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Mother-Infant Contingent Vocalizations in Eleven Countries

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Abstract

Mother-infant vocal interactions serve multiple functions in child development, but the community-common or community-specific nature of key features of their vocal interactions remains unclear. Here we examined rates, interrelations, and contingencies of vocal interactions in 684 mothers and their 5-month-old infants in diverse communities in 11 countries (Argentina, Belgium, Brazil, Cameroon, France, Israel, Italy, Japan, Kenya, South Korea, and United States). Rates of mothers' and infants' vocalizations varied widely across communities and were uncorrelated. However, collapsing across communities mothers vocalized to infants contingent on the offset of their infants' nondistress vocalizing, infants vocalized contingent on the offset of their mothers' vocalizing, and maternal and infant contingencies were significantly correlated, pointing to the beginnings of dyadic conversational turn taking. Despite broad differences in the overall talkativeness of mothers and infants, maternal and infant contingent vocal responsiveness is common across communities, supporting essential functions of turn-taking in early child socialization.

The consequence of parent-child interaction for children's emotional, social, cognitive, and language development has long been recognized by developmental theorists (Bowlby, 1982; Stern, 1985; Trevarthen, 1979; Vygotsky, 1981), and contingent responsiveness is an especially salient almost universal parenting practice, providing infants with experiences that support their development and effectance (Bornstein, 1989a, 2015). More specifically, vocal interactions are special in early development. Nondistress vocalizations constitute a salient infant signal, and language is a primary response mode of mothers, thus reinforcing the prominence of mother-infant vocal interchanges (Bornstein et al. 1992; Hsu & Fogel, 2003; Kärtner et al., 2008; Van Egeren, Barratt, & Roach, 2001). "Conversational" *turn-taking* (which is what mutually contingent vocal exchanges are) is requisite for successful verbal communication and serves as a basis for the acquisition of language and social interaction (Snow, 1977; Stern, 1985).

When humans talk to one another, they normally and ubiquitously engage in conversation, continuous and habitually nonsimultaneous exchanges in which speakers take turns. One person speaks at a time, and a second person begins in the space which follows the first person finishing. Turn-taking in conversation, which was first systematically deconstructed

by Sacks, Schegloff, and Jefferson (1974; see also Wilson, Wiemann, & Zimmerman, 1984), is a fulcrum in the infrastructure and organization of dialogue. Turn-taking involves highly coordinated timing, the cyclical rise and fall in the probability of initiating speech during brief silences, and is essentially resource-free and automatic (Wilson & Wilson, 2005). Several arguments support a universal system for turn-taking that follows a “minimal-gap minimal-overlap” norm (Schegloff, 2006). The functional basis for conversational turns to be immediately adjacent (rather than overlapping or separated) makes clear the link between speakers’ utterances (Schegloff, 1968), ensures that the response is directly contingent on the preceding utterance (Gergely, Nádasdy, Csibra, & Biró, 1995), and reveals how the prior utterance was understood (Sacks, 1963; Sacks et al., 1974; Schegloff, Jefferson, & Sacks, 1977).

To date, most studies of mother-infant vocal exchanges have been conducted on samples collected in the United States and Northern Europe (Gros-Louis, West, Goldstein, & King, 2006; Tomlinson, Bornstein, Marlow, & Swartz, 2014; Van Egeren et al., 2001), and the few exceptions that have collected data elsewhere (East Asia and Africa, notably) have employed methods and samples not comparable in breadth or depth with them. Nonetheless, it is widely believed that mother-infant vocal turn taking may be so common as to be “universal”, where in actuality the degree to which mother-infant “conversations” follow mutually contingent patterns across a broad range of communities and languages is unknown. If mothers and young infants respond contingently to one another’s vocalizations generally, turn taking might be an early developing and community-common phenomenon and speak to a universal mechanism by which infants experience and acquire linguistic and pragmatic skills. Furthermore, turn-taking systems organize all sorts of very different activities; for example, language exchanges might establish a primary way in which social interactions more generally are organized. By contrast, if contingent mother-infant vocal communication is not consistent across diverse communities, then turn-taking will be a later developing and likely community-specific phenomenon and raise questions about how experiential factors regulate vocal and verbal as well as social interactions of mothers and their prelinguistic infants.

Although ethnographic and sociolinguistic evidence has been read as support that different communities hold some contrasting beliefs about human development, social interaction, and verbal communication (Dixon, Keefer, Tronick, & Brazelton, 1982; Ochs, 1988; Richman, Miller, & LeVine, 1992; Schieffelin & Ochs, 1986), we expected that mother-infant vocal interactions would respect universal rules of turn-taking. We arrived at this hypothesis after considering developmental, neurobiological, and cross-linguistic arguments. First, nonverbal turn-taking “proto-conversations” between newborns and caregivers are well documented and thought to constitute a universal “format” for very early joint activity (e.g., Crown, Feldstein, Jasnow, Beebe, & Jaffe, 2002; Holmlund, 1995; Jasnow & Feldstein, 1986; Kaye, 1982; Lavelli & Fogel, 2005; Masataka, 1993; Papoušek, Papoušek, & Bornstein, 1985; Rutter & Durkin, 1987; Stern, 1985; Stevenson, Ver Hoeve, Roach, & Leavitt, 1986; Striano, Henning, & Stahl, 2006). Mothers and babies regularly follow some behaviors (including vocalizations) by suppressing their own behavior, thereby permitting their partner to join in. From an extremely early age infants vocalize different sounds, and their caregivers respond to different infant vocalizations in structured patterns of turn-taking

(Gros-Louis et al., 2006; Van Egeren et al., 2001). This developmental perspective led us to expect conversational turn-taking might be common in mothers and babies.

Even if some forms of “proto-” and actual conversational interactions between mothers and infants are universal in human societies (Keller, Schölmerich, & Eibl-Eibesfeldt, 1988), rates of conversational turn-taking might still be shaped by local conventions. Lafayette, IN, European American mothers speak in response to their infants’ vocalizations more than Nagoya Japanese mothers (Fogel, Toda, & Kawai, 1988), Bostonian, MA, mothers are more verbally responsive to their infants than West Kenyan Gusii mothers (Richman et al., 1992), and urban Berliner mothers show higher levels of contingent vocal responsiveness than rural Cameroonian Nso mothers (Keller, Kärtner, Borke, Yovski, & Kleis, 2005). This perspective on the literature led us to expect community variation in the overall levels of contingent vocal responsiveness.

Second, the human nervous system appears to be wired for dialogue (i.e., adjacent sequences of communication and response; Garrod & Pickering, 2004) and does not cope well with producing and perceiving speech simultaneously because of interference from masking, diverted attention, or disrupted information processing. Under many such challenging acoustic conditions, speakers modify their speech (Aubanel, Cooke, Villegas, & Lecumberri, 2011; Carhart, Tillman, & Greetis, 1969; Lombard, 1911). Even background conversation disrupts foreground conversation. Thus, delay, interruption, or elimination of auditory feedback undermines speech fluency (Black, 1951; Cowie, Douglas-Cowie, & Kerr, 1982; Fukawa, Yoshioka, Ozawa, & Yoshida, 1988; Geers et al., 2003; Howell & Powell, 1987; Mackay, 1968; Schauwers et al., 2004; Siegel, Schork, Pick, & Garber, 1982), and, reciprocally, speech production modulates activity in brain regions involved in speech perception (Zheng, Munhall, & Johnsrude, 2009). Sidnell (2001) argued that turn-taking in conversation constitutes a species-specific biological adaptation, and Wilson and Wilson (2005) proposed that, during conversation, endogenous oscillators in the brains of the speaker and the listener become mutually entrained to engage one another more effectively. Thus, nervous system information processing considerations led us to expect that turn-taking in conversation would be common.

Third, turn-taking may be a rule of language (Caspers, 1998; de Ruiter, Mitterer, & Enfield, 2006; Hafez, 1991; Kjaerbeck, 1998; La France, 1974; Lerner & Takagi, 1999; Murata, 1994; Robbins, Devoe, & Wiener, 1978; Sacks et al., 1974; Sidnell, 2001; Streeck, 1996; Tanaka, 1999, 2000a, 2000b). Stivers et al. (2009) examined 10 major world languages drawn from traditional indigenous communities in an attempt to uncover shared underlying foundations in turn-taking. Speakers of all 10 languages similarly avoided overlap in conversation and minimized silence between conversational turns, pointing to robust human universals and a single shared architecture for language use. Even when the physical substrate of conversation differs radically from that of ordinary speech, as in nonverbal sign languages used by the deaf (Coates & Sutton-Spence, 2001; Mesch, 2000, 2001), turn-taking is systemic and widespread (Langford, 1994). As Wilson and Wilson (2005, p. 958) concluded, “To our knowledge, no culture or group has been found in which the fundamental features of turn-taking are absent.” This cross-linguistic consideration further fueled our expectations that mother-infant conversations would follow turn-taking.

To explore the community-common or -specific nature of mutually contingent mother-infant vocalizations and vocal interactions directly, we sampled speech in mother-infant dyads from communities in one country in North America (United States), two in South America (Argentina, Brazil), three in Europe (Belgium, France, Italy), two in Africa (Cameroon, Kenya), one in the Middle East (Israel), and two in East Asia (Japan, South Korea). We chose to study mothers and infants from communities in different regions and countries of the world because such comparative designs are requisite to understanding community-common versus community-specific influences in caregiving and child development (Norenzayan & Heine, 2005). Our main aim was to explore whether mother-infant dialogues in different communities exhibit central shared features of turn-taking (and if they did not to uncover community-specific manifestations).

In this study, therefore, we investigate, first, mean levels in and, second, correlations of rates of mother and infant vocalization. Analyses of mean levels across communities provide information about base rates of vocalization, and correlations provide information about associations between partners' raw rates of vocalization. It is widely acknowledged that mothers in some ethnic groups and cultures are more verbal than others. For example, Konner (1977) recorded variations in the frequencies of caregiver vocalization to infants across samples drawn from the Kalahari San, Guatemala, and Boston working and middle class, and Richman et al. (1988) reported that North American, Swedish, and Italian mothers had higher rates of vocalization than Kenyan Gusii mothers. U.S. American mothers talk more to their babies than Japanese mothers (Caudill & Weinstein, 1969; Chew, 1969; Ferguson, 1977). Indeed, many observers have noted the relative dearth of speech used by African caregivers, be they Gusii of Kenya or native speakers of Sooninke or Pular from West Africa (Dixon, Tronick, Keefer, & Brazelton, 1981; Rabain-Jamin, 1994; Richman et al., 1988). Likewise, babies in some ethnic groups and cultures are more vocal than others; U.S. American infants vocalize nondistress more than Japanese infants (Bornstein, 1989b; Caudill & Weinstein, 1969).

In addition to these familiar statistical techniques, third, we analyzed timed event sequences of mother and infant vocalizations specifically to examine turn-taking. Sequential analyses provide information about interactional processes that underpin mother-infant exchanges by describing patterns of interaction in real time. Sequential analyses are more faithful (than, for example, correlations among rates of behaviors) to a dynamic approach that explains the behavior of each interlocutor by evaluating contingencies between partners (Bakeman & Gottman, 1997; Bakeman & Quera, 2011). Most research that has examined sequences of mother-infant interactions has used time-sampling coding techniques and looked at sequences of mother and infant behaviors without regard to the timing of those behaviors (event sequences), or has coded durations, without regard to how long it takes the partner to respond and thus become involved in the interaction (state sequences). In contrast, we examine contingency of timed sequences of mother and infant vocalizations at a microanalytic level. This approach permits more fine-grained assessments of turn-taking in mother-infant vocal interactions. Compared to event or state sequences, timed event sequences better capture the complexity and dynamic of real-life interactions because they preserve onset and offset times in partners' speech (Bakeman & Quera, 2011). Timed event sequential data can answer research questions such as how likely is the infant to respond to

the conclusion of his/her mother's vocalization by vocalizing within a specified time window. Thus, timed sequential analysis complements and enriches standard statistical techniques and offers a dynamic process-oriented method to the study of mother-infant interactions that more closely approximates causal inference (Bakeman & Gnisci, 2005). Although mothers are often thought to lead infants in interactions because they are the more mature partner in the dyad (Kochanska & Aksan, 2004; Maccoby, 1992; Vygotsky, 1978), developmental scientists recognize the influence that infants themselves exert in mother-infant interactions, and mother-infant relationships more generally, and so in their own development (Bell, 1979; Bornstein, 2015). Therefore, our analysis of sequences incorporated a within-dyad factor that allowed us to determine which partner was more responsive – mother to infant or infant to mother (Fogel, 1982; Gottman & Ringland, 1981).

In brief, we investigated the following research questions: (i) Do communities (i.e., different countries) differ, or are they similar, in rates of mothers' vocalizations to infants and rates of infants' nondistress vocalizations? (ii) Are rates of mother and infant vocalization correlated, and are patterns of correlations similar or different across communities? (iii) Are mother vocalizations and infant vocalizations universally contingent, or does their contingency vary across communities? (iv) Do mothers who speak with a high degree of contingency to their infants have infants who vocalize with a high degree of contingency to their mothers, or are mother-infant vocal contingencies uncoordinated? (v) Do mothers or infants tend to be more vocally responsive, and are communities similar or different in the relative vocal responsiveness of each partner? As the focus of this paper is on community similarities and differences, analyses that address these five questions controlled for the potential impact of infant age and gender and maternal age and education as needed. In a nutshell, there are many claims in the developmental literature for community similarity and difference in rates of mother and infant vocalization, their correlation, and their contingency, but no adequately broad-ranging, microanalytic, quantitative comparison such as we undertake here has been made.

Method

Participants

To investigate these questions, we recruited 684 mothers and their 5½-month-old infants from distinct communities in 11 countries. Dyads were drawn from more than one socioeconomic and demographic subgroup in each country whenever possible so that country samples would be heterogeneous and broader generalizations could be drawn. In this report, we use the term "community" to refer to our country samples generically; our samples came from different countries, but we do not claim that these samples are representative of their respective nation states. We attempted to collect 50 to 100 families in each community, but some samples were smaller because of recruitment considerations. Argentine mother-infant dyads ($n = 99$) were recruited from greater metropolitan Buenos Aires (67% of the sample) and a rural community in Córdoba Province (33%). Belgian dyads ($n = 100$) were recruited from Ghent and Antwerp. Brazilian dyads ($n = 58$) were recruited from metropolitan Rio de Janeiro. Cameroonian dyads ($n = 29$) were Nso, an indigenous group that lives in northwest Cameroon. French dyads ($n = 49$) were recruited

from Paris and its immediate banlieux. Israeli dyads ($n = 30$) were recruited from metropolitan Haifa. Italian dyads ($n = 92$) were recruited from metropolitan Padua (55%), a northern city, and in and around Ruoti (45%), a southern town. Japanese dyads ($n = 49$) were recruited from greater metropolitan Tokyo. Kenyan dyads ($n = 26$) were Kamba, a Bantu group that lives in eastern Kenya. South Korean dyads ($n = 52$) were recruited from the Seoul metropolitan area. Dyads from the United States ($n = 100$) were randomly selected from a larger sample of European Americans; 77% came from the Washington, DC, metropolitan area, including MD and VA, and 23% from rural WV. Sample sizes per community were designed so that the ratio of the smallest to largest would not exceed 1:4 (Tabachnick & Fidell, 2007).

All infants were approximately 5½ months of age, firstborn singletons, healthy, full term, and weighed 2500 – 5000 g at birth. By 5 or 6 months of age, infants are able to take the initiative leading to genuine turn-taking exchanges. Approximately equal numbers of girls and boys participated in each community sample. Sociodemographic characteristics of participating families are found in Table 1. Much previous research on cross-national differences in mother-infant interaction and communication has not accounted for participant or community differences in maternal age, education, and parity or family social class (Kärtner et al., 2008; Keller, Otto, Lamm, Yovsi, & Kärtner, 2008; Richman et al., 1992); all variables presented in Table 1 were considered as potential covariates if they correlated with dependent variables and shared at least 1% of their variance ($r \geq .10$). Maternal age and education were significantly related to the rate of maternal vocalization, $r(682) = .36$ and $.38$, $ps < .001$, respectively. No other variables in Table 1 met criteria as covariates.

Procedures

Families were recruited using methods common to developmental science research with infants, including mass mailings, hospital birth notifications, patient lists of medical groups, newspaper birth announcements, and advertisements in newspapers. The research project was approved by institutional review boards of the first author and in individual countries and was carried out in accordance with the provisions of the World Medical Association Declaration of Helsinki. We attempted to remain faithful to a principle of ecological validity by focusing on naturalistic interactions between mothers and infants at home (Bronfenbrenner, 1979; Connors & Glenn, 1996). Interactions were videorecorded at a time when the infant was awake and alert, and the only people at home were the mother, the infant, and one trained female videographer who was from the same community as the dyad she was filming. Mothers were instructed that observations were meant to be representative of the dyad's typical routine and behavior and were encouraged to disregard the videographer's presence insofar as possible; the videographer resisted talking to, making eye contact with, or otherwise reacting to the mother or infant while recording. Filming commenced after a conventional period of acclimation to the camera and the presence of the videographer (McCune-Nicolich & Fenson, 1984; Stevenson, Leavitt, Roach, Chapman, & Miller, 1986) and continued for 1 hr. Infants were awake for virtually the entire observation ($M = 99.84\%$, $SD = .01$, range = 92–100%).

Behavioral Coding—The first 50 min of the hr were coded using mutually exclusive and exhaustive coding schemes for mothers and for infants. Onsets and offsets of maternal vocalization directed to the infant and infant nondistress vocalization were coded to the nearest 0.10 s. The minimum duration for a vocalization was set to 0.3 s, and an intervocalization gap of 1 s was necessary for a second vocalization to be counted as new.

We computed the rate (number of times per hour) that mothers vocalized to their infants (called *maternal vocalization*) and the rate (number of times per hour) that infants vocalized in positive or neutral tones (called *infant nondistress vocalization*).

Coders, unaware of the study design and goals, were first trained to reliability (Cohen's, 1960, kappa: $\kappa > .60$) on a standard set of videorecords. Coder reliability was checked every 10 records to guard against coding drift. Inter-coder agreement was calculated in ~30% of each sample. All coders achieved acceptable levels of coder reliability (Fleiss, 1981); specifically, reliability coefficients were assessed with κ separately for each of the 11 communities, and pairs of coders ranged from $\kappa = .63$ to $.74$ (agreements ranged from 86% to 96%).

Sequential Dependent Variables—Following procedures described in Bakeman and Quera (2011) and Bakeman and Gnisci (2005), two dependent variables that captured the sequential aspects of mother-infant vocal interaction were generated: (a) *maternal vocal responsiveness* (MVR), the odds that a mother spoke to her infant within 2 s of the offset of an infant nondistress vocalization relative to other times, and (b) *infant vocal responsiveness* (IVR), the odds that an infant vocalized nondistress within 2 s of the offset of a maternal vocalization directed to the infant relative to other times. A central feature of turn-taking is precision of timing. Turn transitions are commonly tightly synchronized, and the next speaker usually begins speaking with virtually no gap following the end of the prior speaker's utterance. Extensive parametric research determined that a 2-s trailing-edge triggered window captures contingencies in mother-infant vocalizations in naturalistic settings (Van Egeren et al., 2001).

Separately for each dyad, time units were tallied in 2×2 contingency tables for behavioral sequences MVR and IVR. For example, the contingency table for MVR tallied the tenths of a second that a mother (a) vocalized in the time windows after her infant vocalized, (b) vocalized outside time windows after her infant vocalized, (c) did not vocalize in time windows after her infant vocalized, and (d) did not vocalize outside time windows after her infant vocalized. Based on these tables, odds ratios (OR) were computed for each behavioral pair (Bakeman, Deckner, & Quera, 2005). The OR is a descriptive measure of effect size. ORs > 1 indicate that bouts of the target behavior are more likely to begin within 2 s of the offset of the given behavior than at other times, whereas ORs < 1 indicate less likelihood. Concretely, an OR of 3.00 for infant vocal responsiveness means that the odds of the infant vocalizing nondistress within 2 s of the offset of the mother speaking to the infant is 3 times greater than otherwise. If fewer than 5 occurrences of the given behavior were observed, the value of the OR was regarded as missing for that dyad because there would not have been a sufficient sample of the behavior from that dyad to draw conclusions about contingency (Bakeman et al., 2005). Overall, data for very few dyads were insufficient; however, Kenya

(12% of MVR and 27% of IVR) had larger proportions of insufficient data than other countries (2%). Rates and odds ratios were computed using the Generalized Sequential Quierier program (GSEQ version 5.1.09) and were all square-root transformed (after adding a .03 start value) to resolve problems with skewness and kurtosis.

Results

Rates of Maternal and Infant Vocalization and their Correlations

In answer to the first question, analyses of covariance by community and gender, controlling for maternal age and education (infant age was unrelated to rates), showed that rates of maternal vocalization, $F(10, 660) = 13.70, p < .001, \eta^2_p = .17$, and infant vocalization, $F(10, 662) = 13.14, p < .001, \eta^2_p = .17$, varied across communities. Twenty-four of 55 between-community comparisons (44%) were significant for maternal vocalization, and 17 of 55 between-community comparisons (31%) were significant for infant vocalization (Table 2). Results were similar when maternal age and education controls were removed.

In answer to the second question, Pearson correlations were calculated to investigate whether members of a dyad who vocalize more have partners who also vocalize more (overall and separately for each community; Table 2). Rates of mother and infant vocalization were residualized for significant relations with covariates prior to computing these correlations. Rates were not significantly related across all communities or in any individual community (except for Argentina and Brazil, where mothers who vocalized more frequently had infants who vocalized more frequently).

Contingency of Maternal and Infant Vocalization and their Correlations

One sample *t*-tests were performed for all communities combined and separately for each community to determine, for the third question, whether pairs of behaviors were significantly contingent (i.e., whether ORs differed significantly from the transformed equivalent of 1; see descriptives in Table 3 and *t*-tests in Table 4). Maternal vocalization to infants was contingent on infants' vocalizations overall, and in every community, with medium to large effect sizes (except in Cameroon and Kenya which had the smallest sample sizes). Infant nondistress vocalizations were contingent on their mothers' vocalizations to them overall and in approximately one-half of the communities.

Fourth, we explored whether MVR and IVR were similarly contingent overall and across communities. Pearson correlations were calculated to investigate whether mothers who were relatively more responsive to their infants' vocalizations had infants who were relatively more responsive to their mothers' vocalizations (Table 3). MVR and IVR were significantly correlated overall and in ten communities (except in Kenya).

Finally, fifth, we analyzed whether mothers or infants were more responsive (Figure 1) using a repeated-measures analysis of variance (no covariates were related to ORs). Responder (mother vs. infant) was the within-subjects effect, and community and gender were between-subjects effects. Collapsing across communities, a main effect of Responder emerged, $F(1, 671) = 99.13, p < .001, \eta^2_p = .129$; mothers were more responsive partners than infants. However, the Community x Responder interaction was significant, $F(10, 650)$

$= 4.21, p < .001, \eta^2_p = .06$. Analysis of simple effects of Responder within community indicated that mothers were more responsive partners than infants in Belgium, $F(1, 95) = 7.97, p < .01, \eta^2_p = .08$, Italy, $F(1, 88) = 8.54, p < .01, \eta^2_p = .09$, and the United States, $F(1, 96) = 16.48, p < .001, \eta^2_p = .15$. Mothers and infants were similarly responsive in the other communities. The simple effect of community for MVR was significant, $F(10, 654) = 5.00, p < .001, \eta^2_p = .07$; pairwise comparisons are presented in Table 3, and 10 of 55 (18%) community comparisons were significant. The simple effect of community for IVR was nonsignificant; across communities infants did not differ in their odds of vocalizing to their mothers in response to their mothers' vocalizations.

Discussion

Taken together, our findings point to community differences in overall rates of maternal and infant vocalization which are largely uncorrelated; however, mothers nearly universally spoke to their infants in response to their infants' nondistress vocalizing, and when collapsing across communities infants' nondistress vocalizations were significantly contingent on their mothers' vocalizations to them. Differences emerged across communities in the strength of mothers' responsiveness to infant vocalizations (although almost all were significantly contingent), but no community differences emerged in infant responsiveness to maternal vocalizations. Maternal and infant vocal responsiveness were also significantly correlated overall and in 10 of 11 communities, indicating that dyadic turn-taking rhythms are established in mothers and infants by the middle of the first year of life. Finally, and as expected, mothers were more responsive to their infants than their infants were to them. The face validity and consistency of findings from this cross-community study give evidence of the generalizability of our coding and contingency analysis approach, and the results extend findings about mother and infant "conversation" across communities in 11 countries around the globe.

Returning to our initial questions, first we found community differences in rates of maternal and infant vocalization. Different cultures hold different ethnotheories about the utility and meaningfulness of adult speech to infants (Dixon et al., 1982; Ochs, 1988; Richman et al., 1992), reflecting culture-specific interactional goals, conventions, or scripts for parenting (Bornstein, 2015). The dearth of maternal speech to infants in African samples we found has been commonly reported previously in the cross-cultural and anthropological literatures (e.g., Dixon et al., 1981; Keller et al., 2005; Rabain-Jamin, 1994; Richman et al., 1988). For example, Gusii mothers reportedly "ridicule" the idea of talking to children before they are able to speak, which they estimate at about 2 years of age (Richman et al., 1992), and social and religious representations in some African societies hold that a child who is not yet talking (or walking) is still "only a potential human being" (Bonnet, 1994; Goody, 1962; Lancy, 2013). Thus, variation in childrearing philosophies, values, and beliefs likely mediate community differences in maternal vocalization. For their part, community variation in infant vocalization may reflect temperament or its biological roots, for which there is growing cross-cultural evidence (Bornstein, 1989b; Chen & Schmidt, 2015).

Second, we found that infant and mother rates of vocalization were uncorrelated. Mothers and their infants did not vocalize in comparable degrees. A relatively talkative mother does not necessarily have a relatively talkative infant.

Rather, third, and centrally, we found that mothers overall and in most communities vocalized contingently in response to their infants' vocalizing, just as their infants vocalized in response to their mothers' vocalizations. We "equated" mothers on sociodemographic factors, such as age, education, and parity; and the communities we studied varied in structural characteristics from dwellings to geographic locations. Our results cannot readily be ascribed to differences in these variables, an important indication of a universal. Taken together, therefore, our findings point to community-common patterns of maternal and infant conversational turn-taking. Among different possible maternal responses to infant vocalization (speech, touch, play, smile), speech is the most common response in U.S. (Van Egeren et al., 2001) and in other samples (Bornstein et al., 1992; Kärtner et al., 2008). The consistent responsiveness in mothers to infant vocalization suggests that mothers may conceive of their infants as competent language partners, and mothers may be treating their baby's nondistress vocalizations as incipient speech (Schieffelin & Ochs, 1986), even though infants had yet to form words and despite differences in overall talkativeness and possible variations in community meanings and emphases placed on mother-infant communication.

Amid a strong universal pattern, some cultural variation emerged. The lack of significant contingencies in Cameroon and Kenya may reflect their small sample sizes (a limitation of the study), higher proportions of missing data due to low rates of talking (in Kenya), and possible cultural belief systems that moderate universals. Lending support to the suggestion that power may have been the root limitation, odds ratios were above 1.00 for 69% of Cameroonian and 79% of Kenyan dyads, similar percentages to those in other countries (60%-88%). The mean odds ratios in Cameroon and Kenya were also consistent with those in the other countries (Table 3). Our findings also accord with others in the literature; for example, German Muenster mothers show more contingent responses to their infants' signals than Cameroonian Nso mothers (Keller et al., 2008). The nature of vocal interactions in African dyads and reasons for possible differences merit further investigation.

The overall cross-community pattern suggests that maternal vocal contingency is a general response tendency that serves broader functions in the early socialization of human children. Maternal infant-directed speech has been linked to increased infant brain activity (Zangl & Mills, 2007) and blood flow in the frontal cortex (Saito et al., 2006), physical growth (Monnot, 1999), early language skills (Thiessen, Hill, & Saffran, 2005), and social preferences (Schachner & Hannon, 2011), and maternal responsiveness to infant vocalizations predicts later child language development (Bornstein, Tamis-LeMonda, & Haynes, 1999). Our results suggest that, in addition to the automatic and universal way mothers speak to their infants using higher-frequency affect and intonation (e.g., "baby talk"; Burnham, Kitamura, & Vollmer-Conna, 2002; Soderstrom, 2007), maternal verbal responsiveness to infant vocalizations may be a universal characteristic that could also promote diverse social aspects of child development. For example, it is impolite to interrupt; rather, we wait our turn ... to speak and to act.

It is noteworthy that by 5 months of age infants overall vocalize back to their mothers contingent on their mothers' speech. Strong parallels in turn-taking across communities and languages of varied type, geographical location, and cultural traditions in 11 countries offer systematic support for the view that turn-taking in informal conversation is an early developing behavior consistent with the presence of a universal, stable system of conversation that avoids overlaps and minimizes gaps in interlocutor speech. The results argue for an interactional foundation for language that is relatively stable and separable from specific languages and cultural practices where it is instantiated (Levinson, 2006).

Fourth, unlike the raw vocalization frequencies, infant and maternal vocal responsiveness were generally correlated. Infant and maternal vocal responsiveness were not significantly correlated in Kenya, which may be a consequence of the small sample size. Infants who are more vocally responsive to their mothers have mothers who are more vocally responsive to their infants and vice-versa. By 5 months, mothers and infants are coming into turn-taking attunement with its several developmental benefits (Bornstein, 2013). Turns in dialogue are not isolated utterances, but are bidirectional and linked across interlocutors so that interlocutors often tightly interleave and align channels of production and comprehension. Such counterphased mutual entrainment between speaker and listener further suggests that interlocutors activate their production systems even when listening because they have to be prepared to become the speaker. These inferences raise compelling developmental questions.

Finally, fifth, we found that mothers tended to be more responsive to their infants than infants were to their mothers. Thinking about parent-child relationships naturally highlights parents as agents of children's socialization, and there is ample evidence, especially in the early years, that, between parents and children, parents exert more sway and young children command less agency (Elias, Hayes, & Broerse, 1986; Kochanska & Aksan, 2004; Maccoby, 1992; Vygotsky, 1978). This asymmetrical finding therefore accords with other developmental observations concerned with transaction. Maternal responsiveness has attracted the attention of developmental researchers because it faithfully reflects a recurring and significant three-event sequence in everyday exchanges between child and parent that involves child act, parent reaction, and effect on child, and because responsiveness has been found to possess meaningful predictive validity over diverse domains of children's development (Bornstein et al., 1992). Maternal responding serves notice to the infant that mother is attending (a key part of learning about interaction, intentionality, causation, and the like is figuring out when your partner is attending to or has been affected by your behavior), just as responsiveness maintains infant attention and continues the interaction (Bornstein, Arterberry, & Lamb, 2014; Stern, 1985). Responsiveness is central to a mother's job in scaffolding the development of her infant, and by being vocally responsive mothers reinforce and motivate their infants' vocalizations. To a considerable degree, however, parent-infant transactions are a two-way street, and infants actively select, modify, interpret, and create their own environments, including their parenting, as maternal responsiveness is, after all, reaction to an infant act (Murray & Trevarthen, 1986).

Implications and Future Directions

Because conversations need to be organized, and to ensure that conversations proceed smoothly, rules of turn-taking in speech establish order. Language is fundamentally grounded in social interaction, and it is likely that the turn-taking mechanisms underlying verbal and social interaction coevolved. Thinking developmentally, it is therefore meaningful to ask how mother-infant dyads engage in such efficient turn-taking and how they develop turn taking so quickly. Models of inter-turn intervals indicate that speakers and listeners synchronize their speech during dialogue to establish communication and maintain equilibrium (Wilson & Wilson, 2005). Turn-taking must develop very quickly, and its functioning cannot depend on complex decisions or await marshalling considerable resources, suggesting that turn-taking is automatic and emerges without conscious effort. There is evidence that adult interlocutors are almost entirely unaware of the dynamics of turn taking (e.g., they more or less immediately imitate each other's grammar; Pickering & Garrod, 2004, 2007). Adult listeners also likely project an upcoming end of a turn using multiple semantic, syntactic, prosodic, attentional, or body movement cues produced by the speaker, and reciprocally a variety of devices has been proposed by which adult listeners indicate their desire to take a turn, such as movements, audible inbreaths, or interjected words. However, vocal signals alone are sufficient to coordinate smooth turn-taking as Shockley, Santana, and Fowler (2003) learned that coordination between partners was carried by verbal, and not by visual, signals. Developmental approaches to unpacking the transaction of turn taking need to address facts such as one partner talks at a time; although speakers change, the duration and ordering of turns vary; transitions are finely coordinated; and techniques exist for allocating turns. On what cues do mothers and 5-month-old infants rely?

The findings of this study indicate that turn-taking conversation has developed by 5 months of age before infants produce their first words. This pattern of interaction is (nearly) universal across various communities, despite large differences in the overall talkativeness of partners. These conversational skills seem to unfold early, automatically, and without formal instruction. Rather, conversations emerge as an integral ingredient of children's earliest interactions.

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Figure 1.

Contingency of mother and infant vocalizations by country. $M \pm 95\%$ confidence interval.

The reference line at 1.0149 indicates a significant level of contingency. If an error bar overlaps the reference line, the behaviors are not significantly contingent. Error bars that do not overlap across countries indicate significant differences.

Table 1

Sociodemographic characteristics of the participants

	Argentina (<i>n</i> = 99)	Belgium (<i>n</i> = 100)	Brazil (<i>n</i> = 58)	Cameroon (<i>n</i> = 29)	France (<i>n</i> = 49)	Israel (<i>n</i> = 30)	Italy (<i>n</i> = 92)	Japan (<i>n</i> = 49)	Kenya (<i>n</i> = 26)	S. Korea (<i>n</i> = 52)	USA (<i>n</i> = 100)
<i>Mother</i>											
Age (years) ^a	25.31 (4.96)	29.24 (3.66)	26.37 (5.81)	23.44 (3.12)	30.67 (4.75)	28.05 (3.55)	27.23 (4.71)	28.88 (3.55)	21.44 (3.34)	29.00 (2.13)	27.83 (5.57)
Education ^b	3.96 (1.37)	5.25 (0.97)	4.22 (1.83)	3.17 (1.63)	5.45 (1.26)	5.43 (0.73)	3.54 (1.50)	5.14 (1.00)	2.62 (1.63)	5.67 (0.86)	5.34 (1.38)
Working Status ^c	37%	81%	55%	38%	63%	30%	17%	17%	15%	42%	59%
Married ^d	75%	80%	59%	72%	67%	100%	100%	100%	35%	100%	89%
Nuclear Family ^e	59%	93%	72%	45%	N/A	97%	90%	90%	15%	52%	77%
<i>Infant</i>											
Age (months) ^f	5.40 (0.26)	5.16 (0.30)	5.15 (0.13)	5.03 (0.14)	5.49 (0.36)	5.47 (0.16)	5.09 (0.17)	5.28 (0.31)	5.20 (0.29)	5.32 (0.16)	5.35 (0.24)
Gender (Girls:Boys) ^g	44:55	46:54	31:27	15:14	22:27	16:14	47:45	26:23	11:15	26:26	39:61
Birth weight (g) ^h	3467.12 (415.48)	3458.45 (413.08)	3307.16 (371.55)	3272.50 (535.57)	3303.67 (322.80)	3346.21 (433.64)	3265.11 (388.02)	3109.35 (323.06)	3071.67 (427.64)	3330.67 (395.07)	3462.71 (468.95)

Notes. Sample sizes vary due to missing data. *M* (*SD*) unless otherwise specified. Chi-square tests examined community differences for the distributions of mothers working and child gender. For each of the other sociodemographic characteristics, ANOVAs with one between-subjects factor (Community) were performed, followed by *t*-tests with Bonferroni's correction ($\alpha = .05$; however, if variances were heterogeneous, $\alpha = .025$ for pairwise comparisons).

^a Kenyan mothers were younger than mothers in all other countries except Cameroon; Cameroonian mothers were younger than mothers in all other countries except Argentina, Brazil, and Kenya; Argentine mothers were younger than all mothers except Brazilian, Cameroonian, Kenyan, Israeli, and Italian mothers; French mothers were older than Brazilian, Italian, and U.S. mothers; and Belgian mothers were older than Brazilian mothers, $F(10, 673) = 14.93, p < .001, \eta^2 p = .18$.

^b Because differences exist between countries in the duration, quality, and content of schooling, bicultural researchers adjusted mothers' years of education so that the scales were equivalent to the 7-point Hollingshead (1975) index. Belgian, French, Israeli, Japanese, South Korean, and U.S. mothers had higher education than Argentine, Brazilian, Cameroonian, Italian, or Kenyan mothers; Argentine and Brazilian mothers had higher education than Kenyan mothers; and Brazilian mothers had higher education than Cameroonian mothers, $F(10, 673) = 30.89, p < .001, \eta^2 p = .32$.

^c The percentage of mothers who were working when their infants were 5 months old varied across countries, $\chi^2 (10, N = 636) = 118.27, p < .001$.

^d The percentage of mothers who were married when their infants were 5 months old varied across countries, $\chi^2 (10, N = 629) = 114.35, p < .001$.

^e The percentage of infants who lived in nuclear families varied across countries, $\chi^2 (9, N = 569) = 114.59, p < .001$.

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f At the time of the visit Argentine, French, and Israeli infants were older than Belgian, Brazilian, Cameroonian, Italian, and Kenyan infants; French and Israeli infants were older than Japanese infants; French infants were older than South Korean infants; South Korean and U.S. infants were older than Belgian, Brazilian, Cameroonian, or Italian infants; and Japanese infants were older than Cameroonian or Italian infants, $F(10, 673) = 21.64, p < .001, \eta^2 p = .24$.

g No community differences, $\chi^2(10, N = 684) = 6.41, ns$.

h Argentine, Belgian, and U.S. infants weighed more than Japanese and Kenyan infants at birth, and Argentine and U.S. infants weighed more than Italian infants at birth, $F(10, 665) = 5.71, p < .001, \eta^2 p = .08$.

Table 2
Descriptive statistics and correlations between maternal and infant rates of vocalization

	Rates per hour						
	<i>n</i>	Maternal vocalization			Infant vocalization		
		<i>M</i>	<i>SD</i>		<i>M</i>	<i>SD</i>	<i>r</i>
Argentina	99	248.56 _{abc}	120.54		139.26 _{abc}	60.45	.20*
Belgium	100	280.44 _{abc}	137.32		141.96 _{abc}	74.25	-.15
Brazil	58	200.54 _{abcde}	89.51		106.78 _{de}	49.92	.35**
Cameroon	29	80.53 _d	58.36		115.26 _{abc}	45.44	.28
France	49	326.15 _{abcef}	114.52		185.00 _d	68.09	-.09
Israel	30	252.29 _{abc}	99.80		171.25 _{bcd}	58.80	-.03
Italy	92	289.79 _{cf}	131.13		172.28 _{cd}	68.00	.04
Japan	49	246.29 _{abc}	124.17		138.16 _{abcd}	72.63	.11
Kenya	26	110.20 _{de}	101.10		196.27 _{bcd}	61.19	-.15
South Korea	52	376.07 _f	105.36		75.36 _e	50.34	.17
United States	100	260.35 _{ab}	112.98		143.98 _{abc}	68.85	.11
Total	684	260.89	131.49		142.40	70.36	.03

Note. Descriptive statistics are based on untransformed variables, but statistical tests were performed on transformed variables. Community means that do not share subscripts within columns differed significantly ($p < .025$) in Bonferroni post-hoc tests. Correlations are one-tailed.

* $p < .05$.

** $p < .01$.

Table 3
Descriptive statistics and correlations between maternal and infant vocal contingencies

	Contingencies					
	Maternal vocal responsiveness			Infant vocal responsiveness		
	<i>n</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>r</i>
Argentina	97	1.52 _{ab}	.74	1.18	.51	.35***
Belgium	99	1.22 _{acd}	.43	1.07	.51	.46***
Brazil	58	1.33 _{abcd}	.53	1.13	.49	.37** ^a
Cameroon	29	1.46 _{abcd}	.91	1.26	.69	.55***
France	49	1.24 _{abcd}	.39	1.12	.43	.74***
Israel	30	1.38 _{abcd}	.46	1.06	.38	.62***
Italy	92	1.47 _{ab}	.56	1.19	.39	.55***
Japan	49	1.45 _{abd}	.61	1.19	.40	.42**
Kenya	19	1.24 _c	.86	1.42	.61	.21
South Korea	51	1.12 _{cd}	.31	1.23	.45	.27*
United States	100	1.51 _b	.66	1.14	.44	.40***
Total	673	1.38	.59	1.16	.47	.42***

Note. Descriptive statistics are based on untransformed variables, but statistical tests were performed on transformed variables. Community means that do not share subscripts within columns differed significantly ($p < .025$) in Bonferroni post-hoc tests. There was no significant effect of community for IVR. Correlations are one-tailed.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

^a $n = 57$, excluding one influential outlier.

Table 4

Contingencies in mother-infant vocal interactions

Country	Maternal Vocal Responsiveness	Infant Vocal Responsiveness
Argentina	$t(96) = 7.36, p < .001, d = .75$	$t(96) = 2.57, p = .05, d = .26$
Belgium	$t(98) = 5.01, p < .001, d = .50$	$t(98) = 0.63, ns, d = .06$
Brazil	$t(57) = 4.47, p < .001, d = .59$	$t(57) = 1.16, ns, d = .15$
Cameroon	$t(28) = 1.68, ns, d = .31$	$t(28) = 0.84, ns, d = .16$
France	$t(48) = 4.13, p < .001, d = .59$	$t(48) = 1.41, ns, d = .20$
Israel	$t(29) = 4.25, p < .001, d = .78$	$t(29) = 0.45, ns, d = .08$
Italy	$t(91) = 9.28, p < .001, d = .97$	$t(91) = 4.44, p < .001, d = .46$
Japan	$t(48) = 4.53, p < .001, d = .65$	$t(48) = 2.69, p < .01, d = .38$
Kenya ^a	$t(17) = 1.52, ns, d = .36$	$t(17) = 2.93, p < .01, d = .69$
South Korea	$t(50) = 2.28, p < .05, d = .32$	$t(50) = 3.14, p < .01, d = .44$
United States	$t(99) = 9.03, p < .001, d = .90$	$t(99) = 2.33, p < .05, d = .23$
Total	$t(671) = 16.49, p < .001, d = .64$	$t(671) = 6.46, p < .001, d = .25$

Note. One sample *t*-tests compared the mean OR to the transformed equivalent of 1.00.

^aOne influential outlier was removed for Kenya.