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Mothers' and Infants' Responses to their Partners' Spontaneous Action and Vocal/Verbal Imitation

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Abstract

Twenty mother-infant dyads (10 boys, 10 girls) were videotaped longitudinally at ages 10, 13, 17, and 21 months during in-home free play and bath sessions. Mothers' and infants' responses to their partners' naturally occurring action and vocal/verbal imitations were described, and relations to infants' imitation rates and vocabularies were examined. Mothers' response rates were consistently high and unrelated to infants' imitation rates. As early as 10 months, infants responded to the great majority of maternal imitations, especially action imitations, often with actions. Infants' return imitations to action matching indicated increasing awareness of being imitated. Infants' responses to mothers' vocal/verbal imitation were associated with their later vocabulary levels. Children who would be more lexically advanced at 17 and/or 21 months provided more social responses at 10 months, more socially responsive actions and return verbal imitations at 13 months, and more non-imitative socially responsive words at 17 and 21 months.

Keywords

imitation; mother-infant interaction; vocabulary; responses to imitation

Infants' imitation has been proposed as a significant contributor to their cognitive and language development. Studies have found considerable variation in children's rates of elicited imitation during experimental tasks (e.g., Heimann, Strid, Smith, Tjus, Ulvund, & Meltzoff, 2006) as well as in their rates of spontaneous imitation, or "matching behavior" (Uzgiris, Benson, & Vasek, 1983, p. 1), occurring during natural dyadic interactions without direct elicitation (Hwang, & Windsor, 1999; Masur & Rodemaker, 1999; Snow, 1989). Such individual differences in vocal/verbal imitation rate are also associated with consequences for vocabulary acquisition, a critical measure of language development and a predictor of early literacy (Bornstein, Tamis-LeMonda, & Haynes, 1999). Several investigations have now demonstrated that infants who produce more vocal/verbal imitation during the second year have larger lexicons later on (Bates, Bretherton, & Snyder, 1988; Masur, 1995; Masur & Eichorst, 2002; Snow, 1989). Thus, factors that might influence children's imitation rates deserve investigation.

One factor that merits examination is the kind of response children receive from their mothers after their imitations. Although the frequencies and characteristics of children's initial

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spontaneous imitations of their mothers' behaviors have been described (Masur, 1987; Masur & Rodemaker, 1999), there have not been any previous systematic examinations of responses by mothers to their children's imitation during naturally occurring dyadic interactions. There have, however, been a few small-scale experimental investigations, with only 3 or 4 participants, demonstrating that adults' responsive praise can produce increased rates of vocal and action imitation in normal infants aged 1;0 to 1;2 and in young children with autism aged 2;11 to 4;5 (Poulson, Kyparissos, Andreatos, Kymissis, & Parnes, 2002; Young, Krantz, McClannahan, & Poulson, 1994). Whether mothers praise their typically developing infants' vocal/verbal or action imitations during natural interactions and whether praise, or any other maternal response, is related to children's imitativeness have not before been investigated. One goal of the present study was to describe the variety of maternal responses to infant imitation and to consider their associations with children's rates of vocal/verbal and action imitation.

Two other findings raise the possibility of another maternal response which might be related to children's imitation, especially in the vocal domain—return imitation. First, in a small cross-sectional sample of dyads with children aged 10 to 14 months, Masur (1987) found that mothers were more likely to follow their infants' vocal/verbal imitations than their action imitations with a repetition of the imitation, although the reverse held for infants. Second, mothers' rates of initial verbal, but not action, matching were highly related to their children's rates at 13, 17, and 21 months of age (Masur & Rodemaker, 1999). Therefore, the present study addressed whether mothers' return imitations, or other kinds of maternal responses, are indeed associated with greater rates of vocal/verbal or action matching by their children.

Not only children's, but also mothers', vocal and/or verbal imitation is predictive of language development, both for children who are typically developing (Masur, Flynn, & Eichorst, 2005; Tamis-LeMonda, Bornstein, & Baumwell, 2001) and for those with language delays (Girolametto, Weitzman, Wiigs, & Pearce, 1999). For example, mothers' higher rates of vocal/verbal imitation at 13 months are associated with children's more rapid acquisition of 50-word lexicons and early combinatorial speech (Tamis-LeMonda et al., 2001). Furthermore, mothers' greater imitation of their children's words at 13 months is associated with larger vocabularies by their children at 17 months even when maternal utterance frequencies and children's initial vocabulary levels are statistically controlled (Masur et al., 2005). Although these findings are correlational, they lend support to the proposition that maternal verbal imitation may facilitate children's linguistic growth.

If maternal imitation is indeed beneficial, it would be important to investigate the mechanism of influence. One possibility is that children's responses to mothers' matching behaviors promote development, perhaps by providing an opportunity for further practice if children also produce repetitions of their mothers' vocal/verbal imitations. Tracing developmental trends in children's responses to naturally occurring maternal action and vocal/verbal imitation and examining relations between such responses and children's vocabulary levels should provide insight on this issue.

Another possibility is that maternal repetition highlights and brings to the forefront the children's own productions, increasing their attention to and awareness of their own behavior (Masur, 1987; Masur & Rodemaker, 1999; Uzgiris, Vasek, & Benson, 1984). If so, we might expect to see reactions by infants that reveal their developing awareness of having been imitated by a social partner—their "imitation recognition" (Meltzoff, 1996; 2002). Meltzoff and Gopnik (1993) have proposed that imitation recognition aids children in understanding that others are and can have mental states "like me" and serves as a foundation for children's development of a coherent theory of mind by 4 or 5 years of age. Meltzoff (1996) cited increased looking, smiling, and vocalizing at an imitator as evidence that infants recognize being imitated at very young ages. Nadel (2002b), however, posited a developmental progression from responding

socially to repeating the imitations of others at about one year of age as marking infants' growth toward imitation recognition. She emphasized the need for further investigations of infants' behaviors following imitation to understand how children's recognition of being imitated develops over time.

Although no previous study has examined reactions of children at various ages to having their behaviors imitated in natural contexts in their homes, there is evidence that infants respond to being imitated during experimental sessions. First, there are a number of studies showing that children with autism or other disabilities display appropriate socially oriented behaviors more often after than before adult imitation (e.g., Dawson & Galpert, 1990; Field, Field, Sanders, & Nadel, 2001). But those studies did not examine children's specific contingent responses immediately following the partner's imitation.

More relevant are studies providing evidence that infants behave differentially immediately following imitative versus contingent but non-imitative responses. Nadel (2002a) reported that 2-month-old infants looked and smiled and/or vocalized following about 50% of maternal imitations provided through closed-circuit television. Nadel, Revel, Andry, and Gaussier (2004) also reported that 3 infants followed longitudinally demonstrated social and emotional behaviors from 3 to 9 months that included staring, laughing, gaze alternation between the experimenter's movements and the child's, and waiting for the experimenter's next action. However, the specific infant behaviors matched by the mothers and experimenters in these studies were not reported.

Furthermore, Meltzoff (1990) showed that infants at 14 months smiled and gazed significantly more at an experimenter who imitated the child's actions than at an experimenter who performed different actions in a non-imitative, but still contingent, manner. Some infants were also reported to repeat the imitated behaviors with modifications, as if to check whether the stranger was indeed copying them. However, Meltzoff's study employed an experimenter who copied virtually every child action, rather than the children's own mothers who typically match one or two behaviors per minute during natural interactions (Masur & Rodemaker, 1999). Although such experimental findings show what infants do in imitatively intense situations, it is also important to discover what infants do under normal circumstances. The nature and developmental course of children's reactions to their mothers' spontaneous action versus vocal/verbal imitation during natural interactions, including a possible shift at the end of the first year from social responses to return imitation, remain to be determined.

Therefore, the present study is the first examination of mothers' and infants' responses to their partners' imitation during common naturally occurring dyadic interactions in their own homes from the end of the first year to the end of the second year, a period of dynamic language growth. In a longitudinal sample in which maternal and child imitative behaviors had previously been coded, this study investigates developmental changes in the responses of the mothers and infants to their partners' action and vocal/verbal matching. In addition, it examines infants' responses as a possible indicator of their growing capacity for imitation recognition. Furthermore, the questions of whether mothers' responses are related to their children's imitation rates and whether infants' patterns of response are associated with their rates of vocabulary acquisition are addressed.

Method

Participants

Videotapes of interactions by 20 mother-infant dyads (10 boys and 10 girls, 6 of each firstborn) from an existing longitudinal dataset were coded and analyzed for the first time for mothers' and infants' responses to their partners' imitation. The dyads had been recruited through

published birth announcements for a longitudinal, naturalistic study of normal infant development. The families—19 European American, 1 African American, all with English as the native language—lived in small towns, rural areas, and suburban communities surrounding a large mid-western state university. The videotapes were made during home visits that took place when the infants were 10 ($M = 10$ months, 14 days), 13 ($M = 13$ months, 15 days), 17 ($M = 17$ months, 19 days), and 21 ($M = 21$ months, 18 days) months old; an additional visit, not analyzed here, occurred about a week later. Seventeen of the dyads were observed at all four ages, and three (1 boy and 2 girls) joined the study at 13 months as replacements for participants who had moved away or declined to continue. All infants appeared healthy and normally developing.

Procedure

Videotaping and transcribing—The videotapes recorded home visits of dyadic interactions in two naturalistic contexts, free play with toys and bathtime. Dyads also participated in an additional activity not used in the current analyses. A maternal interview, including questions about the children's vocabularies (see *Vocabulary scoring*, below), was conducted at the end of the visit. Free play and bathtime, a typical unstructured interaction and a routine caretaking task, were chosen as natural, frequently occurring, and enjoyable activities for both participants. Employing two different activities, both of which included toys, was designed to increase interactive time and behavioral frequency, while minimizing children's boredom or restlessness.

The two sessions lasted an average of 14.14 min ($SD = 1.97$) for play and 13.78 min ($SD = 1.8$) minutes for bathtime, and their order was counterbalanced across children, with free play occurring either first or second and bathtime occurring either first or third. Mothers were instructed to interact with their children as they normally would during bathtime and when they had 10 to 15 min of free time to play with toys. The same sets of free play and bath toys were used at each visit. The toy sets were chosen to provide the kinds of materials available in many households and to allow a wide developmental range in play, from simple exploration to symbolic pretence (Belsky & Most, 1981). The free play set consisted of a set of stacking boxes with manipulative bottoms and a chick, blocks with a shape-sorter canister, a stuffed animal, a small blanket, a xylophone drum with mallet, a ball, and a set of plates, cups, forks, and a pitcher. The bath toy set included stacking rings and ring holder, two ducks, a barge, a boat with a sailor, stacking boxes with various holes, a canister, and a washcloth.

While videotaping the sessions, researchers attempted to be as unobtrusive as possible and to minimize interactions with the participants during the recording sessions. Videotapes were later transcribed by observers working in pairs who recorded the vocalizations, words, and actions of mothers and children. Both observers had to agree in order for behaviors to be recorded. Utterance boundaries were determined by intonation contours and pauses; unintelligible utterances and false starts were omitted.

Imitation scoring—As part of a previous study, all episodes of imitation by either mothers or infants, starting with the modeled behavior and ending with the last imitation of that behavior, had been identified and categorized and marked on the transcripts of the free play and bath sessions. Imitative episodes were categorized according to the modeled behavior as verbal, including conventional words or phrases and conventionally meaningful sound patterns, such as *uh-oh* or *mmm*; vocal, including all other sounds; actions involving objects; and actions without objects. (See Masur & Rodemaker, 1999, for a complete description.) Imitations involving actions without objects were rare and are not included in these analyses.

Vocabulary scoring—Total expressive vocabulary scores for the children at ages 17 and 21 months were available from a previous study (Masur et al., 2005). Lexicons had been determined by combining information from 2 sources. The first was a maternal interview employing the Words, Sounds, and Actions Checklist. The Checklist, in addition to other items, listed common nouns in 6 categories (food; clothing; household items; body parts; toys and vehicles; and animal names) and non-nouns in 5 categories (actions and requests; personal-social and conventional vocalizations; modifiers; activities, games, and animal noises; and pronouns and functors). As part of the interview, for each category, mothers were asked to identify the listed words and to provide additional words not listed that their children produced spontaneously; words comprehended but not produced were also noted but not included in productive vocabulary counts. Masur and Eichorst (2002) established that children's expressive vocabulary scores on the Checklist were comparable to those reported by other researchers using various maternal report instruments.

Vocabulary scores from the maternal interview were supplemented with information from the second source, the children's productions during the free play and bath sessions. All non-imitative words and conventional vocalizations (e.g., *uh-oh*, *mmm*) were identified on the transcripts of the videotapes, and the videotapes were viewed again by a graduate student in speech/language pathology to ensure that no productions had been overlooked. All words and conventional vocalizations produced by the children during the sessions that had not been reported by their mothers were added to the Checklist counts to produce their total expressive vocabulary scores. (See Masur et al., 2005, for a complete report).

Coding Responses to Imitation

Using the existing transcripts and videotapes with superimposed time codes, one of two researchers located and viewed each episode of vocal, verbal, and object-related action imitation. Employing a coding manual with a flow chart and decision tree (available from the authors) for categorizing mothers' and children's responses, the researcher independently observed and coded the first behavior or set of behaviors following the first imitation in each episode on written data sheets. Responses to imitation during all free play sessions were coded first, and responses during the bath sessions later. Transcripts were coded in a random order, with the constraint that a dyad's behaviors at different ages were never coded successively. For these analyses, responses to vocal and verbal imitations were combined to increase frequencies at younger ages.

The first behavior, or set of behaviors, occurring within 5 sec of the offset of the partner's imitation was coded as one of the 3 following mutually exclusive broad categories: No Reaction to the imitator, Return Imitation, or Social Responses. These broad categories were designed to approximately parallel the 3 general responses mentioned by current theories of imitation and/or imitation recognition (e.g., Meltzoff, 1996; Nadel, 2002b). In order to be considered a response to being imitated, researchers had to judge the behaviors as meeting standards of attention and contingency outlined in Masur (1987). All responses showed evidence that the imitation had been seen or heard and that the response occurred in reply to it, rather than coincidentally.

1. **No Reaction**—included behaviors that followed imitation but did not meet Masur's criteria for attention and contingency. Behaviors in this category included continuation of an ongoing activity with no indication of noticing the imitation, initiation of an unrelated behavior, interruption by external factors, or no response at all. For example, if an infant stirred with the fork, the mother imitated, and the infant continued to stir with no break in the activity and no sign of being aware of the imitation, the infant's behavior would be coded as No Reaction. The rare

indeterminate behavior (less than .1% of all imitation episodes and most often due to obstructed view in the videotape) was also included here.

2. Return Imitation—included responses to the imitation containing an element of the imitated behavior. This category involved behaviors repeating the imitative act exactly or adding or deleting one or more elements. An example from the vocal/verbal domain involved the mother of a 17-month-old saying, *Where's the baby duck?*, the girl imitating, *Duck*, and the mother responding, *The baby duck*.
3. Social Response—included behaviors directed to the imitator that met criteria for a contingent response but did not contain any element of the imitation. Each Social Response was coded further with respect to 3 subcategories to describe it more specifically. The 3 subcategories were not mutually exclusive, allowing multiple coding of a Social Response consisting of behaviors completed simultaneously or in an unbroken sequence:
 - a. Socially responsive signals, including responsive smiles, laughter, vocalizations, gestures, or gaze shifts.
 - b. Socially responsive actions on objects. An example included a 17-month-old who put a fork in his mouth, pretending to eat, the mother imitating with a second fork, and the child responding by feeding his mother with a fork.
 - c. Socially responsive words. An example from the vocal/verbal domain involved a mother asking, *Can I have some more please?*, her 17-month-old daughter imitating, *More*, and the mother responding, *Delicious*.

In addition, maternal responses that included explicit verbal praise, such as *good job* or *that's right*, whether as part of an expanded Return Imitation or a Social Response, were recorded.

Coding Reliability

Reliability between the 2 independent researchers was established before full coding of all responses began. Analysis of agreement in coding the broad categories and the subcategories of Social Responses was examined for a randomly chosen sample of dyads—2 boys and 2 girls and their mothers at each age during free play sessions and 1 boy and 1 girl and their mothers at each age during bath sessions. Interrater agreement for the 3 broad categories was 95%, Cohen's kappa = .92, for classifying responses during the free play sessions and 93%, Cohen's kappa = .89, during the bath sessions. Interrater agreement for classifying the subcategories of Social Responses was 94%, Cohen's kappa = .92, during free play sessions and 97%, Cohen's kappa = .96, during bath sessions. All discrepancies were resolved through discussions.

Analyses

Mothers' and infants' response scores utilized in the analyses are percentages of imitations followed by behaviors in each of the 3 broad categories—No Reaction, Return Imitation, and Social Responses—and percentages of Social Responses that included socially responsive signals, actions, and/or words. Analyses employing percentages of responses controlled for individual differences in partners' imitation rates; repeated measures analyses of variance (ANOVAs) utilizing frequencies yielded a very similar pattern of results. Assumptions regarding homogeneity of covariances were tested for the repeated-measures analyses by Mauchly's test of sphericity; degrees of freedom in the *F* test were adjusted by the Greenhouse-Geisser epsilon in the few cases where assumptions were violated (Howell, 1987). Missing scores, such as those for participants not present at the 10-month measurement, were replaced by mean age group scores in the repeated-measures ANOVAs. Significant main effects from repeated-measures ANOVAs were followed by post-hoc tests of pair-wise comparisons among means employing Bonferroni corrections. In the correlations, missing participants were

omitted from the analyses. Because preliminary analyses showed no main effects or interactions involving gender, this factor was not included in subsequent analyses. In addition, because patterns were similar in the bath and play contexts, responses to imitation in the bath and play sessions were combined for subsequent analyses.

Results

Mothers' and Infants' Responses to Action and Vocal/Verbal Imitation

Initial analysis—The initial analysis examined developmental changes in mothers' and infants' percentages of responses to object-related action versus vocal/verbal imitation in each of the 3 broad categories, No Reaction, Return Imitation, and Social Response. Mothers' and infants' scores were analyzed via a 2 (Partner) $\times$ 4 (Age) $\times$ 2 (Imitation type) $\times$ 3 (Response category) repeated measures ANOVA. The analysis yielded the 4-way interaction of partner, age, imitation type, and response category, $F(6, 114) = 4.69, p < .001$, as well as several other interactions; means are presented in Table 1. To interpret this interaction, follow-up age by imitation category by response category repeated measures ANOVAs were conducted separately for mothers and children.

Analysis of mothers' responses—The analysis for mothers revealed a main effect of response category, $F(1, 28) = 94.49, p < .0001$. Overall, mothers almost always responded to their children's imitations, providing No Reaction infrequently ($M = 11\%$). In general, mothers responded more often with Social Responses ($M = 58\%$) than with Return Imitations ($M = 30\%$; $ps < .001$ for all pair-wise Bonferroni comparisons of means). However, the kinds of responses they provided also varied by imitation category, $F(2, 38) = 40.57, p < .0001$, by age, $F(3, 75) = 4.04, p = .01$, and by both imitation category and age, $F(3, 75) = 4.70, p < .005$.

To analyze the 3-way interaction, age by response category repeated-measures ANOVAs were conducted for action and vocal/verbal imitation separately. The analysis for action imitation yielded only a main effect of response category, $F(2, 38) = 124.99, p < .0001$; see Table 1. At every age, mothers provided much higher rates of Social Responses to their children's action matching ($ps < .001$) than either No Reaction or Return Imitation, which did not differ significantly.

The comparable analysis for maternal responses to vocal/verbal imitation also produced a significant main effect for response category, $F(2, 38) = 34.11, p < .001$, with mothers' providing No Reaction rarely ($M = 10\%$) and significantly less often ($ps < .001$) than Return Imitations or Social Responses, which did not differ significantly. However, there was also an age by response category interaction, $F(3, 62) = 6.15, p = .001$; see Table 1. Tests of simple main effects found a significant effect for response category at each age, $F_s(2, 38) \geq 11.62, ps < .001$. Pairwise comparisons at each age showed significantly lower rates of No Reaction than either Return Imitation or Social Responses at all times ($ps < .001$). However, mothers' responses changed as the children developed. At 10 months, mothers' responses to their infants' vocal/verbal imitation paralleled their responses to action imitation at the same age, with much higher rates of Social Responses than Return Imitation ($p < .001$), but the difference between these two categories was not significant at any age during the second year.

To compare maternal responses to their children's action versus vocal/verbal imitation more directly, separate follow-up age by imitation type repeated-measures ANOVAs were also conducted for each response category. Mothers' rates of No Reaction were similarly low to both action and vocal/verbal imitation and did not change significantly over time. However, maternal Social Responses and Return Imitations exhibited contrasting patterns. Mothers' rates of Social Responses and Return Imitation to their children's vocal/verbal and action imitation diverged over time in opposite ways, $F_s(3, 57) \geq 4.65, ps \leq .006$. Although mothers provided

equivalently high rates of Social Responses and low rates of Return Imitation to both infants' action and vocal/verbal imitation at 10 months, they provided more Social Responses to action than to vocal/verbal imitation and higher rates of Return Imitation to vocal/verbal than to action matching throughout the second year ($ps \leq .001$).

Analysis of children's responses—The analysis for children also revealed a main effect for response category, $F(2, 38) = 21.88, p < .0001$. On average, infants responded to the great majority of their mothers' imitations at all ages, showing No Reaction to less than one quarter of all instances ($M = 23\%$). Even at 10 months of age, 15 of the 16 children whose mothers imitated an action or vocal/verbal behavior responded at least once to an imitation (10 out of 13 to vocal/verbal imitation and 13 out of 13 to action imitation). Infants' overall rates of Return Imitations and Social Responses were roughly comparable overall ($Ms = 36\%$ and 41% , respectively), and both were greater than rates of No Reaction ($ps < .001$).

However, infants' responses also changed with age, $F(4, 69) = 4.19, p < .01$, and differed by imitation category, $F(2, 38) = 25.89, p < .0001$, and by both age and imitation category, $F(6, 114) = 2.27, p = .04$; see Table 1. Follow-up age by response category ANOVAs conducted separately by imitation type demonstrated that infants' pattern of responses differed in several ways from their mothers'. The analysis for infants' responses to their mothers' action imitation revealed only a main effect for response category, $F(2, 29) = 29.77, p < .0001$. In distinction to mothers' consistently low rates of Return Imitation and high rates of Social Responses, infants produced comparable rates of Return Imitation and Social Responses overall, and both were greater than rates of No Reaction ($ps < .001$). Even at 10 months, 11 of the 13 children whose mothers imitated their actions provided at least one Return Imitation, and 9 of them produced Return Imitation 50% or more of the time.

The age by response category follow-up analysis for infants' responses to vocal/verbal imitation revealed a main effect for response category, $F(2, 38) = 14.62, p < .0001$, and an age by response category interaction, $F(3, 63) = 7.18, p = .0003$. Tests of simple main effects of response category at each age were significant at ages 13, 17, and 21 months, $F_s(2, 38) \geq 5.91, p < .01$; see Table 1. In contrast to mothers' shift from lower rates of Return Imitation than Social Responses at 10 months to comparable rates of the two responses over time, infants' rates of Return Imitation and Social Responses did not differ significantly at the start. At 10 months, 9 of the 13 children whose mothers imitated their vocal/verbal behaviors produced at least one Return Imitation, with rates of vocal repetition varying from 25% to 100%. However, infants' rates of Return Imitation declined over time, while their Social Responses rose strongly with age. At 13, 17, and 21 months, infants provided significantly more Social Responses than Return Imitations to their mothers' vocal/verbal imitation ($ps \leq .003$). Infants' rates of No Reaction differed from their rates of other responses only at 17 months, when they were higher than rates of Return Imitation, and at 21 months, when they were lower than rates of Social Responses ($ps < .03$).

Additional age by imitation type follow-up analyses comparing children's responses for each response category also revealed contrasts to mothers' behavior. Unlike mothers, whose rates of No Reaction were low to both kinds of imitation, infants failed to respond much more often overall to vocal/verbal ($M = 32\%$) than to action imitation ($M = 13\%$), $F(1, 19) = 44.89, p < .0001$. However, that difference varied by age, $F(3, 57) = 4.04, p = .01$, with higher rates of No Reaction to their mothers' vocal/verbal than action imitation at 10, 13, and 17 months, $F_s(1, 19) \geq 13.17, ps < .01$, but not at 21 months when infants' rate of No Reaction to vocal/verbal imitation declined to a level similar to that for action imitation. Although mothers' provided more Social Responses to their children's action than vocal/verbal matching throughout the second year, Infants' production of Social Responses changed with age, $F(3, 57) = 3.20, p = .03$, differing only at 21 months when they provided more Social Responses to their mothers'

vocal/verbal than to her action imitation ($p = .004$). And unlike mothers' production of greater Return Imitation to Infants' vocal/verbal than action matching, infants were consistently more likely to supply Return Imitation to their mothers' action than vocal/verbal imitation, $F(1, 19) = 38.06, p < .0001$.

Mothers' and Infants' Social Responses to their Partners' Vocal/Verbal and Action Imitation

The nature of the Social Responses mothers and infants produced was examined via a 2 (Partner) $\times$ 4 (Age) $\times$ 2 (Imitation type) $\times$ 3 (Social Response category: signals vs. actions vs. words) repeated measures analysis. The analysis revealed that the kinds of Social Responses participants provided varied by imitation category, $F(2, 38) = 3.47, p = .04$. Tests of simple main effects disclosed that social signals and words were produced significantly more often as responses to vocal/verbal than to action imitation, $F_s(1, 19) \geq 4.27, p \leq .05$, although provision of socially responsive actions did not differ by imitation type.

The analysis also found that, regardless of imitation category, Social Responses differed by partner, $F(2, 38) = 301.51, p < .0001$, by age, $F(6, 114) = 3.72, p = .002$, and by partner and age, $F(6, 114) = 3.79, p = .002$; see Table 2. Separate follow-up age by response category ANOVAs, averaged across imitation types, for each partner found that mothers' provision of different kinds of Social Responses remained relatively consistent over time. Pairwise comparisons of mothers' categories of Social Responses showed that mothers provided socially responsive words significantly more often than either social signals or social actions, ($ps < .001$), which did not differ. Despite a significant age by response category interaction, $F(6, 114) = 2.26, p = .04$, pairwise comparisons at each age found the same pattern. On average, mothers' Social Responses to either vocal/verbal or action imitation included social signals or actions only about one-quarter of the time. However, their Social Responses included words overwhelmingly ($M = 82\%$) and nearly uniformly, with 68% or more of mothers providing socially responsive words two-thirds or more of the time at each age.

The parallel age by response category follow-up analysis for infants' Social Responses revealed a pattern sharply contrasting with their mothers'. Infants' Social Responses differed by age, $F(3, 57) = 4.14, p = .01$, and by response category, $F(2, 38) = 194.43, p < .001$. Overall, infants were much more likely to include social actions and social signals than social words ($ps < .001$). Furthermore, although there was an interaction of age and response category, $F(3, 60) = 5.06, p = .003$, pairwise comparisons at each age showed that Infants' provision of both socially responsive actions and signals surpassed their production of socially responsive words at every age ($ps \leq .002$).

On average, Infants' Social Responses, which constituted about 42% of their reactions to all maternal imitation, included social actions 60% and social signals 56% of the time. Thus, about one-quarter of all mothers' imitations received socially responsive actions and/or socially responsive signals from their children. However, no socially responsive words were present in infants' Social Responses until 17 months, when 8 children provided at least one responsive word to their mothers' vocal/verbal imitation and 4 of them also provided at least one responsive word to action matching. At 21 months, 16 out of 20 children included words in their Social Responses to their mothers' vocal/verbal imitation, and 4 of them also did so to action imitation. The difference in infants' provision of words to vocal/verbal versus action matching at 21 months was significant by a McNemar Test, $p < .002$, 2-tailed.

Relations between Mothers' Responses to Imitation and Infants' Imitation Rates

These analyses investigated whether infant's imitation rates were related to the kinds of responses their mothers provided. Correlations between mothers' percentages of No Reaction, Return Imitation, and Social Responses and their children's action and vocal/verbal imitation

rates, omitting vocal/verbal imitation at 10 months, were calculated. In addition, for those mothers who produced Social Responses, relations between the proportions of their Social Responses that included signals, actions, and words and their children's imitation rates were examined. There were no significant relations involving action imitation and only one involving vocal/verbal imitation. At 13 months, mothers provided higher proportions of Social Responses that contained actions to children who imitated more vocal/verbal behaviors, $r(8) = .79, p < .01$.

Mothers' Praise of Imitation and its Relation to Infants' Imitation Rates

Analyses in this section examined maternal responses involving praise and relations between mothers' praise responses and children's frequencies of action and vocal/verbal imitation. A 4 (Age) $\times$ 2 (Imitation type) repeated measures ANOVA for percentages of all mothers' responses to infants' imitations that included verbal praise yielded a main effect for imitation type, $F(1, 19) = 12.43, p = .002$, and an age by imitation type interaction, $F(3, 57) = 4.36, p < .01$, indicating variation over time. Pairwise comparisons at each age showed that mothers' praise was significantly more likely to follow their children's action than vocal/verbal imitation at 13, 17, and 21 months ($M_s = 30\%$ vs. 6%, 22 vs. 11%, and 18 vs. 4%, respectively; $p_s \leq .01$). However, most mothers did not employ explicit verbal praise to young infants. The means for praise to Infants' vocal/verbal matching at 10 and 13 months are based on only 2 mothers at 10 and 13 months, on 9 mothers at 17 months, and on 7 mothers at 21 months. More mothers offered praise following children's action matching—7, 12, 12, and 13 mothers at each of the 4 ages, respectively.

To see if maternal praise was related to children's imitateness, correlations were calculated between mothers' provision of praise at each age and the action and vocal/verbal imitation rates of all children who imitated. Because praise for vocal/verbal imitation at 10 and 13 months was so rare, these correlations were not computed. Only one correlation was significant: At 21 months, mothers provided more praise to children with greater vocal/verbal imitation, $r(17) = .60, p < .01$.

Relations between Children's Responses to Imitation and their Vocabularies

Finally, because previous research has demonstrated that mothers' vocal/verbal imitation rates are predictive of children's later vocabularies (Masur et al., 2005; Tamis-LeMonda et al., 2001), correlational analyses were conducted in order to assess whether children's patterns of responses to maternal imitations were associated with their later lexicons at 17 and 21 months. Table 3 presents these correlations between children's lexicons and the percentages of all earlier responses that were No Reaction, Return Imitation, and Social Responses as well as percentages of Social Responses that contained signals, actions, and words in responses to their mothers' vocal/verbal and action imitation.

As Table 3 shows, infants' responses to their mothers' vocal/verbal imitations, even as early as 10 months, were related to their later vocabulary levels. Infants who acquired greater lexicons by 17 months were more likely to provide Social Responses to their mothers' vocal/verbal imitations at 10 months. At 13 months, infants whose Social Responses included more actions, but fewer signals, were the ones who were more lexically advanced at 17 and 21 months. In addition, infants who repeated more of their mothers' vocal/verbal imitations at 13 months also acquired greater vocabularies by 21 months. Although children's rates of Return Imitation at 13 months were not significantly correlated with their 17-month vocabularies, the mere presence of Return Imitation at 13 months was. Of the 18 children whose mothers imitated their vocal/verbal productions at 13 months, 10 children had larger lexicons by 17 months, ≥ 42 words, and 8 children had smaller lexicons at 17 months, ≤ 26 words. Nine of the 10 children who had larger lexicons by 17 months provided at least one Return Imitation at 13 months,

while only 2 of the 8 children with smaller 17-month lexicons did so ($p = .01$, 2-tailed, by Fisher's Exact Probability Test).

By 17 months, the more lexically advanced children shifted again in their responses to their mothers' vocal/verbal matching. As Table 3 shows, at 17 months, the children who had or would have greater vocabularies at 17 and 21 months were significantly less likely to provide No Reaction and significantly more likely to include words in their Social Responses to maternal vocal/verbal matching than were children who had or would have smaller vocabularies. In fact, 8 of the 11 infants with larger 17-month lexicons (≥ 42 words) included words in at least one of their Social Responses to maternal vocal/verbal imitation, while none of the 6 children with smaller lexicons (≤ 26 words) did so ($p < .01$, 2-tailed, by Fisher's Exact Probability Test). Similarly, at 21 months, the more lexically advanced children included words in their Social Responses in significantly higher proportions than less advanced children.

Unexpectedly, there were also a few significant relations or trends between infants' responses to their partners' action imitation and their lexicons. However, at 10 months, the positive relation between children's failure to respond to maternal action imitation and their subsequent 17-month vocabularies should be considered with caution since only 4 of the 13 children whose mothers imitated their actions ever failed to respond. At 17 months, the children who would be most lexically advanced by 21 months were more likely to provide Social Responses to their mothers' action imitation, but less likely to engage in Return Imitation for action matching. This may indicate less engagement in multiple rounds of repeated action matching than in vocal/verbal interaction for these children.

Discussion

Despite the recognized relation between both mothers' and infants' imitation and children's subsequent cognitive and language development (e.g., Bloom et al., 1974; Masur et al., 2005; Masur & Eichorst, 2002; Meltzoff, 1996; Tamis-LeMonda et al., 2001), knowledge about dyads' spontaneous imitative interactions is only in the beginning stages. In fact, the present study is the first systematic investigation of mothers' and infants' responses to each others' imitation during naturally occurring interactions. It charts the developmental course of both mothers' and infants' reactions to their partners' action and vocal/verbal matching from the end of the first to the end of the second year of life, a period of significant growth in language. Because infants' greater imitation, especially greater vocal/verbal imitation, is predictive of subsequent vocabularies, it examined whether particular maternal responses might be related to infants' imitation rates. And because mothers' greater vocal/verbal matching is also associated with children's lexical growth, it investigated whether children's responses might also predict their vocabulary acquisition.

The analyses of the developmental course of responses demonstrated that from the end of the first year, both mothers and infants responded to the overwhelming majority of their partners' imitations. Mothers responded virtually always and comparably to infants' matching of actions on objects and vocal/verbal behaviors, on average between 86% and 94% of the time at each age. Children responded just as often to maternal imitation of object-related actions, 87% of the time on average, but less so to vocal/verbal imitation, where rates of No Reaction ranged from 20% to 39% at each age. Although only a controlled experimental study like Meltzoff's (1990) with 14-month-olds can establish whether reactions to imitation exceed those to equivalent contingent but non-imitative responses, the results here support the position that infants even younger than Meltzoff's are sensitive to maternal matching of their actions on objects, suggesting development in children's recognition of being imitated (Meltzoff & Gopnik, 1993). At 10 months, every one of the infants whose mothers imitated their actions on objects responded to at least one of the imitations. Overall, 90% of maternal matching

behaviors received responses, with 60% eliciting Return Imitations and 30% evoking Social Responses. Although Nadel (2002b) posited that infants would shift from responding socially to repeating maternal imitations at about 12 months, these infants returned action behaviors more often than they responded socially even at 10 months. Infants' generally lower rates of response to maternal vocal/verbal matching may indicate greater sensitivity to behaviors in the action than the vocal domain at the end of the first year. The lexically advanced infants, however, were highly sensitive to vocal matching by 17 months as evidenced by their lower rates of No Reaction. Further research to trace and clarify the developmental progression of responses to mothers' naturally occurring vocal and action imitations by infants younger than those in the present sample would be valuable.

Although both infants and mothers responded to the overwhelming majority of both action and vocal/verbal imitation, the ways they responded to partners' behaviors in the two domains differed sharply. Mothers provided Return Imitations more readily to infants' vocal/verbal than action imitation and higher rates of Social Responses to action than vocal/verbal matching. Infants, however, were more likely to provide Return Imitation to their mothers' action than vocal/verbal imitation, while their rates of Social Responses were similar or slightly higher to vocal/verbal than action matching. This pattern corroborates Masur's (1987) report of greater maternal repetition to vocal than action imitation and greater infant repetition to action than vocal matching, indicating an emphasis on vocal/verbal behaviors by mothers and on action behaviors by children.

But this pattern of responding also extends Masur's (1987) earlier study by pointing up the role of Social Responses, which have not previously been examined in naturally occurring imitative episodes, in the interchange. These responses acknowledging the imitation and the imitator can be quite varied, and mothers and infants employed them differently. Mothers incorporated words into the vast majority of their Social Responses to both kinds of imitation but produced social signals and social actions only about a quarter of the time, reinforcing their vocal/verbal focus. Thus, even infants' action imitation evoked verbal responses. On average 83% of all infants' vocal/verbal matching received a vocal/verbal response, including both Return Imitations (44% of all responses) and Social Responses containing words (85% of the 46% of responses that were Social) are added together. This represents considerable language stimulation, especially to the more imitative infants. Whether this stimulation is instrumental in children's language acquisition remains unknown, but the semantic, morphological, and syntactic characteristics of these linguistic inputs merit future detailed examination.

Mothers were also remarkably similar in their provision of Social Responses to their children's action and vocal/verbal imitation. For example, at 21 months all but 2 of 20 mothers produced words 67% or more of the time in their Social Responses to children's action imitation, and all but 2 of 19 did so 75% or more of the time in their Social Responses to children's vocal/verbal matching. Although associations have been reported between maternal and infant verbal matching (Folger & Chapman, 1978; Masur & Rodemaker, 1999), the near uniformity in mothers' responsive behavior may account for the absence of almost all significant correlations between mothers' patterns of responding and children's imitation rates. Even the less imitative infants were receiving rates of verbal replies to both their action and vocal/verbal matching behaviors as high as those supplied to more imitative infants. However, infants' imitativeness obviously affected the frequency of such potentially beneficial maternal replies, which may be a factor in accounting for associations with children's later language (Bornstein et al., 1999; Masur & Eichorst, 2002).

It was surprising to note that one kind of maternal verbal reply, explicit praise, did not appear to function in the same way in these natural interactions as in experimental settings. Although verbal praise produces higher rates of vocal and action matching under controlled conditions

(Poulson et al., 2002; Young et al., 1994), it was associated with imitation rates in only one of six correlational analyses. Maternal praise was positively related to infants' vocal/verbal matching rates at 21 months; the direction of effect, if any, however, cannot be determined. In the experimental studies, praise was contrasted with no response at all. In natural interactions, with virtually every infant imitation receiving a response, and almost always a verbal one, perhaps the verbal content of the response is of less consequence than its presence.

Despite infrequent association between mothers' praise and children's imitateness, however, the analysis of the incidence of praise revealed interesting results. Overall, mothers' rates of praise were not very high, especially to vocal/verbal imitation where about one in every 10 responses included praise. Only at 17 and 21 months, when infants' vocal/verbal imitation and their lexical acquisition was burgeoning, did a substantial proportion of mothers include any verbal praise in their responses to vocal/verbal matching. Mothers' responses containing praise were about twice as frequent to their infants' object-related action imitation, however; and many more mothers utilized praise. A more detailed analysis of the kinds of infant action imitations receiving praise at each age would be worthwhile. It would be particularly valuable to see if more complex or symbolic play acts are the ones eliciting praise.

In contrast to mothers' great consistency and near uniformity in focus on verbal replies, infants demonstrated considerable reliance on responding with actions on objects. On average, infants responded to 74% of their mothers' action imitations with either imitative (48%) or non-imitative social actions (26%). Even their replies to maternal vocal/verbal matching included action about a quarter of the time. Several of these instances showed that vocal/verbal imitation occurred in the midst of dyads' physical or symbolic play with toys. For example, one child picked up a ball and said, "ball." After her mother imitated the word, the child threw the ball toward her. In another case, a child reached for the toy pitcher and said, "milk." After her mother replied, "Oh, you're gonna put milk in there," the child pretended to pour. Thus, at a time when children have few verbal responses available to them, these action responses may help extend playful interchanges, perhaps providing opportunities for enriched interactions supportive of language growth. This possibility deserves closer investigation since infants with Social Responses at 13 months containing more social actions had larger subsequent vocabularies.

Socially responsive signals were also relatively common. Infants produced them in response to about 20% of mothers' action and 27% of mothers' vocal/verbal imitations. Although not advancing play in the same way as social actions, these responsive signals of gaze, smile, laughter, and/or gesture acknowledge the social partner, and similar behaviors have been noted in younger children as well (e.g., Nadel, 2002a). They may also serve to indicate joint attention, and sustain or reinforce the interactive interchange, although their negative relation at 13 months to children's later lexicons indicate that they are less advanced than socially responsive actions.

Responsive words, the most advanced kind of response available to the children, may have the greatest implications for children's later language skills. Infants' responsive words included both Return Imitations to mothers' vocal/verbal imitation and social non-imitative words in response to maternal action or vocal/verbal matching, and a developmental progression appears to link the two. As early as 13 months, infants' Return Imitations to mothers' vocal/verbal imitation—both presence and rate—were predictive of their later vocabulary levels. These repetitions may have provided opportunities for further verbal practice. From 17 months onward, it was children's use of socially responsive, not imitative, words, however, that was associated with concurrent and subsequent lexical skill. These responsive words reflect, and may contribute to, growing linguistic competence. In one example a 17-month-old said, "Cup." When her mother provided an expanded imitation, "Cup; you want that cup?," the child

responded, “Water.” The child’s response specifies her desire or intention. It is possible that mothers’ intervening imitation serves a scaffolding function for such successive single-word utterances to bridge the transition to more complex constructions, like *cup of water*. A future investigation of the nature of infants’ responsive words in imitative interchanges and their similarities to and differences from spontaneous productions in discourse is planned.

In sum, the pattern of relations between children’s responses to maternal vocal/verbal imitation and their later lexicons across the period from the end of the first to the end of the second year of life reveals a developmental trajectory. Those children whose language would accelerate most during the second year were already behaving differently at the end of the first year of life, long before they were truly verbal. Although maternal vocal/verbal imitation at that age was infrequent, they were the ones more likely to acknowledge it with any Social Response. By the beginning of the second year, those infants who would later be at the forefront were more likely to provide Social Responses containing actions, while the others were more likely to produce socially responsive signals. At the same time, infants in the vanguard were more often producing Return Imitations to their mothers’ vocal/verbal matching than were the others. By the middle of the second year, the more advanced children were highly responsive, rarely failing to react to maternal matching. And they shifted from repetition alone to incorporating socially responsive but non-imitative words into their replies. Some of them also began providing socially responsive words to maternal action imitation as well. These responsive words involve additional and non-repetitive turns by children to the discourse interactions and may represent opportunities to learn and practice greater conversational competence.

From this correlational study, we cannot determine whether this changing pattern of responses to maternal imitations exerted a causal influence on children’s later language ability or was a consequence of it or of a related developmental process. But even as an index rather than an influence, such a sequence of infants’ responses to their mothers’ imitations may be informative for researchers and practitioners evaluating developmental progress. Although this descriptive study represents only one step toward understanding connections between imitative interchanges and children’s language development, we believe such issues deserve increased attention.

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Table 1
Mean Percentages (and SDs) of Mothers' and Children's Responses to their Partners' Action and Vocal/Verbal Imitation

Children's Ages	No Reaction	Mothers' Responses		Social Responses	No Reaction	Children's Responses		Social Responses
		Return Imitation				Return Imitation		
Responses to Action Imitation								
10 Months	14 (13)	21 (15)		66 (18)		10 (15)	60 (30)	30 (27)
13 Months	10 (12)	20 (21)		69 (26)		12 (19)	47 (35)	40 (34)
17 Months	11 (18)	9 (14)		80 (21)		11 (24)	44 (32)	45 (32)
21 Months	13 (19)	17 (19)		70 (22)		19 (21)	40 (27)	41 (26)
<i>M</i>	12 _a	17 _a		71 _b		13 _a	48 _b	39 _b
Responses to Vocal/Verbal Imitation								
10 Months	14 _a (21)	21 _b (22)		64 _c (27)		39(31)	41 (34)	20 (19)
13 Months	6 _a (11)	57 _b (33)		36 _b (32)		33 _{ab} (25)	18 _a (18)	49 _b (25)
17 Months	7 _a (10)	46 _b (24)		47 _b (23)		38 _b (22)	18 _a (13)	44 _b (17)
21 Months	12 _a (18)	52 _b (22)		36 _b (20)		20 _a (13)	18 _a (13)	62 _b (14)
<i>M</i>	10 _a	44 _b		46 _b		32 _a	24 _a	44 _b
Overall <i>M</i>	11 _a	30 _b		58 _c		23 _a	36 _b	41 _b

Note. For mothers and children separately, significant differences among *M* responses to action and to vocal/verbal imitation are indicated by differences in subscripts; see text for values.

Table 2
Mean Percentages of Mothers' and Children's Social Responses Containing Social Signals, Actions, and/or Words

Children's Ages	Mothers' Social Responses		Children's Social Responses	
	Signals	Actions	Words	Words
10 Months	19 (26)	25 (31)	Social Responses to Action Imitation 78 (25) 50 (32)	62 (31)
13 Months	20 (25)	38 (35)		57 (39)
17 Months	27 (27)	28 (32)		68 (30)
21 Months	20 (22)	23 (31)		76 (32)
<i>M</i>	22	28	78	66
10 Months	20 (20)	20 (20)	Social Responses to Vocal/Verbal Imitation 100 (00) 53 (23)	64 (22)
13 Months	38 (30)	20 (22)		41 (33)
17 Months	17 (17)	45 (32)		52 (30)
21 Months	18 (16)	28 (30)		62 (20)
<i>M</i>	23	28	85	55
Overall <i>M</i>	22 _a	28 _a	82 _b	60 _a

Note. For mothers and children separately, significant differences among *M* responses to action and to vocal/verbal imitation are indicated by differences in subscripts; see text for values.

Table 3
Correlations between Children's Responses to Vocal/Verbal and Action Imitation and Children's Lexicons

Child Age at Response	No Reaction	Responses to Vocal/Verbal Imitation				Responses to Action Imitation				Subcategories of Social Responses:		
		Return Imitation	Social Response	Signals	Actions	Words	No Reaction	Return Imitation	Social Response	Signals	Actions	Words
10 Months (<i>n</i> in correlations) Lexicon at 17 Mo.	(13) -.05	(13) -.29	(13) .62*	—	—	—	(13) .67**	(13) .02	(13) -.38	—	—	—
Lexicon at 21 Mo.	-.26	-.04	.52	—	—	—	.36	.08	-.28	—	—	—
13 Months (<i>n</i> in correlations) Lexicon at 17 Mo.	(18) .00	(18) .32	(18) -.23	(16) -.71**	(16) .60*	—	(19) .24	(19) -.35	(19) .23	(14) -.28	(14) .36	—
Lexicon at 21 Mo.	-.11	.48*	-.23	-.67**	.54*	—	-.12	-.28	.36	-.05	.15	—
17 Months (<i>n</i> in correlations) Lexicon at 17 Mo.	(18) -.52*	(18) .01	(18) .67**	(17) -.25	(17) -.01	(17) .56*	(19) -.17	(19) -.31	(19) .43	(14) .48	(14) -.11	.46
Lexicon at 21 Mo.	-.56*	-.02	.74**	-.18	.20	.63**	-.05	-.49*	.52*	.36	-.14	.28
21 Months (<i>n</i> in correlations) Lexicon at 21 Mo.	(20) .27	(20) -.37	(20) .08	(20) -.24	(20) -.27	(20) .46*	(18) .06	(18) -.01	(18) -.04	(18) .21	(18) -.43	.05

Note: The numbers of children participating in the correlations are given in parentheses. Only children whose mothers imitated their behaviors are included, and only those children who provided any Social Responses are included in correlations involving subcategories of Social Responses. Correlations involving 12 or fewer children are not listed.

*
 $p \leq .05$

**
 $p \leq .01$; all 2-tailed.