

# *People and Objects Affect the Quality of Vocalizations in Infants with Down Syndrome*

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**The vocalizations of eight infants with Down syndrome were recorded longitudinally in relation to different social and non-social contexts. The infants were observed biweekly from 8 to 24 weeks and monthly up to 40 weeks. At each visit the infants were presented with their mother, a female stranger, and a rattle puppet, each alternately active and passive. Each condition lasted 60 sec. The results showed that by 4 months of age, the infants produced different types of vocal sounds in relation to environmental contexts. They produced significantly more melodic (speechlike) sounds, vocalic (non-speechlike) sounds, and emotional (crying, laughing and fussing) sounds when facing people than objects. By 6 months of age, these utterances began to be distinguished between mother and female stranger and active and passive adults. However, within the communicative context the overall amount of vocalic (non-speechlike) sounds produced was larger than the amount of melodic (speechlike) sounds. It is suggested that this low output of melodic sounds in the overall vocal production of these infants may adversely affect the development of more appropriate vocal behaviour.**

*Key words:* Down syndrome, infant sounds, prosody, prelinguistic communication.

In order to assess the adaptive significance of the quality of infant sound during social interactions, it is important to ask how listeners perceive these early vocalizations. The human infant is raised in

a social environment where adults support the emergence and rehearsal of early attempts at communication (Papoušek and Papoušek, 1987, p. 303). However, in order to motivate the infants in a didactically effective way, it would seem that the social partner has to perceive the infant vocalizations as 'speechlike' (Oller, 1981), rather than as random vocalizations. Although objective

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analyses of infant vocalizations have provided invaluable information about the acoustic and phonetic properties of infant sounds, it is the social partner's perception of these vocalizations as conveying communicative intent that ultimately has developmental implications.

Using social-perceptual measures Legerstee (1991a) has shown that when 2-month-old normal infants were faced with people and objects, the quality of their vocal sounds changed consistently in relation to the social and non-social contexts. Although few vocalizations were produced in front of toys, when presented with their communicative mother the infants produced primarily melodic (or speechlike) types of sounds that contained varied pitch contours and had oral resonance. When confronted with their unresponsive (e.g. 'still-face') mother the infants increased vocalic (or non-speechlike) sounds that had uniform pitch contours and nasal resonance instead. Thus the infants altered the quality of their sounds when the communicative context changed. This finding supports results by Bloom *et al.* (1987) indicating that when adults maintained a 'conversational' pattern, infants produced a higher ratio of 'speechlike' vocalizations containing variable pitch contours than when they responded at random to the vocalizations of the infants.

That normal infants vocally differentiate social and non-social events has been suggested in other longitudinal studies with the use of spectrographic analyses (Delack and Fowlow, 1978; D'Odorico, 1984) and is consistent with studies indicating differential responsiveness to people and objects in normal infants (Field, 1979; Klein and Jennings, 1979; Legerstee, 1991b, 1992; Legerstee *et al.*, 1987, 1990) as well as in developmentally delayed infants (Legerstee and Bowman, 1989).

The findings that such young infants are able to modify their vocal and non-verbal behaviours according to the social and non-social context is contrary to theories of cognitive development proposing that prior to 6 months, infant responses are not accommodative to the external world. They confirm research suggesting that early infant behaviours are the result of 'an active and intelligent approach to vocalizations' (Oller, 1981, p. 87). For instance, 3- to 4-month-old infants are capable of switching from cooing to pure vowels under the influence of selective imitation (Kuhl and Meltzoff, 1988; Legerstee, 1990), and 3- to 6-month-old infants will reproduce high-pitched and low-pitched vowels when stimulated alternately by a tone or a human model producing these sounds (Kessen *et al.*, 1979).

As indicated earlier, the development of communication is an interactional process, therefore variations in the parental support children experience may contribute to individual differences in their acquisition of language (Bochner, 1986; Bruner, 1983; Lock, 1978). If adults do not interpret the infant sounds as communicative bids, they may fail to respond adequately and thereby hinder the subsequent acquisition of language (Bochner, 1986; Landry and Chapiesky, 1989; Legerstee and Bowman, 1989; Mundy *et al.*, 1988; Velleman *et al.*, 1989).

Thus it becomes important to ask whether infants with Down syndrome who exhibit considerable speech and language delays (Dodd, 1975; Rohr and Burr, 1978) also exhibit atypical vocal behaviours. Although overall low vocal output has been seen in the first 3 months of life in these infants (Berger and Cunningham, 1983; Legerstee and Bowman, 1989), studies that have examined specific speech parameters, such as the number, range and length of utterances at subsequent ages, have shown that the development of these speech patterns is quite similar for normal and Down syndrome infants (Dodd, 1972; Smith and Oller, 1981).

In the research reported here our goals were as follows. First, we wished to establish whether the vocalizations of infants with Down syndrome can be identified from a social-perceptual point of view into melodic or 'speechlike' vocalizations containing varied pitch contours, vocalic or 'non-speechlike' vocalizations containing uniform pitch, and emotional sounds. Secondly, we wanted to add to current knowledge of infants' use of supra-segmental features, by examining whether infants with Down syndrome would be able to use these features selectively according to communicative context, and how this differential responsiveness would develop with age.

To investigate these issues, infants with Down syndrome were observed repeatedly during their first year of life in social and non-social contexts. The infants' vocalizations were assessed when interacting with their communicating mother, and when facing a graspable doll that moved and sounded when they looked at it. Making the non-social stimulus move contingently is a necessary control since people communicating with infants naturally respond in a contingent fashion to the eye contact of their infants (Legerstee *et al.*, 1989; Watson, 1972). Similarly, since a non-social stimulus seems to elicit different types of vocalizations from babies than social stimuli (Delack and Fowlow, 1978; Legerstee, 1991a; Legerstee and Bowman, 1989), the

infants were presented with conditions in which the communication partner remained unresponsive, and also with a non-contingent (passive) toy. Finally, in order to rule out that differential responding to the mother as compared to the doll could be interpreted as being attributable to familiarity of the social stimulus, a female-stranger condition was introduced into the experiment.

## METHOD

### *Subjects*

Eight infants with Down syndrome (four girls and four boys) participated in the study. They were all term infants and healthy. There were no heart or obvious neurological and sensory defects. All infants were diagnosed by chromosome count to be trisomy 21, were first- or second-born, had normal deliveries, and came from middle-class families. Mothers averaged 32 years of age (range 27–37). All infants were between 56 and 66 days old at the beginning of the study ( $M=62$  days). Their mental development was assessed twice during the study with the Bayley Scales of Infant Development (Bayley, 1969). At the beginning of the study the infants' mean mental developmental index (MDI) was less than 2 months, and at age 6 months, their mean MDI was 4.9.

The eight mothers were recruited through two health centres in two major cities where they were enrolled in infant stimulation programmes. They were seen biweekly until 24 weeks and monthly until 48 weeks. They were originally recruited as part of a longitudinal study of interactions between babies and their mothers, strangers, and objects (Legerstee and Bowman, 1989). Only the videotapes of the interactions during the first 40 weeks were used since the quality of the sound recorded at 44 and 48 weeks was not good enough to allow this kind of assessment of the infants' vocalizations.

### *Apparatus*

The infants were videotaped in a laboratory setting resembling an infant's room. Infants were placed in a specially constructed infant seat, which comfortably supported their head and trunk and permitted free movement of arms and legs. Minimal physical restrictions seemed more conducive to infant vocalizations (Lewis and Freedle, 1973). The seat was tilted at a 45-degree angle, to promote easy interaction with the stimuli. Sessions were filmed

using two video cameras that were positioned out of the infants' midline, and 1.8 m from the subjects. Using these cameras and a split-screen generator, the infants' and adults' behaviours were simultaneously recorded onto videotape. Generator-produced date and time (0.10 sec) were inserted into the picture to allow for evaluation of duration of sessions and vocalizations.

### *Procedure*

The infants were filmed when they were content and alert. At each visit, the infants were presented with six experimental conditions: (1) active mother, (2) passive mother, (3) active stranger, (4) passive stranger, (5) active object, and (5) passive object. In the social conditions, the mother or the stranger sat in front of the infant at a 20–30 cm distance. Different female strangers were presented at each visit. In the active condition, they were asked to talk to the infants as they normally would but not to touch the infants. In the passive condition, they were asked to remain silent, to keep a 'friendly' face, and again not to touch the infant. In the non-social conditions, a rattle plush toy was held in front of the infant at a 20–30 cm distance. Different plush toys of the same size were used at each visit. In the active condition, the experimenter, hidden behind a screen, shook the rattle each time the infant looked at it. In the passive condition, the rattle was kept immobile. Each of the six conditions lasted 60 sec and was presented in random order to control for effect of presentation. If infants became distressed during the sessions they were comforted until they were again in an alert and content state (state 4; Wolff, 1966).

### *Vocal Categories*

The vocal categories from the Bloom *et al.* (1987) and Legerstee (1991a) studies were adopted. Three vocal categories were coded auditively for the social and non-social conditions; (1) melodic (speechlike) sounds; these sounds contained varied pitch contours, were produced relaxed and in relatively long units (longer than half a second), were syllable-like, often called cooing or babbling, and contained oral resonance; (2) vocalic (non-speechlike) sounds; the vocal sounds were produced somewhat forced or with effort, they were relatively short (approximately half a second) and were often series of vowel-like sounds, somewhat nasal with uniform pitch; and (3) emotional sounds, such as laughing, crying and fussing. Each discrete measure of

occurrence was separated from another by a noticeable pause (0.3 sec or longer, e.g. Stern *et al.*, 1983). Physiological sounds, such as sneezes, hiccups, coughs, grunts, etc., were not included in the analyses.

### Transcription of Videotapes

The audio-visual tapes were coded by a phonetically trained coder who had coded the quality of the infant sounds of the earlier study with normal infants (Legerstee, 1991a). Only the audio portion of the audio-visual tape was played so that she would not be influenced by the affective facial expressions of the participants. Although the coder was able to hear the mother and stranger talk and the object sound during the active conditions, she was naive to the nature of the experimental hypothesis, and it was therefore unlikely that she would influence the results of this study in one way or another. To further prevent the coder from being influenced by the names of the vocal definitions (e.g. melodic), the sounds were identified by letters of the alphabet (e.g. a, b, and c) and the coder was instructed to categorize the sounds differentially according to the metaphonological characteristics (e.g. pitch contour, duration, resonance pattern, etc.) that distinguished them.

### Observer Agreement

The coder had been instructed by a phonetician to recognize the infant sounds on 20% of the infant tapes at the various ages studied. Interobserver reliability using Cohen's kappa was 0.79 for melodic sounds, 0.79 for vocalic, 0.80 for emotional sounds, and 0.81 for the total amount of vocal utterances. Values greater than 0.75 are considered 'excellent agreement' (Fleiss, 1981). The coder's intrarater reliability at the beginning of the coding and after 50% of the data had been coded was between 0.78 and 0.81. These reliability measures indicated that our coding scheme could be applied reliably.

## RESULTS

Because of the overall low frequencies in the production of the vocalizations, especially in the younger babies (see also Berger and Cunningham, 1983; Legerstee and Bowman, 1989), the biweekly visits of 8 and 10, 12 and 14, 16 and 18, and 20 and 22 weeks were collapsed into 4-week intervals of 9, 13, 17 and 21 weeks respectively. Table 1 presents

the means for each vocal category at these age levels. Repeated measures analyses of variance (ANOVAs) within subject design with age (9), condition (3, mother, stranger, object) and activity level (2, active, passive) were subsequently conducted on two of the dependent measures: melodic and vocalic sounds. These infant sounds had first been subjected to a Freeman-Tukey transformation ( $y' = y + y + 1$ ) to render them suitable to the analysis of variance by reducing heterogeneity of variance. All significance levels have been reported at their most conservative level, Greenhouse-Geisser epsilon. *Post hoc* Tukey's HSD tests ( $\alpha = 0.05$ ) were subsequently used to compare the group means for each of the dependent variables. An ANOVA on the emotional sounds was deemed inappropriate since very few of these vocalizations had been produced in the various conditions.

Table 1. Mean frequencies of melodic, vocalic and emotional sounds produced to active (am) and passive (pm) mother, active (as) and passive (ps) stranger and active (ao) and passive (po) objects at nine age levels

Age (weeks)	Conditions					
	am	pm	as	ps	ao	po
<i>Melodic</i>						
9	0.000	0.000	0.000	0.000	0.000	0.000
13	0.313	0.125	0.250	1.125	0.000	0.063
17	1.250	0.250	1.125	0.875	0.375	0.313
21	0.938	0.000	0.000	0.125	0.000	0.000
24	2.750	0.000	0.375	0.000	0.000	0.000
28	1.875	0.000	2.375	2.250	0.000	0.125
32	1.375	0.875	0.125	0.000	0.000	0.000
36	2.250	0.500	0.250	0.875	0.120	0.125
40	2.125	1.375	0.375	0.250	0.000	0.000
<i>Vocalic</i>						
9	4.688	5.125	3.500	7.500	2.750	1.750
13	3.813	7.438	4.875	4.063	0.750	2.188
17	12.563	9.750	2.688	4.688	2.313	3.500
21	4.875	12.125	4.750	13.250	1.250	3.250
24	6.625	12.125	3.125	2.875	0.500	2.625
28	10.625	12.500	4.250	3.625	0.875	2.250
32	7.750	11.000	3.375	5.625	1.125	2.750
36	4.000	4.000	2.125	1.375	0.750	2.125
40	4.625	6.875	4.000	2.625	2.125	1.875
<i>Emotional</i>						
9	0.313	0.750	0.938	0.813	0.186	0.186
13	0.000	0.000	0.000	0.000	0.000	0.000
17	0.000	4.813	1.563	3.125	0.000	0.000
21	0.125	0.188	2.938	0.313	0.000	0.000
24	0.000	0.000	0.000	0.000	0.000	0.000
28	0.000	0.000	0.000	0.000	0.000	0.000
32	0.375	0.000	0.000	0.000	0.000	0.000
36	0.250	0.125	0.000	0.000	0.000	0.000
40	1.625	1.500	0.000	0.500	0.500	0.000

### Melodic Sounds

Overall main effects for age  $F(8,56)=5.92$ ,  $p<0.004$  and condition  $F(2,14)=29.64$ ,  $p<0.001$  indicated that these variables had a significant effect on the development of the melodic vocalizations of the infants. These effects were qualified by an age  $\times$  condition interaction  $F(16,112)=3.08$ ,  $p<0.045$ . Group comparisons indicated that the infants produced significantly more of these vocalizations to people than to objects at 17 weeks. A significant condition by activity interaction  $F(2,14)=47.91$ ,  $p<0.001$  revealed that overall the infants produced significantly more melodic sounds in the active mother condition than in all other conditions. Melodic sounds decreased significantly in the following order: the active and passive stranger conditions produced more melodic sounds than the passive mother conditions, which was significantly different from the two objects (active and passive), which did not differ from each other. Figure 1 presents the responses to the active and passive people and objects.

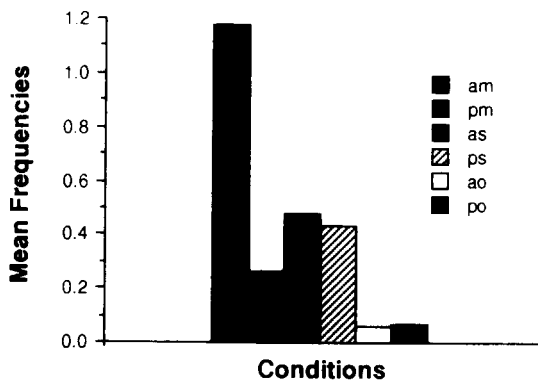


Figure 1. Mean frequencies of melodic sounds as a function of active (am) and passive (pm) mother, active (as) and passive (ps) stranger, active (ao) and passive (po) objects.

A significant age  $\times$  condition  $\times$  activity interaction  $F(16,112)=2.59$ ,  $p<0.046$  further indicated that the condition  $\times$  activity effects described above were larger at 24, 32, 36 and 40 weeks than at all other ages. At 28 weeks significantly more melodic vocalizations were produced to the stranger than to the mother or the objects (see Table 1).

### Vocalic Sounds

Significant main effects for age  $F(8,56)=6.83$ ,  $p<0.001$  and condition  $F(2,14)=73.68$ ,  $p<0.001$  revealed that these variables exerted a significant

influence on the vocalic sounds of the infants. A significant age  $\times$  condition interaction  $F(16,112)=3.05$ ,  $p<0.035$  revealed that at 13, 17 and 21 weeks the infants produced these vocalizations significantly more to people than to objects. A subsequent age  $\times$  activity interaction  $F(8,56)=4.72$ ,  $p<0.005$  and an age  $\times$  condition  $\times$  activity interaction  $F(16,112)=3.14$ ,  $p<0.031$  and subsequent group comparisons indicated that the infants produced these sounds significantly more to passive people at 21 weeks, and significantly more to the passive mother at 24, 28, 32 and 40 weeks than to the other stimuli. Figure 2 portrays the overall responses to the active and passive people and objects.

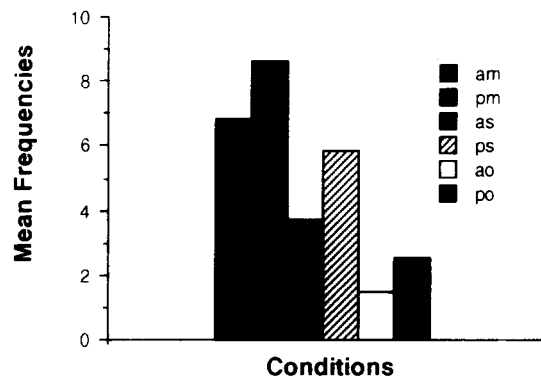


Figure 2. Mean frequencies of vocalic sounds as a function of active (am) and passive (pm) mother, active (as) and passive (ps) stranger, active (ao) and passive (po) objects.

### Emotional Sounds

Although few emotional or affective sounds were produced throughout development, as Table 1 shows, at 17 weeks they began to be produced primarily to people. This trend remained consistent throughout development. Averaged across 9–40 weeks of age, the amount of emotional vocalization produced to people was  $M=0.577$ , and to objects  $M=0.058$ . As can be seen in Figure 3, the emotional vocalizations decreased in the following order: passive mother ( $M=0.820$ ), active stranger ( $M=0.604$ ), passive stranger ( $M=0.528$ ), and active mother ( $M=0.299$ ). Virtually no emotional vocalizations were produced in front of the active ( $M=0.076$ ) and passive objects ( $M=0.042$ ).

## DISCUSSION

Although generalizations must be limited due to the small sample size, the present study has shown that

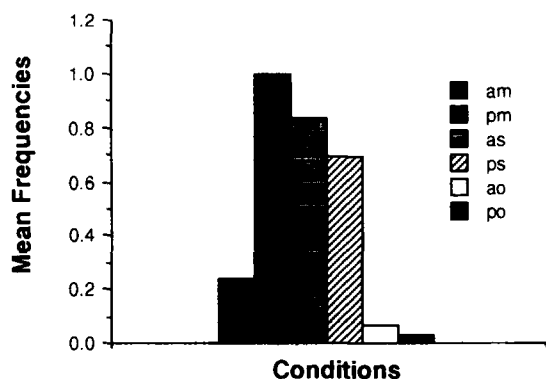


Figure 3. Mean frequencies of emotional sounds as a function of active (am) and passive (pm) mother, active (as) and passive (ps) stranger, active (ao) and passive (po) objects.

as early as 17 weeks the infant vocalizations could be categorized into melodic, vocalic and emotional sounds. At this age the infants also began to change these vocalizations depending on environmental context. They produced significantly more vocalizations and emotional sounds to people than to objects. This is approximately 2 months later than in normal infants (Legerstee, 1991a), and corresponds to the delay noted on their mental age equivalent of the Bayley (Bayley, 1969).

This differential responsiveness to people and objects could not be due to greater familiarity of the mother. The infants responded differentially to the female stranger and puppet and the mother and puppet from 4 months on with overall more vocalizations produced to the women. Differential responsiveness to mother and stranger did not become apparent until the second part of the first year and is consistent with mother/stranger differentiation found in Down syndrome infants in earlier work (Legerstee and Bowman, 1989).

The infants did not appear to distinguish between the active and passive person conditions until approximately 6 months either. Thus, whereas the infants seemed sensitive to the changing social and non-social situation by 4 months of age, they only became aware of the changes *within* the social situation by 6 months of age (cf. Legerstee and Bowman, 1989).

The melodic sounds were distinguished from other sounds by their varied pitch contour and longer durations. In the literature such qualities are often referred to as the 'speechiness' of infant sounds (Oller, 1981), and speech development in children is often thought to begin with the development of intonation (Tonkova-Yampol'skaya,

1978). The present results provide support for such interpretations. By 17 weeks the melodic vocalizations began to be produced primarily in a communicative context, and by 21 weeks the melodic sounds were produced in particular when the infants faced their mother. Few melodic vocalizations were produced in the other contexts.

When mothers communicated, their infants would increase their melodic vocalizations and decrease their vocalic sounds. By 21 weeks, the infants would produce these short utterances, with uniform pitch, to passive people instead. Thus, by 6 months of age, the infants would change the quality of their vocal sounds when confronted with the unresponsive nature of people, in particular the mother.

The finding that the infants produced more melodic sounds to their communicative mother than to the female stranger seems to indicate that mothers may have had more reciprocal interactions with their delayed infants. As Papoušek and Papoušek (1991, p. 302) point out: 'Successful communication between merely crying human newborns and maturely speaking parents would fail if parents were not specifically adapted to the newborn's constraints'. Infants with Down syndrome often present their communicative partners with component interactive responses that are different from those of non-handicapped infants (e.g. atypical eye contact, Berger and Cunningham, 1981; flattened affect, Berger and Cunningham, 1986; Cichetti and Sroufe, 1978; Legerstee and Bowman, 1989). Female strangers may have experienced more difficulty interpreting these atypical behaviours than mothers, and consequently failed to respond appropriately to the relatively clear communicative bids of the infants.

Although the infants produced overall few emotional or affective sounds, a finding supported by other authors (Cichetti and Sroufe, 1978), these sounds were produced more to people than to objects. Thus, by 4 months, infants with Down syndrome laugh, cry and fuss more in the presence of people than when confronted with brightly coloured objects that make sounds when the infants look at them. Although laughing, crying and fussing may remain phonetically distant from speech, 'its occurrence in front of people rather than objects has other features in common with speech, its social responsiveness' (Oller, 1981, p. 21).

The results further provide information about the ontogeny of these vocalizations. It appears that most of the vocalic sounds were produced between 13 and 32 weeks of age and declined thereafter. In contrast, the melodic type of vocalizations appeared

to increase somewhat after 24 weeks, albeit to the active mother only. Thus it appears that after 6 months, when communicating with their mother, infants began to increase vocalizations containing pitch contours to which parents attribute communicative intent (Tonkova-Yampol'skaya, 1978).

It should be noted that although the *pattern* of responses described above for the Down syndrome infants is similar to that of normal infants in the Legerstee (1991a) study on which the experimental paradigm of this study was modelled, the overall *amount* of melodic (speechlike) vocalizations produced towards the active mother ( $M=1.2$ ) was much less than that produced by the normal infants ( $M=5.0$ ), and the overall amount of vocalic (or non-speechlike) vocalizations produced by the Down syndrome infants in the same communicative context (e.g. active mother) was much higher ( $M=7.1$ ) than that produced by normal infants ( $M=2.2$ ) (see Legerstee, 1991a). If this finding can be replicated using caretakers as coders, then parents interacting with Down syndrome infants perceive considerably fewer melodic vocalizations, and a much higher ratio of vocalic or non-speechlike vocalizations, than do caretakers interacting with normal infants.

As suggested by Papoušek and Papoušek (1987), parents function as a universal dialectic counterpart to the infant's integrative capacities and constraints. However, unless taught specific ways of interacting with their infants, it could be expected that these constraints observed in the Down syndrome infants' prespeech vocalizations may have an adverse effect on later language development. Words develop out of the infants' sensorimotor experiences, in particular those interactions that are supported by adults (Bruner, 1983; Lock, 1978) and that involve reciprocal vocalizing (Bloom *et al.*, 1987; Delack and Fowlow, 1978; Legerstee, 1991a). The emergence of communication depends both on developmental changes in infants' behaviour and the interpretability of their vocal productions (Nelson, 1981; Papoušek and Papoušek, 1987, 1991). Therefore, the low output of those types of vocalizations in the Down syndrome infants to which adults attribute communicative intent may interact with the caregiver responsiveness in such a way as to hinder the subsequent acquisition of more appropriate vocal behaviour

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## REFERENCES

- Bayley, N. (1969). *Bayley Scales of Infant Development. Birth to Two Years*. New York: Psychological Corp.
- Berger, J. and Cunningham, C. C. (1981). The development of eye contact between mothers and normal versus Down's syndrome infants. *Developmental Psychology*, **17**, 678-689.
- Berger, J. and Cunningham, C. C. (1983). The development of early vocal behaviours and interactions in Down syndrome and non-handicapped infant-mother pairs. *Developmental Psychology*, **19**, 322-331.
- Berger, J. and Cunningham, C. C. (1986). Aspects of early social smiling by infants with Down's syndrome. *Child: Care, Health and Development*, **12**, 13-14.
- Bloom, K., Russell, A. and Wassenberg, K. (1987). Turn taking affects the quality of infant vocalizations. *Journal of Child Language*, **14**, 211-227.
- Bochner, S. (1986). Development of intentionality in the vocalization of handicapped infants reared in a hospital setting. *Australia and New Zealand Journal of Developmental Disabilities*, **12**, 55-83.
- Bruner, J. (1983). *Child's Talk*. New York: Norton.
- Cicchetti, D. and Sroufe, L. A. (1978). An organizational view of affect: illustration from a study of Down's syndrome infants. In M. Lewis and L. A. Rosenblum (Eds), *The Development of Affect*. New York: Plenum.
- Delack, J. B. and Fowlow, P. J. (1978). The ontogenesis of different vocalizations: development of prosodic contrastivity during the first year of life. In N. Waterson and C. Snow (Eds), *The Development of Communication*. London, pp. 93-110. London: Wiley.
- Dodd, B. J. (1972). Comparison of babbling patterns in normal and Down-syndrome infants. *Journal of Mental Deficiency*, **16**, 35-40.
- Dodd, B. J. (1975). Recognition and reproduction of words by Down's syndrome and non-Down's syndrome retarded children. *American Journal of Mental Deficiency*, **80**, 306-311.
- D'Odorico, L. (1984). Non-segmental features in prelinguistic communications: an analysis of some types of infant cry and non-cry vocalizations. *Journal of Child Language*, **11**, 17-27.
- Field, T. M. (1979). Visual and cardiac responses to animate and inanimate faces by young term and preterm infants. *Child Development*, **50**, 188-194.
- Fleiss, J. L. (1981). *Statistical Methods for Rates and Proportions*. New York: Wiley.

- Kessen, W., Levine, J. and Wendrich, K. A. (1979). The imitation of pitch in infants. *Infant Behavior and Development*, **2**, 93-99.
- Klein, R. P. and Jennings, K. D. (1979). Responses to social and inanimate stimuli in early infancy. *Journal of Genetic Psychology*, **135**, 3-9.
- Kuhl, P. K. and Meltzoff, A. N. (1988). Speech as an intermodal object of perception. In A. Yonas (Ed.), *Perceptual Development in Infancy: The Minnesota Symposia on Child Psychology*, **20**, 235-266.
- Landry, S. H. and Chapiesky, M. L. (1989). Joint attention and infant toy exploration: effects of Down syndrome and prematurity. *Child Development*, **60**, 103-118.
- Legerstee, M. (1990). Infants use multimodal information to imitate speech sounds. *Infant Behavior and Development*, **13**, 345-356.
- Legerstee, M. (1991a). Changes in the quality of infant sounds as a function of social and nonsocial stimulation. *First Language*, **11**, 327-343.
- Legerstee, M. (1991b). The role of person and object in early imitation. *Journal of Experimental Child Psychology*, **51**, 423-433.
- Legerstee, M. (1992). A review of the animate-inanimate distinction; implications for models of social and cognitive knowing. *Early Development and Parenting*, **1**, 59-67.
- Legerstee, M. and Bowman, T. G. (1989). The development of responses to people and a toy in infants with Down syndrome. *Infant Behavior and Development*, **12**, 465-477.
- Legerstee, M., Corter, C. and Kienapple, K. (1990). Hand, arm, and facial actions of young infants to a social and nonsocial stimulus. *Child Development*, **61**, 774-784.
- Legerstee, M., Kienapple, K. and Walsh, E. (1989). Communicative imitation in mother-infant and stranger-infant dyads during the first year. Paper presented at the meeting of the Society for Research in Child Development, Kansas City, April.
- Legerstee, M., Pomerleau, A., Malcuit, G. and Feider, H. (1987). The development of responses to people and a doll: implications for research in communication. *Infant Behavior and Development*, **10**, 81-95.
- Lewis, M. and Freedle, R. (1973). Mother-infant dyad: the cradle of meaning. In P. Pliner, L. Kramer and T. Alloway (Eds), *Communication and Affect: Language and Thought*. New York: Academic Press.
- Lock, A. (1978). *Action, Gesture, and Symbol*. London: Academic Press.
- Mundy, P., Sigman, M., Kasari, C. and Yirmiya, N. (1988). Nonverbal communication skills in Down syndrome children. *Child Development*, **59**, 235-249.
- Nelson, K. (1981). Individual differences in language development: implications for development and language. *Developmental Psychology*, **16**, 170-187.
- Oller, D. K. (1981). Infant vocalizations: exploration and reflexivity. In R. E. Stark (Ed.), *Language Behaviour in Infancy and Early Childhood*. Amsterdam: Elsevier, North Holland, pp. 85-103.
- Papoušek, H. and Papoušek, M. (1987). Intuitive parenting: a dialectic counterpart to the infant's integrative competence. In J. D. Osofsky (Ed.), *Handbook of Infant Development*, 2nd edn. New York: Wiley, pp. 669-719.
- Papoušek, H. and Papoušek, M. (1991). Preverbal vocal communication from zero to one: preparing the ground for language acquisition. In Michael Lamb and Heidi Keller (Eds), *Infant Development: Perspectives from German-Speaking Countries*. Hillsdale, NJ: Lawrence Erlbaum, pp. 299-328.
- Rohr, A. and Burr, D. (1978). Etiological differences in patterns of psycholinguistic development of children of IQ 30 to 60. *American Psychologist*, **33**, 789-798.
- Smith, B. L. and Oller, K. D. (1981). A comparative study of pre-meaningful vocalizations produced by normally developing and Down's syndrome infants. *Journal of Speech and Hearing Disorders*, **46**, 46-51.
- Stern, D. N., Spieker, S., Barnett, R. K. and MacKain, K. (1983). The prosody of maternal speech: infant age and context related changes. *Journal of Child Language*, **10**, 1-15.
- Tonkovo-Yampol'skaya, R. V. (1978). Development of speech intonation in infants during the first two years of life. In C. Ferguson and C. Snow (Eds), *Talking to Children: Language Input and Acquisition*. Cambridge: Cambridge University Press.
- Velleman, S., Mangipudi, L. and Locke, J. L. (1989). Prelinguistic phonetic contingency: data from Down syndrome. *Journal of First Language*, **9**, 159-174.
- Watson, J. S. (1972). Smiling, cooing and 'the game'. *Merrill-Palmer Quarterly*, **18**, 323-339.
- Wolff, P. H. (1966). The causes, controls, and organization of behaviour in the neonate. *Psychological Issues*, **5**, Monograph No. 17.