

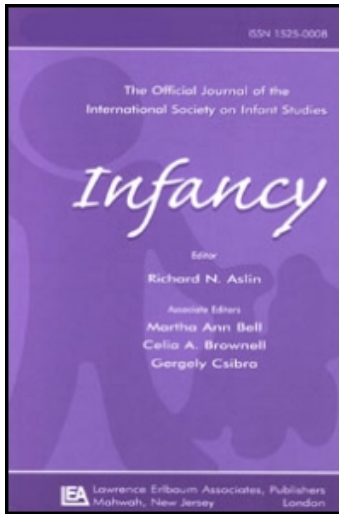
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Maternal Talk About Mental States and the Emergence of Joint Visual Attention

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Twenty-four infants were tested monthly for gaze and point following between 9 and 15 months of age and mother–infant free play sessions were also conducted at 9, 12, and 15 months (Carpenter, Nagell, & Tomasello, 1998). Using this data set, this study explored relations between maternal talk about mental states during mothers' free play with their infants and the emergence of joint visual attention in infants. Contrary to hypothesis, mothers' comments about their infants' perceptual states significantly declined after their infants began to engage in joint visual attention. Comments about other mental states did not change relative to acquisition of joint visual attention skill. We speculate that after infants begin to reliably follow gaze and points, mothers may switch the focus of their conversation from their infants' visual behavior and experiences to the object of their mutual attention.

Mothers' talk about mental states is positively correlated with their children's understanding of others' minds (Dunn, Brown, Slomkowski, Tesla, & Youngblade, 1991; Dunn & Hughes, 1998; Meins et al., 2002; Ruffman, Slade, & Crowe, 2002; Slaughter, Peterson, & Mackintosh, 2007). There are two interpretations of this well-established link. The first is that mothers choose to talk about the mind when they see that their children have acquired some explicit interest in, and knowledge about, mental states and processes. The second interpretation is that mothers' mental state talk promotes and enriches their children's understanding. It seems likely

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that both of these mechanisms operate, although there is some recent evidence to suggest that the stronger direction of causation is the second one, from mother to child (Ruffman et al., 2002; see Harris, de Rosnay, & Pons, 2005, for a brief review). One view is that mothers' talk about the mind serves, among other things, to concretize mental states through labeling and contextualization, and to highlight their subjectivity (see Astington & Baird, 2005; Peterson & Siegal, 2000; Symons, 2004).

The majority of studies on this topic have focused on the preschool period, when there are well-documented changes in children's tendencies to talk about the mind (Bartsch & Wellman, 1995) and in children's performance on a range of tasks assessing understanding of mental states and mental activity (Flavell, Everett, Croft, & Flavell, 1981; Wellman, Cross, & Watson, 2001). However recent work indicates that maternal talk about mental states and processes that occurs prior to the preschool period also correlates with children's later developing theory of mind. In a series of studies, Meins and colleagues reported correlations between maternal "mind mindedness," which they defined as mothers' tendencies to comment appropriately on their 6-month-old infants' mental states and activities during free play, and their children's performance on various theory of mind tasks at age 4 (Meins et al., 2003; Meins et al., 2002). At the same time, mothers' inappropriate comments about their infants' mental states, judged by adult observers as being inaccurate about, or insensitive to, the infants' immediate experience, did not correlate with children's later theory of mind. Meins et al. (2003) suggested that mothers' tendencies to make appropriate mind-minded comments when interacting with their infants at 6 months may be one element in an interactive style that generally highlights awareness of the mind and mental activity for their children.

Taumoepeau and Ruffman (2006) also recently investigated maternal mental state talk in the infancy period. They measured mothers' tendencies to talk about emotions, desires, and beliefs when describing pictures to their toddlers at 15 and 24 months of age, as well as toddlers' vocabulary development and understanding of emotions at 24 months. They separately coded mothers' references to other people's mental states (the mother herself or characters in the pictures being described), and references to the mental states of the toddlers. They did not distinguish appropriate from inappropriate comments, as did Meins et al. (2003; Meins et al., 2002). The results of the study indicated that maternal references to their infants' desires at 15 months was the strongest correlate of the toddler's own mental state vocabulary and their ability to identify another person's emotion from context at 24 months. Maternal references to other people's desires also correlated with those outcome variables, but not as strongly or consistently.

Taumoepeau and Ruffman (2006) argued that if mothers' talk about desires serves to concretize and clarify their subjective experience, then this process

would be most profound when mothers talk about their toddlers' desires as they experience them. They further suggested that the complementary causal mechanism may operate as early as the infancy period: Mothers may notice when their infants and toddlers begin to acquire an awareness of others' goals and intentions, and respond by talking explicitly about desires. They based this argument on experimental studies that suggest that infants between 8 and 18 months begin to interpret human behavior as goal directed (Kuhlmeier, Wynn, & Bloom, 2003; Meltzoff, 1995; Woodward, 1998).

An even more obvious milestone than awareness of goals is when infants demonstrate recognition of others' mental states through joint attention (Tomasello, 1995). Joint visual attention, which includes both gaze following and point following, develops over the first year. Fleeting gaze following is first evident around 3 to 4 months (D'Entremont, Hains, & Muir, 1996; Hood, Willen, & Driver, 1998). Between 9 and 12 months, most infants begin to reliably follow another's outstretched finger or direction of eye gaze (Brooks & Meltzoff, 2005; Butterworth & Jarrett, 1991; Corkum & Moore, 1998; Morrisette, Ricard, & Gouin-Decarie, 1995; Scaife & Bruner, 1975).

There is debate about how much mental state knowledge can be attributed to infants on the basis of joint visual attention. The "rich" interpretation of joint visual attention is that infants follow gaze and points because they recognize that their partner is attending to an object in the world, and they wish to share that experience (Carpenter, Nagell, & Tomasello, 1998; Tomasello, 1995). There are also "lean" interpretations of joint visual attention. One is that infants follow gaze because they have been conditioned to do so; following gaze or points usually leads to the infant enjoying an interesting sight (Corkum & Moore, 1995; Moore & Corkum, 1994). Another "lean" interpretation is that infants follow gaze or points, at least in the early development of the skill, as a reflexive response to seeing directional movement of a head or head plus hand (Corkum & Moore, 1995). These competing theories disagree on the sophistication of infants' motivation for engaging in joint visual attention with a social partner. However, whether the underlying mechanism is awareness of others' visual experience or a lower level mechanism, engagement in joint visual attention opens up the possibility of sharing information with a social partner, both about the object of their common focus, and relatedly, about the form and content of their common perceptual experience. As such, it may provide an early opportunity for mothers to respond to their infants' awareness of subjective mental experience.

We therefore hypothesized that once infants begin following gaze and points, toward the end of their first year, then their mothers may notice this new skill, and comment on it. This would be evident in an increase in mothers' talk about their infants' perceptual states, relative to their infants' mastery of joint visual attention. Along the lines proposed by Taumoepeau and Ruffman (2006), this suggests a mechanism whereby early mental state talk could affect children's theory of mind:

If mothers notice their infants' competence and so begin to label and describe their invisible mental states of perceiving or attending, this would highlight infants' explicit awareness of their own inner experiences and, perhaps most important, link those experiences to the relevant mental state language.

In this study, we investigated whether and how maternal talk about mental states, in particular perceptual states, relates to infants' mastery of joint visual attention. To do this we made use of an archival data set containing longitudinal assessment of 24 infants' performance on a range of tasks, including gaze and point following. These data were published previously in a developmental analysis of the acquisition of joint attention and other skills (Carpenter et al., 1998). Also available were data on the duration of episodes of spontaneous joint attentional engagement with mothers during free play, as well as periodic transcripts of maternal language to infants in the free play sessions.

We performed a novel coding of these transcripts, to identify mothers' mental state talk to their infants. Following previous authors, we coded references to mental states of other people, including the mother herself, as a category distinct from references to the infants' own mental states. We further identified two different types of maternal references to their infants' mental states: (a) imperatives, in which mothers ordered or requested their infants to engage in mental activity (e.g., "Look at this!"), versus (b) declaratives, in which mothers labeled, described, or commented on their infants' current mental states (e.g., "Oh, you're looking at the doggie"). As we report later, maternal references to their infants' perceptual states, in particular, were often imperative, but we reasoned that maternal talk would be most effective in concretizing infants' mental states when mothers referred to their immediate and ongoing experience. Thus we predicted that any relations with infants' joint attention would primarily involve mothers' declarative, rather than imperative, references to their infants' mental states. This would be consistent with word-learning studies that have demonstrated a learning advantage only for maternal language that responds to, rather than directs, the infants' focus of attention (e.g., Carpenter et al., 1998; Nelson, 1973).

Our first goal in this study was to characterize the mental state talk that mothers address to their infants of 9, 12, and 15 months of age in a free play situation. Our second goal was to examine changes in mothers' mental state talk in relation to their infants' developing performance on joint visual attention tasks, as well as a control task (object permanence) that was used as a measure of cognitive development outside the domain of joint attention. Our final goal was to explore associations between infants' spontaneous joint attentional engagement with their mothers and mothers' references to mental states, as another way of evaluating whether mothers increase their tendencies to talk about their infants' mental states, once their infants demonstrate a capacity for joint attention.

METHOD

Participants

Twenty-four mother–infant pairs participated. There were equal numbers of male and female infants. Twenty-two were White, 2 were African American. All 24 pairs attended seven monthly test sessions, starting at 9 months of age and ending at 15 months.

Materials, Procedure, and Scoring

We used three main measures: (a) the frequencies and types of mothers' mental state speech to their infants during a 10-min free play interaction when the infants were 9, 12, and 15 months of age; (b) the duration of episodes of spontaneous joint attentional engagement between mother and infant during the free play interaction (JAEs), and (c) infants' responses on structured laboratory tests designed to elicit gaze and point following (classed together as joint visual attention; JVA). The first of these measures is novel, whereas the others were borrowed from a previously published study of this sample of infants (Carpenter et al., 1998).

Infants and mothers were observed and tested in a 10 × 12 ft playroom. The room was decorated with child-friendly posters. Four stuffed animals were strategically placed around the room (one on a shelf; the others hung from the walls) as targets for visual attention. See Carpenter et al. (1998, p. 36) for a diagram of the playroom.

Each month, on arrival, mothers and infants were seated on the floor of the playroom and invited to engage in 10 min of free play on their own. Mothers were instructed to play "as you do normally at home." During these free play periods, infants and mothers had access to a set of toys that included a bucket, shovel, blocks, ball, doll or animal, stacking cups, small figurines, toys with wheels, picture book, and small rolling objects. There were four sets of these types of toys and these were rotated from month to month to avoid participant boredom. The free play sessions were videotaped. After the fact, episodes of spontaneous joint attentional engagement (JAEs) between infant and mother were coded (see details later). In addition, mother–infant language during the free play sessions at 9, 12, and 15 months was transcribed.

Mothers' mental state speech to infants. As a novel measure for this research (see also Slaughter, Peterson, & Carpenter, in press), we examined mothers' mental state speech to their infants in the transcribed free play sessions. Previous work on this data set did not isolate or measure mental state language. Mothers' talk to their infants during the 9-, 12-, and 15-month free play sessions was coded for references to four mental state types: perception, volition, cognition, and dispo-

sition. The perception category included references to perception across all five senses, but the vast majority (94.3%) for this sample turned out to be references to visual perception. The specific visual perception terms used by mothers were *look*, *see*, *watch*, and *peek*.¹ The volition category included references to states of desire and intention, the cognition category included references to thinking or any other higher order cognitive state or process, and the disposition category captured all references to emotions and fleeting or stable physiological, mood, or personal traits. Table 1 provides explicit coding rules for each mental state category as well as verbatim transcript examples from each mental state code. See Slaughter et al. (in press) for a complete listing of terms referring to volition, cognition, and disposition that were used by mothers in this sample.

We coded references to other people's mental states (the mother, toy characters, the experimenters) separately from references to the infants' mental states. Utterances that referred simultaneously to the infant's and another person's mental states (e.g., "We think X . . .") were counted in both categories (but this was uncommon). For each reference to a mental state of the infant, we further noted whether it was an imperative, directive statement versus a declarative, commenting statement. Imperatives included orders (e.g., "Look at this!") as well as questions that, in context, were clearly meant to change the infant's mental state or behavior (e.g., "You want to put it in there for me?"). Declaratives included explicit labeling of the infant's mental state or process (e.g., "Oh you're looking at that doggie") as well as utterances that clarified or commented on the infant's immediate experience (e.g., "You like that don't you?").

We did not code utterances made by the infants, which were very rare.

Duration of JAEs with mother. Spontaneous JAEs that occurred between mother and infant were coded from the videotapes of the free play sessions. These were summed to obtain a measure of JAE duration for each infant–mother dyad at 9, 12, and 15 months. Bakeman and Adamson's (1984) general coding scheme for "coordinated joint engagement" was used. A JAE was defined as a period in which the infant and mother concurrently attended to a third object and the infant acknowledged this coordination of attention either by alternating gaze between mother and object or verbalizing about the object. An episode could begin with the infant alternating gaze from an object to the mother's face and immediately back again, or it could begin with a verbalization (i.e., an intelligible word) to the mother about an object (without necessarily looking at her face). JAEs continued until the

¹The analyses described in the following were all rerun with only the terms referring to visual perception included in the perception category, and this resulted in no change to the overall pattern of results. In the interest of maintaining an exhaustive coding of mental state input, therefore, the complete perceptual term data that include a small proportion of nonvisual perception terms (*taste*, *hear*, *listen*, *feel*, and *touch*) are reported.

TABLE 1
Examples From the Transcripts of Mental State Coding Categories

<i>Mental State Type</i>	<i>Imperative: Directing or Requesting the Infant to Engage in a Mental State or Act</i>	<i>Declarative: Labeling, Describing, or Commenting on the Infant's Current Mental State or Act</i>	<i>Other: Any Statement About a Mental State or Act of Someone Other Than the Infant</i>
Perception: Nouns, verbs, adjectives, or adverbs referring to states or processes related to perception or attention	"Look at those blocks." "Watch this." "Look here." "Listen." "Feel that carpet." "You try it now." "You need to come back."	"You see something in there." "You're looking at the carpet, huh?" "Ha, do you see yourself?"	"Can I see that?" "We're not looking at you."
Volition: Nouns, verbs, adjectives, or adverbs referring to states of preference, desire, or intention	"Guess which hand." "Remember what the kitty cat says?" "Be nice to her."	"Oh you're gonna tear this castle down." "You want to wear it on your head?" "You know how to do it." "You think it's like a cup?" "You like trucks." "You're sleepy, aren't you?"	"I'm going to take it out." "He wants to play with the turtle." "I don't think it's gonna come down." "I've got an idea." "It hurts her." "I'm so sorry your nose is running."
Cognition: Nouns, verbs, adjectives, or adverbs referring to mental acts of thought, intellect, or reasoning			
Disposition: Nouns, verbs, adjectives, or adverbs referring to emotional feelings, behavior, or traits			

mother or infant disengaged attention from the object for at least 3 sec, or if the infant played with the object without looking, gesturing, or vocalizing to the mother for 10 sec or longer (Carpenter et al., 1998).

Following the free play session, two female experimenters entered the room and carried out a series of structured tasks (see Carpenter et al., 1998, for details). In this study we consider data from three of the tasks, which were presented in randomized order.

Gaze-following task. Experimenter 1 and the infant sat facing each other on the floor of the playroom. The infant was given a relatively uninteresting toy and while the infant was looking at it, the experimenter called the infant's name, waited for eye contact, and then with an excited facial expression and a gasp, turned her head to fixate one of the four stuffed toy targets in the room. Experimenter 1 fixated the target for a few seconds, then turned her head to alternate her gaze between the target and the infant several times. Two trials were completed, one look to a target on the experimenter's left and one to a target on the experimenter's right. Experimenter 2 sat in an unobtrusive location in the room, observed the infant's behavior, and recorded it.

Point-following task. This procedure was identical to the gaze-following task, with the addition of Experimenter 1's outstretched right arm with the index finger pointing at the target. Again, two trials were completed, one to the left and one to the right of the experimenter.

The gaze- and point-following tasks were scored identically: Infants passed if they followed the point or gaze on both trials and localized the target object with their eyes. The ages of emergence (AOEs) for point and gaze following were recorded as the first session in which an infant passed the task. If an infant failed to pass the task by the final test session at 15 months, an AOE of 16 months was assigned. We followed Carpenter et al. (1998) and considered the emergence of JVA ("attention following" was the term used by Carpenter et al., 1998) as the AOE for either gaze or point following.

We acknowledge that JVA is not an all-or-nothing developmental achievement, and that this fairly strict criterion may have underestimated infants' early capacity to share attention, particularly given research that shows nascent gaze following in the first half-year of life (D'Entremont et al., 1996; Hood et al., 1998), and more recent research suggesting that interpersonal variables including the maintenance of a neutral facial expression may increase infants' engagement in joint attention (Flom & Pick, 2005). However, using the AOE for reliable gaze or point following on two trials with an adult acquaintance posing a positive facial expression, as we did here, identifies the developmental stage at which infants' capacity to establish JVA is robust, and therefore perhaps most likely to be noticed by mothers.

Object permanence. Infants were also assessed with a subset of the Uzgiris and Hunt (1975) standardized object permanence tasks. Carpenter et al. (1998) scored only the single invisible displacement task (Test 12) because it was the most advanced test passed, during one of the seven testing sessions, by all infants in the sample. To pass this test, infants were required to find an object following one invisible displacement with two hiding locations. Experimenter 1 put a small toy into a cup and then transferred it from the cup to a location under one of two screens. The cup was then put in the middle of the two screens and infants were encouraged to find the toy. The AOE for object permanence was the month in which the infant removed the appropriate screen to find the toy on two separate trials.

We chose to include object permanence as a control task in this study because it follows a predictable developmental trajectory and as such can be used as a proxy for general cognitive development (Uzgiris & Hunt, 1975). Also, because Carpenter et al. (1998) found no correlation between infants' acquisition of object permanence and their mastery of JVA, it provides an independent cognitive developmental milestone against which to observe changes in mothers' mental state talk to their infants.

Reliability

A research assistant blind to the joint attention performance (both JVA and JAE) of the infants coded the maternal language transcripts. Twenty percent of the data (15 transcripts in total; 5 randomly chosen infant-mother dyads observed at 9, 12, and 15 months) were also coded by the first author and percentage agreement across all mental state coding categories was 93.4%; Cohen's kappa was .92.

The duration of JAEs with mother during the free play sessions was coded from the videotapes by a primary coder and then 17% of the sessions were coded by a naive observer to establish reliability. Overall agreement on time spent in joint attention was 97%, with Cohen's kappa of .75 (Carpenter et al., 1998).

The gaze- and point-following tasks, as well as the object permanence task, were scored as pass-fail online by one of the experimenters, and then 20% of the data were later coded by a naive observer. This resulted in 90% agreement on gaze following and 97% agreement on point following, with Cohen's kappas of .76 and .94, respectively. For the object permanence task, agreement was 96% and Cohen's kappa was .91 (Carpenter et al., 1998).

RESULTS

Preliminary analyses indicated that references to others' mental states were relatively rare in this context, accounting for fewer than 15% of all mental state terms

coded. Because of this, and because we were most interested in mothers' talk about their infants' mental states, we did not include references to others' mental states in the following analyses.

Frequencies of Mental State Utterances by Age and Category

The top row of Table 2 provides the mean number of utterances made by mothers to their infants at 9, 12, and 15 months, where an utterance is defined as any unit of speech bounded by pauses (Aronoff & Rees-Miller, 2001). There was an increase in the total number of maternal utterances per free play session as infants got older, however a repeated measures analysis of variance (ANOVA) on total utterances by age group indicated that the increase was nonsignificant, $F(2, 46) = .85, p = .44$. As the second row of Table 2 shows, there was also a longitudinal decrease in the number of maternal utterances that included a mental state term, but this effect was also not statistically significant, $F(2, 46) = 2.87, p = .07$.

TABLE 2
Mean Number of Utterances and Mean Frequencies and Proportions of Mothers' Mental State References to Their Infants, by Infants' Age

	<i>Age of Infant at Free Play</i>					
	<i>9 Months</i>		<i>12 Months</i>		<i>15 Months</i>	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Total number of maternal utterances in play session	126.92	54.75	138.50	59.18	142.78	57.77
Total number of maternal utterances that referred to mental states	32.92	16.64	27.96	13.82	25.43	11.39
Proportion of maternal utterances that referred to mental states	.25	.07	.20	.07	.18	.06
Proportions of maternal references to infants' different mental states, as a proportion of total utterances/as a proportion of all mental state utterances						
Perception-imperative	.078/.31	.053/.17	.075/.37	.044/.17	.057/.31	.030/.15
Perception-declarative	.046/.18	.030/.12	.022/.12	.013/.09	.020/.11	.019/.10
Volition-imperative	.013/.05	.017/.05	.020/.11	.018/.09	.019/.11	.018/.10
Volition-declarative	.054/.20	.043/.14	.034/.18	.023/.11	.033/.19	.021/.12
Cognition-imperative	.0002/.001	.001/.004	.0003/.001	.002/.006	.0005/.003	.002/.009
Cognition-declarative	.011/.05	.016/.05	.007/.04	.010/.05	.008/.05	.011/.06
Disposition-imperative	.0002/.001	.001/.004	.0003/.002	.002/.008	0	0
Disposition-declarative	.030/.13	.025/.13	.017/.08	.019/.09	.011/.05	.021/.08

The third row of Table 2 shows the proportion of maternal utterances that included at least one mental state term at each free play session. A repeated measures ANOVA on this variable by age group indicated that, as a proportion of total utterances, references to mental states declined significantly from 9 to 15 months, $F(2, 46) = 13.73, p < .001$. For the following analyses, maternal mental state talk is expressed as a proportion of total utterances. These data were not normally distributed in many cases, so we used nonparametric statistical tests to evaluate the hypothesis that mothers' references to their infants' perceptual states and processes would be related to the infants' capacity for joint attention.

The lower portion of Table 2 provides data on the proportions of mothers' utterances that included references to different mental states. The leftmost number in each column represents mental state references as a proportion of total utterances, and the number to its right represents mental state references as a proportion of all mental state utterances. (Note that these latter numbers do not sum to 1.00 because we are not reporting references to others' mental states.) For instance, at the 9-month free play session, 7.8% of mothers' total utterances included a perceptual imperative term, and at the same time, perceptual imperatives accounted for 31% of all maternal mental state utterances.

Examination of the means suggested that mothers talked most often about perceptual states as opposed to other mental states, at all three free play assessments. To confirm this, we collapsed across imperative and declarative uses of each type of mental state, and then compared the proportions of maternal references to perception, volition, cognition, and disposition using Friedman two-way ANOVA by ranks. This was done separately for each age. These analyses revealed that at 9, 12, and 15 months, there were significant overall differences in mothers' references to different mental states, with each $\chi^2(3, N = 24) > 44$, all $ps < .001$. Follow-up Wilcoxon signed ranks tests indicated significant pairwise differences between all of the different mental state types, at each age (all z s > 2.26 , all $ps < .025$), except for references to cognition and disposition at 15 months, which were not significantly different from each other ($z = .15, p = .88$). This indicates that mothers referred most commonly to their infants' perceptual states and processes when their infants were 9, 12, and 15 months of age.

Correlations Between Maternal References to Perception and AOE for Joint Visual Attention and Object Permanence

To initially address the question of whether maternal talk about mental states was related to infants' joint attention skill, we computed Spearman correlations between proportions of mothers' imperative and declarative references to their infants' perceptual states at 9, 12, and 15 months, and their infants' AOE for joint visual attention. Thus we asked if infants who passed the structured joint attention task earlier than their peers had mothers whose talk contained a higher proportion

of references to their infants' perceptual experience. We chose to focus on talk about perception, at the outset, because we hypothesized that mothers would be most likely to respond to their infants' emerging joint attention skill by increasing references to their infants' perceptual states and processes. As planned, we included the AOE for object permanence in this analysis as a control.

The outcome of this analysis is presented in Table 3. There were some significant correlations among the maternal language variables; in particular, it is notable that perception imperatives at 9, 12, and 15 months were all intercorrelated, suggesting that some mothers had a consistent style of interacting with their infants (a similar finding, not specific to mental state talk, was reported by Carpenter et al., 1998). With respect to the JVA and object permanence tasks, none of the correlations with maternal language were significant, meaning that mothers' tendencies to refer to perceptual states in conversation with their infants were not related to the ages at which infants passed the JVA or object permanence tasks.

Changes in Maternal Talk About Mental States in Relation to Infants' Joint Visual Attention Skill

Although we found no global relation between mothers' references to their infants' perceptual states and infants' AOE for JVA, we thought it possible that a more specific relation would exist, so next we examined changes in maternal references to

TABLE 3
Spearman Correlations Between Maternal References to Perceptual States at 9, 12, and 15 Months (as a Proportion of Total Utterances) and Ages of Emergence for Joint Visual Attention in the Structured Task (JVA) and Object Permanence (OP)

	JVA	OP	Imperative Perception 9 Months	Declarative Perception 9 Months	Imperative Perception 12 Months	Declarative Perception 12 Months	Imperative Perception 15 Months
OP	.19						
Imperative perception 9 months	-.06	.03					
Declarative perception 9 months	-.32	.16	.47*				
Imperative perception 12 months	-.12	-.11	.50*	.16			
Declarative perception 12 months	-.17	.06	.19	.40	.48*		
Imperative perception 15 months	-.20	.02	.57**	.30	.67*	.41	
Declarative perception 15 months	-.01	-.11	-.002	.10	.30	.30	.33

* $p < .05$. ** $p < .01$, all two-tailed.

mental states in relation to the age at which infants passed the JVA tasks. To do this, we carried out a series of planned, paired comparisons between proportions of mothers' mental state references in the free play session prior to, versus concurrent with or after, the test session at which infants first demonstrated JVA in the structured task. Thus if an infant's AOE for JVA was 10, 11, or 12 months, then we compared the proportions of mental state utterances his or her mother made in the 9-month free play session to those in the 12-month free play session. If an infant's AOE for JVA was 13, 14, or 15 months, then we compared proportions of maternal mental state talk across the 12- and 15-month free play sessions. If an infant demonstrated JVA at 9 months, or did not pass the task even at the 15-month assessment, we did not have access to before and after data so that infant could not be included in the analysis.

Again, based on our hypothesis that mothers might specifically increase their mentions of perception once infants began following points, gaze, or both, we evaluated changes in mothers' references to perception. We tested for changes in both imperative and declarative perception utterances. Then, to establish that any significant patterns observed were specific to talk about perception, we also tested changes in mothers' declarative references to their infants' volitional, cognitive, and dispositional states, because for these mental state terms, declarative uses were more common. Finally, we carried out the same analyses of maternal mental state talk relative to infants' passing of the object permanence task, as a control. Because these were planned, theory-driven comparisons, there was no need to adjust significance levels to control for multiple statistical tests (Keppel & Zedeck, 1989).

As reported in Carpenter et al. (1998), the AOE for JVA ranged from 9 to 16 months ($M = 11.5$ months, $SD = 1.6$ months). See Carpenter et al. (1998, Figure 9, p. 63) for the number of infants who passed the JVA task at each age. For object permanence the AOE ranged from 10 to 15 months ($M = 12.3$ months, $SD = 1.2$ months). Again see Carpenter et al. (1998, Figure 8, p. 62) for the number of infants who passed the task at each age.

Table 4 provides the pre- and posttask proportions of maternal utterances that referred to mental states, relative to infants' AOE for JVA and object permanence. Wilcoxon signed ranks tests on the pre- and posttask proportions indicated that the only significant change was to mothers' declarative references to perception, which significantly declined as a proportion of total utterances, after infants passed the JVA task, $z(22) = 2.76$, $p = .006$. This change in mothers' talk about their infants' perceptual states was not evident relative to infants' passing of the object permanence task, $z(23) = 1.22$, *ns*. Further, there was no change in mothers' perception imperatives, $z(22) = 1.64$, *ns*, relative to their infants' AOE for JVA. Nor were there any significant changes in mothers' declarative references to their infants' states of volition, cognition, or disposition, relative to infants' AOE for JVA, all z s < 1.94 , *ns*. Thus the data indicate a highly specific decline in mothers' tendencies to label, describe, or comment on their infants' perceptual states and processes, following their infants' passing of the structured JVA task.

TABLE 4
 Mothers' Mental State References as a Proportion of Total Utterances
 Before and After Their Infants Passed the Structured Joint Visual Attention
 and Object Permanence Tasks

Mean Proportion of Maternal Utterances Referring to Mental States	Task							
	Joint Visual Attention ^a				Object Permanence ^b			
	Pre- Pass Task		Post- Pass Task		Pre- Pass Task		Post- Pass Task	
	M	SD	M	SD	M	SD	M	SD
Perception-imperative	.083	.059	.063	.034	.072	.043	.063	.032
Perception-declarative	.041	.029	.022 ^c	.016	.031	.022	.023	.016
Volition-declarative	.048	.044	.039	.022	.042	.038	.038	.024
Cognition-declarative	.012	.015	.008	.011	.009	.013	.007	.011
Disposition-declarative	.030	.028	.020	.020	.026	.021	.017	.019

^a*n* = 22. ^b*n* = 23. ^cSignificant difference (at *p* = .006, two-tailed) between the pre- and posttask means, by Wilcoxon signed ranks test.

To further confirm this significant finding, we redid this analysis using maternal references to perception as a proportion of mental state utterances, as the dependent variable. When expressed this way, a significant drop in perception declaratives was again observed: Prior to passing JVA, 16.8% of maternal mental state utterances included a perception declarative, whereas after passing the JVA task, this proportion was significantly reduced to 11.3% (*z* = 2.36, *p* = .018 by Wilcoxon signed ranks test). In contrast, the change in perception declaratives relative to infants' passing the object permanence task, from 15.1% to 11.4%, was not statistically significant (*z* = 1.48, *p* = .14).

Correlations Between Duration of JAEs With Mother and Mothers' Talk About Mental States

Finally, to get a complete picture of how mothers' talk about perceptual states related to their infants' capacity for joint attention, we computed correlations between the proportion of mothers' utterances that referred to their infants' perceptual states and the durations of spontaneous mother-infant JAEs in the free play sessions. This is a purely descriptive exercise; note that infants' engagement in joint attention with their mothers was not independent of mothers' mental state talk because they were measured during the same interactions. As reported in Carpenter et al. (1998), the mean duration of mother-infant JAEs increased from 13 sec at 9 months (*SD* = 16.3 sec), to 33 sec at 12 months (*SD* = 32.9 sec) and then to 44 sec at 15 months (*SD* = 35.7 sec). Table 5 displays Spearman correlations between the

TABLE 5
Spearman Correlations for Duration of Spontaneous Joint Attention
Episodes (JAEs) With Mother During Free Play and Mothers' References
to the Infants' Perceptual States as a Proportion of Total Utterances

	<i>JAE Duration</i>		
	<i>9 Months</i>	<i>12 Months</i>	<i>15 Months</i>
Imperative perception 9 months	-.26	-.07	.03
Declarative perception 9 months	-.61*	-.17	-.20
Imperative perception 12 months	-.10	-.22	.12
Declarative perception 12 months	-.14	.06	.22
Imperative perception 15 months	-.09	-.36	-.12
Declarative perception 15 months	-.26	-.21	-.05

* $p = .001$, two-tailed.

duration of infants' JAEs with their mothers in the free play sessions at 9, 12, and 15 months, and maternal references to their infants' perceptual states in those same free play sessions. There was a large negative correlation between duration of JAEs at 9 months and the proportion of maternal utterances that included perception declaratives at the same test session. This means that mothers who spent more time in spontaneous JAEs with their infants at 9 months of age made proportionally fewer references to their infants' perceptual states.

DISCUSSION

The results of this study showed that mothers commonly made reference to their 9- to 15-month-old infants' mental states in a free play context. References to perceptual states and processes were more common than references to other types of mental states at every infant age. This finding replicates previous observational studies of maternal mental state talk to infants and toddlers (Beeghly, Bretherton, & Mervis, 1986). A relative preponderance of references to perception may not be unique to mothers' talk to their very young children; structured investigations of mental state talk to preschoolers have also found that perception is the most frequent mental state category mentioned in maternal speech to their children (Adrian, Clemente-Rosa, Villanueva, & Rieffe, 2005; Slaughter et al., 2007).

We found that mothers' declarative references to perception, or their tendencies to label or comment on their infants' perceptual states and processes, declined significantly after their infants passed the structured JVA task. Beeghly et al. (1986) also reported a decline in mothers' references to perception when their infants were 13 to 28 months of age, but they did not isolate different types of references to perception (and this is past the stage at which infants begin reliably to engage in JVA,

so it probably reflects a different developmental process). In this study we found very specific relations: Our analyses ruled out a general decline in all types of references to perception, relative to infants' mastery of JVA, as perception imperatives did not significantly change. Nor was the pattern attributable to a widespread decrease in all types of mental state declaratives, because we found nonsignificant changes in mothers' tendencies to label or comment on their infants' volitional, cognitive, and dispositional states relative to their passing of the JVA task.

Examination of the means suggests that perception declaratives declined generally between 9 and 15 months, which could mean that the drop in perception declaratives we observed occurred independently of infants' mastery of JVA. However the fact that mothers' perception declaratives did not drop significantly relative to the same infants' mastery of object permanence goes against that interpretation. We also observed that at the 9-month test session, mothers' perception declaratives were negatively correlated with the duration of their infants' JAEs. This pattern also suggests that the more competent infants were at engaging and maintaining joint attention, the less their mothers commented on their perceptual states. This negative correlation was not observed at the 12- and 15-month test sessions, possibly because there was less variance, relative to the means, in the durations of JAEs after 12 months. Overall, the pattern of data suggests that mothers in this study tended to do less labeling, commenting, or describing of their infants' perceptual states and experiences once their infants had firmly acquired the capacity to engage in JVA.

This pattern of results contradicted our hypothesis, which was derived from previous findings and hypotheses about other types of mental states, yet it is not difficult to interpret. It appears that mothers may tend to make frequent declarative references to their infants' perceptual states when they are working to create JVA. Comments like "You're looking at the carpet," and "What do you see?" may help mothers to establish that they and their infants are focusing on the same external object. Once infants reliably follow points and gaze, and as a result quickly and automatically share visual attention with their mothers, then the focus of maternal talk may bypass the process of setting up JVA with their infants and instead proceed directly to the object of their mutual focus (Tomasello, 1988; Tomasello & Farrar, 1986). This would account for the reliable positive correlation found between infants' capacity for JVA and their early vocabulary development (Brooks & Meltzoff, 2005; Carpenter et al., 1998; Morales, Mundy, & Rojas, 1998; Tomasello & Todd, 1983).

The lack of a significant change in perception imperatives relative to infants' acquisition of JVA suggests that directives like "Look at this" and "Watch this" are independent of infants' JVA. That is, mothers try to verbally direct their children's attention as part of their ongoing interactions at all ages (and indeed, children return the favor once they master the relevant language). These references to perception may assist mothers in initiating a JAE if their infants respond appropriately.

However if mothers need to explicitly establish that they and their infants are sharing a common referent, as when the infant does not yet reliably follow points or gaze, declarative comments may be more useful.

The data reported here appear to contradict the hypothesis that mothers generally increase their talk about mental states in response to their infants' emerging understanding. It is notable, however, that a separate study of this same data set revealed a positive correlation between maternal references to their infants' volitional states at 15 months and their infants' production of gestural communication in the preceding months (Slaughter et al., in press). This complicated pattern suggests that mothers may indeed respond to their infants' emerging social-communicative skills, but that their responses are tailored to the type of skill and the specific mental states involved. Perhaps because perceptual states and processes are readily recognizable via simple line of sight or salient behaviors, mothers are less motivated to concretize and contextualize them compared to other mental states like desire and intention, which are not as directly observable from overt behavior. To speculate, it may be that mothers' explicit labeling of their infants' physically apparent states of perception decreases once it is no longer necessary to establish and maintain their joint attention, but labeling of volitional states increases at a point when mothers believe their infants are becoming ready to learn the relevant terms.

With respect to the question of whether maternal mental state talk promotes infants' emerging understanding of the mind, we found no evidence to suggest that the more mothers talk about perception, the earlier their infants master gaze or point following. That is, there was no correlation between mothers' references to perception and their infants' AOE for JVA. This is perhaps not surprising, given that comprehension and production of mental state terms is relatively uncommon in the first year of life (Dale & Fenson, 1996). In fact, when we consulted MacArthur Communicative Developmental Inventory data for the infants in this study, we found that 54% of infants in the study passed the structured joint attention task before they were reported by their mothers to understand either of the two most common perception terms, *look* or *see*. Thus it may be that maternal talk about mental states at this early stage does not positively influence infants' social-cognitive skill, whereas at later stages of development, when verbal ability is closely linked to performance on theory of mind tasks (Astington & Jenkins, 1999; Milligan, Astington, & Dack, 2007), individual differences in maternal mental state input have an observable effect. In support of this latter idea, we note that the few published studies that have explored mental state input to infants and toddlers have reported correlations only with later-developing aspects of theory of mind, all of which were based on verbal responding (Meins et al., 2003; Meins et al., 2002; Taumoepeau & Ruffman, 2006).

A drawback to this study was the fact that maternal language was measured only once every 3 months. It would be valuable to replicate these findings in a

study that includes maternal language measures at more frequent time points, to more precisely document how maternal language changes in relation to infants' mastery of JVA. For instance, there is evidence that mothers significantly increase their references to thoughts and beliefs in the months preceding their children's third birthdays, several months before most children typically pass standard verbal false belief tasks (Brown & Dunn, 1991; Taumoepeau & Ruffman, 2006, 2008). The relatively numerous maternal references to perception that we observed at the 9-month assessment might similarly represent a sudden increase just prior to their infants' acquisition of a relevant developmental milestone. Transcripts from earlier in infancy would be required to confirm this hypothesis.

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