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Coordinated attention, declarative and imperative pointing in infants with and without Down syndrome: Sharing experiences with adults and peers

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ABSTRACT
The link between coordinated attention, imperative and declarative pointing was assessed in a longitudinal study. Four groups of infants were studied in interaction with their mothers, a same-aged peer and the peer's mother. Two groups of infants had Down syndrome (DS), one ($n = 11$) with a mean mental age (MA) of 0;8.6 and the other ($n = 11$) with an MA of 1;4.5. These infants were matched on MA with two groups ($n = 10$ each) of typically developing (TD) infants. The following hypotheses were confirmed: (a) that infants with DS produce less coordinated attention and declaratives than typically developing infants, but a comparable number of imperatives; (b) that coordinated attention predicts declarative but not imperative pointing; and (c) that coordinated attention, imperative and declarative pointing should be higher with adults than with peers. Discussion centers on the implications of these findings for theories of early communication development and mental state awareness.

KEYWORDS
Down syndrome; joint attention; nonverbal development; parent-infant interaction; pointing; preverbal communication

INTRODUCTION

It has been well documented that before infants begin to speak, they communicate non-verbally with people about aspects of their environment (Bates, Camaioni & Volterra, 1975). Of particular interest to this study is how infants start to alternate their gazes between a partner and an object in order to communicate either a wish to obtain the object (imperative pointing) or to share an interesting aspect of the object (declarative pointing). Bates et al. (1975) found that both imperatives and declaratives developed between 12 and 18 months, and corresponded with Piaget's fifth stage of sensorimotor development ('causality'). These points are considered acts of intentional communication because they are accompanied by eye contact, and they are produced to direct the attention or behavior of the person to things in the environment in order to communicate about them (Bates et al., 1975). To explain this development the authors put forward the 'tool-use' hypothesis, which proposes that in both situations a person is used as a tool; either the person is used as a tool to obtain an object (imperatives) or an object is used as a tool to obtain another's attention (declaratives), and therefore both gestures involve the same underlying sociocognitive capacity.

Since then, various researchers have argued that declarative pointing might be structurally and functionally different from imperative pointing (Baron-Cohen, 1991; Camaioni, 1993; Camaioni, Perucchini, Bellagamba & Colonnesi, 2004; Legerstee & Barillas, 2003), because declarative pointing, but not imperative pointing, is linked to coordinated attention. Coordinated attention is the ability to alternate gazes back and forth between a person and an object during social interaction. It is different from gaze following, because it involves more than just responding to a change in gaze of the communicative partner. Rather, infants use their gazes to signal to social partners that they want to share interesting aspects of this object. It has been suggested that the child's capacity to represent and influence another person's attentional state about an object or event in triadic interactions (declarative communication) is an early manifestation of social understanding (Camaioni et al., 2004). The emergence of this skill represents a critical social-cognitive advance for the developing infant, because it reflects awareness that meaning can be exchanged between people (Werner & Kaplan, 1963). As such, this ability indexes the intentional stance in infants; namely, infants begin to recognize *others* as intentional agents, and to play a pivotal role in infants' subsequent linguistic development (Charman, 2003; Legerstee, Van Beek & Varghese, 2002; Schaffer, 1977; Tomasello & Todd, 1983).

The hypothesized link between coordinated attention and declarative pointing (but not imperative pointing) has been called the 'joint attention' hypothesis by Camaioni (1993) (see also Sugarman-Bell, 1978; Tomasello & Camaioni, 1997; Zinober & Martlew, 1985).

Coordinated attention hypothesis

Although there is generally a consensus that coordinated attention and declarative pointing are facilitated by infants' maturing concept of people (e.g., Baldwin & Moses, 1994; Baron-Cohen et al., 1996) there are no developmental studies that have assessed the relation between coordinated attention, imperative and declarative pointing. The issue is of significance because differences in coordinated attention appear to be related to differences in cognitive and language development (Hobson, Patrick, Crandell, Garcia Perez & Lee, 2004; Morales et al., 2000). In particular, differences in the ability to use direction of gaze and gestures to direct the attention of others to various interesting sights (declaratives) at 18 months predicts different rates of language development at 24 months, after controlling for cognitive development (Mundy et al., 2007). Although the present study does not attempt to predict later language development from earlier occurring gestures, it predicts the production of declaratives from coordinated attention. Previous research suggests that difficulties in the development of coordinated attention and prelinguistic referential gestures during the preverbal period may shed light on later language delays in children (Iverson, Longobardi & Caselli, 2003). Consequently, it is particularly fruitful to investigate coordinated attention and gestures in infants with Down syndrome (DS), because infants with DS have noted deficiencies in these behaviors (Beeghly, Weiss-Perry & Cicchetti, 1990; Jones, 1980; Landry & Chapiesky, 1990; Legerstee & Bowman, 1989; Legerstee & Weintraub, 1997; Legerstee et al., 2002), and speech (Fowler, 1990; Iverson et al., 2003; Rondal, 1988).

Coordinated attention in typically developing infants

Typically developing (TD) infants show a well-documented developmental sequence of their attentional skills during the first and second years of life. Coordinated attention behaviors emerge between 6 and 12 months and involve the sharing of attention between infants, other people and a preferred object or event (Legerstee, Markova & Fisher, 2007). In their seminal study, Bakeman & Adamson (1984) showed that when children played with mature communicators (mothers), they produced more coordinated attention sequences than when interacting with same-aged peers, although by the end of the study even quite unskilled peers became appropriate partners for the exercise of these capacities (Bakeman & Adamson, 1984: 1278). These findings support a social-interactionist framework in which family input facilitates the development of children’s social understanding, at least in infants who develop typically.

Coordinated attention in infants with Down syndrome

Most researchers have found that infants with DS are delayed or deficient in coordinated attention compared with TD infants (e.g., Beeghly et al., 1990; Jones, 1980; Landry & Chapieski, 1990). Berger & Cunningham (1981) showed that the developmental pattern of attention in infants with DS over the first 6 months does not follow the same course as that of non-handicapped infants. The onset of eye contact with their mothers and the establishment of a peak or high levels of such behavior developed later for infants with DS compared with TD infants. Once established, however, infants with DS maintained eye contact for a longer time than TD infants. Gunn, Berry & Andrews (1982), who studied 6- to 9-month-old infants with

DS, observed that, by 9 months, infants had not yet begun to look away from their mothers to inspect aspects of their surroundings. Instead, attention remained interpersonal rather than becoming referential (e.g., glancing back and forth from person to object). Consequently, by identifying the components of delayed or deficient attention sharing in infants with DS, it may be possible to provide specific insights into the factors that influence the development of communicative gestures.

Legerstee & Weintraub (1997) compared coordinated attention in infants with DS with that in typically developing infants matched on mental age (MA). They found that infants with DS attended to objects less often and engaged in less coordinated attention than TD infants. In contrast, Harris, Kasari & Sigman (1996) found that infants with DS spent more time in coordinated attention than TD infants. The difference in results might be explained by the difference in coding definitions used by the authors. Most researchers define coordinated attention as the alternation of infant gaze between the face of the social partner and the object both partners attend to, i.e., what Bakeman & Adamson (1984) call *coordinated joint attention*. The definition used by Harris et al. (1996) follows Bakeman & Adamson's (1984) definition for *passive joint attention*, in which both partners attend to the same object without looking at each other's face.

Coordinated attention and pointing in typically developing infants

Legerstee, Corter & Kienapple (1990) studied infants between 9 and 15 weeks of age, and found that pointing co-occurred with negative or positive affect and vocalizations when infants interacted with mothers, but not with dolls, suggesting that soon after birth pointing is a social/communicative action. Franco & Butterworth (1996) established that by 10 months, infants visually checked their partner's face in association with prelinguistic gesturing. Between 12 and 16 months, infants became increasingly aware that partners attend to the same object that they themselves were focusing on. The authors established that 12-month-olds checked *after*, 14-month-olds checked *during*, and 16-month-olds checked *before* pointing. Franco & Butterworth (1996) argued that the latter is most advanced because it implies an understanding that experience sharing is most effective if the partner is attending first. In a more recent experimental study, Legerstee & Barillas (2003) assessed 12-month-old infants in conditions where the experimenter vocalized while looking at the same object as the infant or a different object. The authors suggested that by 12 months, infants are aware of the attentional state of a person, because they pointed and vocalized more often to direct her attention to the object she was not looking at than to the one she did look at – findings later replicated by Liszkowski, Carpenter, Henning, Striano & Tomasello (2004).

Coordinated attention and pointing in infants with Down syndrome

Research examining the relation between coordinated attention and pointing in infants with DS is scarce, and the various methodologies used make it difficult to form definite conclusions about the link between coordinated attention and pointing. Greenwald & Leonard (1979) compared the production of declarative and imperative pointing by TD infants with that of infants with DS, who were matched according to whether they were at stage 4 (mean age = 8–12 months) or stage 5 (mean age = 12–18 months) of the sensori-motor period. Although neither infant group performed many declaratives at stage 4, TD infants exhibited significantly more declaratives but a similar amount of imperatives as the infants with DS at stage 5. In contrast, Mundy, Sigman, Kasari & Yirmiya (1988) found that infants with DS, matched on MA (one group below 21 months, the other above 21 months) with TD infants, were significantly more competent in the production of nonverbal social interaction skills, such as coordinated attention. However, the authors also found that infants with DS who had a high mental age displayed a significant deficit in non-verbal requests for objects, compared with TD infants with a high mental age.

When controlling for language rather than for mental age, Franco & Wishart (1995) found high levels of pointing at 20–22 months (language age) and advanced visual checking (looking at the partner before pointing, which the authors interpreted as 'a need to know whether the partner is attending and ready to receive the message'), in declarative as well as imperative contexts. In contrast, Iverson et al. (2003) who tested the relationship between gestures and words in children with DS and in typically developing children with a mean language age of 18 months, and an average mental age of 2 years, found that infants with DS had significantly lower gesture production than TD children as well as considerable delays in two-word utterances. The authors attributed this delay to problems in early gestural communication in infants with DS.

Social influences

A number of studies have shown that the social milieu is an important mechanism in promoting the development of infant sociocognitive abilities (Carpendale & Lewis, 2004; Legerstee et al., 2007). Vygotsky's (1978: 57) theory of the zone of proximal development proposes that every function in the child's development appears initially between a familiar adult and the child (i.e., interpsychological), and only thereafter is internalized to become a property of the child (i.e., intrapsychological). In support of this theory, empirical studies have shown that coordinated attention, gestures and words are facilitated by adult partners, who scaffold this behavior in infants (Bakeman & Adamson, 1984; Legerstee & Weintraub, 1997; Legerstee et al., 2002). A comparison of these sociocognitive abilities in typically developing infants and infants with Down syndrome during interactions with different social partners should allow for an examination of the role the social environment plays in referential communication in infants.

The present study

To shed light on the development of coordinated attention and its relation to declarative and imperative pointing, and the influence of the social milieu on the development of such behaviors, we investigated infants with Down syndrome and typically developing infants in a longitudinal study. Four groups of infants were studied in separate interactions with their mothers, a same-aged peer and the peer's mother. Namely, a group of TD infants and a group of infants with DS. Each group was divided into two mean mental ages (MA), namely low MA (9 months); and high MA (18 months) at the beginning of the study, and were seen bimonthly for 8 months.

Three hypotheses guided the present research. First, if, as research shows, infants with DS are delayed in coordinated attention (Beeghly et al., 1990; Landry & Chapiesky, 1990; Legerstee & Weintraub, 1997) and declarative pointing (Mundy et al., 1988) but not imperative pointing (Greenwald & Leonard, 1979), then we expect typically developing infants to produce more coordinated attention and declarative pointing, but a similar amount of imperative pointing compared to infants with DS. Second, if according to the 'joint attention' hypothesis (Camaioni, 1993), coordinated attention is linked to declarative but not imperative pointing, then coordinated attention should predict declarative pointing only. Finally – and related to the above hypotheses – if, according to the social interactionist framework (Bruner, 1983; Vygotsky, 1978), coordinated attention is scaffolded by mature communicators, then infants should produce more coordinated attention and also declarative pointing when interacting with mature communicators than with less mature communicators.

METHOD

Participants

Participants consisted of 22 infants with DS (17 boys) and another group of 20 TD infants (11 boys). The high number of males in the group of infants with DS is characteristic of the DS population (Selikowitz, 1997). One infant with DS was excluded from the sample because of a failure to complete all sessions. Thus, the final total consisted of 21 infants with DS. The infants belonged to a database that has previously been investigated for the development of coordinated attention (Legerstee & Weintraub, 1997) and for the effects of parenting skills on the production of referential communication (Legerstee et al., 2002). The present study is different in that it examines the onset and development of declarative and imperative pointing and its relation to coordinated attention.

Infants with DS had been previously diagnosed with Trisomy 21, a chromosomal disorder that results in mental retardation and specific language delays (Rondal, 1988). None exhibited severe sensory or physical disabilities. The mothers of the infants with DS were recruited through infant stimulation centers and through regional Down syndrome parent associations. Mothers of the typically developing infants were recruited from daycare centers and hospitals. The TD infants had a chronological age of 6–20 months at the time of recruitment. Infants with DS were matched with TD infants on MA at the time of recruitment. Mental-age-equivalent scores were assessed using the Bayley Scales of Infant Development (Bayley, 1969). There were no significant differences in MA between infants with DS and TD infants. Because infants point by 12 months of age (Legerstee & Barillas, 2003;

Liszkowski et al., 2004), infants with a mental age below 12 months were classified as having a low MA, and infants with an MA greater than or equal to 12 months were classified as having a high MA. Thus we examined four groups of infants; namely typically developing infants and infants with Down syndrome, each having a High and Low Mental age group. Table 1 summarizes the mean mental ages (MA) and chronological ages (CA) for each infant group at the first and last visits.

Two one-way ANOVAs comparing maternal characteristics, with group as a between-subjects factor, showed that mothers of infants with DS did not differ from mothers of TD infants in terms of education, i.e., total years of schooling ($F(1, 39) = 1.553$, $p = 0.220$) or age ($F(1, 39) = 1.064$, $p = 0.530$). The mothers of infants with DS and TD infants recruited a same-aged TD peer who had previously played with their infant, thereby avoiding a novelty effect. The CA of the peers for the infants with DS ranged from 8 to 34 months, and the CA of the peers for the TD infants ranged from 6 to 36 months. A one-way ANOVA with group as the between-subjects factor showed no significant difference between the ages of the peers for the infants with DS and those of the peers for the TD infants, $F(1, 39) = 3.607$, $p = 0.065$. All families that participated spoke English.

Table 1 Mean mental (MA) and chronological ages (CA), in months, of High and Low MA TD and DS infants at visits 1 and 4

	Visit 1		*Visit 4*	
	MA	*CA*	*MA*	*CA*
High MA				
DS (*n* = 11)				
M	16.636	22.818	19.200	29.000
SD	2.984	3.481	3.600	3.800
TD (*n* = 11)				
M	18.773	17.818	24.210	23.180
SD	4.875	5.658	4.000	2.120
Low MA				
DS (*n* = 10)				
M	8.500	17.650	13.200	23.300
SD	1.700	5.879	3.000	2.900
TD (*n* = 9)				
M	8.944	7.778	16.100	14.800
SD	1.648	1.326	3.000	1.240

Design and procedure

The participants were visited in the homes of the target infants four times over an 8-month period. At each visit, infants participated in three randomized 5-minute interactions: one with the mother, one with a peer's mother, and one with a peer. Thus, for both groups there were a total of 592 five-minute conditions.

Toys that could be manipulated were provided during each interaction (e.g., a jack-in-the-box, a telephone, musical instruments, stacking cups, a book). Of these toys, some were closer to the infant (which facilitates coordinated attention), and others were somewhat further away (which may promote pointing). Breaks of approximately 3 minutes were held between interactions to allow for partners to change and for toys to be put back into position.

During mother-infant interactions, the dyad played on the floor with the toys. Mothers were asked to play with their infants as they normally would. During interactions with the peer's mother and the peers, mothers sat in the same room reading an article. If the infant initiated contact with them, mothers were asked not to interact with their children, but to encourage them to continue playing with the respective partner. In order to control for potential stranger or novelty effects, all peers and the peers' mothers had prior contact with the infants during the month of testing.

An experimenter surreptitiously videotaped the interactions with a portable camcorder. A timeline was imposed directly onto the video image to aid in determining the length of sessions and coding behaviors. This allowed for behaviors to be coded continuously on a second-by-second basis.

Coding scheme

Three infant behaviors were assessed in the present study: coordinated attention, declarative pointing, and imperative pointing. In order to accurately identify differences in infant behaviors during interactions with various partners, only behaviors directed to the designated social partner at the time of each interaction were coded. For instance, if the infant pointed to the mother who was off-screen during a designated interaction with the peer or peer's mother, the point was not coded.

Interaction segments during which the target infant, peer or adult partner was moving around the room, lying on the floor or showing emotional distress were excluded. Thus, only instances of coordinated attention, declarative pointing and imperative pointing that occurred when both partners were physically *able* to engage in these behaviors were coded.

Coordinated attention

Coordinated attention was coded when the infant gazed from an object attended to by both partners towards the partner's face, followed immediately by a look back at the same object (Bakeman & Adamson, 1984; Legerstee & Weintraub, 1997; Legerstee et al., 2007). Instances of coordinated attention lasting longer than 5 s were considered extended gazes at the face, and therefore were not coded. (This 5-s duration refers to the time from which the infant looked from the shared object to the partner's face until the time the infant looked back to the same object.) The frequency (number of times) and proportional duration (number of seconds spent in coordinated attention out of the total interaction time) of coordinated attention were calculated for each interaction.

Declarative and imperative pointing

In line with Legerstee & Barillas (2003; see also Franco & Butterworth, 1996), points were defined as partial or full extensions of the arm, hand with the palm down (rather than up), the index finger extended towards an object and the other fingers either loosely or tightly curled with the aim to direct the attention and behavior of another person to an object or event. Points were associated with gaze to the adult within 2 s before/after gesture (Camaioni et al., 2004; Franco & Butterworth, 1996; Leung & Rheingold, 1981).

Definitions of declarative and imperative points were established during pilot work. Coders judged the type of point based on the following criteria: (1) the presence of point hand posture (as defined above), (2) the visual and vocal behaviors associated with the infants' points, and (3) the behaviors following a partner's response/no response to infants' points (see Table 2). Thus, to determine whether such points were declaratives or imperatives, they were defined according to particular clusters of behavior (see Camaioni et al., 2004). Behaviors from each cluster were coded from 2 s before the point until 2 s after the partner's response (or lack of response) to the point. Infant reactions to the partner's response to the infant's point or lack thereof was examined based on evidence of behavioral persistence by infants when their goal is not met (see Franco & Gagliano, 2001). Specifically, if the partner did not respond, infants would probably repeat or modify their behavior according to their communicative goal (i.e., to share attention about, or being given, a toy).

The partner was given 3 s to respond to the infant's point. This was considered adequate time for the partner to notice the infants' communicative attempts before the infant would repeat/modify behavior. A 'failure to respond' was recorded when the partner did not comment or act upon the *pointed at object* within 3 s after the point. In such a case, the infants' behavior within 2 s *after* this failed response time was assessed. These assessments provide valuable information about the communicative goal of the point and, consequently, aided in the classification of points into declaratives or imperatives.

Declarative points

In addition to the description of a point provided above, declarative points were defined as points that were followed by some of the following behaviors: (1) accompanied by visual checking, (2) accompanied by 'speech-like' vocalizations, and (3) followed by specific infant behaviors to partner's response/no response to point.

Visual checking was defined as the first look to a social partner associated with a gesture, which was not elicited by the infant's partner (Franco & Butterworth, 1996; Legerstee et al., 2007). Visual checking is different from coordinated attention in that it involves 'checking' to find out what the person is attending to, whereas a key characteristic of coordinated attention is that both share an interest in a third object and both are aware of the other (Tomasello & Todd, 1983).

Speech-like vocalizations were defined as syllable-like sounds containing varied pitch contours and oral resonance and produced in a relaxed manner in long units (longer than 0.5 s). Although some authors (Blake, McConnell, Horton & Benson, 1992; Franco & Butterworth, 1996) found that the *frequency* of vocalizations did not differentiate between declaratives, imperatives or reaching, Legerstee (1991) and Legerstee & Bowman (1989) have shown that the *quality* of infants' speech sounds differentiates between various contexts in typical infants and infants with Down syndrome. That is, infants produce more speech-like vocalizations when communicating with people about something, but more demand vocalizations when in non-social (facing dolls) or demand situations (requesting an object). In addition, Legerstee & Barillas (2003) found that infants produced significantly more gaze and vocalizations with declaratives than with other types of gestures.

Infant behavior following partner's response (or no response) to declarative points: infants produced at least one of the following behaviors within 2 s after the partner's response: (a) repeated visual checking, and/or (b) a speechlike vocalization. In such an instance, the communicative goal was achieved in that the experience of the object was shared in some way.

Infants displayed one or more of the following behaviors within 2 s after the lack of a response: (a) repeated or modified the point and checked the partner's face before or during the point, and/or (b) produced a speech-like vocalization, or repeated or modified the initial vocalization.

Imperative points

In addition to the description of points provided above, imperative points were defined as points that included one of the following behaviors: (1) 'demand-type' vocalizations, and (2) followed by specific infant behaviors to the partner's response/no response to the point. *Demand-type vocalizations* involved a series of vowel-like sounds that contained uniform pitch and were produced somewhat forced, with effort, and in short units \eh eh\ (approximately 0.5 s) (Legerstee, 1991; Legerstee & Bowman, 1989).

Infant behavior following partner's response (or no response) to imperative points: when the partner responded by giving the infant the object, or acted upon it, the infant's reactions were coded within 2 s after the partner's response: (a) received the object from the partner and manipulated it in some way, and/or (b) watched the object being manipulated by the partner (by *looking at the hands and/or actions of the partner*). Responses (a) and (b) were indicative of an imperative rather than a declarative point because they demonstrate the goal of such a point: to obtain or manipulate an object.

Infants reacted with at least one of the following behaviors within 2 s after the parent *failed* to respond: (a) checked to see whether or not the partner was attending (visual checking); (b) repeated or modified the point (especially pointing repetitively, i.e., two or more times); (c) produced demand vocalizations; (d) *attempted to obtain* or succeeded in obtaining the object themselves (i.e., leaned towards, reached for, crawled to or walked to the object); and/or (e) *manipulated the object* or gave it to the partner to manipulate.

Table 2 summarizes the operational definitions for behaviors included in the coding of declarative and imperative points.

Table 2 Summary of operational definitions for all behaviors included in the coding of declarative and imperative points

Behavior	*Operational definition*
Point	Partial or full extensions of the arm, hand with the palm down, the index finger extended towards an object, and the other fingers either loosely or tightly curled.
Visual checking	First look to social partner within 2 s before or during point or after partner's response (or lack of response); not elicited by partner's redirection.
Speechlike vocalizations	Speech-like preverbal sounds of varied pitch and oral resonance, produced in relaxed manner and in long units (longer than 0.5 s). May accompany declarative points before or during point, or after partner's response (or lack of response).
Demand vocalizations	Non-speech-like preverbal sounds of uniform pitch produced forcedly and in short units (approximately 0.5 s); series of vowel-like sounds (e.g., 'demand' sounds). May accompany declarative points before or during point, or after partner's response (or lack of response).
Attempts to obtain object	Leans to, reaches for, or moves (crawls or walks) to object. May accompany imperative points after partner's response (or lack of response).
Object manipulation	Infant acts on object in some manner, or looks at hands and/or actions of partner manipulating object. May accompany imperative points after partner's response (or lack of response).

Inter-rater reliability

The coders first trained on each behavior independently and then judged each cluster of behavior to be either imperative or declarative. One of the experimenters coded all the data. For reliability, another coder, who was blind to the hypotheses of the study, coded 20% of the data independently. Cohen's κ values were 0.81 for coordinated attention, 0.83 for visual checking, 0.89 for speechlike vocalizations, 0.89 for demand vocalizations, 0.87 for attempts to obtain the object and 0.91 for object manipulation. The coders then judged each of the points as either declarative or imperative. Cohen's κ was 0.83 for declaratives and 0.85 for imperatives.

RESULTS

The present study was designed to measure the *onset* and *development* of the ability of typically developing infants and infants with Down syndrome between 9 and 18 months mean mental age to produce coordinated attention, declarative and imperative pointing. We were interested in the onset of these behaviors, because we predicted that coordinated attention was a precursor to declarative pointing, and hence we had to study infants at a point in time when declaratives and imperatives were not yet part of the infants' repertoires. By comparing these triadic abilities in infants with and without Down syndrome at mental ages where coordinated attention (but not yet declarative and imperative pointing) was beginning to be established in typically developing infants (Bakeman & Adamson, 1984) and MA-matched Down syndrome infants (Legerstee & Weintraub, 1997), significant developmental trends and relations between coordinated attention, and the onset of declarative and imperative pointing were revealed.

Descriptive statistics for Low MA infants (DS; TD) for measures of coordinated attention, and declarative and imperative pointing with each partner and at each visit are listed in Table 3. The corresponding descriptive statistics for High MA infants (DS vs. TD) are listed in Table 4. For both declarative and imperative points, frequencies (the number of points each infant produced) as well as occurrences (number of infants who produced at least one point) were analyzed. We examined occurrences, because the mean frequency of points does not reveal how many infants are able to point, and, consequently, is not an accurate indication of the individual abilities of infants.

Group, visit and partner comparisons

As can be seen from Table 3, both groups of infants had began to produce coordinated attention at visit 1. However, only one infant with DS produced a declarative point (visit 3), and few infants with DS produced imperative points. In contrast, both coordinated attention, and declarative and imperative points were beginning to be produced by High MA infants (see Table 4). Consequently the data of the two MA groups were analyzed separately. Because of the low frequencies of points in the repertoire of Low MA infants with DS, only the frequencies of coordinated attention were submitted to repeated measures ANOVAs. For High MA groups, a set of three ANOVAs were computed on each of the three behaviors. For each ANOVA the within-subjects factors were Visit (1 to 4) and Partner (mother, peer's mother, peer), and the between-subjects factor was Group (DS vs. TD). While both frequency and proportional duration measures were used as measures of coordinated attention, only the frequencies of declarative and imperative points were used in the ANOVAs. Comparison of group, visit and partner regarding the occurrence of imperative and declarative points in TD infants and infants with DS was assessed with a non-parametric chi-square analysis. Specifically, a chi-square analysis was used to compare the occurrence of a behavior between infants with DS and TD infants. A Cochran *Q*-test was computed to compare the occurrence of a behavior between ages and with different partners. If the Cochran *Q*-test revealed significant values, pairwise comparisons were computed using the McNemar test.

Low MA infants

Frequency of coordinated attention

A comparison of the frequency of coordinated attention between Low MA infants with DS and TD infants revealed a main effect for partner, $F(2, 26) = 3.680$, $p = 0.039$.

Table 3 Means (and *SD*s) for all behaviors of Low MA infants: Down syndrome (DS) and typically developing (TD)

Measures	*DS (n = 10)*			*TD (n = 9)*		
	M	*PM*	*P*	*M*	*PM*	*P*
Coordinated attention						
Frequency						
Visit 1	1.400	1.200	0.500	3.780	6.000	5.220
	(1.506)	(1.874)	(0.527)	(2.682)	(3.674)	(3.073)
Visit 2	1.700	1.600	0.800	5.500	4.500	3.250
	(1.567)	(1.350)	(1.033)	(2.828)	(2.673)	(2.605)
Visit 3	1.860	1.570	0.000	3.440	6.220	4.330
	(1.345)	(1.813)	(0.000)	(2.789)	(2.635)	(1.414)
Visit 4	2.200	1.800	0.900	4.250	5.750	4.880
	(1.135)	(1.549)	(1.287)	(2.550)	(3.454)	(2.800)
Proportional duration						
Visit 1	0.012	0.008	0.005	0.028	0.041	0.043
	(0.012)	(0.012)	(0.006)	(0.018)	(0.030)	(0.023)
Visit 2	0.012	0.014	0.007	0.042	0.044	0.028
	(0.012)	(0.015)	(0.008)	(0.020)	(0.027)	(0.025)
Visit 3	0.012	0.010	0.000	0.019	0.058	0.044
	(0.008)	(0.013)	(0.000)	(0.019)	(0.029)	(0.014)
Visit 4	0.014	0.015	0.007	0.034	0.051	0.044
	(0.008)	(0.013)	(0.012)	(0.036)	(0.028)	(0.017)
Declarative pointing						
Frequency						
Visit 1	0.000	0.000	0.000	0.000	0.330	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.707)	(0.000)
Visit 2	0.000	0.000	0.000	0.630	0.250	0.000
	(0.000)	(0.000)	(0.000)	(1.408)	(0.463)	(0.000)
Visit 3	0.000	0.000	0.140	0.670	0.110	0.220
	(0.000)	(0.000)	(0.378)	(1.414)	(0.333)	(0.441)
Visit 4	0.000	0.000	0.000	0.130	0.250	0.130
	(0.000)	(0.000)	(0.000)	(0.354)	(0.463)	(0.354)
Occurrence						
Visit 1	0	0	0	0	2	0
Visit 2	0	0	0	2	2	0
Visit 3	0	0	1	2	1	2
Visit 4	0	0	0	1	2	1

(*continued*)

Table 3 (*continued*)

Measures	*DS (n = 10)*			*TD (n = 9)*		
	M	*PM*	*P*	*M*	*PM*	*P*
Imperative pointing						
Frequency						
Visit 1	0.100 (0.316)	0.000 (0.000)	0.100 (0.316)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Visit 2	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.130 (0.354)	0.000 (0.000)
Visit 3	0.140 (0.378)	0.000 (0.000)	0.000 (0.000)	0.330 (0.707)	0.110 (0.333)	0.000 (0.000)
Visit 4	0.200 (0.422)	0.300 (0.483)	0.100 (0.316)	0.130 (0.654)	0.250 (0.463)	0.000 (0.000)
Occurrence						
Visit 1	1	0	1	0	0	0
Visit 2	0	0	0	1	2	1
Visit 3	1	0	0	2	1	0
Visit 4	2	3	1	2	1	2

Note. M = interaction with mother; PM = interaction with peer's mother; P = interaction with peer

According to post-hoc tests with a Bonferroni correction, coordinated attention was more frequently produced to the peer's mother than the other partners ($p = 0.027$); see Fig. 1.

Proportional duration of coordinated attention

No significant interactions or main effects resulted from a comparison of the proportional duration of coordinated attention between Low MA infants with DS and TD infants (see Table 3 for these descriptive statistics).

High MA infants

Frequency of coordinated attention

A comparison of the frequencies of coordinated attention of high MA groups yielded a significant Visit x Group interaction, $F(3, 48) = 2.900$, $p = 0.044$. Further analyses revealed that TD infants engaged in significantly more coordinated attention than infants with DS at visit 1 ($F(1, 20) = 39.820$, $p < 0.001$), visit 2 ($F(1, 18) = 21.183$, $p < 0.001$) and visit 3 ($F(1, 19) = 12.197$, $p = 0.002$). By the fourth visit, there was no significant group difference (see Fig. 2). Thus, although high MA infants with DS produced less coordinated attention at the beginning of the study, this difference disappeared at visit 4.

Table 4 Means (and *SD*s) for all behaviors by High MA infants: Down syndrome (DS) and typically developing (TD)

Measures	*DS (n = 11)*			*TD (n = 11)*		
	M	*PM*	*P*	*M*	*PM*	*P*
Coordinated attention						
Frequency						
Visit 1	2.180	2.360	0.100	4.180	6.820	4.910
	(1.779)	(1.286)	(0.316)	(2.601)	(3.250)	(2.587)
Visit 2	2.360	2.640	1.180	4.440	5.670	3.330
	(1.567)	(2.420)	(1.168)	(2.877)	(3.873)	(2.872)
Visit 3	3.100	2.000	1.700	3.730	7.000	4.450
	(2.846)	(2.108)	(1.636)	(2.102)	(4.690)	(2.622)
Visit 4	3.090	4.450	0.820	4.090	4.270	2.550
	(3.270)	(3.532)	(1.168)	(2.508)	(1.849)	(2.296)
Proportional duration						
Visit 1	0.017	0.015	0.000	0.038	0.052	0.043
	(0.015)	(0.010)	(0.001)	(0.032)	(0.026)	(0.025)
Visit 2	0.016	0.019	0.007	0.034	0.041	0.023
	(0.011)	(0.015)	(0.008)	(0.024)	(0.025)	(0.019)
Visit 3	0.019	0.012	0.012	0.027	0.059	0.035
	(0.017)	(0.012)	(0.011)	(0.020)	(0.039)	(0.025)
Visit 4	0.026	0.028	0.004	0.025	0.035	0.023
	(0.036)	(0.030)	(0.006)	(0.018)	(0.022)	(0.020)
Declarative pointing						
Frequency						
Visit 1	0.000	0.000	0.000	0.180	0.730	0.000
	(0.000)	(0.000)	(0.000)	(0.405)	(0.905)	(0.000)
Visit 2	0.000	0.090	0.000	0.220	1.330	0.220
	(0.000)	(0.302)	(0.000)	(0.441)	(2.500)	(0.441)
Visit 3	0.000	0.200	0.100	1.640	0.450	0.180
	(0.000)	(0.422)	(0.316)	(2.014)	(0.688)	(0.603)
Visit 4	0.090	0.300	0.000	0.730	0.910	0.000
	(0.302)	(0.640)	(0.000)	(1.191)	(1.221)	(0.000)
Occurrence						
Visit 1	0	0	0	2	5	0
Visit 2	0	1	0	2	3	2
Visit 3	0	2	1	6	4	1
Visit 4	1	2	0	4	5	0

(*continued*)

Table 4 (*continued*)

Measures	*DS (n = 11)*			*TD (n = 11)*		
	M	*PM*	*P*	*M*	*PM*	*P*
Imperative pointing						
Frequency						
Visit 1	0.090 (0.302)	0.090 (0.302)	0.100 (0.316)	0.000 (0.000)	0.360 (0.505)	0.180 (0.603)
Visit 2	0.090 (0.302)	0.550 (1.214)	0.000 (0.000)	0.440 (0.726)	0.110 (0.333)	0.000 (0.000)
Visit 3	0.200 (0.422)	1.500 (2.121)	0.100 (0.316)	0.180 (0.603)	0.360 (0.674)	0.090 (0.302)
Visit 4	1.090 (2.468)	0.820 (1.328)	0.000 (0.000)	0.550 (1.214)	0.360 (0.674)	0.090 (0.302)
Occurrence						
Visit 1	1	1	1	0	4	1
Visit 2	1	3	0	3	1	0
Visit 3	2	5	1	1	3	1
Visit 4	3	3	4	3	3	1

Note. M = interaction with mother; PM = interaction with peer's mother; P = interaction with peer

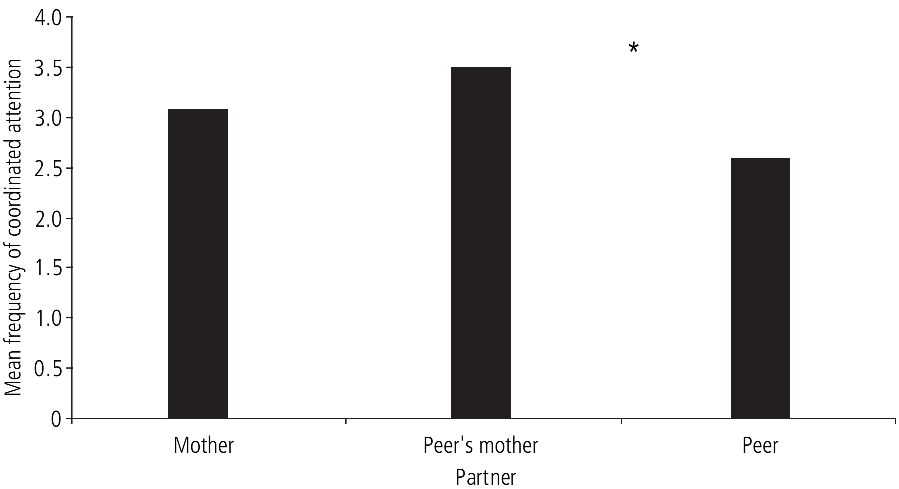

Figure 1 Mean frequency of coordinated attention of the Low MA groups as a function of partner (* $p < 0.05$)

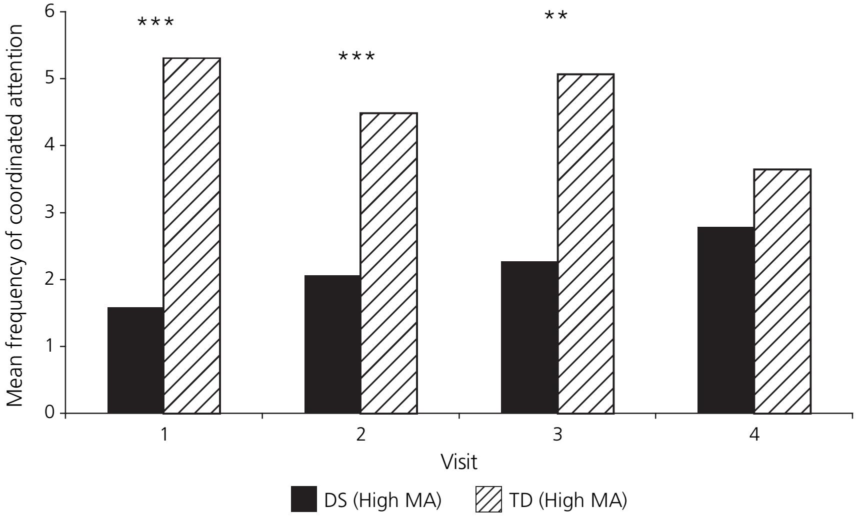

Figure 2 Mean frequency of coordinated attention of the High MA group as a function of visit (** $p < 0.01$; *** $p < 0.001$)

Subsequent analyses examining differences between visits revealed that the frequency of coordinated attention of High MA TD infants and infants with DS did not change significantly from one visit to the next.

The ANOVA also revealed a significant main effect for partner, $F(2, 32) = 7.549$, $p = 0.008$. Post-hoc comparisons with a Bonferroni correction indicated that the infants engaged in significantly more coordinated attention with the peer's mother than with the mother ($p = 0.014$) or the peer ($p = 0.007$). Thus High MA infants were most likely to engage in coordinated attention when their partner was a less familiar adult (i.e., the peer's mother).

Proportional duration of coordinated attention

There was a significant Group x Visit x Partner interaction, $F(6, 11) = 4.363$, $p = 0.017$. Subsequent analyses assessing differences between infant groups did not reveal a difference between infants with DS and TD infants in the amount of time spent in coordinated attention during interactions with their mothers' (see Fig. 3).

During interactions with the peer's mother, TD infants spent more time in coordinated attention than infants with DS; however, this group difference seemed to decrease with age (visit 1: $F(1, 16) = 10.970$, $p = 0.004$; visit 2: $F(1, 16) = 4.330$, $p = 0.054$; visit 3: $F(1, 16) = 12.578$, $p = 0.003$; visit 4: $F(1, 16) = 0.174$, $p = 0.682$).

Figure 3 shows that at all visits TD infants spent significantly more time in coordinated attention with the peer than did infants with DS (visit 1: $F(1, 16) = 19.296$, $p < 0.001$; visit 2: $F(1, 16) = 5.734$, $p = 0.029$; visit 3: $F(1, 16) = 5.630$, $p = 0.031$; visit 4: $F(1, 16) = 6.379$, $p = 0.022$).

Further analyses examining differences between visits showed that the duration of coordinated attention, like the frequency of coordinated attention, did not

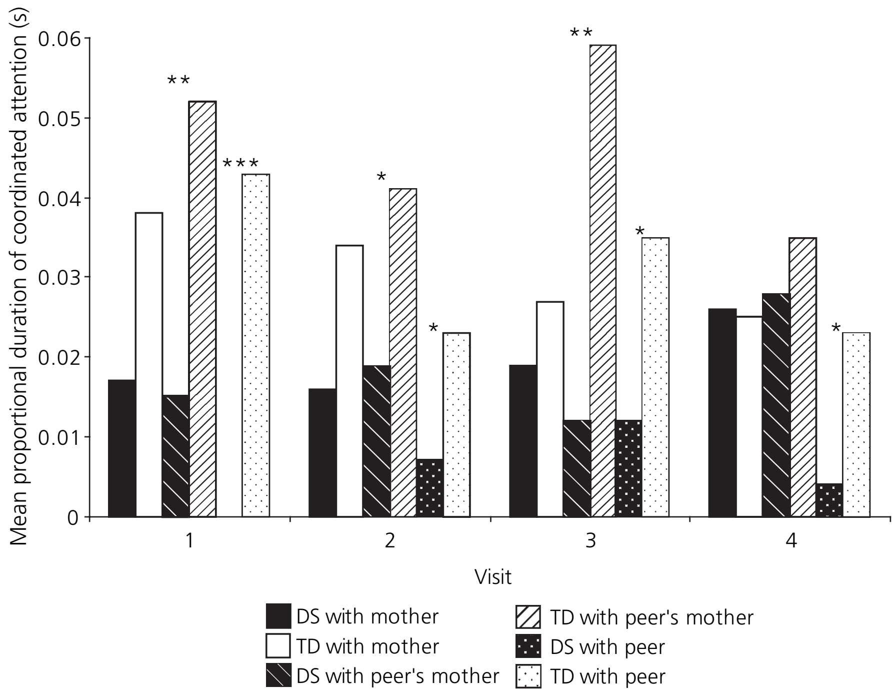

Figure 3 Mean proportional duration of coordinated attention of the High MA group as a function of partner and visit (* $p \leq 0.05$; ** $p < 0.01$; *** $p < 0.001$)

change significantly from one visit to the next. This was the case for High MA infants regardless of chromosomal group

Subsequent analyses examining differences between partners showed that while High MA infants with DS spent the same amount of time in coordinated attention with all partners, High MA TD infants spent significantly more time coordinating attention with the peer's mother than with the mother ($p = 0.006$).

Frequency of declarative points

A repeated-measures ANOVA comparing the frequency of declarative points between high MA groups revealed a significant Partner x Group interaction, $F(2, 32) = 2.657$, $p = 0.013$. Further analyses between infant groups showed that TD infants produced more declarative points than infants with DS during interactions with the mother ($F(1, 20) = 14.245$, $p < 0.001$) and the peer's mother ($F(1, 20) = 16.820$, $p = 0.001$), but not during interactions with the peer.

Subsequent analyses between partners showed that while High MA infants with DS produced the same amount of declarative points with all partners, the frequencies produced by High MA TD infants varied as a function of partner. Specifically, TD infants produced more declaratives with the peer's mother than with the peer ($p = 0.008$); see Fig. 4.

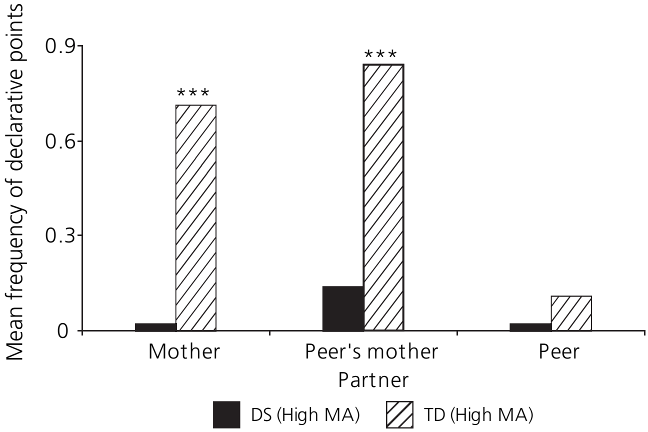

Figure 4 Mean frequency of declarative points of the High MA group as a function of partner (*** $p = 0.001$)

Occurrence of declarative points

To compare the number of High MA TD infants with the number of High MA infants with DS who produced a declarative point, a chi square analysis was used. An analysis of the overall occurrence (i.e., at least one declarative point at any time in the study) and an analysis of the occurrence at each visit separately were not suitable because more than 20% of the cells had an expected count smaller than 5. This was the same when the occurrences with the peer's mother or peer were analyzed. However, the occurrence of declarative points with the mother (i.e., at least one point with the mother at any time in the study) was a suitable analysis. Consequently, the chi-square analysis specifically compared the number of infants in each group who produced a declarative point *with the mother*. Significantly more TD infants pointed declaratively than infants with DS during interactions with their mothers ($\chi^2(1, N = 22) = 11.733$, $p = 0.001$). Figure 5 illustrates this group difference for declarative pointing by High MA infants.

When comparing the occurrence of declarative pointing with each partner, a Cochran *Q*-test indicated that the number of High MA infants who pointed declaratively was significantly different across partners, $Q(2) = 14.533$, $p = 0.001$. Follow-up McNemar pairwise comparisons revealed that significantly more infants pointed declaratively with the peer's mother than with the peer ($p < 0.001$).

Frequency of imperative points

A repeated-measures ANOVA assessing the frequency of imperative points of High MA infants yielded a main effect for partner, $F(1.455, 23.278) = 3.904$, $p = 0.046$. Pairwise comparisons indicated that more imperative points were produced during interactions with the peer's mother than with the peer ($p = 0.025$); see Fig. 6.

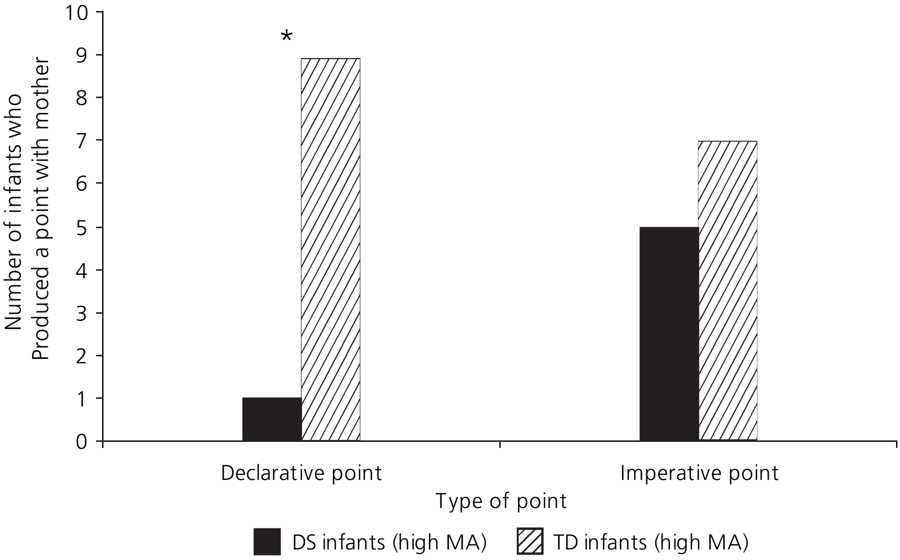

Figure 5 Occurrences of declarative and imperative points of the High MA infants with their mother (* $p < 0.05$)

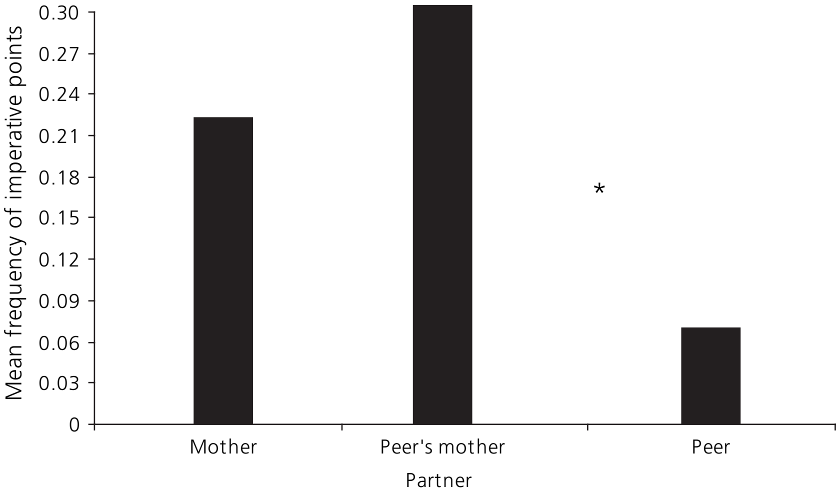

Figure 6 Mean frequency of imperative points of the High MA group as a function of partner (* $p < 0.05$)

Occurrence of imperative points

A chi-square analysis was used to compare the number of High MA TD infants with the number of High MA infants with DS who produced an imperative point with the mother. There was no significant difference as a result of this analysis.

A comparison of the occurrence of imperative pointing with each partner using a Cochran *Q*-test indicated that the number of High MA infants who pointed imperatively was significantly different across partners, $Q(2) = 10.308$, $p = 0.006$. Follow-up McNemar pairwise comparisons revealed that significantly more infants produced an imperative point with the mother ($p = 0.039$) and the peer's mother ($p = 0.012$) than with the peer.

Coordinated attention in relation to declarative and imperative pointing

To investigate the link between coordinated attention and declarative pointing and between coordinated attention and imperative pointing, the variables were first correlated for all High and Low MA infants from both chromosomal groups. Initially, the mean frequencies of coordinated attention at visit 1, 2, 3, 4 were correlated with the mean frequencies of declarative and imperative points at visit 4. Because the youngest infants were 14 months chronological age by the final visit, we expected that most infants would point by then (see Legerstee & Barillas, 2003; Liszkowski et al., 2004). Tables 3 and 4 show that all infant groups had pointed at least once by visit 4. Of these, 1 High TD infant, 1 Low TD infant, 3 High infants with DS, and 4 Low infants with DS had not pointed by the fourth visit. Frequency rather than occurrence measures were used in the regression, in order to maintain a continuous measurement across the predictor and dependent variables.

Table 5 Correlations between frequencies of: (a) coordinated attention (at each visit) and point type at visit 4, and between (b) coordinated attention (at each visit and with mother) and point type at visit 4

Measurement of coordinated attention	*Declarative points at visit 4*	*Imperative points at visit 4*
Mean coordinated attention at visit 1 ($n = 40$)	0.361*	−0.001
Mean coordinated attention at visit 2 ($n = 38$)	0.362*	0.061
Mean coordinated attention at visit 3 ($n = 36$)	0.368*	0.084
Mean coordinated attention at visit 4 ($n = 40$)	0.223	0.245
Coordinated attention with mother at visit 1 ($n = 40$)	0.494**	0.044
Coordinated attention with mother at visit 2 ($n = 38$)	0.393*	−0.035
Coordinated attention with mother at visit 3 ($n = 36$)	−0.101	−0.126
Coordinated attention with mother at visit 4 ($n = 40$)	0.145	0.275

* $p < 0.05$; ** $p < 0.01$

Results showed that coordinated attention at visits 1, 2 and 3 was significantly correlated with declarative pointing at visit 4. No such correlations were found between coordinated attention at any visit and imperative pointing at visit 4 (see Table 5).

To investigate which partner and visit combination correlated with declarative and imperative pointing at visit 4, the mean frequencies of coordinated attention at visits 1, 2, 3 and 4 were further collapsed according to partner. Coordinated attention with the mother during the first 2 visits was significantly correlated with infants' declarative but not imperative pointing at visit 4, and coordinated attention with the peer's mother at visit 3 was correlated with declarative pointing at visit 4, $r(36) = 0.541$, $p = 0.001$. Table 5 shows the correlations between: (a) coordinated attention (at each visit) and pointing at visit 4, and between (b) coordinated attention (at each visit, with the mother) and pointing at visit 4.

Two subsequent hierarchical regressions were run using coordinated attention with the mother in visits 1–4 as the predictor variables. The first hierarchical regression was conducted to assess at which visit coordinated attention with the mother predicted declarative pointing at visit 4. A summary of the regression steps and results is presented in Table 6, which shows that coordinated attention with the mother at the first visit significantly predicted declarative pointing, $F(1, 32) = 9.368$, $p = 0.004$. Specifically, 23% of the variance in declarative pointing at visit 4 was predicted by coordinated attention with the mother at visit 1. Thus, infants who frequently engaged in coordinated attention with their mothers at the beginning of the study frequently produced declarative points 8 months later.

Table 6 Summary of hierarchical regression for frequency variables predicting frequency of declarative pointing at visit 4 ($N = 34$)

Predictor variables	*B*	*SE B*	*ß*
Step 1			
Coordinated attention with mother at visit 1	0.092	0.030	0.476**
Step 2			
Coordinated attention with mother at visit 1	0.075	0.037	0.388*
Coordinated attention with mother at visit 2	0.023	0.030	0.149
Step 3			
Coordinated attention with mother at visit 1	0.065	0.037	0.339
Coordinated attention with mother at visit 2	0.041	0.032	0.268
Coordinated attention with mother at visit 3	−0.044	0.028	−0.259
Step 4			
Coordinated attention with mother at visit 1	0.067	0.038	0.346
Coordinated attention with mother at visit 2	0.042	0.032	0.271
Coordinated attention with mother at visit 3	−0.043	0.029	−0.254
Coordinated attention with mother at visit 4	−0.005	0.026	−0.030

Note. $R^2 = 0.226$ for step 1; $\Delta R^2 = 0.014$ for step 2; $\Delta R^2 = 0.057$ for step 3; $\Delta R^2 = 0.001$ for step 4.
* $p = 0.055$; ** $p = 0.004$

In order to examine whether this relation was applicable to all infant groups, an ANOVA was conducted with declarative points at visit 4 as the dependent variable, group (DS Low, DS High, TD Low, TD High) as a between-subjects factor, and coordinated attention with the mother at visit 1 as a covariate. There was no significant interaction between group and coordinated attention, nor was there a main effect for group, indicating that early coordinated attention with the mother predicted later declarative pointing in the same manner for all infant groups (i.e., Low MA infants with DS, High MA infants with DS, Low MA TD infants, and High MA TD infants).

The second hierarchical regression was conducted to assess at which visit coordinated attention with the mother predicted imperative pointing at visit 4. Results showed that, unlike declarative pointing, coordinated attention with the mother at the first visit was not a significant predictor of imperative pointing at any visit. A univariate ANOVA with imperative points at visit 4 as the dependent variable, group as a between-subjects factor, and coordinated attention with the mother at visit 1 as a covariate indicated that the *lack* of relationship between imperative pointing and early coordinated attention with the mother was the same for all four infant groups.

Summary of results

The results showed that there was no effect of chromosomal group in the production of coordinated attention in Low MA infants. However, an effect of partner revealed that Low MA infants produced more coordinated attention with the peer's mother than with the peer. In contrast, there was a significant effect of chromosomal group in the production of coordinated attention in the High MA infants. TD infants produced more coordinated attention than infants with DS at visits 1, 2 and 3, but not at visit 4. Thus, although High MA infants with DS may have shown delays in the amount of coordinated attention they produced in the beginning of the study, they were comparable at the final visit.

There was an effect of chromosomal group for declarative pointing. Whereas Low and High MA infants with DS produced few declarative and imperative points, and did not differentiate their pointing as a function of partner, High MA TD infants produced more declarative points with adults than with peers. As predicted, there was no effect of chromosomal group on imperative pointing. However, there was an effect of partner; infants produced more imperative points with the peer's mother than with the peer.

Interestingly, coordinated attention at visits 1, 2 and 3 correlated with declarative pointing at visit 4. Regression analyses revealed that coordinated attention at visit 1 with the mother predicted declarative pointing at visit 4. No such findings were found for imperative pointing.

DISCUSSION

The present study was conducted to compare the development of the ability of typically developing infants and infants with Down syndrome between 9 and 18 months mean mental age to engage in coordinated attention, point to objects for the purpose of sharing attention about interesting aspects of the object (declaratives), and point to objects for the purpose of obtaining them (imperatives) during naturalistic observations. Infants were observed in a study designed to provide a thorough assessment of the onset and development of the target behaviors, in situations where objects were within and outside the reach of the infants, which provided ample opportunities for infants to coordinate attention between objects and partners, and to produce imperative and declarative points. By comparing these triadic abilities in infants with and without Down syndrome at mental ages where coordinated attention (but not yet declarative and imperative pointing) was beginning to be established in typically developing infants (Bakeman & Adamson, 1984) and MA-matched Down syndrome infants (Legerstee & Weintraub, 1997), significant novel developmental trends and relations between coordinated attention and declarative and imperative pointing were revealed. As a result, several important issues regarding the ability to share experiences in both infants with Down syndrome and typically developing infants were approached.

As expected, all infants produced coordinated attention at the onset of the study. However, probably as a result of the few occurrences in Low MA infants ($M = 9$ months), coordinated attention was not differentiated as a function of chromosomal group. Overall, the infants coordinated attention more with the peers' mothers than peers. With an increase in MA, the production of coordinated attention increased. Typically developing infants with a High MA ($M = 18$ months) produced significantly more coordinated attention at the first three visits, but not the fourth visit compared with infants with DS. Others have also found that sharing attention over objects is delayed in infants with DS when this capacity is still developing (see Beeghly et al., 1990; Jones, 1980; Legerstee & Weintraub, 1997). What factor(s) contributes to this apparent initial delay in coordinated attention? Infants with DS show less active involvement with toys than typically developing infants (Gunn et al., 1982; Kasari, Mundy, Yirmiya & Sigman, 1990; Krakow & Kopp, 1983; Landry & Chapieski, 1990; Legerstee & Weintraub, 1997; MacTurk, Vietze, McCarthy, McQuistin & Yarrow, 1985). In addition, infants with DS show significant and measurable delays on specific nonsocial measures in the early months of life. They take longer to habituate and have poorer visual recognition memory than typically developing infants (Fantz, Fagan & Miranda, 1975). It is likely that the infants' atypical functioning in the nonsocial domain produces problems in the subsequent interaction phase. That is, if infants with DS lack interest in salient objects that are potentially interesting and worth sharing, they are not likely to attempt to share them with others (O'Neill & Happe, 2000).

It is interesting that the difference in the production of coordinated attention decreased at the fourth visit for the typically developing infants. This is consistent with a recent finding that typically developing children began to rely less on nonverbal behaviors because they were beginning to talk (Legerstee et al., 2002). However, whereas TD infants with a high MA produced more declarative points, in particular when interacting with adults than with peers, high MA infants with DS produced low frequencies with all partners. Thus, towards the end of the study, infants with DS displayed rather good strength in nonverbal social interaction skills, but still a significant deficit in communicative gestures involving the sharing of objects (see also Mundy et al., 1988).

In support of the 'joint attention hypothesis' (Camaioni, 1993), coordinated attention predicted declarative but not imperative pointing for the four mental ages and infant groups studied. Surprisingly, although it has been claimed that coordinated attention is 'the impelling force behind early indicating forms of communication' (Bruner, 1981: 162), no past research has specifically investigated the relation between coordinated attention and declarative pointing, nor between coordinated attention and other types of indicating such as imperative pointing. The finding that coordinated attention is a precursor to declarative pointing suggests that the ability to alternate gazes back and forth between a person and an object during social interaction and the ability to direct someone's attention to an interesting event through pointing (declaratives) are part of a continuous process and reflect an increasing awareness that interesting aspects about external events can be exchanged between people. Specifically, the infants' propensity to monitor the gazes of others while pointing indicates an awareness of the effects their gestures have on people (Bates et al., 1975). Such attentiveness requires that infants recognize people as intentional agents with whom they can share experiences. The data further show that coordinated attention was not linked to the production of imperative points, supporting our predictions and that of others (Greenwald & Leonard, 1979) that the developmental pattern of the production of imperative points is different from that of declaratives.

The idea that coordinated attention and declarative pointing reveal an awareness of simple mental states is supported by research involving children with autism who have difficulty understanding how mental states govern behavior. Children with autism fail to make eye contact as a means of commenting about the state of the world (e.g., 'Look, that's a nice toy'). In addition, they rarely point to direct people's attention to interesting sights, or follow points of others (Baron-Cohen et al., 1996). Like children with DS, children with autism do not have particular difficulties with imperative pointing. Therefore, they seem to understand their partners as causal agents, but not as intentional agents, with whom they may share experiences (Mundy, Sigman & Kasari, 1990). In fact, impairments in coordinated attention are among the earliest signs of autism, and coordinated attention and declaratives, but not imperatives, are positively related to language gains in these infants (Charman, 2003). However, the development of coordinated attention is less impaired in higher functioning infants with DS, compared with infants with autism, but more impaired compared with typically developing infants. As a result, infants with Down syndrome show a reduction in preverbal gestures, but infants with autism often show a complete absence of these behaviors (Sigman & Ruskin, 1999).

Mundy et al. (1988) found that object-requesting skills were significantly associated with a measure of expressive language in infants with Down syndrome, and suggested that a deficit in expressive language is associated with earlier developing nonverbal communicative gestures in these infants. Iverson et al. (2003) attributed the significantly lower production of gestures by infants with Down syndrome and their subsequent delay in two-word utterances to the deficits in early gestural communication. These findings suggest that delays in the development of coordinated attention and prelinguistic referential gestures during the preverbal period may shed light on language delays in children with DS later in development.

We found that coordinated attention, and declarative and imperative points had higher frequencies and occurrences during interactions with adult partners (i.e., the mother and peer's mother) than with the peer for both TD infants and infants with DS. These findings support those of other studies (Bakeman & Adamson, 1984; Legerstee & Weintraub, 1997; Legerstee et al., 2002) which found differences in coordinated attention between adult and peer conditions. The authors suggested that adults are better able to support sharing attention over toys because adults appear more able and willing to structure the interaction: 'They may provide predictable repeating patterns of actions as they interact with infants, patterns that may have developmental roots in the person-focused games of earliest infancy' (Bakeman & Adamson, 1984: 1287).

It is especially noteworthy that coordinated attention with mothers, when the participants were first visited, predicted the frequency of declarative pointing at the last visit. Recent research showed that the degree to which mothers synchronize their own attention with that of their children at 3 months predicted coordinated attention at 10 months in typically developing infants (Legerstee et al., 2007), and child language 16 years later in children with autism (Siller & Sigman, 2002). Other studies found that maternal scaffolding influences infants' mentalizing abilities. Mothers who treat their infants as intentional beings support infant awareness that people are intentional agents (Meins, 1997). Indeed, maternal responsiveness during the first six months predicts the size of speaking vocabulary later on (Ruddy & Bornstein, 1982), and maternal interactive skills predict infants' attention span and symbolic play, such as pretense, at 13 months (Bornstein & Tamis-LeMonda, 1997). When mothers rank low on maintaining infant attention and on sensitive and contingent play, infants also tend to score low on social interaction and coordinated attention during the last quarter of the first year (Goldsmith & Rogoff, 1997; Legerstee et al., 2002). These findings suggest that maternal behaviors, such as maintaining infant attention, responsiveness, affect attunement and mental state language, are mechanisms that promote infant sociocognitive abilities.

Communication with partners and the use of language as a tool for representing mental states is only possible when both participants can mentalize, and, although at some point in development, language and theory of mind appear to be individual abilities, research into their development suggests that they are products, in part, of prior social interactions (Hatano, 2004; see also Thoermer & Sodian, 2001). Structured and conventional formats (see Bruner, 1995), where mothers support their infants attentional focus through play, allow infants to move from simple triadic interactions where interesting aspects of objects are shared with both participants looking at the object, to complex triadic interactions where the attention of the participant is directed to an object the partner is not yet attending to, through the use of declarative points. Thus, infants progress from 'tuning into' mothers and the objects in which they are interested to actively attempting to get others to 'tune into' objects they themselves find interesting.

These findings support the social interactionist view of language. The zone of proximal development (Vygotsky, 1978), provides a framework in which parental attempts to develop a child's understanding of mind may be scaffolded through the parental use of certain experiences that bootstrap understanding of mental activities such as sharing attention over objects.

Interestingly, although typically developing infants and infants with Down syndrome, of high mental ages, produced significantly more coordinated attention and declarative points with adults than with the peer, they produced more imperatives with the peer's mother than with their own mother. This finding suggests that infants have developed more stable routines with their mothers than with the female strangers. When engaging in a familiar pattern of play, infants produce less checking and requesting than when in novel situations (Bruner, 1981, 1995, 1999). The continuous interactional conventions infants develop with their caretakers provide infants with a 'template' for interacting in the world, and for sharing experience with other people. Eventually, infants are likely to extend the knowledge they gain from highly scaffolded interactions with their mothers to new contexts and people (Hobson et al., 2004; Vygotsky, 1978).

Overall, infants with DS were not similarly influenced by their partner in terms of time spent in coordinated attention and declarative points as typically developing infants. Thus, there may be limitations in how much parents are able to support the production of coordinated attention and declarative pointing in infants with DS. These findings support Vygotsky's (1978) theory of intermental and intramental planes of knowing, namely that the influence of the social environment remains constrained by the infants' developmental levels.

Interestingly, although infants of both groups produced more coordinated attention and pointing with adults than with peers, the data show that both infants with Down syndrome and typically developmental infants with a mean MA of 9 months communicated with each other, either with the use of imperatives or declaratives. This is the first time that this effect has been shown in 9- to12-month-old infants. Although the rate of pointing is very low and, admittedly, statistical analyses remain difficult, the frequencies of pointing (see Table 3) not only in the typically developing infants but also those with Down syndrome has not been shown before and should be replicated in more controlled situations.

Taken together, the results of the present study support Camaioni's (1993) 'joint attention' hypothesis, which postulates that declarative and imperative pointing are supported by different sociocognitive abilities. That is, pointing to share psychological experiences about things external to the dyad is more complex than using the person as a tool to obtain objects. Coordinated attention and declarative pointing require a basic understanding that people are psychological beings with whom experience can be shared (Camaioni, 1993; Camaioni et al., 2004; Legerstee & Barillas, 2003; Sugarman-Bell, 1978; Zinober & Martlew, 1985) and are precursors to later language development (Charman et al., 2000).

The present study has further provided empirical support for suggestions and ideas about the interactive strategies for the acquisition and production of nonverbal communicative behaviors as proposed by various authors (Bruner, 1983; Fogel, 1993; Vygotsky, 1978). These authors have suggested that adults who scaffold infants' earliest communicative intentions promote these abilities. By examining our hypotheses in a naturalistic and longitudinal play study we have found support for this theorizing. Consequently, the present study is directly relevant to the issue regarding which skills are foundational for later cognitive and communicative abilities and the mechanisms that promote their development. However, even though these developmental processes are becoming better understood, there is a need to continue the study of the development of coordinated attention, its relation to nonverbal and verbal abilities, and the mechanisms that promote such development in a variety of child populations, in order to deepen the potential for intervention (Charman, 2003).

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