = 148) and their mothers and fathers (n = 296 parents) from ethnically and socioeconomically diverse backgrounds, we examined the associations between "serve and return" (SR) parent-child interactions and children's language skills at 18 and 24 months. We also examined the moderation effects between maternal and paternal SR interactions on language outcomes. SR interactions were transcribed and coded from videotaped parent-child toy play activities during home visits. We report three findings. First, mothers who provided more meaningful responses to their child's serves at 9 months had children with higher expressive language skills at 18 months. Second, fathers' prompt responses (i.e., within 4 seconds) at 9 months were associated with higher receptive language scores at 18 months, but their meaningful responses were negatively associated with receptive language scores at 24 months. Third, the negative association between fathers' meaningful responses and children's receptive language scores was reduced (compensated) when mothers' meaningful responses were high. Findings show that infants in ethnically and socioeconomically diverse families engage in frequent SR interactions with both mothers and fathers, who make unique contributions to infants' language development. We discuss implications for programs and policies that aim to promote early language development and reduce gaps in school readiness.

Key words: serve and return, contingency, interaction, language development, fathers, diversity

1. Introduction

The first years of children's lives are critical for learning sounds and words and acquiring communication skills, because the brain is particularly susceptible to environmental input during that period (National Scientific Council on the Developing Child, 2007; Shonkoff & Phillips, 2000; Werker & Hensch, 2015). Although multiple factors, such as children's physical and cognitive abilities, gender, and exposure to two or more languages, matter for language development during the early years (Adani & Cepanec, 2019; Davidse et al., 2011; Hoff, 2018; Hoff et al., 2014; Iverson, 2010; Umek et al., 2008), a robust body of research suggests that high-quality parent-child interactions are one of the most significant contributors to the development of early language skills (Blackwell et al., 2015; Curtin et al., 2021; Elmlinger et al., 2022; Golinkoff et al., 2015; Hirsh-Pasek et al., 2015; Malin et al., 2014; Romeo et al., 2018; Rowe, 2012; Shneidman & Woodward, 2016). Specifically, the back-and-forth reciprocal interactions between parents and children during the early years, also known as "serve and return," (SR; Shonkoff & Bales, 2011), are hypothesized to be a strong predictor of early language learning and cognitive and social competence (National Academies of Sciences, Engineering, and Medicine, 2016; National Scientific Council on the Developing Child, 2007).

Although researchers have used various terms (e.g., *temporally contingent*, *semantically contingent, responsive*) to refer to these back-and-forth interactions, SR (coined by the Harvard Center for the Developing Child, n.d.) is a useful metaphor, because it captures the essence of these interactions where children take the lead in serving and parents return or respond (Fisher et al., 2016; Harvard University Center on the Developing Child, n.d.; Keller et al., 2018). In this study we use the term "serve" to refer to infants' vocalizations and non-vocal behaviors (e.g., gesturing, looking, or reaching for a toy). We use the terms "prompt" and "meaningful" to refer

to the parents' verbal responses (e.g., that's a ball) that are close in time and semantically relevant to what infants are attending to at the moment. For SR interactions to benefit children's learning, parents' responses should be prompt (i.e., within 2 to 5 seconds) and meaningful in a way that communicate important information about the object of interest (Baumwell et al., 1997; Benassi et al., 2018; Choi et al., 2020; Tamis-LeMonda et al., 2001, 2014). Children learn language through SR interactions because these prompt and meaningful back-and-forth interactions help them map the words they hear to the objects of interest (i.e., word-to-world mapping), learn to take turns in communication—one person serves and the other responds, and associate intention with social behaviors (Shneidman & Woodward, 2016; Tamis-LeMonda et al., 2014).

Past research has shown that SR interactions during children's first two years are positively associated with receptive and expressive language skills later on (Benassi et al., 2018; Donnelly & Kidd, 2021; Elmlinger et al., 2019; Gros-Louis et al., 2014; McGillion et al., 2013). However, this literature has some limitations. First, the majority of the studies on SR interactions and language development have been conducted with a select sample who are mostly White, English-speaking families from middle socioeconomic status (SES). Given the importance of context for development, more evidence is needed to understand whether these processes are the same (e.g., How prompt do parents' responses need to be to support language learning?) in non-White, non-English-speaking samples (Ramírez, 2022; Shimpi et al., 2012). Second, within this literature, there is a large variability in what is considered a "prompt" return from parents that impacts early language learning. Some studies have found that returns within 2 seconds of infants' serves are related to language skills, whereas others have found 5 seconds to be significant (Gros-Louis et al., 2014; Lopez et al., 2020; McGillion et al., 2017; Miller & Lossia,

2013; Paavola, Kunnari, Moilanen, et al., 2005; Tamis-LeMonda et al., 2001). Another group of studies have indicated that mothers' contingent responses on average occur within 1 or 3 seconds of infants' serves (Keller et al., 1999; Van Egeren et al., 2001). In this vein, more research is needed to understand how promptly parents respond to their child. Third, all the studies on SR have focused on interactions with mothers. This is problematic because research has shown that fathers make a unique contribution to children's language, cognitive, and social development (e.g., Cabrera et al., 2017, 2020; Leech et al., 2013; Malin et al., 2014; Pancsofar & Vernon-Feagans, 2010). Thus, not including fathers may also overestimate the effect of mother-child SR interactions on children's language development.

We advance this literature by drawing from a sample of ethnically and socioeconomically diverse mothers and fathers and by using a continuous measure of the promptness of parent returns to infants' serves. We focus on SR interactions at 9 months because this is a sensitive period when children begin to show joint attention, understand common words, babble syllables, and rely on contingent and reciprocal interactions with parents to master these skills. We focus on language outcomes at 18 and 24 months because language development at these ages is substantial, including word spurt, ability to comprehend and understand simple questions, and to combine words (Hoff, 2014). Moreover, parental input at as early as 7 months has been linked to language skills and language differences related to SES has been observed at as early as 18 months (Fernald et al., 2013; Newman et al., 2016). Therefore, it is particularly interesting to examine whether SR interactions at 9 months facilitate language development during the first two years. Specifically, using data from a NIH-funded randomized controlled trial (RCT) longitudinal parenting intervention study (Authors, 2017; McKee et al., 2021), we examine the

associations between mothers' and fathers' SR interactions with their children at 9 months and children's receptive and expressive language skills at 18 and 24 months.

1.1 Theoretical Frameworks

Vygotsky's *sociocultural theory* suggests that learning is best supported when more advanced social partners (e.g., caregivers, teachers) provide just enough support to help children achieve new abilities that children would otherwise be unable to obtain independently, hence the Zone of Proximal Development (ZPD; Vygotsky, 1978). In infancy, parents provide prompt and meaningful feedback to children's bids for attention, thus facilitating language learning (Reed et al., 2016; Tamis-LeMonda et al., 2014). For example, when children point to a ball ("serve"), parents can label the ball and talk about how they can play with the ball while demonstrating the actions ("return"). Complementing the ZPD is the transactional model of development (Sameroff, 2010) that reciprocal interactions, such as SR, during infancy are particularly important because children have limited abilities and need more stimulation and regulation from the environment (e.g., parents; Sameroff, 2010). Furthermore, such interactions occur within the context of family in which every subsystem (e.g., father-child, mother-child, father-mother) within the family system has bidirectional influences on each other as well as joint influences on individuals (e.g., children; Cox & Paley, 1997, 2003). Accordingly, we expect that the effects of maternal and paternal SR on early language development to be accumulative. That is, children benefit more from reciprocal interactions with both mothers and fathers compared to with one parent (accumulative advantage hypothesis). Alternatively, engaging in high levels of reciprocal interactions with one parent may protect children from the negative effect of low levels of reciprocal interactions with the other parent (compensatory hypothesis). Previous studies support these hypotheses by showing that one parent's high levels of supportive parenting (e.g.,

sensitivity, warmth) compensates for the effect of the other parent's low levels of supportive parenting on toddlers' social skills and that toddlers with two supportive parents have better cognitive skills than those with one or no supportive parents (Feldman et al., 2023; Ryan et al., 2006).

1.2 Contribution of SR Interactions to Early Language Development

Experimental evidence suggests that infants produce more vocalizations in total and more vocalizations that mimic the phonological features of their mothers' speech when they receive contingent responses rather than non-contingent responses during interactions (e.g., Elmlinger et al., 2019; Goldstein & Schwade, 2008; Gros-Louis & Miller, 2018; Miller, 2014; Miller & Lossia, 2013). Longitudinal and correlational studies have found that SR interactions are associated with children's receptive and expressive language skills (e.g., Baumwell et al., 1997; Benassi et al., 2018; Miller & Lossia, 2013; Paavola et al., 2005; Shimpi et al., 2012; Tamis-LeMonda et al., 2001). In a study with a small sample of White, middle-SES, English-speaking mothers and their infants, Tamis-LeMonda and colleagues (2001) found that infants who engaged in more responsive interactions (i.e., coded as positive and meaningful responses from mothers within 5 seconds) with their mothers at 9 and 13 months achieved language milestones (e.g., 50 words in production, combining words) earlier than infants who engaged in fewer responsive interactions. In another study with mother-child dyads from White, middle-SES, English-speaking families in the U.K., McGillion and colleagues (2013) found that maternal responses that were temporally (i.e., within 2 seconds) and semantically linked to children's vocalizations and attention at 9 months were associated with children's expressive vocabulary at 18 months. Similarly, studies with "slow-talking" toddlers in White, middle-class families in Australia showed that maternal responsive verbal input at 24 months (e.g., imitations and

expansions of their toddlers' vocalizations), although the promptness of maternal input was not directly measured, was associated with children's receptive and expressive language skills at 36 and 48 months (Conway, Levickis, Mensah, et al., 2018; Conway, Levickis, Smith, et al., 2018). However, in a study of Black, low-SES mothers and their children in the United Sates, Shimpi and colleagues (2012) reported nonsignificant correlations between maternal contingent vocalizations (i.e., within 2 seconds) and responsive labels from birth to 2 years and children's vocal production at 24 months (Shimpi et al., 2012). These findings show the variability in SR parent-child interactions as well as the inconsistent ways in which SR is coded and analyzed, making it difficult to draw conclusions that are generalizable to ethnically and socioeconomically diverse families. Thus, more research is necessary to understand how prompt and meaningful SR interactions look like in families from non-White, non-English-speaking, and various SES backgrounds and with both mothers and fathers to obtain a better understanding of the range of reciprocal interactions between parents and children (Akhtar & Gernsbacher, 2007; Keller et al., 2018; Mesman et al., 2018).

1.3 The Current Study

Guided by the sociocultural and transactional models and building upon the existing research on SR interactions, we examine the associations between maternal and paternal SR at 9 months on children's language skills at 18 and 24 months. Specifically, we ask: (1) Are maternal and paternal SR interactions at 9 months associated with children's receptive and expressive language skills at 18 and 24 months, controlling for demographic factors (e.g., parent education and nativity status), parental stress, parental responsiveness, child temperament, and earlier language skills (main effects)? (2) Are the associations between one parent's SR interactions at 9 months and children's receptive and expressive language skills at 18 and 24 months moderated

by the other parent's SR interactions (moderation effects)? We hypothesized that (1) mothers and fathers who engage in more SR interactions with their children at 9 months will have children with higher receptive and expressive language scores at 18 and 24 months than parents who engage in fewer SR interactions; (2) the *positive* association between one parent's *high* levels of SR interactions at 9 months and children's receptive and expressive language skills at 18 and 24 months will be *stronger* when the other parent also engages in *high* levels of SR interactions at 9 months (accumulative advantage hypothesis) and the *negative* association between one parent's *low* levels of SR interactions at 9 months and children's receptive and expressive language skills at 18 and 24 months will be *weaker* when the other parent engages in *high* levels of SR interactions at 9 months (compensatory hypothesis).

2. Method

2.1 Study Sample

Data for this study were drawn from the [removed for blinding] project, an NIH-funded longitudinal English-Spanish bilingual parenting intervention in which educational information about typical child development and effective parenting practices were embedded in baby books given to parents (Authors, 2017; McKee et al., 2021). To be eligible for the [removed for blinding] project, (1) children were first-born and under 9 months; (2) mothers and fathers were cohabiting with each other and the child at enrollment; (3) parents were literate at or above the first-grade level in English or Spanish; and (4) parents reported household incomes below $75,000 at enrollment. All families lived in southern California and the Washington, D.C. metro areas.

This study includes n=296 parents (148 mothers and 148 fathers) and their children who had valid data for SR interactions at 9 months and language skills at 18 or 24 months. Using the Root Mean Square Error of Approximation (RMSEA) approach (Preacher & Coffman, 2006),

the minimum sample size required to achieve a power level of 0.80 for our planned path analysis is 144 participants. Therefore, our sample size is sufficient to detect an effect when there is in fact a true effect. Table 1 shows the demographic characteristics of the study sample. The majority of mothers and fathers (76% and 73%) self-identified as Hispanic, followed by non-Hispanic African American (11% and 10%), non-Hispanic White (7% and 8%), and other ethnic and racial groups (e.g., Asian, multiracial; 6% and 9%). More than twice as many fathers (24%) than mothers (10%) reported less than a high school education and almost twice as many mothers (25%) than fathers (14%) reported a 4-year college degree or above. More than 90% of the fathers reported currently working for pay at 9 months, whereas less than half of the mothers reported so. More than half of the mothers and fathers were born outside the U.S. About 60% of children lived in households where parents reported speaking only English or Spanish to them and 38% lived in households where parents reported speaking two or more languages to them. About half of the parents reported annual household incomes at or below $40,000, which is 200% of the federal poverty line for a family of three in 2017 at the time the [removed for blinding] project started enrolling parents (U.S. Department of Health and Human Services, 2017). Half of the children in the sample were boys.

At 18 and 24 months, n=145 (98% of the 148 children in our sample) and n=102 (69% of the 148 children in our sample) children had valid receptive or expressive language scores. Missing data in language scores were mostly due to parents withdrawing from the study, not participating in data collection at the wave, or home visits not being conducted due to social distancing requirements of COVID-19. Chi-square and independent-samples t tests indicated that the families with valid language outcomes at 18 and 24 months and those without did not differ significantly in child gender, household income, parent education, parent ethnicity, marital status,

parent nativity status, employment, child language exposure, child language skills at 9 months, SR interactions at 9 months, or intervention condition.

2.2 Procedure

During the home visit at 9 months, mothers and fathers were videotaped during four types of semi-structured interactions with their child (i.e., book reading, play without toys, play with toys, and cleanup). The order of mother-child and father-child interactions was randomly assigned at 9 months. For this study, we used the toy play activity, in which parents were given two bags, one at a time, containing age-appropriate toys (e.g., shape sorter, plastic food toys) to play with their child for 10 minutes. Parents were asked to sit on a mat with the child, play as they normally would, and try to ignore the researchers' presence. During the visit, mothers and fathers were also interviewed in their preferred language (English, Spanish, or both) about family and child demographic characteristics. During the visits at 18 and 24 months, a trained researcher (English-Spanish bilingual researchers for children in Spanish-speaking families) assessed children's language skills after their interactions with mother and father.

2.3 Measures

2.3.1 Children's Language Skills at 18 and 24 Months

Trained researchers assessed children's receptive and expressive language skills at 18 and 24 months using the Preschool Language Scale, 4th edition (PLS-4; Zimmerman et al., 2002). PLS has been validated in a nationally representative sample in the U.S. that was stratified based on parent education, geographic region, and race described by the 2000 U.S. Census and provides age-appropriate standardized scores for children's receptive, expressive, and total language skills (Zimmerman et al., 2002). Researchers administered the PLS-4 in either English or Spanish after consulting with parents about the child's preferred language use. For children

whose parents reported them to understand/speak only Spanish *or* only English, the assessment was conducted in that language. For children whose parents reported them to understand/speak both English *and* Spanish, parents determined which language was more appropriate to use for the assessment, and if the child did not answer an item correctly in the preferred language, we assessed the item in the other language to capture the child's conceptual knowledge regardless of language (Anaya et al., 2016; Byers-Heinlein & Lew-Williams, 2013; Marchman et al., 2010).

Of the children who had valid language scores, n=81 (56%) and 59 (58%) were assessed entirely or primarily using the English PLS-4 and n=65 (45%) and 44 (43%) using the Spanish PLS-4 at 18 and 24 months, respectively. Independent samples t-tests revealed no significant differences between English and Spanish standardized receptive or expressive scores at 18 or 24 months.

2.3.2 "Serve and Return" Interactions at 9 Months

SR interactions were coded from the videotaped parent-child toy play activities at 9 months. The coding process included three steps: (1) we first transcribed child vocalizations and parent speech from the video; (2) we then coded child non-vocal behaviors (e.g., eye gaze, pointing, touching, playing with toy) from the video; (3) at last we coded parent speech as responses to child vocalizations or non-vocal behaviors.

Native English- and/or Spanish-speaking researchers transcribed the videotaped parent-child toy play activities in Datavyu (Gilmore et al., 2016) using the standardized format dictated by Codes for the Analysis of Human Language (CHAT), which is available through the Child Language Exchange System (CHILDES; MacWhinney, 2000). For parents, transcription was conducted at the utterance level (i.e., a conversational unit), followed by a pause of 1 second or more, ending with a terminal intonation contour, or having a complete grammatical structure

(Ratner & Brundage, 2020). For infants, vocalizations of all durations were transcribed and a new vocalization was credited if there was a change in the vocalization or a pause of 1 second or more (Bornstein et al., 1992). All transcribers achieved a minimum of 90% agreement with the lead transcriber on timing, content, and segmentation of parent utterances and child vocalizations during the training process. Each transcript was checked by a second transcriber to ensure accuracy.

We developed the coding scheme for SR interactions based on the definition of SR by the Harvard Center on the Developing Child (n.d.) and the existing literature that captures the temporal and semantic contingency of parent responses at a micro level (e.g., Tamis-LeMonda et al., 2001; McGillion et al., 2013). The definition of SR by the Harvard Center on the Developing Child (n.d.) includes: (1) noticing what the child is attending to, (2) following in by letting the child know you are seeing the same thing, (3) naming the child's actions and interests, (4) encouraging turn-taking by giving the child time to respond, and (5) knowing when the child is ready to end the activity or switch to another. In this study, we focused on the first three components which reflect the parent's ability to notice and tune in to the child's focus and provide meaningful information to the child to support language learning.

In our coding scheme, we coded both communicative (i.e., vocalizations, gestures) and non-communicative (e.g., looking at a toy, manipulating a toy) behaviors of the child as "serves," because these behaviors are frequent during the first year of children's life and are closely monitored and responded to by caregivers (Bornstein & Manian, 2013). Our measure of "serves" aligns well with previous research that captures infants' vocalizations, as well as acts and focus of attention, as "serves" (e.g., Levickis et al., 2018; McGillion et al., 2013; Tamis-LeMonda et al., 2001). Each SR interaction began with the child's serve, regardless of whether the child

spontaneously initiated the behavior or not. In some cases, the child's serve (e.g., looking to a toy) may be a response to the parent previously drawing the child's attention to the toy. We counted those child behaviors as serves because they still signaled the child's attention and provided an opportunity for the parent to respond.

2.3.2.1 Child Vocal and Non-vocal Serves. Child *vocal serves* included non-distress vocalizations (i.e., excluded vegetative sounds such as coughing, sneezing). Child *non-vocal serves* included eye gaze (e.g., looking at an object), reaching for and touching an object, gestures, such as pointing, and manipulation of an object (with hands or mouth), and were coded every time the child shifted attention from one object/activity to another (McGillion et al., 2013). For example, if the child was first playing with the toy car and then looked to the ball, this attention shift was coded as a non-vocal serve signaling to the parent the child's interest in the ball. Brief looks that lasted less than 1 second were not coded. The start and end time of child vocal serves (i.e., from when the child began vocalizing until he/she stopped) and non-vocal serves (i.e., from when the child began attending to an object/activity until he/she shifted attention to a different object/activity or became nonattentive) were coded in milliseconds.

2.3.2.2 Parent Returns. Maternal and paternal returns to child vocal and non-vocal serves were coded at the utterance level and were coded along two dimensions: how promptly parents responded to the child (i.e., temporal contingency) and whether their response provided meaningful information about the object/activity the child was attending to (i.e., semantic contingency). The start time of parents' returns (i.e., the start of the utterance) was coded in milliseconds. Parent returns to vocal and non-vocal serves were coded in separate paths and a return was counted twice if following a vocal and a non-vocal serve that occurred concurrently. Figure 1a and 1b provide schematics for the coding scheme.

Based on previous coding schemes in the literature (Benassi et al., 2018; Gros-Louis & Miller, 2018; McGillion et al., 2013; Tamis-LeMonda et al., 2001), *parent returns to child vocal serves (i.e., vocal returns)* included the *first* utterance that occurred after the *end* of a child vocal serve. If the child had two consecutive vocal serves and the parent only responded after the second serve, the first serve was coded as not receiving a return and the second serve was coded as receiving a return. Because, on average, infants begin to babble at 9 months (Hoff, 2014) and the infants in our sample rarely said words during the interaction, most of the time it was not possible to determine whether parent returns were semantically relevant to infants' vocalizations. Therefore, semantic contingency was not coded for parent vocal returns. We calculated mothers' and fathers' *vocal return time* (i.e., how many seconds between the end of the child vocal serve and the start of the parent return to the vocal serve) for each child vocal serve and then averaged across all the vocal serves during the interaction.

To measure *parent returns to child non-vocal serves (i.e., non-vocal returns[1])*, we coded *every* maternal and paternal utterance that occurred after the *start* of a child non-vocal serve and before the *end* of the serve. In other words, a child non-vocal serve was coded as not receiving a return if the parent did not produce any utterance between the start and the end of the serve. Parent utterances that occurred while the child was not attending to any toys/activities were not coded as returns. Next, each return to a non-vocal serve was coded based on whether the utterance provided semantically relevant information about the object/activity the child was attending to, such as labeling and describing the object/activity (e.g., That's a ball. You see stars on it?), giving play prompts specific to the object/activity (e.g., Throw it to me), and connecting the object/activity to the child (e.g., [referring to the baby doll] it's just as small as you). We

[1] It does not mean that the parent return is non-vocal but that the return is in response to a non-vocal child serve. We use "non-vocal return" as a simplified way to represent returns to non-vocal serves.

calculated two variables for mothers' and fathers' returns to non-vocal serves: (1) *non-vocal return time* (i.e., how many seconds between the start of the child non-vocal serve and the start of the *first* parent return to the non-vocal serve) for each child non-vocal serve and then averaged across all the non-vocal serves during the interaction and (2) *meaningful returns* (i.e., the proportion of parent returns to non-vocal serves during the interaction that were semantically relevant to the non-vocal serve).

The extant literature has examined parents' responses to children's vocalizations separately from responses to non-vocal behaviors, because vocal exchanges and vocal turn-taking is an essential feature of human communication and provides the basis for the acquisition of language and social interactions (Bornstein et al., 2015; Fagan & Doveikis, 2019; Goldstein & Schwade, 2008; Gros-Louis et al., 2006). However, in this study, we regarded vocalizations and non-vocal behaviors equally as serves that trigger returns from parents and thus combined them for analysis. Therefore, we calculated a composite variable for *parent return time*, that is, the average return time between vocal and non-vocal returns to represent parents' overall temporal contingency regardless of the type of child serves (from now on, *return time*). Because parents' meaningful returns were only coded for non-vocal returns, we included this variable on its own.

2.3.2.3 Reliability. Native English- and/or Spanish-speaking researchers coded child non-vocal serves and parent returns to vocal and non-vocal serves in Datavyu (Gilmore et al., 2016). Coders achieved 90% agreement with the lead coder on the timing and content of serves and returns during the training process. A random selection of 20% of the independently coded videos were double coded. Intercoder agreement was 80% for child non-vocal serves, 89% for parent returns to non-vocal serves, and 97% for parent returns to vocal serves. Cohen's kappa ranged between 0.74 and 0.91, indicating acceptable agreement (McHugh, 2012).

2.3.3 Covariates

To isolate the associations between maternal and paternal SR interactions at 9 months and children's language skills at 18 and 24 months, we included the following theoretically and empirically relevant covariates: intervention condition randomly assigned for the [removed for blinding] project, study site, child attendance in non-parental care, parent education, parent nativity status, parenting stress, globally rated parent responsiveness, child language exposure from parents, child gender, child temperament, and child language skills at 9 months.

The intervention condition (0 = control group; 1 = intervention group) was randomly assigned to families at 9 months. We did not expect intervention condition to be associated with variables measured at 9 months, but it might explain the variability in children's language skills at 18 and 24 months. *Study site* was coded as 1 = DC and 2 = Southern California. Child attendance in *non-parental childcare* (0 = no; 1 = yes) was reported by mothers at 9 months. Maternal and paternal *education* (1 = less than high school; 2 = high school; 3 = some college; 4 = 4-year college degree or higher) and *nativity status* (0 = born outside U.S.; 1 = born in the U.S.) was self-reported at 9 months. Maternal and paternal *parenting stress* was self-reported using the Parenting Stress Scale (Berry & Jones, 1995) and Cronbach's alpha for the 18 items in the scale was 0.80 for mothers and 0.81 for fathers. Maternal and paternal *responsiveness* was rated on a 1-5 scale from videotaped toy play activities at 9 months using the Qualitative Ratings for Parent-Child Interaction coding system (Cox & Crnic, 2003). C*hild language exposure* was coded as 0 = English or Spanish only and 2 = two or more languages and *gender* was coded as 0 = boy and 1 = girl. *Child temperament* was reported by mothers using the EAS Temperament subscale of emotionality (Bus & Plomin, 1984; Buss, 1991) and Cronbach's alpha for the 5 items

in the subscale was 0.72. Children's standardized *total language scores at 9 months* were measured using the PLS-4 (Zimmermann et al., 2002).

2.4 Analytic Plan

We conducted two path analysis models with observed variables to test the main and moderation effects of maternal and paternal SR interactions at 9 months and children's language skills at 18 and 24 months. Path analysis is best suited for this study because it emphasizes the testing of theoretically supported causal paths among variables and accounts for the shared variance between mother and father from the same family (Mueller & Hancock, 2019). We used full information maximum likelihood (FIML) estimation to adjust for missing data and maximum likelihood with robust standard errors (MLR) estimation to account for non-normality in the data.

Each model included maternal and paternal return time (i.e., promptness) and meaningful returns, and their interaction terms (i.e., moderation) as exogenous variables, children's receptive and expressive language skills as endogenous variables, and covariates. To test moderation effects, we first mean-centered maternal and paternal return time and meaningful returns and then calculated the product of the mean-centered maternal and paternal variables (i.e., mother mean-centered return time x father mean-centered return time, mother mean-centered meaningful returns x father mean-centered meaningful returns). We allowed the error terms of the covariates, of maternal and paternal SR variables, and of receptive and expressive language skills to covary among themselves. We also allowed the error terms of the covariates and of the SR variables to covary with each other.

2.4.1 Model Fit and Effect Sizes

We used four indices to assess model fit: chi-square test, comparative fit index (CFI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR). Hu and Bentler's (1999) guidelines recommend a CFI > 0.95, a RMSEA < 0.06, and a SRMR < 0.08 for good fit (Hu & Bentler, 1999). We conducted the path analysis models using R (R Core Team, 2020) and the following packages: lavaan (Rosseel, 2012) for structural equation modeling, psych (Revelle, 2020) for calculating descriptive statistics, tidyverse (Wickham et al., 2019) for data cleaning, manipulation, and plotting. We used standardized coefficients (i.e., Betas) to represent the effect size of individual exogeneous variables. Acock (2014) considers $\beta < 0.2$ to be weak, $0.2 < \beta < 0.5$ moderate, and $\beta > 0.5$ strong. We also calculated R^2 for each model to indicate the proportion of variance in children's receptive and expressive language skills explained by the model. Lastly, using Cohen's f^2 (Selya et al., 2012), we calculated the effect size for SR interactions in a multivariate context—dividing the proportion of variance uniquely accounted for by SR interactions over and above that of the covariates by the unexplained variance by the model. Cohen (1998) recommended that $f^2 \geq 0.02$, $f^2 \geq 0.15$, and $f^2 \geq 0.35$ represent small, medium, and large effect sizes, respectively.

3. Results

3.1 Descriptive Statistics

Table 2 shows the descriptive statistics on the primary study variables (i.e., SR interactions and language outcomes). Most of the variables were approximately normally distributed, except for maternal and paternal return time, which showed skewness beyond acceptable levels (i.e., smaller than -2 or greater than 2; Curran et al., 1996; Kim, 2013). To adjust for skewness, we conducted non-parametric tests (i.e., Spearman's correlation) and used the MLR estimation in path analysis models.

In terms of SR interactions, during the 10-minute toy play activity at 9 months, children on average produced 13 vocal serves (M = 13.16, range = 0-62 and M = 12.50, range = 0-124, respectively with mothers and fathers) and more than 100 non-vocal serves (M = 107.47, range = 44-191 and M = 103.23, range = 31-176, respectively with mothers and fathers).

On average, 87% and 64% of child vocal and non-vocal serves, respectively, were followed by a return from mothers, and 85% and 59% of child vocal and non-vocal serves, respectively, were followed by a return from fathers. Vocal serves on average were returned by mothers at M = 2.66 s (range = 0.18-29.06 s) and fathers at M = 3.63 s (range = 0.37-26.12 seconds) and non-vocal serves were on average returned by mothers at M = 1.73 s (range = 0.78-4 seconds) and by fathers at M = 2.04 s (range = 0.55-7.61 seconds). The distributions of maternal and paternal return time demonstrate that the majority of parent returns occurred within 3 seconds following the child's serve (Figure 2a and b). This is an important findings given that children on average sustained their attention to each toy/activity for only 6 seconds (M = 5.51, range = 3.06-13.92 and M = 5.89, range = 3.24-13.97, respectively with mothers and fathers), thus giving parents only a brief amount of time to notice their child's attention and respond.

Regarding children's receptive skills at 18 and 24 months, over a third (n = 52) and more than half (n = 55) of the children scored 1 SD (SD = 15) below the normative mean, respectively (Zimmerman et al., 2009). For expressive language skills at 18 and 24 months, about 30% (n = 31) and 8% (n = 11) of the children scored 1 SD below the normative mean, respectively.

3.2 Bivariate Correlations

Table 3 presents Pearson and Spearman (for skewed variables) correlations among the continuous study variables. There were no significant correlations between SR variables and receptive language scores at 18 months, but maternal meaningful returns and return time were

significantly correlated with expressive language scores at 18 months (r = 0.22, p = 0.01; ρ = -0.18, p = 0.03, respectively). Paternal return time was significantly correlated with receptive language scores at 24 months (ρ = -0.25, p = 0.01) and maternal return time was significantly correlated with expressive language scores at 24 months (ρ = -0.29, p = 0.003).

3.3 Main and Moderation Effects of SR Interactions on Language Outcomes

Model 1 (Figure 3) testing the main and moderation effects of maternal and paternal SR interactions at 9 months on language outcomes at *18 months* demonstrated good fit: $\chi^2(df = 38) = 47.32$, $p = 0.14$; CFI = 0.99; RMSEA = 0.03 (90% CI [0.00 – 0.07]); and SRMR = 0.03. This model explained 16.4% and 24.0% of the variance in receptive and expressive language scores, respectively. Controlling for the covariates, paternal return time at 9 months was significantly associated with children's receptive scores at 18 months (β = -0.22, p = 0.049) and maternal meaningful turns were significantly associated with expressive scores at 18 months (β = 0.18, p = 0.03) both in the hypothesized direction. That is, the less paternal return time (i.e., more prompt returns) and the more maternal meaningful returns, the better children's receptive and expressive language skills. None of the interaction terms assessing the moderation between maternal and paternal SR interactions showed significant associations with language outcomes at 18 months (Table 4). The effect sizes (Cohen's f^2) for the associations between SR interactions and language skills at 18 months were 0.05 for receptive skills and 0.15 for expressive skills, indicating small effects (Cohen, 1988).

Model 2 (Figure 4) testing the main and moderation effects of SR interactions at 9 months on language outcomes at *24 months* also demonstrated good fit: $\chi^2(df = 38) = 47.02$, $p = 0.15$; CFI = 0.99; RMSEA = 0.03 (90% CI [0.00 – 0.07]); and SRMR = 0.03. This model explained 32.8% and 38.4% of the variance in receptive and expressive language scores,

respectively. Controlling for the covariates, paternal meaningful returns at 9 months were significantly associated with children's receptive scores at 24 months (β = -0.19, p = 0.01; Table 4). Although we hypothesized a significant association between paternal meaningful returns and language outcomes, it was not in the direction we hypothesized. The effect size (Cohen's f^2) for the associations between SR interactions and language skills at 24 months were 0.11 for receptive skills and 0.07 for expressive skills, indicating small effects (Cohen, 1988).

The interaction term between maternal and paternal meaningful returns showed a significant association with receptive scores at 24 months (β = 0.18, p = 0.005; Figure 5). We investigated the moderation effects in two ways because, theoretically, we expected that either parent would moderate the behavior of the other. To test this, we first conducted simple slopes analysis treating paternal meaningful returns as the moderator (maternal meaningful returns x paternal meaningful returns) but found no significant association between maternal meaningful returns and receptive scores at low, average, or high levels of paternal meaningful returns. We then conducted simple slopes analysis to test whether maternal meaningful returns moderated the association between paternal meaningful returns and receptive scores. We found significant negative associations between paternal meaningful returns and receptive scores at low (1 SD below the mean) and average (mean) levels of maternal meaningful returns (B = -0.69, SE = 0.22, t = -3.11, p = 0.004; B = -0.37, SE = 0.15, t = -2.49, p = 0.02), but not at high (1 SD above the mean) levels of maternal relevant returns. This indicates that fathers' meaningful returns only had a negative effect on children's receptive scores at 24 months when mothers' meaningful returns were low or average.

4. Discussion

Grounded in sociocultural and transactional models that back-and-forth reciprocal parent-child interactions during the early years facilitate language skills (Vygotsky, 1978), this study drew on a sample of ethnically and socioeconomically diverse families to examine the main and moderation effects of mothers' and fathers' SR interactions with their infants at 9 months on language skills at 18 and 24 months. This study addresses significant gaps in the literature regarding how *mothers and fathers* from *diverse backgrounds* engage in back-and-forth reciprocal interactions with infants and the contribution of these interactions to *early language development*. We found that maternal and paternal SR interactions at 9 months were independently and interactively associated with children's language outcomes at 18 and 24 months. Fathers' return time and mothers' meaningful returns showed significant associations with receptive and expressive language skills at 18 months, respectively, suggesting that the promptness and meaningfulness of mothers' and fathers' responses to their infants play a crucial role in early language development. However, paternal meaningful returns were negatively associated with receptive scores at 24 months and this negative association was compensated by high levels of maternal meaningful returns.

4.1 Main Effects of SR Interactions on Language Outcomes

In our study, the majority of the mothers and fathers responded promptly (within 3 seconds) when their infants vocalized or showed attention (e.g., look, touch, play) to a toy/activity at 9 months, but in just a fourth of their responses, mothers and fathers provided meaningful information about what their infant was attending to. These findings are consistent with the 3-second time window the field uses to classify parents' responses as contingent or prompt (Bornstein et al., 1992; Fagan & Doveikis, 2019; Van Egeren et al., 2001). These

findings are also remarkable in that parents' responses occur within the short 6-second time window where infants' attention is sustained on the object of interest. These findings suggest that the parents in our sample are attentive and responsive to their children's serves and thus are putting their children on a positive trajectory of language development at 9 months.

We hypothesized that more maternal and paternal SR interactions at 9 months would be associated with higher languages scores of children at 18 and 24 months and the results supported this hypothesis with some nuances. For parent return time, we found that controlling for the covariates (e.g., demographic factors, parental responsiveness, child temperament and earlier language skills), the shorter the paternal return time at 9 months, the higher children's receptive language scores at 18 months. Despite the small effect size, this is an important new finding suggesting that fathers' prompt responses (in our study, the average was just over 3 seconds) support the early learning of receptive language skills. This finding is consistent with previous research demonstrating the benefits of mothers' prompt responses for vocal development and word learning during infancy and extends it to fathers (e.g., Gros-Louis et al., 2014; McGillion et al., 2017; Rollins, 2003; Tamis-LeMonda et al., 2001). In the case of learning new words, when children hear certain words immediately after they act on a specific toy, they associate them with the toy they're playing with and thus learn the proper label for the toy.

Furthermore, the finding that paternal promptness was significant for receptive language skills at 18 but not 24 months is consistent with views that parent-child interactions where parents respond promptly to children's social bids helps children associate sounds with meaning, which is critical for vocabulary growth (Bornstein & Azuma, 1992; Keller et al., 1999). As children become more linguistically and cognitively mature, promptness may not be as crucial

for learning new words, whereas receiving meaningful information about their surroundings may continue to support language development.

However, the promptness of maternal responses (i.e., maternal return time) was not significantly associated with children's language outcomes when the effect of paternal promptness was accounted for, suggesting that past studies may have overestimated maternal effects on early language skills when not including fathers' returns. It is also possible that because the majority of the mothers in our sample responded promptly (85% mothers and 78% fathers responded within 3 seconds), there may not be enough variability in their return time to detect significant associations with language skills.

We also found that when mothers returned their children's serves in a meaningful way (e.g., label or describe the toy/activity in the child's attention) at 9 months, children had better expressive language skills at 18 months, although the effect size was small. This finding corroborates previous research that has found positive associations between mothers' appropriate and relevant responses and infants' vocabulary and language skills (e.g., Baumwell et al., 1997; Benassi et al., 2018; Conway et al., 2018; McGillion et al., 2013; Rollins, 2003). It is also important to note that despite mothers' relatively low proportion of meaningful returns (only 25% of their returns) in our sample, children still benefited from it as evidenced in the significant positive association.

Unexpectedly, we found a negative main effect of paternal meaningful returns on children's receptive language skills at 24 months, that is, the more meaningful responses fathers provided, the lower children's receptive language scores. It is possible that the linguistic features of paternal meaningful returns are different from those of maternal meaningful returns. Previous research indicates that fathers tend to use more challenging language (e.g., *wh*-questions) than

mothers with their children (Leech et al., 2013; Rowe et al., 2004), which is important for language learning with older children, but maybe less helpful for infants whose language development benefits the most from clear pronunciations and repeated words (Rowe & Snow, 2020). In our study, fathers may be providing information, albeit meaningful, that is too syntactically complex for 9-month-old infants to facilitate word learning. For example, in one of the father-child interactions we observed, the child was playing with a pretend credit card (from a register toy) and the father said "You shouldn't use those. If you don't pay it back, you'll be in debt." Although these responses are semantically relevant to the credit card, a 9-month-old infant may not be able to learn the word "credit card" from this father's rather lengthy way of describing it and may even become confused with the additional new word ("debt"). To probe this possibility that fathers are more likely to use challenging language with children than mothers, we compared maternal and paternal token-type ratio (TTR) and mean length of utterance in words (MLU) but did not find significant differences, although on average fathers had slightly higher TTR and MLU (i.e., more diverse and complex language input) than mothers.

Another possibility to explain our finding on fathers' meaningful returns is that because over 90% of the fathers in our sample were working for pay at 9 months, they might be spending less time with their child, which might make them "less sensitive" to their children's needs simply because they do not know their children well. However, it is not always the case that amount of time spent with children is related to high-quality interactions. It is possible that mothers who spend all day at home with the child might actually interact with less quality, whereas fathers who spend more time at work may actually spend more quality time with their infants to make up for not being there (Aldoney & Cabrera, 2016). In addition, studies of stay-at-home mothers have shown that children did not necessarily spend more time with mothers and

some of it was not of high quality (e.g., increased TV watching; Hsin & Felfe; 2014). Other studies that control for fathers' and mothers' time spent with child or employment have also found significant paternal effects (Cabrera et al., 2007, 2000; Volling et al., 2019). Therefore, more research is needed to further understand the differential effects of father-child and mother-child interactions on developmental outcomes.

4.2 Moderated Effects of SR Interactions on Language Outcomes

We also hypothesized that maternal and paternal SR interactions would jointly influence children's language outcomes either by strengthening the other parent's positive effect or compensating for the other parent's negative effect. In support of the compensatory hypothesis, we found a significant moderation effect such that the *negative* main effect of paternal meaningful returns at 9 months on children's receptive language skills at 24 months was *reduced* to nonsignificant when maternal meaningful returns were at a high level. That is, fathers who provided a large proportion of meaningful returns at 9 months had children with better receptive language skills at 24 months only when mothers also provided a large proportion of meaningful returns. Other studies have also reported compensatory effects between parents. A study with low-income parents found that children with at least one supportive (e.g., responsive, warm) parent at 24 months had better cognitive skills concurrently and at 36 months than children with no supportive parents (Ryan et al., 2006). In a recent study with a large sample of parents in Norway, Feldman and colleagues (2023) found that maternal and paternal supportive parenting during toddlerhood moderated each other's influence on children's behavior problems and social skills in first grade (Feldman et al., 2023).

To conclude, our findings indicate that both maternal and paternal SR interactions during infancy contribute, independently and jointly, to early language development in a sample of

ethnically and socioeconomically diverse families. The more promptly fathers respond to their infants and the more meaningful responses mothers provide, the better children's language skills during the first two years. Fathers' effects seem to be more contextual than mothers' as evidenced by the finding that fathers' meaningful responses at 9 months do not negatively impact early language development only when mothers provide a high level of meaningful responses.

4.3 Other Findings

A finding of interest, although not part of our hypotheses, that is consistent with past studies is that SR parent-child interactions, which are micro-coded every time it occurs seem to capture different dimensions of parent-child interactions from parental responsiveness, which is globally rated over the 10-minute parent-child interaction; Bornstein & Manian, 2013; Keller et al., 1999). In our study SR and parental responsiveness were significantly but not highly correlated (r = 0.35-0.38), suggesting that they are not the same construct. In addition, SR and paternal responsiveness at 9 months were significantly associated with children's language outcomes over and above each other (i.e., paternal responsiveness at 9 months was associated with receptive language scores at 24 months; $\beta = 0.20$, p = 0.03). Therefore, when we zoomed in to examine how back-and-forth reciprocal interactions between parents and children occur, we found that the promptness and meaningfulness of the SR interactions, which cannot be captured with global measures, mattered for early language learning.

4.4 Limitations and Future Directions

This study has a few limitations. First, the PLS-4 language assessment, despite being more objective than parent-report language measures, was challenging to administer in a home setting, especially with infants, and sometimes a score of 0 may be the result of the child not being compliant to follow the instructions rather than lack of knowledge. Although the PLS-4

was administered to measure the conceptual knowledge of children exposed to both English and Spanish (i.e., those children received points for answering correctly when the item was administered in either language), the assessment is not originally designed to assess bilingual skills and thus may not be able to capture the full language ability of bilingual children.

Second, due to language limitations of the research team, we were only able to include families whose parent-child interactions were in English and/or Spanish. Therefore, our findings on SR interactions may not be generalizable to other families who do not speak English or Spanish. It is also important to acknowledge that this is a select sample of parents who agreed to participate in a longitudinal parenting intervention study and the eligibility requirements of the intervention study (i.e., two-parent families, co-resident at baseline, literate at a first-grade reading level) predisposed the sample to meet certain characteristics that may place them in a comparatively advantaged position.

Third, we only coded a subset of the possible parent and child behaviors during dyadic interactions (i.e., children's attention and vocalizations and parents' speech) because we were particularly interested in how they relate to language development and because these behaviors are prominent and conducive of parent responses during infancy. However, the literature has examined other behaviors (e.g., smiles, touch, physical movements) of parents and children to assess contingent and reciprocal interactions (e.g., Choi et al., 2020; Wu & Gros-Louis, 2014) and has shown that certain types of serves (e.g., gaze-coordinated behaviors that indicates intentional communication) are more likely to receive responses from parents (Donnellan et al., 2020). Therefore, future research should include a wider range of parent and child behaviors to obtain a more comprehensive understanding of SR interactions during the early years.

Lastly, the parents in our study were videotaped during toy play interactions with their infants while the researchers were present. Although videotaped semi-structured activities is a common method in the field of developmental science, it is not without its limitations. It is possible that parents may have altered their behavior to appear more desirable due to the Hawthorne effect (McCarney et al., 2007) or may have acted less naturally than how they typically play with their infants at home. Therefore, the findings in our study should be interpreted being mindful of the setting (i.e., home in the presence of researchers) where we videotaped the interactions.

5. Conclusion

Using observational data on parent-child interactions with a longitudinal design, this study tested the main and moderation effects of maternal and paternal SR interactions at 9 months on children's language skills at 18 and 24 months. We found that the promptness and meaningfulness of maternal and paternal SR interactions in a sample of ethnically and socioeconomically diverse families, independently and jointly, contributed to early language skills. This study demonstrates that back-and-forth reciprocal interactions between parents and infants benefit early language learning and thus enables us to examine the predictors of the normative patterns of language development in diverse families as well as individual differences, which emerge early and have long-lasting effects. By showing that parents in a primarily Hispanic and low-SES sample respond promptly to their children's serves and that their SR interactions during the first year of life are associated with children's language outcomes later on, this study also adds to the existing evidence that SR interactions between parent and children are rather universal and supportive of early language development (Bornstein et al., 2015; Mesman et al., 2018). Furthermore, the finding that parents in our study provide few meaningful

responses to their children's non-vocal behaviors suggests that early childhood programs could put more emphasis on helping mothers and fathers recognize their infants' attention and needs and respond by labeling the object, describing its color and shape, or giving specific play/function prompts (e.g., if the child is interested in the ball, say "throw it to me" or "bounce it"). Overall, this study indicates that encouraging and educating both mothers *and* fathers to be more attuned to their child's focus of attention or attempts to socially interact and to respond promptly by providing meaningful information that is easy for children to understand may be an enjoyable and cost-effective way to reduce early language gaps and better prepare children for school.

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Table 1

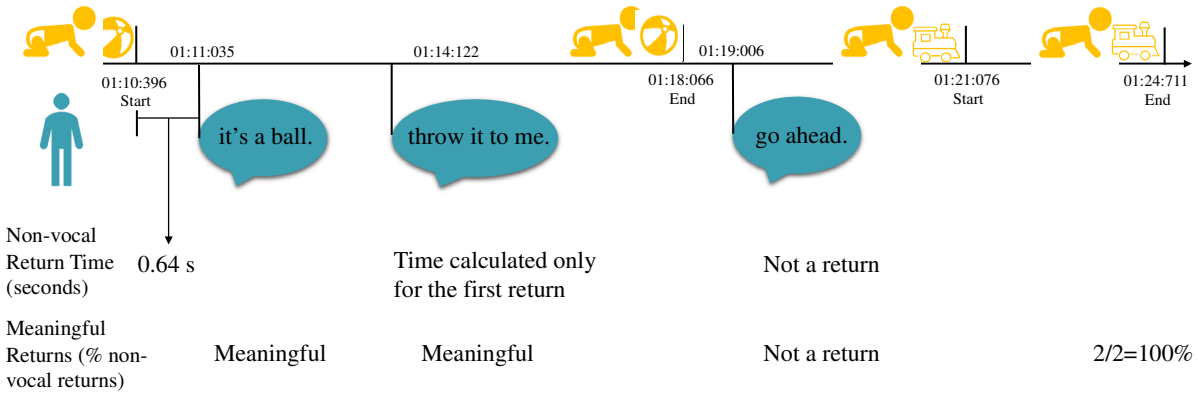
Sample Demographic Characteristics

Variable	Family-Level Reports (n = 148)		Mothers (n = 148)		Fathers (n = 148)	
	n	%	n	%	n	%
Race and ethnicity[a]						
Hispanic/Latinx			113	76.4	108	73.0
African American			16	10.8	15	10.1
White			10	6.8	12	8.1
Other (e.g., Asian, multiracial)			9	6.1	13	8.8
Parent education						
Less than high school			15	10.1	35	23.6
High school			29	19.6	36	24.3
Some college			67	45.3	57	38.5
4-year college degree or above			37	25.0	20	13.5
Parent language use with child						
English only			57	38.5	63	42.6
Spanish only			63	42.6	60	40.5
English and Spanish			21	14.2	17	11.5
Other (e.g., French, Mam)			7	4.7	8	5.4
Parent born outside the U.S.			75	50.7	81	54.7
Parent working for pay			61	41.2	136	91.9
Household income						
Below $25,000	40	27.0				
$25,001 to $40,000	37	25.0				
$40,001 to $75,000	60	40.5				
More than $75,000	8	5.4				
Child language exposure						
English only	45	30.4				
Spanish only	45	30.4				
English and Spanish	49	33.1				
Other (e.g., English and French)	7	4.7				
Child is boy	73	49.3				
Child attended nonparental childcare	69	46.6				
BB2 intervention group						
Intervention	107	72.3				
Control	41	27.7				
BB2 data collection site						
UMD	71	48.0				
UCI	77	52.0				

Note. Proportions were calculated based on the analytic sample (n=148 for mothers, fathers, and families) and may not add to 100 due to missing data or rounding.
[a]African American, White, and Other are non-Hispanic

Figure 1a

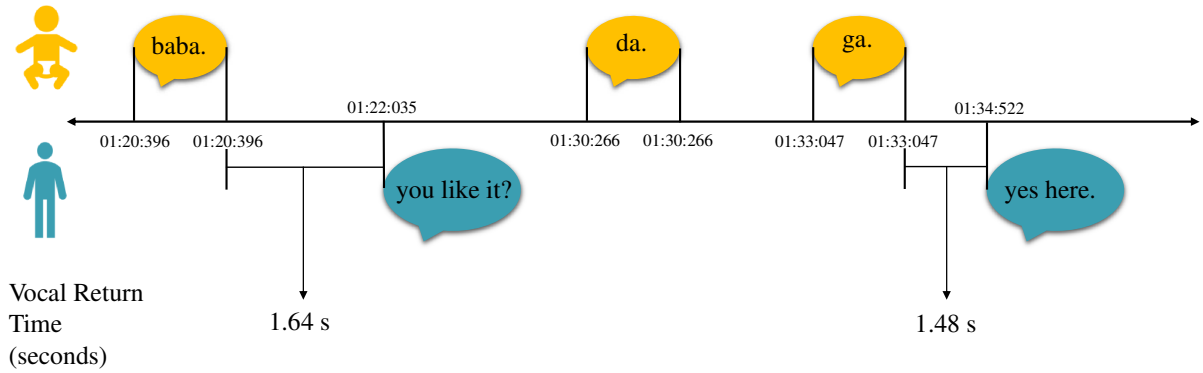
Schematics for SR Interactions Coding (Parent Non-vocal Returns)



Note. In this segment, the child had two non-vocal serves (looking at the ball and looking at the car). The parent provided two returns for the first serve, both of which were semantically relevant, and none for the second serve.

Figure 1b

Schematics for SR Interactions Coding (Parent Vocal Returns)



Note. In this segment, the child had three vocal serves and two of them received parent returns. Parent vocal return time for this segment is the average of the two vocal return times.

Table 2

Descriptive Statistics of Primary Study Variables and Covariates

	Mothers (n = 148)			**Fathers (n = 148)**			**Child (n = 148)**		
	Mean (SD)	Range	n	Mean (SD)	Range	n	Mean (SD)	Range	n
Parenting stress	1.81 (0.42)	1-3.17	148	1.76 (0.41)	1-2.94	148			
Globally rated responsiveness	3.35 (0.75)	2-5	148	3.21 (0.78)	2-5	147			
Child vocal serves	13.16 (12.48)	0-62	146	12.50 (13.93)	0-124	145			
Child non-vocal serves	107.47 (28.30)	44-191	146	103.23 (31.81)	31-176	145			
Parent vocal return time (seconds)	2.66 (3.17)	0.18-29.06	136	3.63 (5.02)	0.37-26.12	136			
Parent non-vocal return time[a] (seconds)	1.73 (0.60)	0.78-4.00	146	2.04 (0.98)	0.55-7.61	145			
Parent return time[b] (seconds)	2.17 (1.71)	0.72-16.12	146	2.78 (2.63)	0.83-14.43	145			
Parent meaningful returns[c] (% non-vocal returns)	0.25 (0.10)	0.06-0.53	146	0.22 (0.10)	0-0.49	145			
Child temperament (12M)							2.26 (0.78)	1-5	143
Total language scores at 9 months							95.64 (9.78)	66-119	148
Receptive scores (18M)							86.94 (11.92)	67-129	139
Expressive scores (18M)							97.85 (9.51)	73-131	145
Receptive scores (24M)							88.03 (16.23)	60-123	100
Expressive scores (24M)							92.37 (12.202	64-125	101

Note. 12M = 12 months. 18M = 18 months. 24M = 24 months. If not indicated, variable was measured at 9 months. [a]Significant difference between maternal and paternal non-vocal return time ($V=3388$, $p<0.001$). [b]Significant difference between maternal and paternal return time ($V=3739$, $p=0.005$). [c]Significant difference between maternal and paternal relevant returns ($t=3.46$, $p<0.001$).

Figure 2a

Distribution of Maternal Vocal, Non-vocal, and Average Return Time (Temporal Contingency)

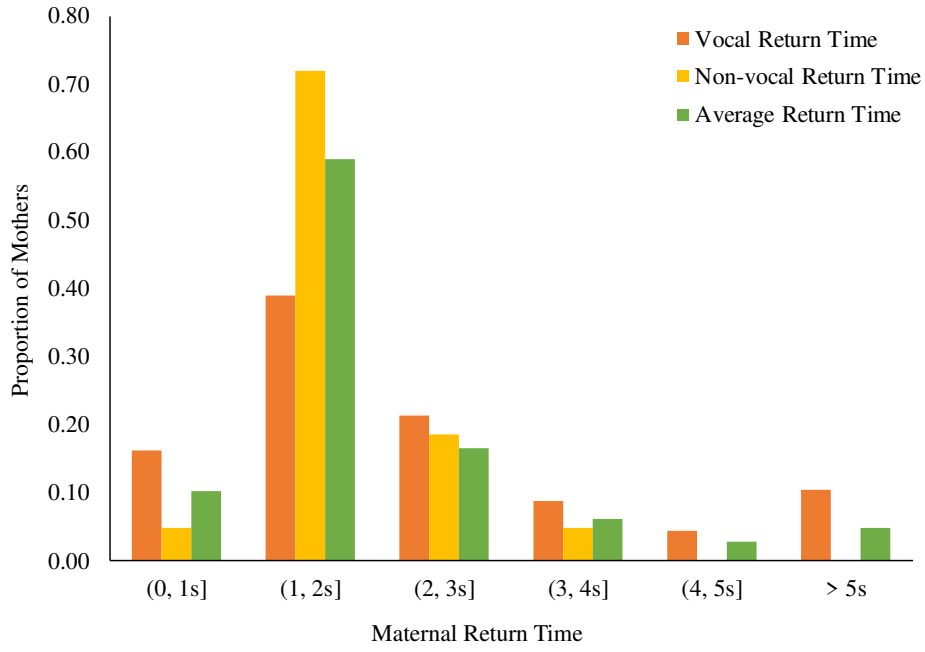


Figure 2b

Distribution of Paternal Vocal, Non-vocal, and Average Return Time (Temporal Contingency)

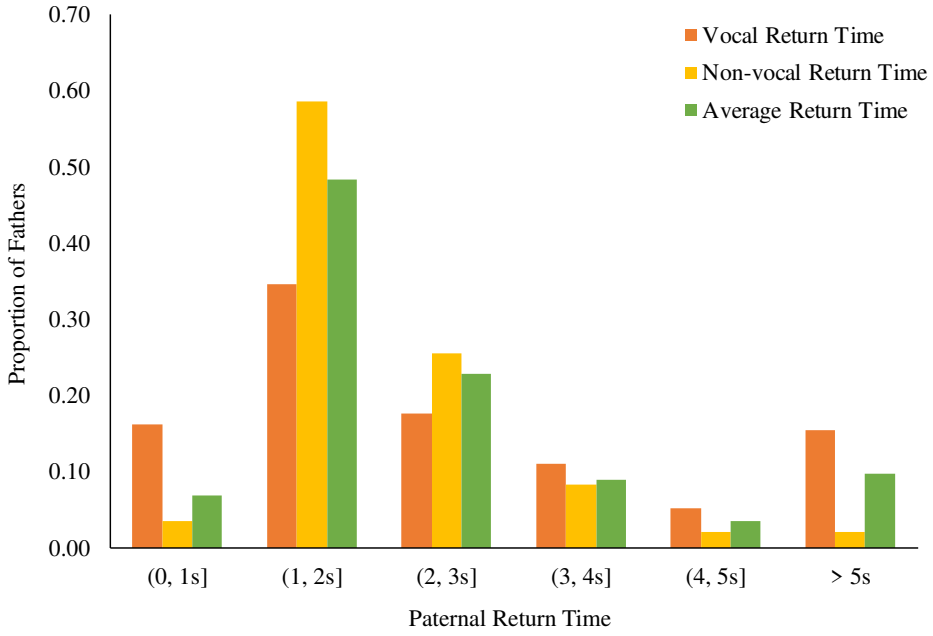


Table 3

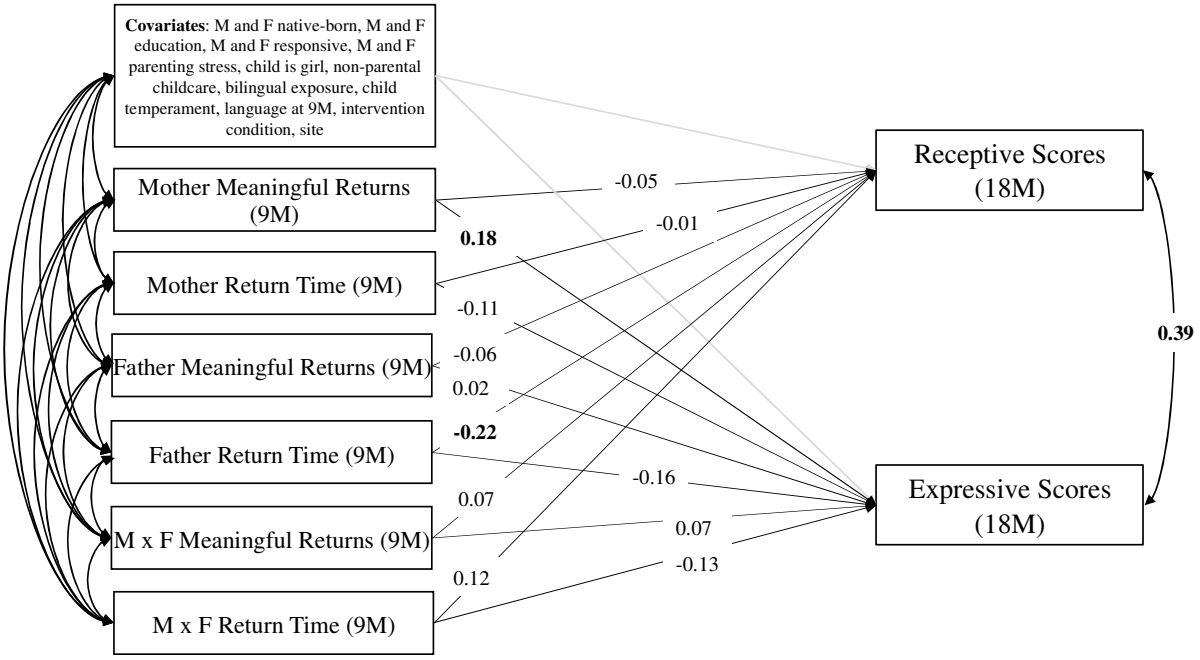
Bivariate Correlations among Continuous Study Variables

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	17.
1. M PSS	--												
2. F PSS	**0.35**	--											
3. Temperament	**0.30**	**0.18**	--										
4. M responsive	-0.04	-0.11	0.00	--									
5. F responsive	-0.06	-0.02	-0.01	**0.24**	--								
6. M meaningful returns	-0.07	-0.02	-0.10	0.09	0.07	--							
7. F meaningful returns	0.02	0.08	-0.01	0.03	-0.03	**0.22**	--						
8. M return time	0.12	0.06	0.12	**-0.38**	-0.04	-0.05	0.05	--					
9. F return time	0.13	0.12	-0.06	-0.02	**-0.27**	0.02	-0.08	**0.18**	--				
10. Lang09	-0.16	**-0.21**	-0.09	0.15	**0.17**	0.07	-0.06	**0.20**	-0.07	--			
11. AC18	-0.15	-0.01	**-0.18**	0.07	0.13	0.08	0.01	-0.04	-0.09	0.01	--		
12. EC18	-0.04	-0.02	**-0.17**	**0.18**	0.10	**0.22**	0.10	**-0.19**	-0.07	-0.05	**0.39**	--	
13. AC24	-0.17	**-0.22**	**-0.26**	**0.22**	**0.26**	0.15	-0.10	-0.18	**-0.25**	0.11	**0.37**	**0.25**	--
14. EC24	-0.01	**-0.21**	-0.13	**0.35**	**0.27**	0.09	-0.04	**-0.29**	-0.16	0.12	**0.34**	**0.22**	**0.67**

Note. Bolded correlations are significant at $p<0.05$. M=mother. F=father. PSS=parenting stress. Temperament=child temperament. Lang09=child total language skills at 9 months. AC18/24= child auditory (receptive) comprehension skills at 18 and 24 months. EC18/24 = child expressive comprehension skills at 18 and 24 months.

Figure 3

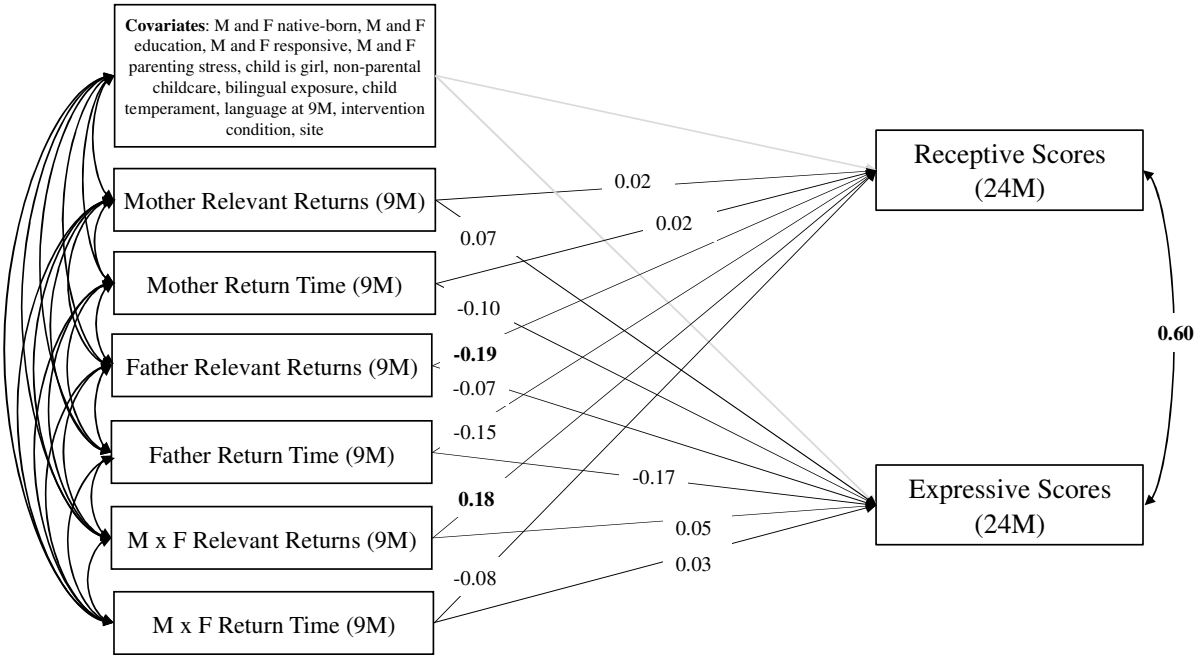
Path Analysis Model Testing Direct and Moderation Effects of SR Interactions at 9 Months on Language Outcomes at 18 Months (Model 1)



Note. 9M = 9 months. 18M = 18 months. M=mother. F=father. Black lines are hypothesized direct paths and grey lines are not hypothesized direct paths. Bolded coefficients are significant at $p<0.05$. Each covariate was modeled to have a direct path to each language outcome. Covariance coefficients are not shown for visual clarity but are available upon request. Standardized coefficients for covariates are listed in Table 4.

Figure 4

Path Analysis Models Testing Direct and Moderation Effects of SR Interactions at 9 Months on Language Outcomes at 24 Months (Model 2)



Note. 9M = 9 months. 24M = 24 months. M=mother. F=father. Black lines are hypothesized direct paths and grey lines are not hypothesized direct paths. Bolded coefficients are significant at $p<0.05$. Each covariate was modeled to have a direct path to each language outcome. Covariance coefficients are not shown for visual clarity but are available upon request. Standardized coefficients for covariates are listed in Table 4.

Table 4

Summary of Path Analyses Testing Direct and Moderation Effects of SR Interactions at 9 Months on Language Outcomes at 18 and 24 Months (Models 1 and 2)

	18 Months				24 Months			
	Receptive Scores		Expressive Scores		Receptive Scores		Expressive Scores	
	Beta	*SE*	*Beta*	*SE*	*Beta*	*SE*	*Beta*	*SE*
M meaningful returns (%)	-0.05	0.12	**0.18**	0.10	0.02	0.18	0.07	0.15
M return time (s)	-0.01	0.06	-0.11	0.04	0.02	0.09	-0.10	0.06
F meaningful returns (%)	-0.06	0.11	0.02	0.08	**-0.19**	0.15	-0.07	0.11
F return time (s)	**-0.22**	0.04	-0.16	0.03	-0.15	0.04	-0.17	0.03
M x F meaningful returns	0.07	0.12	0.07	0.09	**0.18**	0.14	0.05	0.10
M x F return time	0.12	0.08	-0.13	0.07	-0.08	0.19	0.03	0.11
M native-born	0.08	0.22	-0.15	0.18	0.19	0.37	0.17	0.22
F native-born	-0.12	0.24	0.01	0.17	-0.18	0.36	**-0.23**	0.24
M education	-0.02	0.10	-0.06	0.10	0.07	0.19	0.03	0.11
F education	**0.22**	0.09	0.02	0.10	0.10	0.18	0.12	0.11
Child temperament	-0.13	0.03	-0.15	0.02	**-0.24**	0.04	-0.12	0.03
UCI site	0.08	0.20	0.04	0.15	-0.08	0.32	-0.16	0.24
Child bilingual exposure	-0.13	0.20	-0.01	0.15	0.13	0.29	0.08	0.19
M responsiveness	0.05	0.15	0.11	0.11	0.09	0.20	0.17	0.14
F responsiveness	0.06	0.15	0.08	0.11	**0.20**	0.19	0.13	0.15
Non-parental childcare	-0.03	0.21	0.12	0.16	-0.01	0.33	**0.21**	0.22
Child is girl	0.10	0.22	0.14	0.16	0.17	0.32	**0.17**	0.20
Intervention group	-0.01	0.23	**-0.17**	0.17	-0.07	0.34	0.07	0.24
M parenting stress	-0.17	0.29	-0.01	0.21	-0.05	0.32	**0.15**	0.21
F parenting stress	0.09	0.30	0.07	0.22	-0.08	0.41	-0.15	0.24
Language skills at 9 months	-0.01	0.01	-0.07	0.01	0.04	0.02	0.07	0.01

Note. Standardized coefficients are presented. Bolded coefficients are significant at $p<0.05$. M=mother. F=father.

Figure 5

Maternal Meaningful Returns Moderating the Effect of Paternal Meaningful Returns at 9 Months on Children’s Receptive Language Skills at 24 Months