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Effects of maintaining and redirecting infant attention on the production of referential communication in infants with and without Down syndrome*

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ABSTRACT

The effects of maternal interactive styles on the production of referential communication were assessed in four groups of infants whose chronological ages ranged between 0;6 and 1;8. Two groups of infants with Down syndrome (DS), one ($n = 11$) with a mean mental age (MA) of 0;8.6, and the other ($n = 11$) of 1;4.5, were matched on MA with two groups ($n = 10$ each) of typically developing infants. Infants were seen bi-monthly, for 8 months, with mothers, same-aged peers, and mothers of the peers. Results showed that High MA non-Down syndrome (ND) infants produced more words, and High MA DS infants produced more gestures when playing with mothers than peers. Mothers exhibited more attentional maintaining behaviours than peers, in particular to High MA infants, but they redirected the attentional focus of Low MA infants more. Sequential loglinear analyses revealed interesting contingencies between the interactive strategies of mothers and the referential communicative behaviours of their infants. Whereas maintaining attention increased, redirecting attention decreased the likelihood of the production of gestures and words in children. However, redirecting attention was followed by maintaining attention. Thus, mothers redirect the attentional focus in order to promote joint attention and referential communication. Furthermore, words and gestures of the children also promote joint attention in mothers. This highlights the reciprocal nature of these dynamic communicative interactions.

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INTRODUCTION

In the beginning, infants communicate with eye contact, emotions, prelinguistic vocalizations and gestures, while adapting the rhythm of their interactions to that of their caretakers (Trevarthen, 1979). As infants mature, they become increasingly sophisticated in their interaction skills. They express their intentions through coordinating their eye contact with various gestures and vocalizations to request help from people in obtaining objects, or to direct people's attention to interesting events (Bakeman & Adamson, 1984; Legerstee & Weintraub, 1997). Around 1;0, typically developing infants achieve a major linguistic milestone. They begin to use referential language (words) to refer to objects (Nelson, 1973; Carpenter, Nagel & Tomasello, 1998). Theoreticians have proposed different developmental paths for the acquisition of language in infants. For instance, Chomsky (1965) posits that because the language that children hear does not provide enough information for them to learn the abstract structures of Generative Grammar, they must have an innate Language Acquisition device. Markman (1989), however, argues that even for lexical acquisition, infants need to have innate linguistic knowledge in order to learn the meaning of words.

Alternatively, social interactionists believe that language acquisition is not the work of the child alone. These authors define language more socially and cognitively and propose that its acquisition should be understood in relation to the social and cognitive abilities of children. They focus on the richly structured social/cultural environment in which children live, and argue that it is this structure that enables human infants to learn language. Thus, language is seen as a cultural skill and is similarly acquired, in dyadic and triadic relationships (e.g. Vygotsky, 1978; Bruner, 1982). For instance, Bruner (1982) proposes that early parent–infant interactions occur within common 'formats' or 'routines' where infants and caregiver are jointly attending to the same object or event, such as book reading or object play. During these routines children maintain a common focus of attention with their partners. They readily perceive what the object of attention is for the adult, which makes the task of determining reference easier for children. Even after infants begin to use words, their word learning continues to benefit from such joint attentional episodes (see Carpenter *et al.*, 1998, for a review).

Typically developing infants show a well-documented developmental pattern of their ATTENTIONAL skills during the first and second year of life. They progress from visually examining objects or people, to interacting with either a person or an object around 0;6, to an intermediate state (passive joint) between 0;6 and 0;9 (where mother and child share toys, but the infant shows no awareness of the mother), to the prelinguistic communicative state between 0;9 and 1;0, where infants coordinate their attention to both the

person and an object with which the person is involved (Bakeman & Adamson, 1984). Interestingly, when interacting with mature communicators (mothers), infants produced more coordinated attention 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, p. 1278). These results indicate that the social environment plays an important role in the development of these skills.

Hence, by 0;9, infants are beginning to engage in triadic interactions (I-thou-it) that enable them to participate in the cultural activities that make language acquisition possible. Trevarthen (1979) argues that infants are capable of these behaviours because they have developed secondary intersubjectivity, e.g. the ability to share with others things that they perceive in the environment. This allows infants to understand that people refer to objects when speaking, and that they use words to label these objects. It is this awareness that is proposed to promote language learning in infants (Tomasello, 1992; Baldwin, 1995). Thus, social interactionists believe that intersubjectivity facilitates language learning just as much as the actual structure of maternal language does, and emphasize that the interactive strategies of parents can facilitate or interfere with language learning.

For instance, Tomasello & Farrar (1986) revealed that mothers who FOLLOWED or MAINTAINED children's foci of attention while naming objects had children who increased their vocabulary more than mothers who REDIRECTED infant attention away from an object of mutual interest. The authors suggested that redirecting attention may tax the information processing demands of infants. As a result, children may have less opportunity to attend to adult language.

Whereas most studies of older infants have found that redirecting infant focus is detrimental to language learning (e.g. Masur, 1982; Tomasello & Farrar, 1986; Akhtar, Dunham & Dunham, 1991; Akhtar & Tomasello, 1996), other studies of younger prelinguistic infants have found the opposite. It appears that younger, less competent infants benefit from directive and controlled structuring of their play (Vygotsky, 1978; Tamis-LeMonda & Bornstein, 1989, Pine, 1992). For instance, maternal switches of their six-month-old infants' visual focus (mothers refer to a different toy by name than the infants are attending to) was positively related to joint attention at 0;6, and joint attention was positively related to language competence at 1;5 to 2;0 (Saxon, 1997). This could be because unlike older language-producing children, the linguistic skills of younger infants and their social/cognitive skills, e.g. intersubjectivity, are not well advanced. These infants are less likely to have language comprehension, to follow others' gazes and points, and imitate actions on objects. These skills would enable them to link words and sentences with the correct objects and events.

Consequently, mothers have to redirect infant attention in order to

establish joint attention. In older, more linguistically competent infants, redirecting interferes with word learning because it interrupts the original focus of the child which makes word learning more difficult (Tomasello & Farrar, 1986; Ahktar *et al.*, 1991).

Infants with Down syndrome (DS) appear to have marked delays in expressive language development, and persistent difficulties with language structure, because their levels of syntactic and morphological abilities are consistently low across studies (Fowler, 1990). In addition to their apparent lack of linguistic knowledge, infants with DS also show a different developmental pattern in their ability to share attention with people over objects. In a recent longitudinal study it was shown that infants with DS, aged 0;8 to 2;0 (mental age), displayed less object attention at the beginning of the study than infants without Down syndrome (ND) and less coordinated attention at the end of the study (Legerstee & Weintraub, 1997). Because signalling to someone about an external topic through shared gazing seems to set the pragmatic structure for subsequent conventional communication (Bruner, 1982), adults would need to create a shared referential context in which the language of adults makes sense to the child. Thus, just as with very young typical children who do not yet coordinate their attention between people and objects, parents of low mental age infants with Down syndrome would need to direct the attention to objects in order to set the stage for joint attention.

Although research indicates that mothers of atypical infants appear more directive in their play, this behaviour seems negatively related to the developing language skills in these children (see Marfo, 1990, for a review of these studies). Even in studies where mothers change the focus of attention more often, but also spend more time in joint attention with their children with DS than with typically developing children, their redirective interactive strategies appear to be negatively related to the children's receptive language gains (Harris, Kasari & Sigman, 1996).

The foregoing account of the effects of MAINTAINING and REDIRECTING attention on the development of communication in typical and atypical developing infants is drawn from several sources. Consequently, the definitions of (re)directives and maintaining behaviour are not always uniform in this literature, nor are the categories of the coding schemes always mutually exclusive. In the present study the interactive strategies of the partners are coded with a mutually exclusive coding scheme. Maintaining attention is coded when partners FOLLOW or MAINTAIN the focus of attention of the child. Redirecting attentional focus is coded when partners CHANGE the attentional focus of their infants. Discontinued attentional focus is coded when partners do not redirect, follow or maintain the infant's attentional focus. To control for infant activity levels, we code the infant's self-initiated attentional changes. To determine whether these interactive strategies influence the

PRODUCTIVE language skills of infants, their referential words and gestures are coded as well. We coded gestures in addition to words, because we were interested in examining whether interactive strategies would influence referential communication of PRELINGUISTIC infants, and also of infants with DS, who are documented to have specific difficulties with speech (Rondal, 1988).

To examine the effects of the interactive strategies on the production of referential communication, a longitudinal study should be conducted. The relationship between maternal interactive strategies and the production of referential communicative acts of two samples, one of typical and the other of atypical (DS) developing infants (each being divided into High and Low Mental age), is examined. By pitting these four groups of children together in one developmental paradigm, and by relating their referential communication (words and gestures), IN TIME to the interactive skills of their partners, we should be able to clarify which strategies set the stage for referential communication. We should further be able to assess whether these strategies change as a function of time and group.

We set out to test the following four hypotheses. Like Bakeman & Adamson (1984), we examined the role the SOCIAL ENVIRONMENT played in fostering the maintenance of joint attention, but unlike that study, we examined typical and atypical infants in interaction with mothers, peers and mothers of the peer. If scaffolding depends on proper interpretation of the signals of the infant, then an adult who is familiar with the infants' signals should be better suited to support the infants' attempts to share attention than less familiar individuals. Similarly, a partner who is less competent than an adult at interpreting the signals of others, such as a child, should be the least able to foster the shared context in which joint attention emerges. Second, we wanted to find out whether communicative partners use different interactive strategies with children of different abilities. Given the attentional deficits of infants with DS (Landry & Chapieski, 1989; Mundy, Kasari & Sigman, 1992; Legerstee & Weintraub, 1997), and the lack of coordinated attention in typical infants below 0;9 (Bakeman & Adamson, 1984; Legerstee & Weintraub, 1997), we hypothesized that caretakers will be MORE DIRECTIVE (initiate more topic changes) in their communicative interactions with infants with DS and lower mental age (MA) typical infants in order to set the stage for joint attention. But, they FOLLOW or MAINTAIN the attention more of higher MA children who have developed the capacity for secondary intersubjectivity. Third, in order to find out whether there are changes in these interactive behaviours when the mental and linguistic abilities of the infants change, we included very young prelinguistic typical and atypical children with a mean MA of 0;8.6 (lower MA, below 12-month MA group), and older infants with a mean MA of 1;4.5 months (higher mental age, older-than-12-month MA group). We studied these infants over an 8-month period during

four bi-monthly visits. We divided the infants into Low MA and High MA groups, because before 0;9, neither infants with DS nor typically developing infants coordinate their attention between people and objects (Bakeman & Adamson, 1984; Legerstee & Weintraub, 1997), and by 0;9 to 1;0, non-delayed infants are beginning to use signals to communicate intentionally (Bates, Benigni, Bretherton, Camaioni & Volterra, 1979; Carpenter *et al.*, 1998). This indicates that infants are becoming aware of the conventional aspects of language, which is a prerequisite to producing and understanding language. By 1;0, infants begin to understand that objects have names, and may begin to produce words to request or name objects and events (Nelson, 1973). Fourth, after Akhtar *et al.* (1991) and Tomasello & Farrar (1986), we investigated the effects of redirecting and maintaining attention on the referential behaviours (words and gestures) of children. Previous researchers examining maternal interactive strategies have analysed their data using multivariate or correlational statistics. These provide information about how often the dependent variables occur in each condition, or whether they vary together, but they do not provide information about the sequential dependency between maternal and infant behaviours. For instance, they do not indicate whether maternal redirecting strategies are sequentially related to joint attention, or whether joint attention is related to the production of referential communication. To provide information about these causal relationships, SEQUENTIAL LOG LINEAR ANALYSES were performed on these variables (see also Bakeman & Adamson, 1984, for a rationale on the use of sequential analysis in research concerned with antecedents and consequences of behaviours). This research should enable us to shed light on the contributions of the social environment and infants' mental and linguistic abilities in the acquisition of language.

We predicted that words (for ND infants) and gestures (for DS infants) would follow maintaining attention more than redirecting attention in particular for High MA infants, and that redirecting attention would have a negative effect on referential communication. However, we predicted that Maintaining attention would be produced more to High MA infants and Redirecting more to Low MA infants, in particular when infants were playing with mothers than with peers, but that for younger MA (DS and ND) infants, redirecting attention would set the stage for maintaining attention. Thus, we predicted that Maintaining followed Redirecting attention significantly more, and that maintaining attention preceded referential communication more than would be expected by chance alone, particularly when infants become more competent communicators.

METHOD

Participants

Participants consisted of two groups of infants. One group of 22 DS infants (17 boys) their mothers and same-aged peers, and another group of 20 ND infants (11 boys), their mothers and same-aged peers. One infant with DS was excluded from the sample because of failure to complete all sessions. Thus the final total consisted of 21 DS infants.

Infants with Down syndrome all had Trisomy 21, a chromosomal disorder that results in mental retardation and specific language delays (Rondal, 1988). None of the infants exhibited severe sensory motor handicaps. The mothers of DS infants were contacted through Infant Stimulation centres. The infants' mental-age-equivalent scores were assessed using the Bayley Scales of Infant Development (Bayley, 1969).

The mothers of the ND infants were recruited from daycares and hospitals in the city of Greater Toronto. The infants were matched on mental age with DS infants at the time of recruitment. Consequently, there were no significant differences between DS and ND in MA. Within each group, infants were divided into two cohorts, one with a low MA (M = 0;8.6), and one with high MA (M = 1;4.6). Because coordinated attention becomes consolidated for typically developing infants between 1;0 and 1;2, subjects with a MA equivalent or below 1;0 were included in the lower MA group (range = 0;6 to 0;11), (n = 10, range = 0;6 to 0;11 for DS infants, and n = 10, range = 0;6.5 to 0;11 for ND infants), while those subjects with an equivalent greater than or equal to 1;0 were included in the higher MA group (range = 1;0 to 1;9.5), (n = 11, range = 1;0 to 1;8.5 for DS infants, and n = 10, range = 1;1 to 1;9.5 for ND infants). Table 1 presents the

TABLE 1. *Mean developmental age for infants with Down syndrome* (DS) *and without Down syndrome* (ND) *of Low and High MA levels at the first and final visits*

	Low MA level				High MA level			
	DS (n = 10)		ND (n = 10)		DS (n = 11)		ND (n = 10)	
	M	S.D.	M	S.D.	M	S.D.	M	S.D.
First visit								
Bayley MA	0;8.6	0;1.7	0;9.18	0;2.6	1;4.6	0;2.9	1;6.3	0;3.24
CA	1;5.3	0;2.1	0;8.15	0;1.21	1;11	0;4.9	1;5.9	0;2.12
Final visit								
Bayley MA	1;1.2	0;3	1;4.1	0;3	1;7.2	0;3.6	2;0.21	0;4
CA	1;11.3	0;2.9	1;2.8	0;1.24	2;5	0;3.8	1;11.18	0;2.12

TABLE 2. *Demographic information on infants with and without Down syndrome and their families*

	Infants with DS		Infants without DS	
	Low MA	High MA	Low MA	High MA
Target infants				
Age range of mothers	26;0–37;0	28;0–47;0	28;0–37;0	27;0–36;0
Mean age of mothers	32;0	34;0	32;5	31;7
Mean schooling for mothers	17;9	16;0	15;7	16;2
Age range of fathers	28;0–45;0	28;0–47;0	29;0–40;0	30;0–50;0
Mean age of fathers	34;5	34;2	34;3	38;3
Mean schooling for fathers	16;0	16;5	15;8	17;0
SES range (in classes)	LM–UM*	LM–UM	LM–UM	LM–UM
Modal SES (in classes)	Middle	Middle	Middle	Middle
Peers				
Age range of mothers	27;0–43;0	25;0–38;0	26;0–36;0	29;0–38;0
Mean age of mothers	33;7	32;0	30;3	33;2
Mean schooling for mothers	15;2	15;5	14;2	15;7
Age range of fathers	27;0–46;0	23;0–45;0	29;0–40;0	25;0–44;0
Mean age of fathers	35;5	32;5	32·3	35·2
SES range (in classes)	LM–UM*	LM–UM	LM–UM	LM–UM
Modal SES (in classes)	Middle	Middle	Middle	Middle

* LM, Lower middle; UM, upper middle.

mean mental and chronological ages for the infants at the first and last visit to their homes.

The mothers of DS and ND infants recruited a same aged normal peer who had previously played with their infants in order to avoid a novelty effect. All mothers reported that prior to the sessions their infants had played with the peer once in the previous month. The chronological ages of the peers for the DS infants were between 0;8 and 2;10, and the chronological ages of the peers for the ND infants were between 0;6 and 3;0. A one-way ANOVA with group as between subjects factor on peers' age showed no significant difference between the ages $F(1, 39) = 3{\cdot}607$, $p = 0{\cdot}065$. All families spoke English. The results of two one-way ANOVAs, with group as a between subjects variable, showed no significant differences. One was on years of schooling of the DS and ND mothers $F(1, 39) = 1{\cdot}553$, $p = 0{\cdot}220$, and the other on the DS and ND mother's age $F(1, 39) = 1{\cdot}064$, $p = 5{\cdot}309$. Table 2 presents the demographic characteristics of the participants.

Materials

Three sets of toys were used containing similar items such as a telephone, a book, colored nesting cups, musical instruments, a jack-in-the-box, a rattle, a set of keys, and a puzzle. Each set differed in color, type of animal and books used. Order of set presentation was randomized over sessions.

Design and procedure

The participants were visited in the home of the target infant once every 2 months for a total of four visits. Each visit consisted of three 5-minute conditions. In the MOTHER CONDITION the infant and mother played on the floor with the set of toys. They were surrounded by pillows, which marked the play area. Mothers were asked to play with their infants as they usually do when not observed. In the MOTHER OF THE PEER CONDITION, the above condition was repeated with the mother of the peer. In the PEER CONDITION, the two infants sat in the play area and were provided with a set of toys. Their mothers sat in the same room reading an article, and were asked not to interact with their children, but to encourage them to continue playing when they initiated contact with them. The conditions were separated by a 3-minute break during which partners were changed and toys were put back into the reach of the infants. Thus, in total there were 164 subject visits (41 × 4 visits each), and a total of 492 observations (three 5-minute conditions per infant). Except for one occasion in each group, the same peer attended every session. The order of conditions was randomized within and between each visit and all segments were videotaped with a portable camcorder.

Coding

After each visit, the master tapes were randomly transposed onto unlabelled copies using a VCR with an internal time generator. In this way, a timeline was imposed directly onto the image to aid in determining the length of sessions and behaviours. Frequency of occurrence of the partners' interactive strategies and sensitivity, and of the infants' attentional states and verbal and gestural symbolic behaviours were coded on a second-by-second basis.

Behavioural categories. Coding of the various dependent measures occurred as follows. At the onset of each condition, infants' attentional focus was recorded to be either toward person, toy or other. The coder subsequently waited until a change in attentional focus occurred in the target child for longer than 3 seconds. Now the time was set at 0:00 and coding of the onset and offset of the various dependent variables would commence for the next 300 seconds. Self-initiated change was coded, when the focus of attention was changed by the child, without any influence from the partner. For example, if the child and partner were playing with blocks and the child turned to the jack-in-the-box for more than 3 seconds, the moment at which the child turned to the jack-in-the-box was coded as Self-initiated change. Maintaining attention (MAINTAIN) was coded when (1) the partner followed the child's attentional focus after a self-initiated change, or (2) both child and partner focused on the same object and the partner made verbal (comments or suggestions) or nonverbal requests with regard to the object of focus. For

example, taking the above scenario, the moment from which the partner looks at the jack-in-the-box would be coded as MAINTAIN ATTENTION. REDIRECT ATTENTION was coded when the child's focus of attention was changed directly by the partner, either by verbal or nonverbal prompting. REDIRECT ATTENTION was coded from the moment that the partner turned to the new object until the moment that the child turned to this new object for more than 3 seconds. For example, if the child and partner were playing with the jack-in-the-box and the partner placed a set of cups in front of the child, and then tried to engage the child to play with these cups, this was coded as REDIRECT ATTENTION. REDIRECT ATTENTION was coded from the moment that the partner turned to the cups until the moment that the child focused on the cups. In cases where the partner was unsuccessful in changing the child's attention, REDIRECT was coded from the moment at which the partner focused on the new object until the moment when the partner turned attention back to the original object. DISCONTINUED ATTENTION was coded if the partner did not follow the child's change in focus of attention. For example, if the child changed focus from the cups to a doll and the partner continued to play with the cups, this moment was coded as DISCONTINUED ATTENTION. The duration thereafter would be coded as REDIRECT if the partner tried to elicit attention from the child until the dyad joined attention again.

In a separate pass through the tapes, the onset and offset times of the referential behaviours of the infants were coded. Referential behaviours included nonverbal GESTURES with eye contact such as pointing, showing/offering, requesting and giving, and also the WORDS of the infants that described things and events. Table 3 presents the behavioural categories.

Interrater reliability

To obtain reliability, the experimenter and four coders unaware of the experimental hypotheses, coded a random selection of 20% of the data. Cohen's kappa coefficient was computed for each condition separately. Agreement was assessed on a second-by-second basis for all behaviours. This allowed for discrepancies in coding of both frequency and duration to be taken into account in one score. Kappa scores were used because they correct for chance. Training continued until kappa scores averaged at least 0·80 with each partner. For videotapes of DS and ND infants, kappa coefficients for all behaviours ranged from 0·80 to 0·94 for children and partners. After this training, another 20% of the data was scored again by the four coders. Again, agreement was high, kappas ranged from 0·80 to 0·91 for all behaviours.

Data reduction

Frequencies and durations of each of the dependent variables (maintain, redirect, discontinue, self-initiated changes, words and gestures) were coded for each condition and visit. Because maintain and discontinue attention were

TABLE 3. *Behavioural categories*

Infants' activity level	
Self-initiated change	Infant changes focus of attention to new object or event without any influence from partner
Partners' interactive strategies	
Maintain attention	Partner follows or maintains the infant's focus of attention, making comments suggestions or requests, either verbally or nonverbally
Redirect attention	Partner induces infant to change focus of attention to a new object or event, either by verbal or nonverbal prompting
Discontinued attention	After a self-initiated change by infant, does not follow focus of infant
Infants' referential behaviours	
Nonverbal gestures	
Points	Arm and index finger extended to person or object
Offers/shows	Holds object and directs arm to person; requests These actions always involve a person and objects
Verbal acts	
Words	Words that name/describe objects or information
Meaningful gestures	E.g. bye-bye (wave), no/yes (head shake)

the only behaviours that lasted more than 3 seconds, their proportional durations were used and for the other behaviours, the proportional frequencies were used for further analyses.

RESULTS

To determine whether the responses of infants and partners changed as a function of the various independent variables, the frequencies of the DEPENDENT infant measures (WORDS, GESTURES, and SELF-INITIATED CHANGES), and the proportional frequencies of the dependent adult measures (REDIRECT) and the proportional durations of the dependent adult measures (MAINTAIN

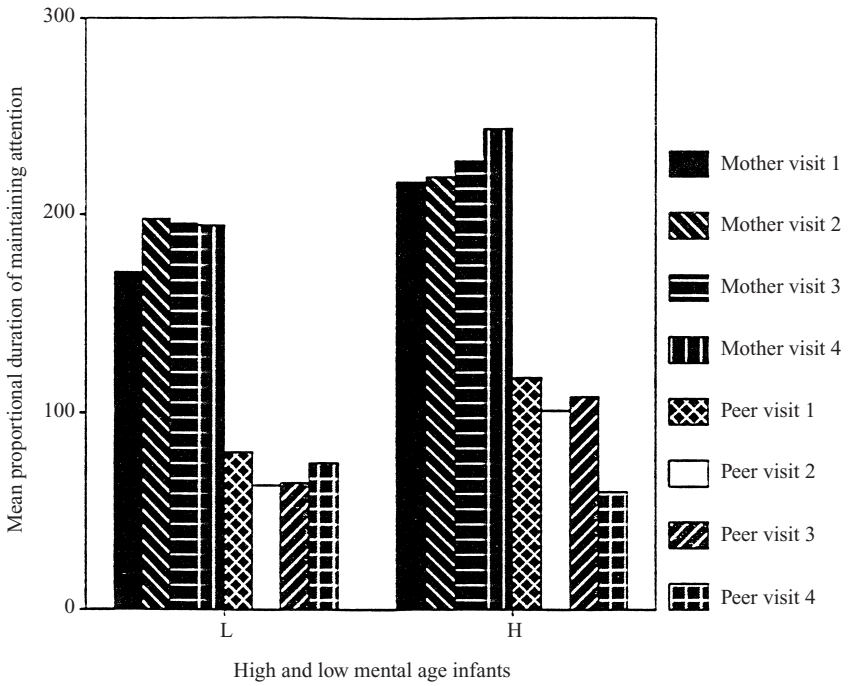

Fig. 1. Mean proportional duration of partners maintaining attention to high and low mental age infants.

ATTENTION) and (DISCONTINUED ATTENTION) were submitted to a mixed model ANOVA with GROUP (2, with and without Down syndrome) and MENTAL AGE (MA: 2, High and Low) as the between-subjects factor, and VISITS (4) and PARTNERS (3, Mothers, Peer mothers and Peers) as the within-subjects factor. None of the analyses showed a significant difference between Mothers and Peer mothers. Thus, familiarity of the mother did not influence the dependent variables. Consequently, the dependent variables were submitted to the same mixed model ANOVA, although now PARTNER had only two levels (2, Mothers and Peers). All within-subjects effects are reported with Greenhauser–Geisser adjusted p-values. Significant interactions were analysed by planned orthogonal contrasts. *Post hoc* simple effects analyses were conducted when necessary (Winer, 1971).

Prior to the analyses, data distributions were examined for normality (Levene) and homogeneity of variance (Kolmogrov–Smirnov). The assumptions were upheld.

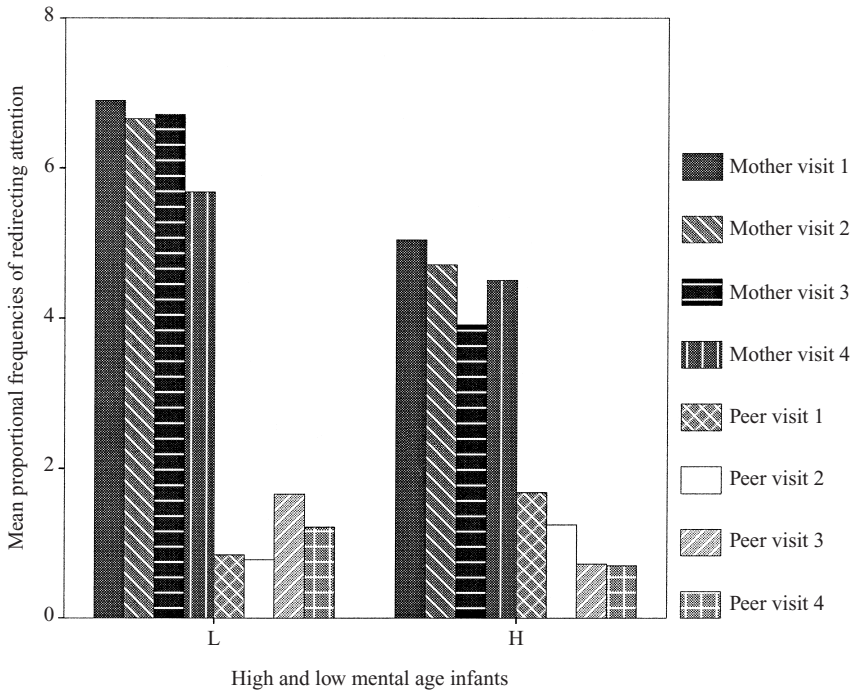

Fig. 2. Mean proportional frequencies of partners redirecting attention to high and low mental age infants.

Maintain attention

The analysis of the durations of maintain attention showed a main effect for MA $F(1, 37) = 13{\cdot}37$, $p < 0{\cdot}001$. Significantly more maintaining attention was produced to High MA children than to Low MA children. A significant interaction for partner × visit, $F(3, 35) = 3{\cdot}19$, $p = 0{\cdot}04$, and *post hoc* analyses revealed that mothers maintained the attention significantly more than peers $F(3, 111) = 3{\cdot}48$, $p = 0{\cdot}02$. As can be observed from Figure 1, mothers' maintaining increased over visits. Such an effect was not noted when infants played with peers.

Redirect attention

A significant MA × partner × visit interaction $F(3, 35) = 3{\cdot}48$, $p = 0{\cdot}026$, and *post-hoc* analyses revealed that mothers redirected the attention more than peers, when she played with Low MA rather than High MA infants. As can be noted from Figure 2, a decrease of REDIRECT over visits was found in the Low MA group when playing with mother.

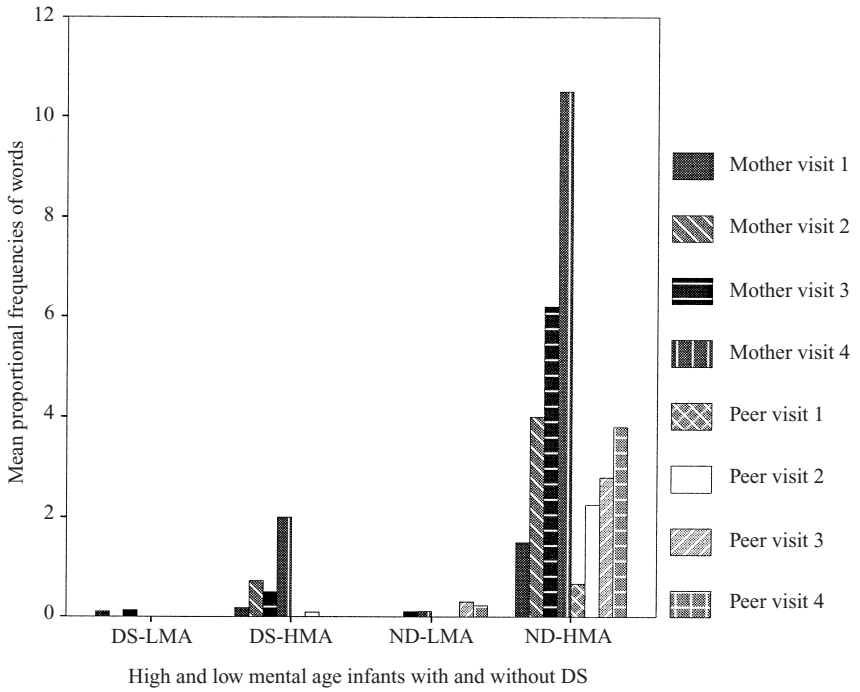

Fig. 3. Mean proportional frequencies of words of low and high mental age infants with Down Syndrome, and without Down Syndrome to mothers and peers.

Discontinued attention

A main effect of partner $F(1, 33) = 501{\cdot}02$, $p < 0{\cdot}001$ indicated that peers ($M = 174{\cdot}6$, S.D. $= 30{\cdot}7$) discontinued their attention more than mothers ($M = 4{\cdot}21$, S.D. $= 5{\cdot}6$).

Self-initiated changes

The results showed a significant effect of Partner $F(1, 37) = 208{\cdot}22$, $p < 0{\cdot}001$. Infants changed their attention significantly more when they played with peers ($M = 13{\cdot}4$, S.D. $= 4{\cdot}67$), than with mothers ($M = 4{\cdot}7$, S.D. $= 2{\cdot}8$). No interactions were observed.

Words

There were two significant 3-way interactions. A group × MA × visit $F(3, 111) = 3{\cdot}43$, $p = 0{\cdot}027$. *Post hoc* analysis revealed that Words increased with visits, but only for the High MA ND infants $F(2, 111) = 11{\cdot}06$,

$p < 0{\cdot}001$. The other interaction was for MA × partner × visit $F(3, 35) = 5{\cdot}35$, $p = 0{\cdot}004$. *Post hoc* analysis revealed that in High MA infants, the increase in words was higher when playing with mothers than with peers (see Figure 3).

Referential gestures

A significant 4-way group × MA × partner × visit interaction, $F(3, 35) = 3{\cdot}98$, $p = 0{\cdot}015$ and subsequent *post hoc* analyses showed that High MA DS infants produced significantly more gestures that increased over visits $F(2, 111) = 4{\cdot}13$, $p = 0{\cdot}023$, than the other three groups, when they interacted with mothers rather than with peers (see Figure 4).

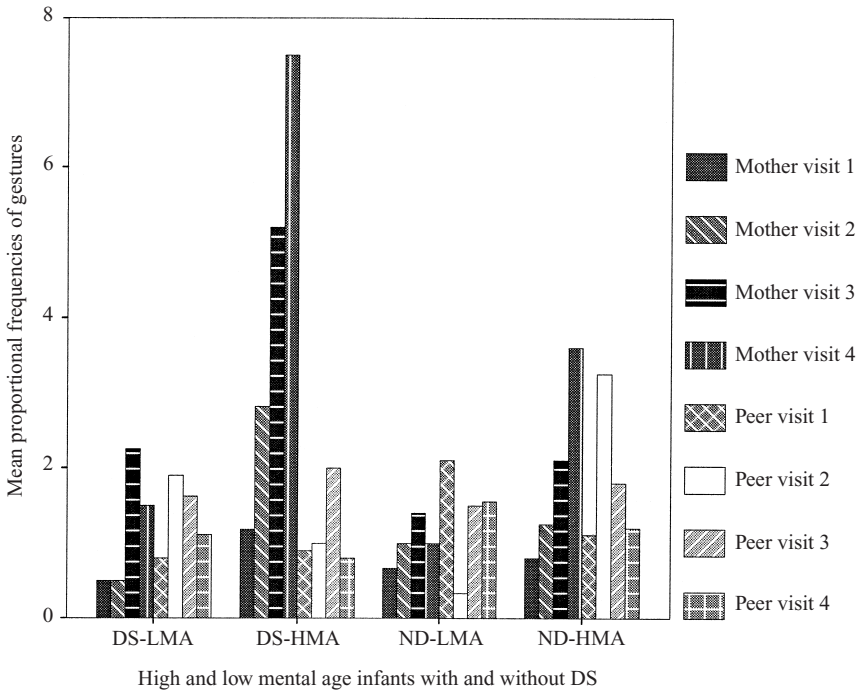

Fig. 4. Mean proportional frequencies of gestures of low and high mental age infants with Down Syndrome and without Down Syndrome to mothers and peers.

Sequential analyses

The ANOVA provided information about the duration of particular dependent variables in each condition, but they do not allow us to determine whether the particular behaviours of one partner facilitate or hamper the

behaviours of the other in any particular way. That is, whether maternal attention-directing behaviours influence the production of words and gestures in their infants. Therefore, a sequential analysis for nominal data was conducted by means of sequential log-linear modelling. This sequential analysis allowed us to determine the likelihood that a particular communicative behaviour is influenced by the previous behaviour of the partner. Moreover, we studied whether this sequential dependency differed between the groups of infants under study.

As such, the first variable included in the sequential model was 'present behaviour' ([B_t], where t indicates the time) that consisted of the mutually exclusive categories MAINTAIN (MT), REDIRECT (RA), DISCONTINUED ATTENTION (DA), SELF INITIATED CHANGE (SIC), and SYMBOLIC BEHAVIOURS (SYMBOLS). SYMBOLIC BEHAVIOURS included both words and referential gestures. One occurrence of MT could include either one or more successive maternal actions in the same period of joint attention. As such MT could not follow itself. The second variable in the model was the behaviour that immediately preceded the present behaviour, indicated by [B_{t-1}]. By including the present and previous behaviour, a first order sequential dependency could be tested. In order to test whether this dependency was the same in all groups, we also included the variables 'group' ([G]: DS or ND), 'mental age' ([MA]: high and Low MA), and 'partner' ([P]: mother or adult stranger).

The general idea behind sequential modelling is to find the simplest model that fits the observed sequential frequencies. To do so, we applied the so-called backward hierarchical method, beginning with the saturated model (Bishop, Fienberg, & Holland, 1975; Gottman & Roy, 1990). The saturated model includes all possible interactions between the variables in the model. Then interaction terms are deleted from the model step by step (starting with the most complicated 5-way interaction between all variables, then the 4-way interactions etc.) and the resulting simpler model is fitted. For each interaction term deleted from the model, the change in fit (expressed in terms of log-likelihood χ^2 or G^2) was tested for significance. If the term was not significant, it was deleted from the model. The procedure stopped when the change in fit was significant, i.e. the model including this interaction term described the observed sequential frequencies better than the simpler model. (If none of the interaction terms is significant the final model is the so-called 'independence' model, in which each behaviour follows the other by chance and no sequential dependency exists.)

This procedure yielded in the following log-linear model:

$$[B_t\ B_{t-1}\ MA]\ [B_t\ B_{t-1}\ G]\ [B_t\ MA\ G]\ [B_t\ MA\ P]\ [B_{t-1}\ MA\ G]\ [B_{t-1}\ MA\ P].$$

The first two interaction terms in the model are the most interesting, since they indicate the sequential dependency (they include an interaction between

TABLE 4. *Observed and expected frequencies for the first order sequential dependency between dyadic states in two mental age groups*

Ongoing behaviour		Previous behaviour RA	MT	SIC	DA	SYMBOLS	Total
LOW mental age							
RA	Observed	227	344	**199**	**144**	37	951
	Expected	285·6	388·1	**166·1**	**65·3**	45·8	
MT	Observed	513	0	238	**35**	96	882
	Expected	447·6	0	260·3	**102·3**	71·8	
SIC	Observed	*182*	*292*	113	33	28	648
	Expected	*194·6*	*264·5*	113·2	44·5	31·2	
DA	Observed	82	*96*	31	25	8	242
	Expected	72·7	*98·8*	42·3	16·6	11·7	
SYMBOLS							
	Observed	**50**	**92**	*32*	4	0	178
	Expected	**53·5**	**72·6**	*31·1*	12·2	8·6	
Total		1054	824	613	241	169	2901
HIGH mental age							
RA	Observed	83	213	**168**	**80**	77	621
	Expected	117	284·4	**106·4**	**21**	92·2	
MT	Observed	396	0	239	**13**	361	1009
	Expected	350·8	0	318·8	**62·9**	276·4	
SIC	Observed	*148*	*295*	143	24	79	689
	Expected	*129·9*	*315·5*	118	23·3	102·3	
DA	Observed	36	*56*	25	12	6	135
	Expected	25·4	*61·8*	23·1	4·6	20·1	
SYMBOLS							
	Observed	**73**	**372**	*94*	3	57	599
	Expected	**112·9**	**274·3**	*102·6*	20·2	89	
Total		736	936	669	132	580	3053

RA, Mother Redirects Attention; MT, Mother Maintains Attention; SIC, Self-initiated Change of the Infant; DA, Disconnect Attention; Symbols, Symbolic Behaviours of Infants (words or gestures). The **bold** numbers indicate significant differences between low and high MA infants. The *italic* numbers indicate the cells that do not contribute to sequential dependency in any of the groups.

the present and the previous behaviour). The two terms indicate that 'mental age' ($G^2 = 47{\cdot}0$, df = 15, $p < 0{\cdot}0001$) and 'group' ($G^2 = 26{\cdot}2$, df = 15, $p < 0{\cdot}05$) respectively have a significant effect on the first order sequential dependency, i.e. the way in which infant and maternal behaviour influence each other differs between Low and High MA infants and between DS and ND infants. The rest of the terms are less interesting as they indicate interaction effects between 'MA' and 'Group', and between 'MA' and 'Partner' on the frequencies of the ongoing behaviours. Such effects are shown in much more detail by the ANOVA analyses above, and will not be further discussed here.

The next steps were to investigate which behaviours followed each other more (or less) likely than expected by chance, and to find out which of these sequential dependencies contributed to the effects of 'MA' and 'Group'. Tables 4 and 5 display both the observed and the expected frequencies of

TABLE 5. *Observed and expected frequencies for the first order sequential dependency between dyadic states in Down syndrome and typical groups of infants*

		Previous behaviour					
Ongoing behaviour		RA	MT	SIC	DA	SYMBOLS	Total
Down Syndrome							
RA	Observed	134	329	181	74	48	766
	Expected	177·2	376·6	121·7	24·2	66·3	
MT	Observed	519	0	251	17	213	1000
	Expected	455·1	0	312·5	62·1	170·3	
SIC	Observed	*142*	*317*	108	22	46	635
	Expected	*146·9*	*312·2*	100·9	20	55	
DA	Observed	30	*63*	17	8	3	121
	Expected	28	*59·5*	19·2	3·8	10·5	
SYMBOLS							
	Observed	**62**	**209**	*52*	0	22	345
	Expected	**79·8**	**169·6**	*54·8*	10·9	29·9	
Total		887	918	609	121	332	2867
Without DS							
RA	Observed	176	228	186	150	66	806
	Expected	199·9	309	149	55·8	92·3	
MT	Observed	390	0	226	31	244	891
	Expected	358·4	0	267·1	100	165·5	
SIC	Observed	*188*	*270*	148	35	61	702
	Expected	*174·1*	*269·2*	129·8	48·6	80·4	
DA	Observed	88	*89*	39	29	11	256
	Expected	63·5	*98·2*	47·3	17·7	29·3	
SYMBOLS							
	Observed	**61**	**255**	*74*	7	35	432
	Expected	**107·1**	**165·6**	*79·8*	29·9	49·5	
Total		903	842	669	252	417	3087

RA, Mother Redirects Attention; MT, Mother Maintains Attention; SIC, Self-initiated Change of the Infant; DA, Disconnect Attention; Symbols, Symbolic Behaviours of Infants (words or gestures). The **bold** numbers indicate significant differences between Down Syndrome (DS) and typical infants without DS. The *italic* numbers indicate the cells that do not contribute to sequential dependency in any of the groups.

each pair of two behaviours following each other in the groups under study. The expected frequency is the likelihood that the two behaviours follow each other by chance (calculated by fitting the independence model). If there is a difference between the observed and the expected frequency, the previous

behaviour influences the likelihood of the present behaviour. Most cells showed a significant difference between observed and expected frequencies, although the difference is larger in some than in others. The cells, which do not show a significant difference in any of the groups are indicated by italic numbers. We will discuss the most relevant significant cells concerning our hypotheses.

Firstly, we see that REDIRECT follows SELF-INITIATED CHANGE and DISCONTINUED ATTENTION more often than expected by chance, whereas this behaviour is less likely to follow SYMBOLS of the infant. Conversely, MAINTAIN is shown less than expected by chance after SELF-INITIATED CHANGE and DISCONTINUED ATTENTION, and more often after SYMBOLS. Furthermore, SYMBOLS are shown more often after MAINTAIN and less often after REDIRECT than expected by chance. SELF-INITIATED CHANGES in attention did not increase or decrease the likelihood of SYMBOLS. Finally, MAINTAIN follows REDIRECT more often than expected by chance.

These data indicate that MAINTAIN stimulates SYMBOLS, whereas REDIRECT seems to suppress them. SYMBOLS also elicit (more) MAINTAINING from the mother. REDIRECT is shown after the infants change their attention. After redirecting the attention of the infant, mothers are more likely than chance to MAINTAIN the attention of the infant.

By displaying the observed and expected frequencies separately for the two MA groups (Table 4) and the DS and NS groups (Table 5), respectively, we can further investigate which cells in the table are responsible for the effects of 'MA' and 'group'.

To test these effects, the loglikelihood χ^2 (G^2) for the first two interaction terms in the model were calculated twice: once for the complete table, and once for the table in which the cell of interest was deleted. The difference in G^2 (with 1 df) gives an indication of the contribution of this particular behavioural sequence to the fit of the interaction term (Bishop *et al.*, 1975).

In Table 4, the cells that contributed to the effect of MA on the sequential dependency are indicated by bold numbers. The first three cells show changes in the likelihood of REDIRECT or MAINTAIN by the adults after the infant's change their focus of attention (SIC) or joint attention is DISCONTINUED. We see that with an increase in MA the likelihood that the adult partners attempt to REDIRECT the infants after they have changed their attention increases ($G^2 = 4{\cdot}3$, df $= 1$, $p < 0{\cdot}05$ and $G^2 = 5{\cdot}1$, df $= 1$, $p < 0{\cdot}05$ for SIC and DA respectively). In contrast, the likelihood that MAINTAIN occurs after SELF-INITIATED CHANGES decreases with an increase in MA ($G^2 = 6{\cdot}8$, df $= 1$, $p < 0{\cdot}01$). Thus it would seem that after infants have changed their focus of attention (SIC), adults are more likely to REDIRECT infant attention, and less likely to MAINTAIN it. These patterns increase with MA of the infants.

The other two cells relate to the sequential dependency between symbolic behaviours and maternal behaviours. SYMBOLS are less likely to occur after REDIRECT and more likely after MAINTAIN. These effects are stronger for High MA than for the Low MA group ($G^2 = 8{\cdot}6$, df = 1, $p < 0{\cdot}005$ for both REDIRECT and MAINTAIN). In fact, in young infants REDIRECT hardly suppresses the occurrence of SYMBOLS.

The findings shown in Table 5 indicate that DS and ND children differ in the likelihood that they emit SYMBOLS after maternal attention directing strategies (indicated by bold numbers). Although in both groups symbolic behaviours are less likely after REDIRECT and more likely after MAINTAIN, the differences between observed and expected values are higher in ND than in DS infants ($G^2 = 4{\cdot}2$, df = 1, $p < 0{\cdot}05$ and $G^2 = 8{\cdot}9$, df = 1, $p < 0{\cdot}005$ for REDIRECT and MAINTAIN, respectively).

Thus overall, referential behaviours in children appear stimulated by MAINTAIN and suppressed by REDIRECT of the communicative partners. The positive effects of MAINTAIN on the symbolic behaviours of infants was greater for High MA and for ND infants, indicating that these maternal strategies were more effective in promoting the production of symbolic behaviours in the more skilled groups. Additionally, MAINTAIN and REDIRECT also showed an opposite link with SELF-INITIATED CHANGES in that adults are more likely to redirect attention back to the task at hand and less likely to maintain attention after SELF-INITIATED CHANGES. These sequential effects were stronger in High MA than in Low MA children.

In summary, the analysis of variance showed that both mothers of the target infants and mothers of the peers produced significantly more verbal and nonverbal behaviours that maintained attentional focus in High MA infants, and more activities aimed at redirecting the attentional focus of Low MA children than peers. In addition, same aged peers discontinued their attention significantly more, and both groups of infants changed their attention more when with mothers than with peers. It is clear that willing adults attempt to scaffold infant play, whereas play with peers is more solitary. Interestingly, whereas mothers increased Maintaining attention over visits for High MA infants, they decreased Redirecting attention over visits for Low MA infants. Nondelayed infants produced more words, and infants with DS produced more gestures when playing with mothers rather than peers. The production of words and gestures increased over visits for the High MA infants in both groups.

The sequential analyses showed that whereas maintaining infant attention promoted words and gestures in infants, the referential gestures of the infants promoted maintaining of attention in mothers. In addition, mothers redirected the attention of Low MA children more often, which seemed to suppress referential behaviours. However, maintaining was more likely than chance to follow redirecting. Thus, redirecting indirectly affected the

production of referential behaviour in all children because it set the stage for joint focus of attention.

DISCUSSION

This study was conducted to assess the hypothesis that caretakers adjust their interactive strategies when playing with infants that differ on mental and linguistic abilities, in order to promote communicative competence (Vygotsky, 1978; Bruner, 1982). Previous studies had shown that interactive strategies, such as maintaining or following infant attentional focus increase referential communication in language-using infants (Carpenter *et al.*, 1998). This hypothesis was based on the idea that joint focus of attention is important for the acquisition of conventional linguistic forms in infants, and that the progress of children depends on the establishment of a shared world of events. We hypothesized that before infants are able to independently coordinate their attention between caregiver and referent, adults need to provide scaffolding through directing infant attention to objects and events before attention can be maintained. Having adults interact with infants whose mental and linguistic skills are not fully developed, and relating the referential behaviours of infants to the interactive strategies of adults through sequential analyses, we were able to clarify which interactive strategies increased or suppressed the referential behaviours of infants of different competencies.

We expected that mothers would be better able to maintain the attention of infants than the mothers of peers because they were more familiar with their infants' signals. We also expected that peers would be least capable of maintaining the attention of the target infants. However, there was no difference in the amount of maintaining attention between the adult communicators. Both adults produced these behaviours significantly more than the peers. These results replicate the findings of Bakeman & Adamson (1984) with typical children and extends them to atypically developing infants. However, our findings also revealed new information about the redirecting strategies of mothers and mothers of the peer. The fact that there was no significant difference between the adults in the amount of redirecting attention suggests that willing adults commonly use these strategies with young children and that they form part of the usual play repertoire.

We also predicted that mothers would maintain the attention of High MA infants more than of Low MA children because research had shown that older infants were more able to coordinate their attention between people and objects (Legerstee & Weintraub, 1997). Because Low MA infants lack this skill, adults may try to direct infant attention, thereby encouraging them to focus on objects. This attention could then be maintained, which would promote language learning in infants. These hypotheses were also confirmed.

We further hypothesized that maintaining attention would increase the production of referential types of behaviours, and that this effect was stronger for the High MA infants than for the Low MA infants. This hypothesis was confirmed. The sequential analyses indicated that interactive strategies that maintained infant attention promoted referential behaviours more in High MA (words in ND and gestures in DS) than in the other infants. These findings support studies with language-using children (Tomasello & Farrar, 1986; Akhtar *et al.*, 1991; Saxon, 1997) that maintaining infants' focus of attention increases language production. However, this study is different from previous works, in that it does not attempt to predict language development at some (later) point in time from earlier occurring maternal strategies. Rather, the present study has coupled the maternal and infant behaviours in real time (i.e. during communication with the mother). As a result this research is more focused on how infants respond to specific maternal behaviours and *vice versa*. As a consequence, the present study is able to shed light on the mechanism underlying the production of referential communicative behaviours.

We further found that redirecting did not show a positive relationship with the occurrence of referential behaviours. Thus, superficially, there appears to be no positive relationship between redirecting attention and the production of referential behaviours. Interestingly, however, the sequential analyses showed that maintaining attention followed redirecting by mothers at a rate that was significantly higher than would have been expected by chance alone, and maintaining significantly preceded the production of referential gestures in infants. Because redirecting attention occurred significantly more in Low MA children, mothers appear to promote referential communication INDIRECTLY in Low MA infants by preparing them for joint attentional play.

Our results concerning maternal redirecting strategies with delayed infants clarifies a controversy in the literature. Studies comparing parent–child interaction processes in pathological and nonpathological populations report that mothers of mentally handicapped infants are often more controlling and directive than mothers of nonhandicapped children (e.g. Field, 1980; Maurer & Sherrod, 1987), because these infants are generally less active. Finding more redirectives in parental speech to delayed children has been considered as evidence to argue for a detrimental language learning environment for those infants (see Marfo, 1990, for a review). However, the fact that there was no significant difference in the amount of self-initiated changes in both groups of infants (ND and DS) indicates that the infants in the present conditions have similar activity levels. The finding that mothers of the target infants and peers redirected the attention of typical and also of atypical infants supports the idea put forth earlier, that redirecting attention is not a result of an absence of clear and frequent signals of DS infants. Rather, this behaviour is part of the interactive strategies parents use, that offer some

potential for referential communication in children. The results of the sequential analyses are in agreement with this hypothesis. They show that rather than interfering, redirecting supports the development of referential behaviours in low functioning or very young infants, because it draws attention to objects and events about which caretakers are talking. These findings are supported by studies that point to the beneficial effects of redirecting the attention of very young typical infants toward objects (Bornstein & Tamis-LeMonda, 1989, 1990; Saxon, 1997) and redirecting that of atypical infants (Landry & Chapieski, 1989; Roach, Barratt, Miller & Leavitt, 1998).

As expected, words and gestures were most prevalent in infants when they attended with mothers to objects. This coupling of referential behaviours with maintaining attentional focus increased with age, because the relationship was stronger for High-MA (words for ND and gestures for DS infants) than for Low MA infants. In addition, the finding that more words and gestures were produced with adult communicators than with immature communicators supports the SOCIAL-INTERACTIONIST view of language, suggesting that variations in social support interact with innate language capacities to affect lexical acquisition differentially (Bruner, 1982; Tomasello, 1992). However, the relationship between joint attention and referential communication appears to be bi-directional. Mothers maintaining of attentional focus promoted communicative behaviour, but the words and gestures of children promoted joint attention in their mothers. Roach *et al*. (1998) also found that maternal redirecting attention was associated with more object play and vocalizations in DS children.

There were also limitations in how much parents were able to support the acquisition of words and gestures in children. Whereas they were able to promote the production of referential gestures in infants with DS, the relationship between their interactive strategies and word production was less strong. Overall, maintaining attentional focus stimulated the production of referential gestures less in Low MA and DS children than in High MA and ND children. In addition, the negative relationship between redirecting attention and referential communicative is less strong for low MA and atypical infants than for high MA and ND children. These findings support Vygotsky's (1978) theory of intermental and intramental planes of knowing. He argued that although infants develop a skill first on the social plane between infants and parent (intermental), before it can exist on the psychological plane within the child (intramental), the influence of the social environment remains constrained by the infants' developmental levels.

To conclude, we have provided empirical support for a variety of suggestions and ideas about the importance of adult interactive strategies for the acquisition of early conventional communicative behaviours as proposed by various authors (Vygotsky, 1978; Bruner, 1982; Fogel, 1993; Carpenter

et al., 1998). These authors have suggested that adults who help infants maintain focus of attention while naming the referent aid lexical acquisition. We examined this hypothesis in a naturalistic play study, in which the behaviour of typical and atypical infants at the relevant ages was compared under different conditions. We found support for this theorizing and for the empirical data that until now had only been derived from typical, language-producing children or from descriptive studies that examined the interactions of infants and mothers (Carpenter *et al.*, 1998; Stevens, Blake, Vitale & MacDonald, 1998). We further provided evidence concerning the interactive strategies that promote lexical development in prelinguistic and delayed infants. There has been a tendency in the literature (see Marfo, 1990) to draw conclusions based on the finding that a predominant amount of directives were found in parental speech to atypical populations, that they were responsible for delayed language acquisition. However, simple frequency analysis of maternal directives ignores the sequential nature of communicative interactions. In particular, they do not reveal how the various interactive strategies cluster within language learning contexts. Although redirecting attention was coupled negatively with referential communication in infants, it preceded maintaining attention. This significant relationship indicated that when adults redirected infant attention, it was to motivate joint attention. Once children begin to use words and gestures, sharing attention over objects with partners increases because it enables mothers to maintain attention longer.

In general, partners that maintain infant attention promote the production of referential behaviours in infants. They do so by focusing infant attention on objects and events in the environment. When infants are young, more active interactions are needed to direct infant attention to the appropriate objects and events. When infants become able to sustain their attention for longer periods, adults maintain this interest, and when infants begin to use referential communication, adults intensify their attentional focus. Thus, when the child begins to speak, 'language provides the system for framing attention and giving it continuity that allows for the recruitment of content and background presuppositions – joint attention, serves not only to form culture but to maintain such coherence as it achieves' (Bruner, 1995, p. 12).

Social interaction theories emphasize the importance of parental input as an integral component influencing development. Parents take responsibility for structuring the play interactions through toy-centred activities (Bruner, 1982) and other turn-taking games (Fogel, 1993). The present study revealed that successful parenting depends on sensitive tailoring of support to the developmental abilities of children in which both redirecting and maintaining attention of children have an important place.

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