Assessment of nonsymbolic communication skills in children with Down syndrome and autism

Mona Hegazi[a], Samira Ismail[b], Jilan Nasser[a] and Mohammed Mamdouh[b]

[a]Unit of Phoniatrics, Otorhinolaryngology Department, Ain-Shams University and [b]Clinical Genetics Department, National Research Center, Cairo, Egypt

Correspondence to Samira Ismail, Department of Clinical Genetics, National Research Center, Behoth Street, Dokki, 11769 Cairo, Egypt
Tel: +01224611528; fax: +26240199;
e-mail: drsamira951@yahoo.com

Received 7 January 2012
Accepted 23 January 2012

The Egyptian Journal of Otolaryngology
2012, 28:136–141

Introduction
Communication is among the most basic of human needs. Verbal communication is the highest level of communication, whereas nonverbal (nonsymbolic) communication may remain the only mode of communication in individuals with significant cognitive limitation. Assessment of nonsymbolic skills of two categories of patients with limited verbal output, namely, those with autism [autistic disorder (AD)] and those with Down syndrome (DS), is our main aim. We used the Dynamic Assessment of Nonsymbolic Communication (DANC) test to achieve our aim, because most traditional language tests underestimate this type of communication. Insight into the nonverbal communication abilities of AD and DS patients helps to maintain the communication between them and their caregivers.

Participants and methods
The current study recruited 20 patients with DS, 20 patients with AD, and 20 normal children as controls. The age of the AD and DS patients ranged from 2 to 5 years, whereas the age of controls ranged from 1 to 2 years. All participants were subjected to detailed personal, family, medical, and developmental history taking. Full clinical examination, hearing tests, and assessment of mental ability (intelligence quotient) were performed. The Childhood Autism Rating Scale was provided to evaluate the severity of autism. The DANC test was administered to evaluate the nonsymbolic skills of all participants.

Results
The control group achieved the highest score in all parts of the DANC test, followed by the DS group and the AD group, respectively. There was no significant difference between the DS group and normal group ($P > 0.05$), whereas the autistic group showed highly significantly lower scores compared with both the normal and DS groups ($P < 0.001$). There was also a highly significant difference in scores on the DANC test among the patients in the autistic group in terms of its severity.

Conclusion
Application of the DANC test reflected a specific pattern of nonsymbolic skills of AD and DS patients with respect to their relative strengths and weakness. Such patterns should be considered while designing their intervention program aiming either at developing verbal communication or at enhancing the nonverbal skills. Maintaining communication with such patients helps to fulfill their simple needs and prevents frustration among their caregivers caused by lack of communication.

Keywords:
autism, down's syndrome, dynamic assessment of nonsymbolic communication test nonsymbolic communication

Egypt J Otolaryngol 28:136–141

1012-5574

Introduction

Communication is a two-way activity, entailing the sharing of ideas between two partners. It could be verbal or nonverbal. Nonverbal communication is of important communicative value [1]. Ellis and Beattie [2] divided the nonverbal channels of communication into static and dynamic. The main static channels are interpersonal distance, touch, and appearance, whereas the main dynamic channels are facial expression, hand movement, head movement, eye gaze, and posture. Other terms to describe nonverbal means of communication include nonoral, nonvocal, gestural, assistive, and nonsymbolic [3]. If a child does not understand or use symbols in communication then the term 'nonsymbolic' is used to describe his or her form of communication. Normally, the acquisition of symbolic skills happens rapidly and without much effort [4]. In contrast, in some conditions such as autism or severe mental retardation, nonsymbolic communication may remain the only mode of communication in those individuals [5].

This work aims at assessing nonsymbolic communication skills in two categories of children with limited verbal output, namely, autism and Down's syndrome (DS), using

the test of Dynamic Assessment of Nonsymbolic Communication (DANC) [5,6]. One of the most common causes of mental retardation is DS [7]. Most DS children have difficulties in verbal communication; yet, they show fairly developed nonverbal communication skills, starting at early ages [8]. Abbeduto *et al.* [9] described their pattern of nonverbal communication saying that they show relative strengths in imitation and protodeclarative (commenting) function of gestures and relative weaknesses in protoimperative (requesting) function of gestures.

In contrast, children with autistic disorder (AD) show a rather severe deficit in development of nonverbal communication [10,11]. They often use a limited range of conventional gestures and vocalizations in the early stages of communication development [12]. However, they have a specific pattern of relative strengths in protoimperative (requesting) gestures, with a reliance on presymbolic contact gestures (like leading or manipulating another's hand) [13], and relative weaknesses in (protodeclarative) skills manifested by impaired joint attention.

Most of the traditional language tests underestimate the communication skills of children who rely only on verbal communication. That is why it was important to find a test that can assess their nonverbal communication skills. The aim of this work was to apply the DANC test on two groups of children with AD and DS with the hope of gaining an insight into their nonverbal communicative abilities. Assessment of these skills may also be helpful to design treatment protocols for enhancing communication skills of these children and to monitor the efficacy of such protocols along treatment sessions.

Participants and methods

This study was conducted on 60 children (36 boys and 24 girls) who were divided into three groups: group 1 consisted of 20 autistic children (17 boys and three girls), group 2 included 20 children with DS (nine boys and 11 girls), and group 3 included 20 normal children (10 boys and 10 girls). Groups 1 and 2 included children attending the Phoniatric Unit, Ain-Shams University, and the Clinical Genetics Clinic, National Research Centre, from 2008 and 2009. The ages of the children suffering from AD and DS ranged from 2 to 5 years, whereas the ages of normal children ranged from 1 to 2 years. Group 3 (considered the controls) consisted of children belonging to this age group of 1–2 years, being the age when nonverbal communication is expected to be predominantly present in case of normal language development.

According to the Language Assessment Protocol of Ain-Shams University Hospitals, all participants were subjected to full personal, family, medical, and developmental history taking, full clinical examination, and assessment of mental ability [intelligence quotient (IQ)] using the Stanford–Binet Intelligence Scale [14] or Ruth Griffith's Intelligence Scale [15], which was used mainly among the normal children below 2 years of age. Furthermore, the Childhood Autism Rating Scale [16] was used to assess the severity of autism in the group of autistic children, and the Arabic modified version of the DANC test was used to evaluate the nonverbal communication skills of all children.

The test of DANC was translated and modified to be more feasible for the caregivers. A scoring system was assigned for each item to allow quantitative measurement of the tested items and so that the scores could be used for statistical analysis. The whole test is divided into three parts, with a total number of 62 items and a total score of 70:

(1) Part 1 is a survey of forms (signals) and functions (meanings), including 15 items, with a score of 12 for the whole part.
(2) Part 2 is composed of forms used to indicate specific requests, needs, or emotions, including 26 items, with a score of 26 for the whole part.
(3) Part 3 is for assessment of nonsymbolic communication competence, including 21 items, with a score of 32 for the whole part.

The test questionnaire was given to one of the family members of each child for completion, mostly to the mother and sometimes to the father or elder sister or brother. The questionnaire was left with the family member for an uncertain period of time to be completed. After the questionnaire had been filled in, it was revised quickly with the family member, with emphasis on the unclear items, explaining their meaning to him/her and then registering his/her answer. The items of the questionnaire were then scored on the basis of whether the caregiver gave positive or negative responses.

Group comparisons were made using the analysis of variance test, followed by the post-hoc test using SPSS program, version 11 (SPSS Inc., Chicago, Illinois, USA).

Table 1 Results of analysis of variance of the scores of the Dynamic Assessment of Nonsymbolic Communication test among the three studied groups

DANC test	Part 1 (score=12)	Part 2 (score=26)	Part 3 (score=32)	Total (score=70)
Autism (n=20)	10.25±1.48	16.6±4.76	20.6±4.75	47.45±9.69
Down (n=20)	11.7±0.73	20.4±2.74	22.75±2.05	54.85±4.53
Normal (n=20)	11.75±0.72	20.05±2.78	25.2±1.79	57.00±4.22
F-test	13.411	6.978	10.6	11.392
P value	<0.01	<0.01	<0.01	<0.01
Significance	HS	HS	HS	HS

DANC, Dynamic Assessment of Nonsymbolic Communication; HS, highly significant.

Results

The mean age of children of the AD group was 3 years and 1 month and the mean IQ score was 52. The DS group had a mean age of 3 years and 2 months, with a mean IQ of 59, whereas the mean age of normal children was 1 year and 7 months and their mean IQ was 97.

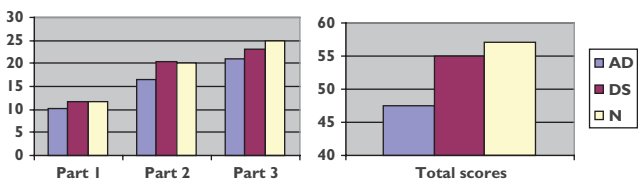
Table 1 and Figure 1 show the results of analysis of variance for the scores of the three parts of the DANC test among the studied groups, as well as the total scores. There was a highly significant *F* ratio in the total score and in the scores for each part of the DANC test. In general, the children of the normal group generally obtained the highest scores on nonverbal communication skills, followed by the children with DS and those with AD, respectively.

The post-hoc test (Table 2) revealed that the group with DS did not show a significant difference from the normal group, except in part 3 of the test (which reflects non-symbolic communication competence), in which children with DS scored significantly lower compared with normal children. Moreover, the autistic group showed significantly (or highly significantly) lower scores compared with both the normal group and DS group in the total score and in all parts of the test.

According to the results of the Childhood Autism Rating Scale test, the children in the AD group were classified into three subgroups, and the results of the DANC test were compared in the three subgroups to determine the effect of severity of autism on the scores obtained in the test. Table 3 shows that severity of autism had a significant effect on the total scores and on the scores obtained for each part of the DANC test. Generally, children with mild autism obtained the highest scores on nonverbal communication skills, followed by children with moderate autism and those with severe autism, respectively. However, the post-hoc test revealed that severe degree resulted in statistically significantly lower values in total scores and in scores obtained for each part of the test, compared with mild and moderate degrees. There was no significant difference between the mild and moderate degrees of autism with regard to the scores obtained for any part of the test, nor with regard to its total score (Table 4).

There was a positive correlation between the total score of the DANC test and each of the ages and IQ of children of the three groups. However, the correlation was significant only in the normal group (Table 5).

Figure 1



Showing a graphic representation of the values obtained in the three parts of the Dynamic Assessment of Nonsymbolic Communication test (left) and its total scores (right) in the three groups studied. AD, autistic disorder; DS, Down's syndrome.

Table 2 Results of the post-hoc test comparing the scores of the Dynamic Assessment of Nonsymbolic Communication test among the three studied groups

DANC test	Comparison	Mean difference	*P* value	Significance
Part 1	Autism vs. Down	1.45	<0.01	HS
	Autism vs. normal	1.5	<0.01	HS
	Down vs. normal	0.05	>0.05	NS
Part 2	Autism vs. Down	3.8	<0.01	HS
	Autism vs. normal	3.45	<0.01	HS
	Down vs. normal	0.35	>0.05	NS
Part 3	Autism vs. Down	2.15	<0.05	S
	Autism vs. normal	4.6	<0.01	HS
	Down vs. normal	2.45	<0.05	S
Total score	Autism vs. Down	7.4	<0.01	HS
	Autism vs. normal	9.55	<0.01	HS
	Down vs. normal	2.15	>0.05	NS

DANC, Dynamic Assessment of Nonsymbolic Communication; HS, highly significant; NS, non-significant; S, significant.

Discussion

Evaluation of the nonverbal communication skills of individuals with significant cognitive limitations, such as autism or mental retardation, may be helpful in understanding the functions or meanings of their communication

Table 3 Distribution of scores of the Dynamic Assessment of Nonsymbolic Communication test, and results of analysis of variance of these scores for the three degrees of severity of autism

DANC test	Degree of Autism	*n*	Score of DANC test	*F*-test	*P* value	Significance
Part 1	Mild	9	10.33±1.22	4.385	<0.05	S
	Moderate	8	10.88±1.46			
	Severe	3	8.33±0.58			
Part 2	Mild	9	19.33±3.74	5.483	<0.05	S
	Moderate	8	15.63±4.41			
	Severe	3	11±2.65			
Part 3	Mild	9	22.44±3.84	5.191	<0.05	S
	Moderate	8	21±4.38			
	Severe	3	14±2.65			
Total score	Mild	9	52.11±6.66	6.815	<0.01	HS
	Moderate	8	47.5±9.44			
	Severe	3	33.33±2.31			

DANC, Dynamic Assessment of Nonsymbolic Communication; HS, highly significant; S, significant.

Table 4 Comparisons of the scores of the Dynamic Assessment of Nonsymbolic Communication test in different degrees of autism

DANC test	Degrees of autism being compared	Mean difference	*P* value	Significance
Part 1	Mild vs. moderate	0.54	>0.05	NS
	Mild vs. severe	2	<0.05	S
	Moderate vs. severe	2.54	<0.01	HS
Part 2	Mild vs. moderate	3.71	>0.05	NS
	Mild vs. severe	8.33	<0.01	HS
	Moderate vs. severe	4.63	>0.05	NS
Part 3	Mild vs. moderate	1.44	>0.05	NS
	Mild vs. severe	8.44	<0.01	HS
	Moderate vs. severe	7	<0.05	S
Total score	Mild vs. moderate	4.61	>0.05	NS
	Mild vs. severe	18.78	<0.01	HS
	Moderate vs. severe	14.17	<0.05	S

DANC, Dynamic Assessment of Nonsymbolic Communication; HS, highly significant; NS, non-significant; S, significant.

Table 5 Correlations between the total score of the Dynamic Assessment of Nonsymbolic Communication test and each of age and intelligence quotient in the groups of autistic disorder, Down's syndrome, and normal children

Variables	TSDT in AD group	TSDT in DS group	TSDT in normal group
Age ($n=20$)			
Pearson correlation	+0.26	+0.243	+0.557
P value (two-tailed)	$P>0.05$	$P>0.05$	$P<0.05$
Significance	NS	NS	S
IQ ($n=20$)			
Pearson correlation	+0.207	+0.395	+0.738
P value (two-tailed)	$P>0.05$	$P>0.05$	$P<0.01$
Significance	NS	NS	HS

AD, autistic disorder; DS, Down's syndrome; HS, highly significant; IQ, intelligence quotient; S, significant; TSDT, total score of the Dynamic Assessment of Nonsymbolic Communication test.

forms (patterns). Understanding the meaning of their communication forms (e.g. requesting), and thus fulfilling their simple needs, may diminish the outrages and hostile behaviors of these individuals and also decrease the frustration of their caregivers caused by failure to communicate with them. Furthermore, the evaluation of the communicative abilities of these individuals may also be helpful in designing protocols that basically target enhancement of their communication skills.

In general, nonverbal communication is not desired when it hinders the progress of verbal communication. This may be the case in disorders like DS, early and mild autism, hearing impairment, and specific language impairment. However, nonverbal communication is considered a favorable outcome of communicative rehabilitation in cases in which verbal communication is not expected to develop, such as in cases of severe dysarthria and anarthria, severe dyspraxia, severe cases of autism, and select cases of hearing impairment auditory neuropathy/dys-synchrony, as well as in the case of individuals with severely unintelligible speech [17]. In the current work, the nonverbal communication skills of autistic children, those with DS, and normal children were assessed using the test of DANC using an Arabic version. In a trial to quantify the data obtained from the test, scores were assigned to each item in order to facilitate follow-up evaluations.

Compared with the normal (control) and DS groups, the AD group obtained the lowest total scores, as well as lowest scores on all parts of the DANC test. This reflects the overall deficits of nonverbal communication skills revealed by the autistic children. It means that the AD group does not even rise to the level of the nonverbal communication of normal children of younger ages (1–2 years). This result is in agreement with those of previous studies that argued that children with autism show a rather severe deficit in the development of gestural communication, along with impaired joint attention skills [10,18–24]. However, several investigators have observed that, in spite of the overall defect of nonverbal communication, autistic children seem to be able to formulate nonverbal requests for objects, actions, and social routines, using mainly contact gestures (as leading) and, less frequently, distal gestures such as pointing and ritualized requests [25,26]. This pattern of requesting behavior (protoimperative gestures) was obvious also in the nonverbal communication profile of the AD children of our study, frequently in the form of contact (leading) gestures, vocalizations, or crying and sometimes in the form of problem behaviors, reaching, or pointing. Meanwhile, this group of AD children in our study showed relatively less frequent commenting or showing behaviors (protodeclarative gestures), as compared with requesting behaviors. Furthermore, these protodeclarative gestures were present in fewer numbers of children of the AD group than in the normal group and DS group. Stone *et al.* [27] also reported that less than 1% of communicative acts of a group of AD children served the purpose of commenting, whereas almost one-third of the communicative acts of a group of other developmentally delayed children served this purpose. They argued that the lower rates of comments and associated forms (e.g. distal pointing and showing) were not simply because of lower overall rates of communication in autistic children but rather because of the less intrinsically rewarding experience of sharing attention with adults. In contrast to requesting behavior, which results in the acquisition of desired objects or events, the outcome of commenting behavior is social or emotional in nature.

It is obvious from the results of this study that severity of autism has a significant effect on the potential of acquiring nonverbal communication skills. Children with mild autism obtained the highest scores, followed by those with moderate autism and those with the severe form of the disorder,

respectively. Similar results were reported by Mundy *et al.* [10] and Naber *et al.* [28] who mentioned that symptom severity can be the main source of individual differences in joint attention behaviors in children with autism.

The DS children in our study obtained scores that were generally comparable to those of normal children (regarding the total score of the DANC test and the scores of parts 1 and 2). They showed significantly lower values compared with the scores obtained by normal children only in part 3 of the test. These results agree with the studies by Singer Harris *et al.* [29] and Caselli *et al.* [30] who found that children with DS aged 10 months to 4 years used several types of gestures, as measured by parent checklists. Furthermore, Singer Harris *et al.* [29] reported that prelinguistic children affected with DS had even substantially larger gesture repertories than did a linguistically matched group of normally developing children. However, we suggest that this finding in our study indicates a general impairment of communication in this group of children affected with DS, because the communication skills of this group of children whose mean age was 3 years and 2 months were comparable to the nonverbal communication skills of a normal group of children who are younger in age (with a mean age of 1 year and 7 months). The predominance of nonverbal communication in this studied age of the DS group reflects a general delay in verbal communication, which is readily replaced by nonsymbolic skills. This agrees with the study by Rondal [31] who reported that the transition into symbolic intentional communication in children with DS takes anywhere from 24 to 36 months, compared with normally developing children who begin to communicate intentionally during the last 3 months of the first year of life and begin to communicate symbolically by words and/or signs sometime between 12 and 18 months of age. The significantly lower values of part 3 of the DANC test in the DS group compared with the normal group in our study may indicate that the items of part 3, which reflect nonsymbolic communication competence, require a considerable cognitive function that is lacking in this age group of DS.

The communicative functions of gestures used by children with DS may differ from those of normally developing children. Several investigators found that children with DS show more delayed in the requesting function of gestures (protoimperatives), as they make fewer requests, particularly instrumental requests, than do their developmental level-matched typical peers [32–35]. However, this was not the trend in our study, as part 2 of the DANC test, which reflects the requesting function in most of its items, has scores (even slightly higher in the DS group) comparable between the DS children and normal younger children, with nonsignificant differences between them.

Wetherby *et al.* [36] found that a small sample of children with DS tended to score at the very low end of the normal distribution on a standardized measure of nonverbal requesting. They also found that these children scored in the average-to-high range on a measure of joint attention skills (protodeclaratives). The latter finding is consistent with the results of our study in which a pattern of relative strengths regarding the protodeclaratives (showing and commenting gestures) was determined. In our study, most of the children of the DS group scored with positive responses on the items measuring the commenting or showing behaviors, compared with the AD group (in which most children did not show positive responses to these behaviors). In contrast, the normal group showed a slightly larger number of children with these behaviors compared with the DS group.

The well-developed joint attention skills observed in DS children may be attributed to the good social aspects of these children, in comparison with the relatively deficient nonverbal requesting skills that were explained in several studies by an impaired aspect of cognitive ability in these children, namely, 'cause and effect thinking' [33,36–40].

However, the current study revealed that, in DS and also in AD, neither age nor IQ showed significant correlations to the total score of the DANC test. The findings of the studies by Perovic [41] and Laws and Bishop [42] showed that the language delays expressed by the DS children are not merely a simple consequence of their delayed mental abilities but show a certain pattern that reflects other mechanisms responsible for the language delay in such cases. The nonsignificant results in our study regarding the effect of IQ and age in children with DS and AD on nonverbal communication may be in line with the results of the latter two studies, suggesting that the trends in nonverbal communication in these disorders are disorder-specific rather than affected by other confounders of age and IQ, at least in the age group studied in these disorders (2–5 years). In contrast, positive significant correlations were obtained for age and IQ in the normal group, indicating that in the age range of 1–2 years nonsymbolic communication continues to grow. In fact, it is believed that this mode of communication is expected to regress as the patient grows older and as verbal communication develops more and more. However, the positive significant correlations in our study may be explained by the presence of some items, especially in part 3 of the DANC test, related to verbal communication, reflecting the assumption that, while the process of communication progresses toward verbal communication, the total score of the DANC test will increase.

In conclusion, the application of the DANC test on certain groups in which no verbal language is expected may be very useful for detecting the development and progress of the desired nonsymbolic communication skills in such disorders. Furthermore, the areas of strengths in the specific nonverbal communication patterns of the disorders of autism and DS, as obtained by the DANC test, should be considered during the design of intervention programs, aiming either at developing verbal communication or enhancing the persistent nonsymbolic communication skills of children affected by these disorders. Repeated assessment of nonverbal communication skills using the DANC test is recommended also for nonverbal individuals for further delineation of the changes in their profile over time and to monitor changes, even subtle, occurring during therapy.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

References

1 Kotby MN. Diagnosis and management of the communicatively handicapped child. Ain Shams Med J 1980; 31:303–304.

2 Ellis A, Beattie G. *The psychology of language and communication*. Lawrence Erlbaum, London: The Guilford Press; 1986.

3 American Speech-Language-Hearing Association. Non-speech communication: a position paper. ASHA 1980; 22:267–272.

4 Snell ME. Using dynamic assessment with learners who communicate nonsymbolically. Augmentat Alternat Commun 2002; 18:163–176.

5 Snell ME, Loncke F. *A manual for the dynamic assessment of nonsymbolic communication*. University of Virginia; 2002.

6 Loncke F, Snell ME. A procedure for dynamic assessment of nonsymbolic and prelinguistic communication. Paper presented at the 9th Biennial Conference of the International Society for Augmentative and Alternative Communication; Washington, DC; August 2000.

7 ACOG Practice Bulletin No. 77. Screening for fetal chromosomal abnormalities. Obstet Gynecol 2007; 109:217–228.

8 Roberts JE, Price J, Malkin C. Language and communication development in Down syndrome. Ment Retard Dev Disab Res Rev 2007; 13:26–35.

9 Abbeduto L, Warren SF, Conners FA. Language development in Down syndrome: from the prelinguistic period to the acquisition of literacy. Ment Retard Dev Disab Res Rev 2007; 13:247–261.

10 Mundy P, Sigman M, Kasari C. Joint attention, developmental level and symptom presentation in young children with autism. Dev Psychopathol 1994; 6:389–401.

11 Chen GK, Kono N, Geschwind DH, Cantor RM. Quantitative trait locus analysis of nonverbal communication in autism spectrum disorder. Mol Psychiatry 2006; 11:214–220.

12 Wetherby AM, Prizant BM, Schuler AL. Understanding the nature of communication and language impairments. In: Wetherby AM, Prizant BM, editors. *Autism spectrum disorders: a transactional developmental perspective*. Baltimore, MD: Paul H. Brookes; 2000. pp. 109–141.

13 Wetherby AM, Warren S, Reichle J. *Transitions in prelinguistic communication*. Baltimore, MD: Brookes Publishing; 1998.

14 Thorndike RL, Sattler JM, Hagen EP. *Stanford-Binet Intelligence Scale*. 4th ed. Itasca, IL: Riverside Publishing; 1986.

15 Griffith R. *The abilities of babies: a study in mental measurement*. University of London Press; 1964.

16 Schopler E, Reichler RJ, Renner BR. *The Childhood Autism Rating Scale (CARS) for diagnostic screening and classification of autism*. Los Angeles, CA: Western Psychological Services; 1988.

17 Silverman MJ. Nonverbal communication, music therapy and Autism: a review of literature and case example. J Creativ Ment Health 2008; 3: 3–19.

18 Curcio F. Sensorimotor functioning and communication in mute autistic children. J Autism Child Schizophr 1978; 8:281–292.

19 Miller Wetherby A, Prutting CA. Profiles of communicative and cognitive-social abilities in autistic children. J Speech Hear Res 1984; 27:364–377.

20 Mundy P, Sigman M, Ungerer J, Sherman T. Defining the social deficits of autism: the contribution of non-verbal communication measures. J Child Psychol Psychiatry 1986; 27:657–669.

21 Sigman M, Mundy P, Sherman T, Ungerer J. Social interactions of autistic, mentally retarded and normal children and their caregivers. J Child Psychol Psychiatry 1986; 27:647–656.

22 Baron Cohen S. Perceptual role taking and protodeclarative pointing in autism. Br J Dev Psychol 1989; 7:113–127.

23 Abrahamsen EP, Mitchell JR. Communication and sensorimotor functioning in children with autism. J Autism Dev Disord 1990; 20:75–85.

24 Sowden H, Perkins M, Clegg J. The co-development of speech and gesture in children with autism. Clin Linguist Phonet 2008; 22:804–813.

25 Bates E, Camaioni L, Volterra V. The acquisition of performatives prior to speech. Merril Palmer Q 1975; 21:205–226.

26 Tomasello M, Camaioni L. A comparison of the gestural communication of apes and human infants. Hum Dev 1997; 40:7–24.

27 Stone WL, Ousley OY, Yoder PJ, Hogan KL, Hepburn SL. Nonverbal communication in two- and three-year-old children with autism. J Autism Dev Disord 1997; 27:677–696.

28 Naber FBA, Bakermans Kranenburg MJ, Van IJzendoorn MH, Dietz C, Van Daalen E, Swinkels SHN, *et al*. Joint attention development in toddlers with autism. Eur Child Adolesc Psychiatry 2008; 17:143–152.

29 Singer Harris NG, Bellugi U, Bates E, Jones W, Rossen M. Contrasting profiles of language development in children with Williams and Down syndromes. Dev Neuropsychol 1997; 13:345–370.

30 Caselli MC, Vicari S, Longobardi E, Lami L, Pizzoli C, Stella G. Gestures and words in early development of children with Down syndrome. J Speech Lang Hear Res 1998; 41:1125–1135.

31 Rondal J. Prelinguistic training. In: Rondal J, Buckley S, editors. *Speech and language intervention in Down syndrome*. 1st ed. London: Wiley; 2003. pp. 11–30.

32 Beeghly M, Weiss Perry B, Cicchetti D. Beyond sensorimotor functioning: early communicative and play development of children with Down syndrome. In: Cicchetti D, Beeghly M, editors. *Children with Down syndrome: a developmental perspective*. New York: Cambridge University Press; 1990. pp. 329–368.

33 Mundy P, Kasari C, Sigman M, Ruskin E. Nonverbal communication and early language acquisition in children with Down syndrome and in normally developing children. J Speech Hear Res 1995; 38:157–167.

34 Sigman M, Ruskin E, Arbelle S, Corona R, Dissanayake C, Espinosa M, *et al*. Continuity and change in the social competence of children with autism, Down syndrome and developmental delays. Monogr Soc Res Child Dev 1999; 64:1–114.

35 Fidler DJ, Philofsky A, Hepburn SL, Rogers SJ. Nonverbal requesting and problem-solving by toddlers with Down syndrome. Am J Ment Retard 2005; 110:312–322.

36 Wetherby AM, Yonclas DG, Bryan AA. Communicative profiles of preschool children with handicaps: implications for early identification. J Speech Hear Disord 1989; 54:148–158.

37 Greenwald CA, Leonard LB. Communicative and sensorimotor development of Down's syndrome children. Am J Ment Defic 1979; 84:296–303.

38 Coggins TE, Carpenter RL, Owings NO. Examining early intentional communication in Down's syndrome and nonretarded children. Br J Disord Commun 1983; 18:98–106.

39 Smith L, von Tetzchner S. Communicative, sensorimotor and language skills of young children with Down syndrome. Am J Ment Deficiency 1986; 91:57–66.

40 Mundy P, Sigman M, Kasari C, Yirmiya N. Nonverbal communication skills in Down syndrome children. Child Dev 1988; 59:235–249.

41 Perovic A. Language in Down syndrome: delay of principle A effect? Durham Working Papers Linguis 2002; 8:97–110.

42 Laws G, Bishop DVM. A comparison of language abilities in adolescents with Down syndrome and children with specific language impairment. J Speech Lang Hear Res 2003; 46:1324–1339.