Eur Child Adolesc Psychiatry (2006)
15:12–18 DOI 10.1007/s00787-006-0499-6

ORIGINAL CONTRIBUTION

Erin L. Mooney
Kylie M. Gray
Bruce J. Tonge

Early features of autism

Repetitive behaviours in young children

Accepted: 27 July 2005

E. L. Mooney, BSc (Honours) · K. M. Gray, PhD (✉) · B. J. Tonge, MD, FRANZCP
Monash University Centre of Developmental Psychiatry and Psychology
Department of Child and Adolescent Psychiatry
Monash Medical Centre
246 Clayton Rd.
Clayton (VIC) 3168, Australia
Tel.: +61-3/9594-1301
Fax: +61-3/9594-6333
E-Mail: kylie.gray@med.monash.edu.au

Abstract This study examined whether repetitive behaviours were a differentiating feature of autism in children aged less than 51 months. The study also examined the relationship between age (chronological and developmental) and repetitive behaviours in young children with autism. Standardised developmental and diagnostic assessments were conducted on 55 children aged between 22 and 51 months, consisting of 40 developmentally delayed children with DSM-IV-TR Autistic Disorder and 15 developmentally delayed children without Autistic Disorder. Results indicated that several measures of repetitive behaviour, particularly more complex *high-level* ones, were significantly positively associated with the probability of receiving a diagnosis of autism. No significant relationships were found between developmental age and the presence of repetitive behaviours in children with autism, but younger chronological age was associated more with simple or low-level repetitive behaviours.

Key words autism – early features – repetitive behaviours

Introduction

In an attempt to address the issue of early identification and diagnosis of autism in young children, there has been a research focus on early features of the disorder. However, studies examining the manifestations of restricted, repetitive and stereotyped behaviour in young children with autism have produced differing results [12].

Restricted, repetitive and stereotyped patterns of behaviour, interests and activities

The expression of the diagnostic criterion of repetitive behaviours is heterogeneous [4, 24]. Turner has therefore proposed that human repetitive behaviours can be divided into *lower-level* and *higher-level* behaviours [34]. Lower-level repetitive behaviours are characterised by repetition of movement including stereotyped movements, self-injury, tardative dyskinesia, tics and repetitive manipulation of objects. Higher-level repetitive behaviours include circumscribed interests, obsessions, compulsions, rigid adherence to routines and rituals, insistence of sameness and abnormal attachments to objects.

Turner proposed that lower-level repetitive behaviours may not be exclusive to autism [34]. Instead, they may be related to broader factors, such as level of cognitive ability or brain pathology. Turner also suggested that, although there are research inconsistencies, certain classes of higher-level repetitive behaviours such as circumscribed interests may signify Pervasive Developmental Disorders (PDDs) [10, 37]. However, some studies have indicated that the higher-level repetitive behaviours characteristic of autism may not become evident until a particular developmental level is achieved [17, 18, 31]. Identifying this diagnostic criterion of autism in young children may consequently be problematic.

ECAP 499

Diagnostic issues in young children and infants with autism

The average age of diagnosis of autism is 6 years [14, 21]. Earlier diagnosis is preferable because children beginning intervention between the ages of 2 and 4 years are more likely to achieve developmental progress [20].

The diagnosis of autism in a young child is challenging as their symptoms may be more restricted in comparison to an older child [5, 29]. The levels of language and cognitive maturity necessary to identify whether particular symptoms of autism are present may be lacking in younger children. Consequently, not all criteria may be able to be assessed in very young children [10, 29, 35]. Nevertheless, there is evidence that a stable and reliable diagnosis of autism can be made in children aged less than 3 years, although the expression of repetitive behaviour is highly variable [31].

A diagnostic issue relating to repetitive behaviour in autism is the difficulty in differentiating it from normal early development. Sallustro and Atwell's observations of normally developing children indicated that rhythmic behaviours are common in infants [25]. Research conducted by Thelen reported that a variety of rhythmic and stereotyped behaviours are frequently performed by normal infants within their first year of life [33]. It was suggested that these behaviours are manifestations of "incomplete cortical control in maturing neuromuscular pathways" correlated with motor skill acquisition [33, p. 699].

Research indicates that frequencies of compulsive-like behaviour fluctuate in normally developing children aged between 2 and 4 years [9]. This behaviour may include an insistence on sameness, such as always wanting to read the same book. As early as 1928, Gesell proposed that these ritualistic, repetitive behaviours might have an adaptive purpose, helping individuals to deal with environmental change [11].

Another challenge to early diagnosis is differentiating the features of autism and intellectual disability or developmental delay. Because 70–80% of people with autism also have an intellectual disability [3, 37], Lord has suggested that, in diagnosis, the behavioural features of autism must be differentiated from those due to developmental delay [15]. The symptoms of autism can be difficult to distinguish from behavioural features of developmental delay and may account for a delay in the diagnosis of autism [18, 23]. It is, therefore, essential that research examining the early diagnosis of autism compares children with autism to those with developmental delay who do not have autism in order to identify symptoms that are specific to autism.

Early identifying features of autism in young children

Impairments in social and communication skills are probably the most reliable early features of autism in children under 48 months of age [2, 27, 31]. In children under 4 years of age, impairments in communication, social interaction, play, and imitation differentiate children with autism from children with developmental delay without autism [7, 30].

Repetitive behaviour is reported to have a later onset in comparison to impairments in social interaction and communication, probably as a function of developmental level [12, 27, 31]. However, repetitive behaviour in children under 3 years of age is inconsistently expressed. Therefore, some argue that it may not be a reliable differentiating feature of autism at this age [5, 12, 31]. In agreement with these findings, a number of studies of children aged under 36 months have reported that repetitive behaviour did not differentiate subjects with autism from those without [7, 13, 36]. Osterling et al. found that, although repetitive behaviour distinguished infants with autism from normally developing infants at one year of age, repetitive behaviour did not discriminate infants with autism from developmentally delayed infants of the same age [19]. This finding suggests that repetitive behaviour is more likely to be a symptom of developmental delay than autism specifically in children younger than 3 years.

However, studies using experimental measures encompassing both higher- and lower-level repetitive behaviour (i. e. algorithm and non-algorithm items of the Autism Diagnostic Interview-Revised and the Infant Behavioral Summarised Evaluation) have found a range of repetitive behaviours (both higher- and lower-level) to differentiate children with autism who are older than 3 years, taking developmental level into account [1, 17, 18]. These findings suggest that repetitive behaviour is a reliable diagnostic feature of autism in children older than 3 years.

Evidence that the expression of repetitive behaviours may occur as a function of developmental progression is reported by Cox et al. [6]. Comparisons were made at 20 and 42 months of age between 8 children with autism, 13 with other PDDs, 9 with language delay and 15 who were developing normally. Although repetitive behaviours did not significantly distinguish subjects with autism from the other groups at either 20 or 42 months, more subjects with autism or other PDDs were displaying repetitive behaviours at 42 months of age. These behaviours included hand, finger, and complex body mannerisms and repetitive use of objects.

The current study examined whether repetitive behaviours are a feature of autism in children aged less than 51 months, independent of developmental level, by investigating the relationship between chronological age, developmental age and the presence of repetitive

behaviours. These questions were also addressed in relation to Turner's definition of higher-level and lower-level repetitive behaviours [34].

Methods

Participants and procedure

Participants included 55 children aged between 22 and 51 months ($M = 36.95$, $SD = 7.26$), consisting of 9 girls and 46 boys. All participants were referred for developmental assessment from paediatricians and Specialist Children's Services practising within the western and southern metropolitan regions of Melbourne, Australia. Participants were assessed in consecutive order (according to time of referral) between March and December 2003. Criteria for inclusion required all participants to have a confirmed developmental delay of at least 6 months and/or a language delay. Language delay was defined as a score of 1 or 2 on item 30 of the Autism Diagnostic Interview-Revised (ADI-R) [22]. Detailed information was gathered on the child's expressive language ability and then summarised in this item. Children who only had a physical disability and children with a diagnosis of a PDD other than Autistic Disorder, that is PDD-Not Otherwise Specified, were excluded.

Clinical diagnoses were made according to DSM-IV-TR diagnostic criteria, on the basis of information gathered with parent and child assessments including the ADI-R and the Autism Diagnostic Observation Schedule (ADOS) [3, 16, 22]. The diagnoses were independently confirmed by a second experienced clinician. There were 40 children with Autistic Disorder ($M = 36.75$ chronological months, $SD = 7.43$; $M = 20.25$ developmental months, $SD = 7.53$), consisting of 34 boys and 6 girls. The high proportion of males in the autism group is consistent with the known gender ratio [3]. The other 15 children had developmental delay only ($M = 37.47$ chronological months, $SD = 7.00$; $M = 27.00$ developmental months, $SD = 8.52$) and consisted of 12 boys and 3 girls.

The two groups did not differ significantly in chronological age ($t = 0.32$, df = 53, $p = 0.75$), but the autism group was significantly more delayed than the non-autism group as measured by the Psychoeducational Profile-Revised (PEP-R) ($t = 2.86$, df = 53, $p = 0.01$) [26]. The autism group also had a significantly lower level of adaptive behaviour, as measured by the Vineland Adaptive Behaviour Scale (VABS) ($t = 3.38$, df = 53, $p = 0.01$) [28].

In order to examine the relationship between chronological age and the presence of repetitive behaviours in children with autism, participants from the autism group were divided into chronologically older (≥ 36 months, $n = 16$) and younger sub-groups (< 36 months, $n = 24$). Due to the presence of considerable developmental delay, a lower developmental age-bracket of 24 months was established to investigate the relationship between developmental age and the presence of repetitive behaviours in developmentally delayed children with autism. This required participants from the autism group to be divided into developmentally older (developmental age ≥ 24 months, $n = 8$) and younger (developmental age < 24 months, $n = 32$) sub-groups.

Assessment instruments

Several standardised assessment tools and questionnaires were administered as part of the assessment of each individual participant. The Developmental Behaviour Checklist-Primary Carer Version (DBC-P) is a 96-item checklist and was completed by the primary caregiver of the child [8]. It is a reliable and valid measure of behavioural and emotional disturbance in children with an intellectual disability, and includes items specific to repetitive and stereotyped behaviours and interests, encompassing both higher- and lower-level behaviours.

The ADI-R was administered by a trained clinician to the parents of all children [22]. This instrument is designed to provide a lifetime assessment on a variety of behaviours that are relevant to the differential diagnoses of PDDs. The Restricted, Repetitive, and Stereotyped Patterns of Behaviour domain was of particular interest in this study. Items making up this domain have good reliability (kappas ranging from 0.64 to 0.86), intraclass correlations ranging from 0.93 to 0.95, and internal consistency of 0.69 (Cronbach's alpha) [17].

The PEP-R, designed for use in children with autism, was administered to participants of this study in order to establish their developmental age [26]. The VABS was a questionnaire administered by a clinician in the interview with parents to provide an evaluation of adaptive behaviour [28].

Data analysis

A severity of developmental delay variable was created by subtracting chronological age (months) from developmental age, as measured by the PEP-R. In addition to the ADI-R repetitive behaviour algorithm score (ADI-REP-ALG), two further repetitive behaviour variables were calculated from ADI-R items in order to differentiate between Turner's description of higher-level and lower-level repetitive behaviours (ADI-REP-HIGH and ADI-REP-LOW) [34]. The construction of these variables required ADI-R items measuring repetitive behaviours that had ever been displayed by the child to be classified into higher-level and lower-level behaviours and then to be separately summed (see Table 1). Finally, all

Table 1 Items summed to calculate ADI-R higher-level, lower-level and DBC-P repetitive behaviour variables

ADI-R higher-level repetitive behaviour items	ADI-R lower-level repetitive behaviour items	DBC-P repetitive behaviour items
39: Verbal rituals	69: Repetitive use of object or interest in parts of objects	5: Arranges objects/ strict routine
67: Unusual preoccupations	77: Hand/finger mannerisms	25: Flicks/twirls objects
68: Circumscribed interests (only for 3 years or older)	78: Other complex mannerisms	28: Obsessed with idea/activity
70: Compulsions and rituals	83: Self-injury	44: Holds/plays with unusual objects
71: Unusual sensory interests		54: Looks at, listens to, dismantles mechanical things
74: Difficulties with minor changes		58: Preoccupied interests
75: Resistance to trivial changes		60: Repeated movements
76: Unusual attachment to objects		68: Stares at lights or spinning objects
		72: Switches lights on and off, or similar activity

Note. Item descriptions have been shortened for presentation

DBC-P items measuring repetitive behaviour, according to the DSM-IV-TR diagnostic criteria for Autistic Disorder, were also summed to create another repetitive behaviour variable (DBC-P), a combined measure of both types of repetitive behaviour (Table 1) [3]. All four of these repetitive behaviour variables were used in statistical analyses.

Data screening highlighted a single univariate outlier (a Vineland Adaptive Behaviour Composite score-VABCS). This outlier was recoded down to one unit larger than the next most extreme score within the distribution [32]. As the level of adaptive behaviour and developmental age significantly differed between the autism and non-autism groups, both of these variables were controlled for in the regression analyses.

A direct logistic regression analysis was conducted to examine whether levels of repetitive behaviour were significantly positively associated with the probability of receiving a diagnosis of autism. Diagnostic outcome (autism/non-autism) was entered as the dependent variable, while repetitive behaviour was entered as a predictor variable. To account for other possible confounding variables, chronological age (months), severity of developmental delay in months and level of adaptive behaviour, were entered into the equation. This analysis was completed for each measure of repetitive behaviour. The DBC-P was not completed for three participants; therefore, the overall sample size was reduced in all regression analyses where the DBC-P repetitive behaviour score (DBC-REP) variable was entered.

Results

Means and standard deviations of repetitive behaviour variables in relation to diagnostic group are displayed in Table 2. Percentages of participants displaying higher-level, lower-level and both categories of repetitive behaviour are displayed in Table 3. The odds ratios and their 95 % confidence intervals of the logistic regression analyses are displayed in Table 4. Confidence Intervals (CI) were not displayed for predictor variables that were not found to be significant predictors of diagnosis outcome in any of the four regression models (i. e. Chron age, delay and VABCS).

Repetitive behaviour was significantly positively associated with the probability of receiving a diagnosis of autism, as measured by the ADI-R repetitive behaviour

Table 2 Means (M) and Standard Deviations (SD) of repetitive behaviour variables in relation to diagnostic group (autism/non-autism)

Repetitive behaviours	Diagnostic group					
	Autism			Non-autism		
	M	SD	n	M	SD	n
ADI-REP-ALG	4.33	1.75	40	2.00	2.00	15
ADI-REP-HIGH	3.10	2.47	40	1.53	1.81	15
ADI-REP-LOW	3.93	2.04	40	2.07	1.94	15
DBC-REP	7.68	3.94	37	4.60	5.30	15

Table 3 Mean number of items and percentage of participants displaying higher-level, lower-level, and both categories of repetitive behaviour relating to diagnosis

Repetitive behaviours	Diagnostic group			
	Autism (n = 40)		Non-autism (n = 15)	
	Percentage	Mean items	Percentage	Mean items
ADI-REP-HIGH	85	2.05	66.67	1.07
ADI-REP-LOW	97.5	2.30	80	1.40
Both	82.5	4.35	66.67	2.47

Note: Both = repetitive behaviours from both ADI-REP-HIGH and ADI-REP-LOW variables

European Child & Adolescent Psychiatry (2006) Vol. 15, No. 1

Table 4 Summary of direct logistic regression analysis for variables associated with the probability of children receiving a diagnosis of autism

Model	Exp (B) Rep bhvr	95% CI for Rep bhvr	Exp (B) Chron age	Exp (B) Delay	Exp (B) VABCS
ADI-REP-ALG*	1.83	1.18, 2.85	0.94	0.91	0.99
ADI-REP-HIGH*	1.56	1.03, 2.36	0.91	0.89	0.97
ADI-REP-LOW	1.47	0.95, 2.28	0.99	0.96	0.95
DBC-REP	1.19	0.98, 1.44	0.96	0.92	0.96

Note. Exp (B) = Odds ratio; *CI* = Confidence interval; *Rep bhvr* = Repetitive behaviour; *Chron age* = Chronological age (months); *delay* = severity of delay (months); *VABCS* = Vineland Adaptive Behaviour Composite Score
* $p < 0.05$

algorithm and the ADI-R higher-level repetitive behaviour scores ($z = 7.26$, $p = 0.007$; $z = 4.39$, $p = 0.04$, respectively). Odds ratios indicate an 83% and 56% increase in the odds of receiving a diagnosis of autism on the basis of one unit of change in repetitive behaviour, as measured by the ADI-R repetitive behaviour algorithm and the ADI-R higher-level repetitive behaviour scores, respectively. The ADI-R lower-level and DBC-P repetitive behaviour scores were not significantly associated with the diagnosis of autism.

The means and standard deviations for repetitive behaviour variables in relation to both chronological and developmental age groups are displayed in Table 5.

The first set of standard multiple regression analyses tested each measure of repetitive behaviour as the dependent variable in relation to the independent variables; chronological age group (younger and older), severity of developmental delay and VABCS. This regression analysis indicated that chronological age group was a significant predictor of lower-level repetitive behaviour measured by the ADI-R [$\beta = 0.58$ (3.61), $p = 0.001$, 95% CI = –3.71, –1.20], and the VABCS was a significant predictor of DBC-P repetitive behaviour scores only [$\beta = -0.61$ (–2.66), $p = 0.01$, 95% CI = –0.44, –0.06]. The independent variables did not predict repetitive behaviour measured by the ADI-R repetitive behaviour algorithm or the higher-level repetitive behaviour measure of the ADI-R.

The second set of standard multiple regression analyses tested each measure of repetitive behaviour as the dependent variable in relation to the independent variables; developmental age group (younger and older) and VABCS. These regression models indicated that developmental age group did not significantly predict levels of repetitive behaviour in any of the four standard regression models. VABCS was found to be the only significant predictor of DBC-P repetitive behaviour scores [$\beta = -0.43$ (–2.39), $p = 0.02$, 95% CI = –0.32, –0.03]. An examination of the mean scores of repetitive behaviours for both chronological and developmental age groups shows no trends, as the older age groups do not consistently display higher mean scores than the younger age groups.

Discussion

This study investigated whether the presence of repetitive behaviours was a differentiating feature of autism in children with developmental delay aged less than 51 months. After accounting for chronological age, severity of developmental delay and levels of adaptive behaviour, it was found that the chance of receiving a diagnosis of autism was significantly positively associated with the presence of repetitive behaviour, as measured by the ADI-R repetitive behaviour algorithm. This finding is consistent with studies that have used participants of similar ages [1, 17, 18]. The DBC-P repetitive behaviour

Table 5 Means (M) and Standard Deviations (SD) of repetitive behaviour variables in relation to chronological and developmental age groups

Repetitive behaviour	Age group							
	Chronological				Developmental			
	Younger (n = 16)		Older (n = 24)		Younger (n = 32)		Older (n = 8)	
	M	SD	M	SD	M	SD	M	SD
ADI-REP-ALG	4.06	1.44	4.50	1.93	4.38	1.56	4.13	2.48
ADI-REP-HIGH	2.19	1.68	3.71	2.74	2.97	2.22	3.63	3.42
ADI-REP-LOW	5.00	2.00	3.21	1.77	4.28	2.07	2.50	1.19
DBC-REP	8.33	4.47	7.23	3.57	7.62	3.58	7.88	5.33

Note. Sample size differs for DBC-REP analyses: Chronological Younger (n = 15); Chronological Older (n = 22); Developmental Younger (n = 29); Developmental Older (n = 8)

score was not significantly positively associated with the chance of receiving a diagnosis of autism. This inconsistency between two measurements of repetitive behaviour – a parental questionnaire (DBC-P) and a semi-structured interview conducted by a clinician (ADI-R) – may be a reflection of the more detailed information obtained in a standardised interview compared to the more limited information obtained in a parent-completed checklist. Alternatively, missing DBC-P data in three cases lowered the statistical power in analyses looking at the repetitive behaviour as measured by the DBC-P, possibly contributing to this inconsistent result.

When severity of developmental delay, chronological age and levels of adaptive behaviour are taken into account, the presence of higher-level repetitive behaviour was found to be significantly positively associated with the chance of receiving a diagnosis of autism. This finding further supports Turner's proposal that some higher-level repetitive behaviours may be more specifically predictive of autism [34].

Conversely, after accounting for severity of developmental delay, chronological age and levels of adaptive behaviour, the presence of lower-level repetitive behaviour was not found to be significantly positively associated with the chance of receiving a diagnosis of autism. This supports Turner's suggestion that although lower-level repetitive behaviour may be commonly displayed by individuals with autism, these behaviours are more likely to be a function of developmental delay [34].

There was a significant difference in levels of repetitive behaviours between the younger and older chronological age group, as measured by the ADI-R lower-level repetitive behaviour score, after accounting for severity of developmental delay and adaptive behaviour within the autism sample. This result supports Turner's view that the presence of lower-level repetitive behaviour is more associated with younger age rather than with a diagnosis of autism [34]. This finding supports other research that suggests that change in repetitive behaviour may be a function of developmental progression [5, 12, 29]. No significant differences were found in levels of repetitive behaviour between the older and younger chronological age group within the autism sample when using the remaining three measures of repetitive behaviour, but this might reflect the small age range of the children studied.

After accounting for adaptive behaviour, there were no significant differences in levels of repetitive behaviour between the developmental age groups within the autism sample. This finding might also be due to the limited developmental age range of the sample. Longitudinal investigation of the children in this study might help to further define the relationship between age (both chronological and developmental) and the development of higher-level repetitive behaviours.

This study has some limitations. The small sample size may have given individual scores undue influence on group means and tests of statistical significance, especially when the sample was further divided into age groups. The allocation of participants into dichotomous age groups (younger/older) may have limited the capacity to examine the effect of age. The limited range of age and the low developmental levels of participants accounted for a limited range of scores on the measures used, which constrained the statistical analyses. Results may have also been influenced by the autism group being significantly more delayed than the non-autism group. Finally, the level of expressive language (inclusion criterion) and all repetitive behaviour variables were obtained through parental information and were, therefore, not directly observed in participants.

The results of this study have several research and practical implications. The statistically significant results strengthen existing literature, particularly that of Turner, which suggests that the presence of higher-level repetitive behaviour is a differentiating feature of autism in young children [34]. This finding might, therefore, contribute to improvements in the earlier diagnosis of autism. The relationship between age (chronological and developmental) and the presence of repetitive behaviours in children with autism remains somewhat unclear; however, further longitudinal study should help to clarify this issue.

Acknowledgements This study was supported by the National Health and Medical Research Council (NHMRC), the Financial Markets Foundation for Children, and the Forest Hill Early Childhood Foundation. We would like to thank the families who participated in this research project, the Monash Autism Program (Megan Morling), paediatricians and Specialist Children Services in Melbourne for assisting with data collection, and Dr. John Taffe for his advice on statistical analyses.

References

1. Adrien JL, Bathelemy C, Perrot A, Roux S, Lenoir P, Hameury L, et al. (1992) Validity and reliability of the infant behavioural summarised evaluation (IBSE): A rating scale for the assessment of young children with autism and developmental disorders. J Autism Dev Disord 22(3):375–394
2. Adrien JL, Lenoir P, Martineau J, Perrot A, Hameury L, Larmande C, et al. (1993) Blind ratings of early symptoms of autism based upon family home videos. J Am Acad Child Adolesc Psychiatry, 32:617–626
3. American Psychiatric Association (2000) Diagnostic and Statistical Manual of Mental Disorders – Text Revision 4th edn. Washington, DC: American Psychiatric Association

4. Bryson SE (1996) Brief report: Epidemiology of autism. J Autism Dev Disord 26(2):165–167
5. Charman T, Baird G (2002) Practitioner review: Diagnosis of autism spectrum disorder in 2- and 3-year-old children. J Child Psychol Psychiatry 43(3):289–305
6. Cox A, Klein K, Charman T, Baird G, Baron-Cohen S, Swettenham J, et al. (1999) Autism spectrum disorders at 20 and 42 months of age: Stability of clinical and ADI-R diagnosis. J Child Psychol 40(5):719–732
7. Dahlgren SO, Gillberg C (1989) Symptoms in the first two years of life: A preliminary population study of infantile autism. Eur Arch Psychiatry Neurol Sci 238:169–174
8. Einfeld SL, Tonge BJ (2002). Manual for the Developmental Behavioural Checklist: Primary Carer Version (DBC-P) and Teacher Version (DBC-T) 2nd edn. Melbourne: University of New South Wales and Monash University
9. Evans DW, Leckman JF, Carter A, Reznick JS, Henshaw D, King RA, et al. (1997) Ritual, habit, and perfectionism: The prevalence and development of compulsive-like behaviour in normal young children. Child Dev 68(1):58–68
10. Frith U (1989) Autism: Explaining the enigma. Oxford: Blackwell
11. Gesell A (1928) Infancy and human growth. New York: MacMillan
12. Gray KM, Tonge BJ (2001) Are there early identifying features of autism in infants and preschool children? J Paediatr Child Health 37:221–226
13. Hoshino Y, Kumashiro H, Yashima Y, Tachibana R, Watanabe M, Furukawa H (1982) Early symptoms of autistic children and its diagnostic significance. Folia Psychiatrica et Neurology Japan, 36(4):367–374
14. Howlin P, Moore A (1997) Diagnosis in autism: A survey of over 1,200 patients in the UK. J Autism Dev Disord 1: 135–162
15. Lord C (1997) Diagnostic instruments in autism spectrum disorders. In: Cohen DJ, Volkmar FR (eds) Handbook of autism and pervasive developmental disorders. New York: John Wiley and Sons, pp 460–483
16. Lord C, Rutter M, DiLavore PC, Risi S (1999) Autism Diagnostic Observation Schedule. USA: Western Psychological Services
17. Lord C, Rutter M, Le Couteur A (1994) Autism Diagnostic Interview-Revised: A revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. J Autism Dev Disord 24(5): 659–685
18. Lord C, Storoschuk S, Rutter M, Pickles A (1993) Using the ADI-R to diagnose autism in preschool children. Infant Mental Health Journal 14(3):234–252
19. Osterling JA, Dawson G, Munson JA (2002) Early recognition of 1-year-old infants with autism spectrum disorder versus mental retardation. Dev Psychopathol 14:239–251
20. Rogers SJ (1996) Early intervention in autism. J Autism Dev Disord 26(2): 243–246
21. Rutter M (1978) Diagnosis and definitions of childhood autism. J Autism Child Schizophr 8(2):139–161
22. Rutter M, Le Couteur A, Lord C (2003) Autism Diagnostic Interview-Revised. Los Angeles, CA: Western Psychologist Services
23. Rutter M, Schopler E (1987) Autism and pervasive developmental disorders: Concepts and diagnostic issues. J Autism Dev Disord 17(2):159–186
24. Rutter M, Schopler E (1988) Autism and pervasive developmental disorders: Concepts and diagnostic issues. In: Schopler E, Mesibov GB (eds) Diagnosis and assessment in autism. New York: Plenum Press, pp 15–36
25. Sallustro F, Atwell CW (1978) Body rocking, head banging and head rolling in normal children. J Pediatr 93(4): 704–708
26. Schopler E, Reichler RJ, Bashford A, Lansing MD, Marcus LM (1990) Individualized assessment and treatment for autistic and developmentally disabled children – Volume 1: Psychoeducational Profile – Revised (PEP-R) (Vol. 1). Texas: ProEd
27. Siegal B, Pliner C, Eschler J, Elliot GR (1988) How children with autism are diagnosed: Difficulties in identification of children with multiple developmental delays. Dev Behav Pediatr 9(4):199–204
28. Sparrow SS, Balla DA, Cicchetti DV (1984) Vineland Adaptive Behaviour Scales. Circle Pines, MN: American Guidance Services
29. Stone WL (1997) Autism in infancy and early childhood. In: Cohen DJ, Volkmar FR (eds) Handbook of autism and pervasive developmental disorders. New York: John Wiley and Sons
30. Stone WL, Hoffman EL, Lewis SE, Ousley OY (1994) Early recognition of autism: Parental reports vs clinical observation. Arch Pediatr Adolesc Med 48:174–179
31. Stone WL, Lee EB, Ashford L, Brissie J (1999) Can autism be diagnosed accurately in children under 3 years? J Child Psychol Psychiatry 40(2):219–226
32. Tabachnick BG, Fidell LS (2001) Using multivariate statistics (4th ed.). Boston: Allyn and Bacon
33. Thelen E (1979) Rhythmical stereotypies in normal human infants. Animal Behaviour 27:699–715
34. Turner M (1999) Repetitive behaviour in autism: A review of psychological research. J Child Psychol Psychiatry 40(6): 839–849
35. Vig S, Jedrysek E (1999) Autistic features in young children with significant cognitive impairment: Autism or mental retardation? J Autism Dev Disord 29(3):235–248
36. Vostanis P, Smith B, Corbett J, Sungum-Paliwal R, Edwards A, Gingell K, et al. (1998) Parental concerns of early development in children with autism and related disorders. J Autism Dev Disord 2(3):229–242
37. Wing L, Gould J (1979) Severe impairments of social interaction and associated abnormalities in children: Epidemiology and classification. J Autism Dev Disord 9(1):11–29