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Autism 2009; 13; 613
DOI: 10.1177/1362361309340029

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SAGE Publications
and The National
Autistic Society
Vol 13(6) 613–633; 340029
1362-3613(2009)

Assessing progress during treatment for young children with autism receiving intensive behavioural interventions

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ABSTRACT This study examined progress after 1 year of treatment for children with autism who received a mean of 36 hours per week one-to-one University of California at Los Angeles Applied Behavior Analysis (UCLA ABA) treatment. Two types of service provision were compared: an intensive clinic based treatment model with all treatment personnel ($N = 23$), and an intensive parent managed treatment model with intensive supervision only ($N = 21$). A non-concurrent multiple baseline design across participants ($N = 13$) examined whether progress was associated with ABA treatment or confounders. Between intake and follow-up, children in both groups improved significantly on IQ, visual-spatial IQ, language comprehension, expressive language, social skills, motor skills and adaptive behaviour. There were no significant differences between the two groups on any of the measures at follow-up. Mean IQ for participants in both groups increased by 16 points between intake and follow-up. These findings are consistent with previous studies demonstrating the benefits of ABA treatment.

KEYWORDS *autism; behavioural interventions; children; outcome*

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Autism is a pervasive developmental disorder characterized by severe impairment in social interaction and communication along with high rates of ritualistic and stereotyped behaviour (DSM-IV: American Psychiatric Association, 1994). Recent reported prevalence rates are 1 to 4 per 1000 and at least 4 to 6 per 1000 when milder variants (called autism spectrum

DOI: 10.1177/1362361309340029

disorders) are included (Baird et al., 2006; Fombonne, 2003). Research suggests that 50–80 percent of children with autism have mental retardation (Baird et al., 2006; Fombonne, 1999), and that the majority will require professional care throughout their lives (Billstedt, E., Gillberg, C., and Gillberg, C., 2005). Although specific causes of the condition have not yet been identified, research suggests medical, neurobiological and genetic factors are involved (Bailey et al., 1995; Freitag, 2007; Muller, 2007; Volkmar, Lord, Bailey, Schultz, and Klin, 2004).

A wide variety of psycho-educational interventions for children with autism have been proposed (Dawson and Osterling, 1997; Howlin, 1987; Smith, 1999). However, only a few have been subjected to outcome research. Among those, treatment based on Applied Behaviour Analysis (ABA) has been widely investigated. Research suggests children receiving ABA may make significantly more gains than comparison group children on standardized measures of IQ, language and adaptive functioning. Some recent studies evaluating ABA for children with autism have included data on maladaptive behaviour, personality, school performance or changes in diagnosis (Eikeseth, Smith, Jahr, and Eldevik, 2002; 2007; Sallows and Graupner, 2005).

By the early 1990s ABA had been suggested as beneficial for many children with autism (Lovaas, 1987; Maurice, 1993; McEachin et al., 1993). As a result, the demand for ABA treatment accelerated in the UK. As there were no ABA services for children with autism in the UK, families initially set up parent managed programmes with input from a variety of international providers. Mudford, O.C., Martin, N.T., Eikeseth, S., and Bibby, P. (2001) compared these programmes to the recommendations of the UCLA Multi-Site Young Autism Project to assess whether parent managed programmes in the UK adhered to the UCLA protocol. Most children (57%) started after 3½ years old (later than is considered preferable in the UCLA protocol), and 16 percent did not exceed the minimum IQ criterion. Children experienced fewer hours of treatment (mean of 32 hours) and their programmes received relatively infrequent supervision. Twenty-one percent of the programmes received supervision from individuals identified as competent to provide UCLA ABA treatment. No child received the full UCLA protocol (starting prior to 3½ years, receiving 40 hours per week, and having weekly supervision from qualified personnel).

Bibby, Eikeseth, Martin, Mudford, and Reeves, (2001) analysed data for 66 children who had participated in the Mudford et al. (2001) study. They found that mental age and Vineland adaptive behaviour increased significantly for a subgroup of the participants, but failed to find significant changes in IQ. None of the participants obtained best outcome status, that is, performed within the normal range on IQ tests and achieved

unassisted mainstream school placement. Thus, the results were disappointing.

As part of the UCLA Multi-Site Young Autism Project, we aimed to demonstrate that UCLA ABA treatment can be implemented effectively in the UK by applying the variables that were recommended in the UCLA Protocol and were lacking in the programmes described by Mudford et al. (2001). The present study examined progress after 1 year of treatment for children with autism who received intensive one-to-one UCLA ABA treatment.[1] Two different models of service provision were compared. One was an intensive clinic based treatment model where all treatment personnel were provided. The other was an intensive parent managed treatment model where intensive supervision was provided while tutoring staff were recruited and managed by parents. This was an outreach service provided to families who resided outside the catchment areas for the clinic based service.

Method

Participants

All children residing within specified locations, who joined UK Young Autism Project between Autumn 1998 and Spring 2005, were included in the study if they met all of the following criteria: (1) a diagnosis of autism according to the ICD-10 criteria (World Health Organization, 1993); (2) chronological age at intake between 24 and 42 months; and (3) absence of other severe medical conditions, as certified by a medical practitioner. The participants were diagnosed by independent agencies. Subsequently the diagnosis was confirmed by the Autism Diagnostic Interview–Revised (ADI–R: Lord et al., 1994). The ADI–R was conducted by the first author, who had been certified to use the instrument for research purposes.

Group assignment

Children were assigned to one of two treatment groups that represent the two services provided: (1) intensive clinic based treatment group in which all treatment personnel (i.e. tutors, senior tutors and programme consultants) were provided; and (2) intensive parent managed treatment group where tutors were recruited and managed by parents. For the latter group, intensive supervision was provided by our programme consultants. Eight families also hired one of our senior tutors.

Twenty-three participants (four girls) entered the clinic based group and 21 (six girls) entered the parent managed group. Mean age at treatment start was 36 months for the clinic based group and 34 months for the parent managed group. Mean intake IQ was 53 for the clinic based group and 54

for the parent managed group. One referral who was eligible for the study did not enter because the parents chose a parent managed programme despite residing within the clinic based catchment area. Five children left the study before the 1 year follow-up (three clinic based and two parent managed) and hence were not included in the data analysis. Group assignment was based on the geographical location of the participants, as follows. Between Autumn 1998 and Spring 2005, children residing within 60 kilometres and within a maximum travel time of 1 hour of the Brunel University campus in Twickenham, Middlesex were assigned to the clinic based group. Between Spring 2001 and Spring 2005, children residing within 60 kilometres and within a maximum travel time of 1 hour of Pershore Road in Birmingham were assigned to the clinic based group. This second catchment area was defined when we opened a clinic in Birmingham. Between Spring 1999 and Autumn 2000, children residing within 120 kilometres and within a maximum travel time of 2 hours of the Brunel University campus were assigned to the parent managed group. Between Winter 2000 and Spring 2005, the parent managed group's catchment area was increased to cover the whole of England and Wales excluding the catchment areas of the clinic based group.

Setting

The majority of the treatment for all participants was provided in their homes. In each home, equipment for the programme was usually in one particular room, for example the child's bedroom, the lounge or in some cases a specially allocated room. While the child's programme was usually based in this room, the whole house and garden was utilized as a teaching environment and the tutors moved with the child around the house in order to incorporate incidental teaching, natural environment teaching and generalization. The family was encouraged to continue as usual and move around the house and all areas where the child was being taught. Some treatment was also provided in the children's communities, including shops, cafés, parks, museums, extra-curricular classes and clubs, etc. If a child had started nursery or school, treatment was also implemented there.

Staff training

In the clinic based programme, each child's team comprised a programme consultant, a senior tutor and two to five tutors. All staff members were provided with induction packs including company policies and training booklets. Each tutor received basic and advanced theory seminars, a 60 hour practicum, and continued training and supervision from the senior tutor and programme consultant via weekly team meetings and session overlaps.

Senior tutors had a minimum of 1 year experience working as a tutor with at least three children. They were trained and supervised by programme consultants and directors. Senior tutors assisted programme consultants in running the child's programme and provided one-to-one teaching.

Programme consultants had a minimum of 3 years clinical experience as both tutor and senior tutor. They completed a course which led to the demonstration of competency in all the principles, procedures and programmes required to run a child's programme independently.

Parent managed programmes were supervised for a minimum of 6 hours every 6 weeks by the same programme consultants who worked on clinic based programmes. Tutors, and in some cases senior tutors, were recruited and managed by the families. Teams received training during programme consultant workshops.

Parent training

Parents in both groups were given a half-day course on ABA principles followed by several days of intensive hands-on training from senior tutors and programme consultants. Training thereafter was provided during team meetings, supervision sessions and tutor sessions.

Treatment

All children in both groups received treatment based on the UCLA model for early intensive behavioural intervention (Lovaas, 2003; Lovaas et al., 1981). Principles of ABA were used to increase behavioural deficits such as language, play skills, social skills, academics, self-help skills and understanding of emotions, and to decrease behavioural excesses such as self-stimulatory behaviour, self-injurious behaviour, tantrums and aggression. Teaching methods used were discrete trial teaching, natural environment teaching and incidental teaching. These principles and teaching methods are described in further detail elsewhere (e.g. Catania, 1998; Cooper et al., 1987; Leaf and McEachin, 1999; Lovaas, 2003; Lovaas et al., 1981; Maurice et al., 1996; 2001).

Curriculum

Each child's curriculum was individualized and comprehensive, teaching skills in all areas of development. Beginning skills included prerequisites in the areas of attention, communication and play. Examples include sitting in a chair, responding to simple instructions such as 'come here' and 'wave bye-bye', matching identical objects, imitating gross motor actions or imitating actions with objects, imitating sounds and words, identifying and naming objects, playing independently with toys, and basic interactive skills such as rolling a ball to and from an adult. Intermediate skills included

further language training such as identification and naming of abstract concepts, parallel play, turn taking, imitating sentences, early academic skills such as identifying letters and numbers, drawing imitation and tracing, and self-help skills such as dressing and undressing, toilet training, drinking from an open cup and increasing the range of foods and drink taken. Once these skills were acquired, social language such as conversation and asking questions, advanced pretend play and cooperative play, social-emotional skills such as theory of mind, advanced academic skills, observational learning and learning in the classroom environment were addressed.

Treatment integrity

Treatment skills were assessed using a measure developed by the UCLA Multi-Site Young Autism Project (YAP) based on Koegel et al. (1977). For each tutor assessed, a videotape was made following a standardized protocol in which the tutor had to demonstrate teaching for 15 minutes while teaching 5 minutes each of vocal imitation, receptive language and expressive language. During the first 2 years of the project all tutors were assessed; subsequently tutors were intermittently selected to be assessed. A sample of the videotapes were scored and approved by Dr Tristram Smith, who is one of the Directors of the UCLA Multi-Site Young Autism Project (YAP). A further sample of the videotapes were scored and approved by the third author, who was trained to score the videotapes, and was consistent with Dr Smith.

Programme consultants were assessed on their abilities to select and to introduce new programmes to a child they had not previously worked with. The programme consultant reviewed the child's record before identifying programmes to introduce in the following four areas: a programme with a verbal instruction and verbal response, receptive language, expressive language and interactive play. These videotapes were then scored and approved by Dr Smith.

Measures

Diagnostic instrument The Autism Diagnostic Interview–Revised (ADI–R: Lord et al., 1994) was used to confirm the diagnosis of autism for each participant. The ADI–R is a comprehensive interview comprising 93 items across eight content areas, assessing three domains: language and communication; reciprocal social interactions; restricted, repetitive and stereotyped behaviours and interests. The first author was trained and certified to use the standardized interview procedures and to score results using the diagnostic algorithm. The interview was administered with one or both parents of each participant, during which the informant's responses were recorded

and coded. Results were then scored and interpreted using the diagnostic algorithm.

Treatment intensity Number of treatment hours per week for each child was measured by recording the start and end times of tutored sessions, parent sessions, shadowed time in school, team meetings and/or workshops.

Child measures All children were assessed at intake and 1 year after treatment began. An independent psychologist carried out all intake and follow-up assessments. The examiners had extensive experience with children with autism. They were independent of the study and were not informed of children's group assignment. Intake assessments were carried out in order of referral, and follow-up assessments were carried out in the order that children completed 1 year of treatment. Assessments were composed of standardized tests of intelligence, visual-spatial skills, language and adaptive functioning.

Intellectual functioning Depending on their chronological age, children were given the Bayley Scales of Infant Development–Revised (Bayley, 1993) or WPPSI–R (Wechsler, 1989). The Bayley is a test of cognitive functioning in children aged 2 to 42 months. The WPPSI–R measures cognitive functioning in children aged 3 years to 7 years 3 months. Children old enough to be assessed with the WPPSI–R but who did not achieve basal on the WPPSI–R (defined for this study as two 2-point responses on the vocabulary subtest) were given the Bayley.

Visual-spatial skills The Merrill–Palmer Scale of Mental Tests (Stutsman, 1948) was given to all participants at intake and follow-up. This instrument assesses primarily visual-spatial skills in children aged 1 year 6 months to 6 years 6 months, and it has been shown to predict later functioning in children with autism (e.g. Lord and Schopler, 1989). A ratio IQ was derived from it.

Language functioning The Reynell Developmental Language Scales (Edwards et al., 1997; Reynell and Gruber, 1990) were used to assess language functioning in all participants at intake and in all participants who were younger than 7 years at follow-up. The Reynell yields developmental ages and standard scores for language comprehension and for expressive language. It is commonly administered to children with autism (Sparrow et al., 1997), although its psychometric properties have not been studied with this population. A standard score was derived from the manual. If the child performed below the range covered by the manual, a ratio quotient

was substituted for the standard score. Participants not achieving basal on the Reynell were assigned a mental age of 20 months.

Adaptive behaviours Children' s adaptive skills were assessed with the Vineland Adaptive Behavior Scales (Sparrow et al., 1984). The Vineland yields standard scores for communication, daily living skills and socialization, as well as a composite standard score. It also provides a measure of maladaptive behaviour (normed for children ages 5 years and older, and hence given only at follow-up).The Vineland is widely regarded as the instrument of choice for assessing adaptive functioning in children with autism (Newsom and Hovanitz, 1997).

Design

The outcome for all participants in both treatment groups was assessed using a pre–post design comparing scores on IQ, visual IQ, Reynell comprehension, Reynell expressive language and adaptive behaviour obtained pretreatment with scores on the same measures obtained 1 year into treatment.

A non-concurrent multiple baseline design across participants was used to assess progress in early treatment for the first 13 children to enter intensive clinic based treatment. This was done to examine whether progress was associated with ABA treatment rather than other confounding variables such as other interventions that the children may have been receiving, maturation and/or the reactiveness of measures. Participants were randomly assigned to baseline periods of 6, 12 or 18 weeks during which they received no ABA treatment. During baseline and the early phase of treatment, each child was assessed every 3 weeks on receptive language, non-vocal imitation, vocal imitation and expressive language.This Early Language Measure (ELM) measure has been described in more detail by Smith et al. (2000). The ELM assessors, and other observers scoring tapes for reliability purposes, were blind to each participant's assigned baseline period and therefore their treatment start date, as well as to their intake test scores and progress in treatment. The investigators and treatment personnel, including parents, were not informed of the exact items on each child's baseline and thereafter tested on the ELM.

The ELM was conducted at start of baseline and then every 3 weeks during baseline and for the first 6 months of treatment or until the child reached 42 months of age, whichever period was greater.

Inter-rater reliability was established on 27 percent of tests. This was conducted by observers with experience of discrete trial teaching. Inter-rater reliability was calculated by dividing the number of agreements by the number of agreements and disagreements and multiplying this by 100. Mean inter-rater reliability was 96 percent for non-vocal imitation; 95 per-

cent for receptive instructions; 94 percent for expressive labels; and 97 percent for verbal imitation.

Data analysis

Independent sample *t*-tests were conducted to examine whether the two groups differed at intake and at follow-up. Paired sample *t*-tests were conducted to assess changes between intake and follow-up. Finally, unprotected Pearson correlations were conducted to assess whether intake measures were associated with outcome measures and with changes in scores.

Results

Treatment measures

The mean number of treatment hours per week for the clinic based group was 37.4 (SD = 3.47) as compared to 34.2 (SD = 5.29) for the parent managed group. This difference was statistically non-significant ($p > 0.05$).

Progress early in treatment

Figure 1 presents progress in non-vocal imitation. The top graph presents mean percentage correct responding from the participants who had a 9 week baseline. The middle graph presents mean percentage correct responding for the participants with a 15 week baseline, and the bottom graph displays mean percentage correct responding for the participants who had a 21 week baseline. Figures 2, 3 and 4 present data for receptive instruction, vocal imitation and expressive labels, respectively. As can be seen, the participants made little or no progress on the items in the skill domains before the treatment started. After treatment started, marked improvement was demonstrated on items in all four skill domains. Mean age at treatment start was 36.7 months for the participants who were given this measure. Mean intake scores on IQ, visual-spatial IQ, Reynell and Vineland were 56.4, 78.8, 20 months (comprehension and expressive) and 62.6, respectively. Mean follow-up scores on IQ, visual-spatial IQ, Reynell and Vineland were 71.3, 83.5, 24.9 months (comprehension) and 25.5 months (expressive) and 62.6 months, respectively.

Outcome measures

There were no significant differences between the clinic based group and the parent managed group at intake on any of the measures. At follow-up, between-group differences were non-significant on all measures. These data are exhibited in Table 1.

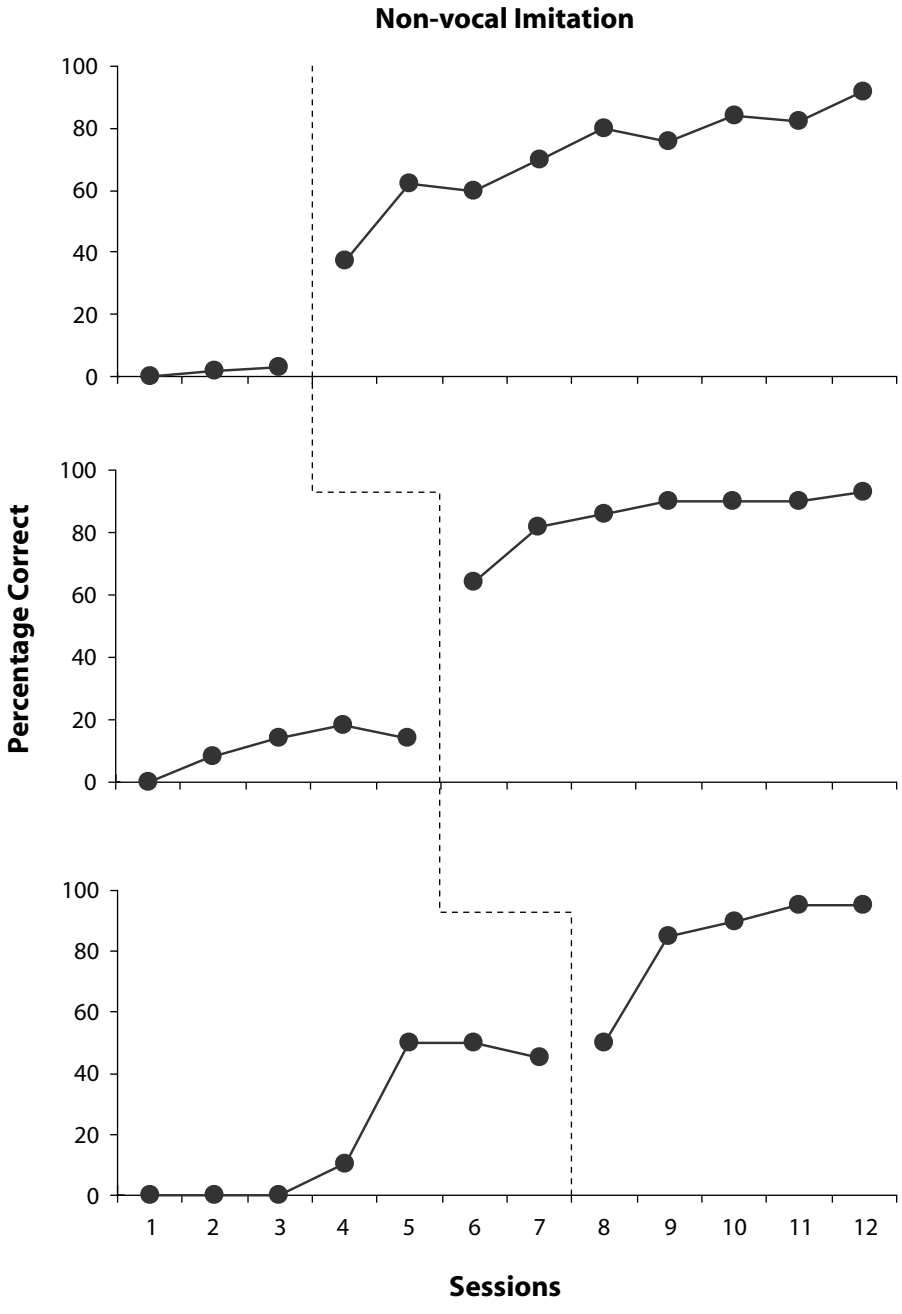

Figure 1 **Mean percentage of correct responding for non-vocal imitation for all participants during baseline and after treatment. Top graph displays participants with a 6 week baseline, middle graph displays participants with a 12 week baseline, bottom graph displays participants with a 21 week baseline**

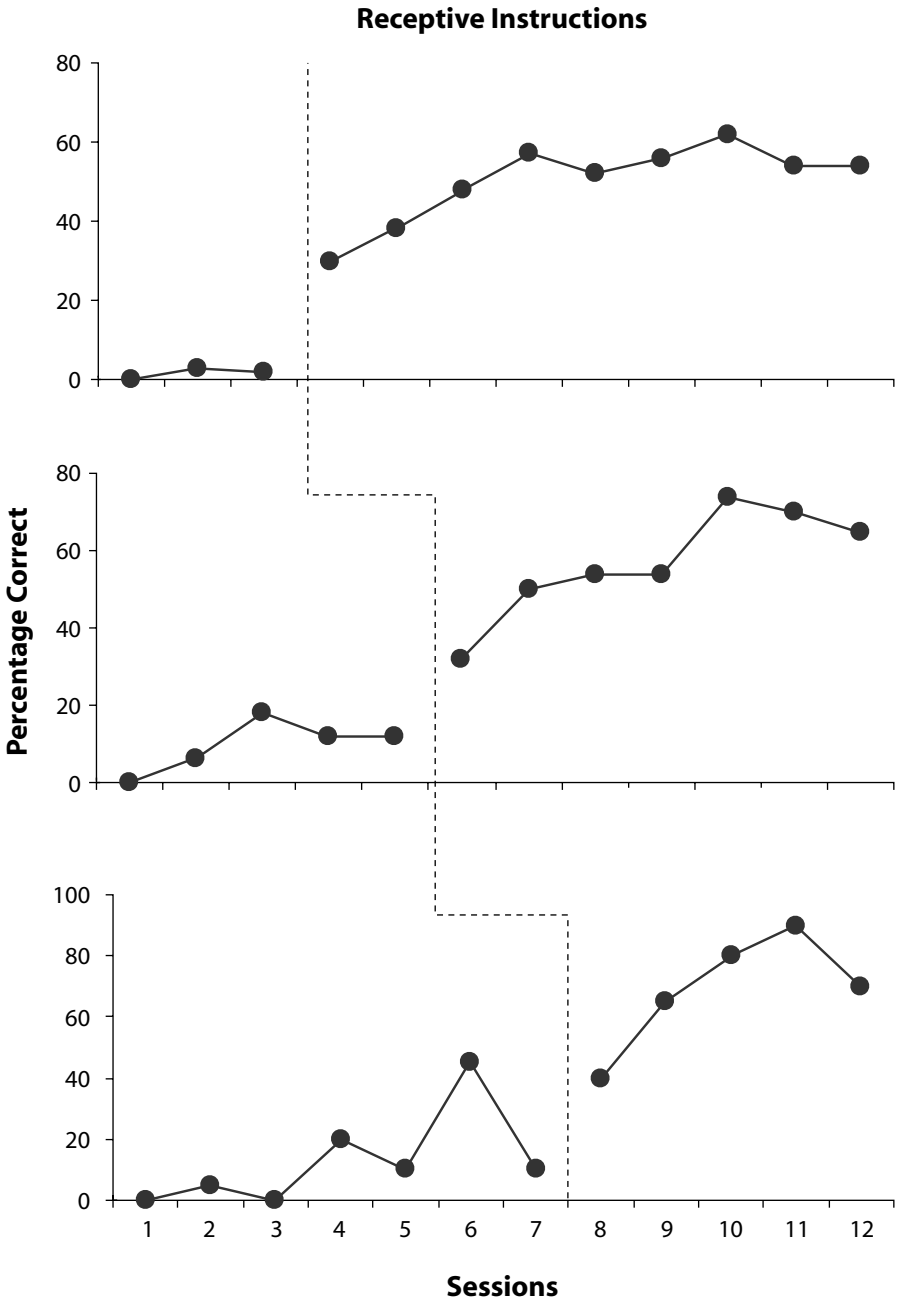

Figure 2 **Mean percentage of correct responding for receptive instructions for all participants during baseline and after treatment. Top graph displays participants with a 6 week baseline, middle graph displays participants with a 12 week baseline, bottom graph displays participants with a 21 week baseline**

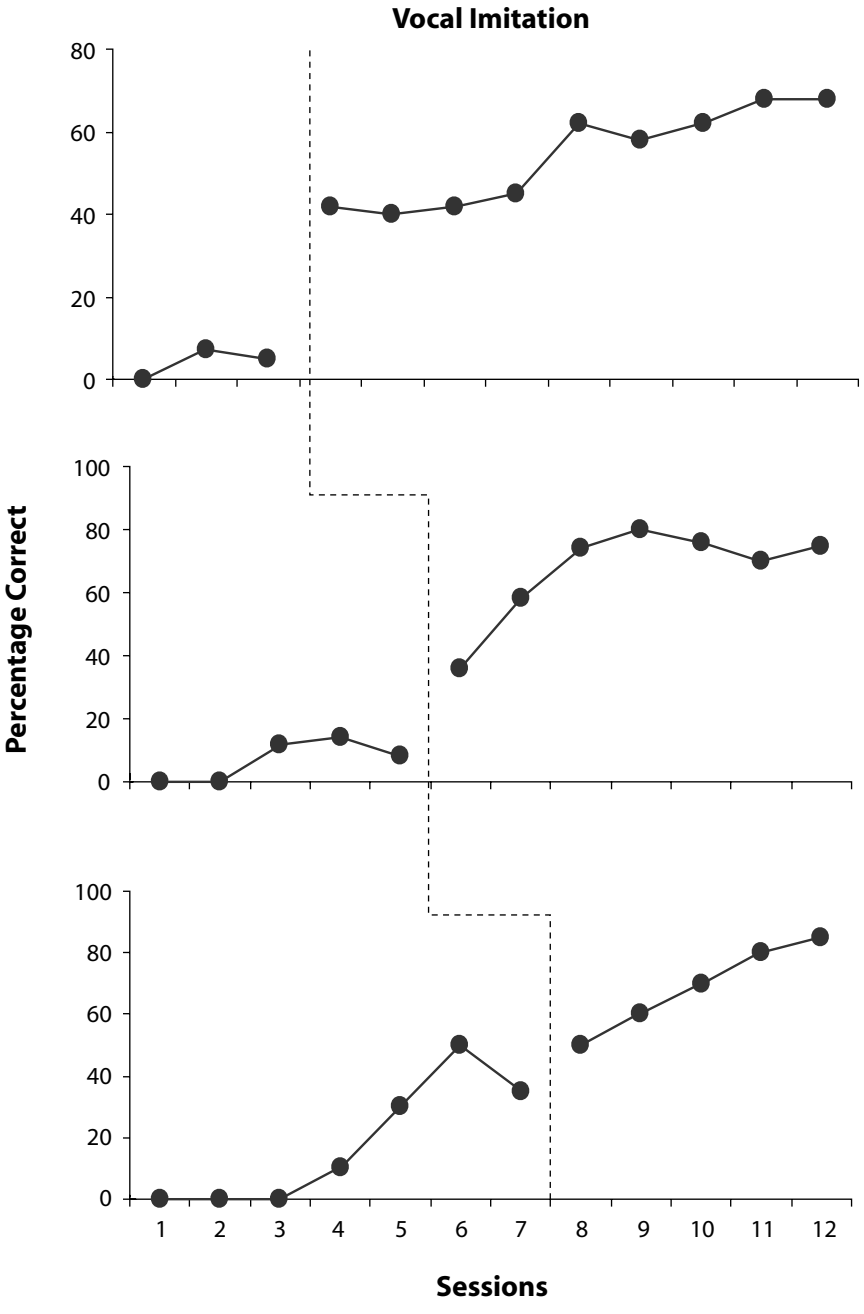

Figure 3 **Mean percentage of correct responding for vocal imitation for all participants during baseline and after treatment. Top graph displays participants with a 6 week baseline, middle graph displays participants with a 12 week baseline, bottom graph displays participants with a 21 week baseline**

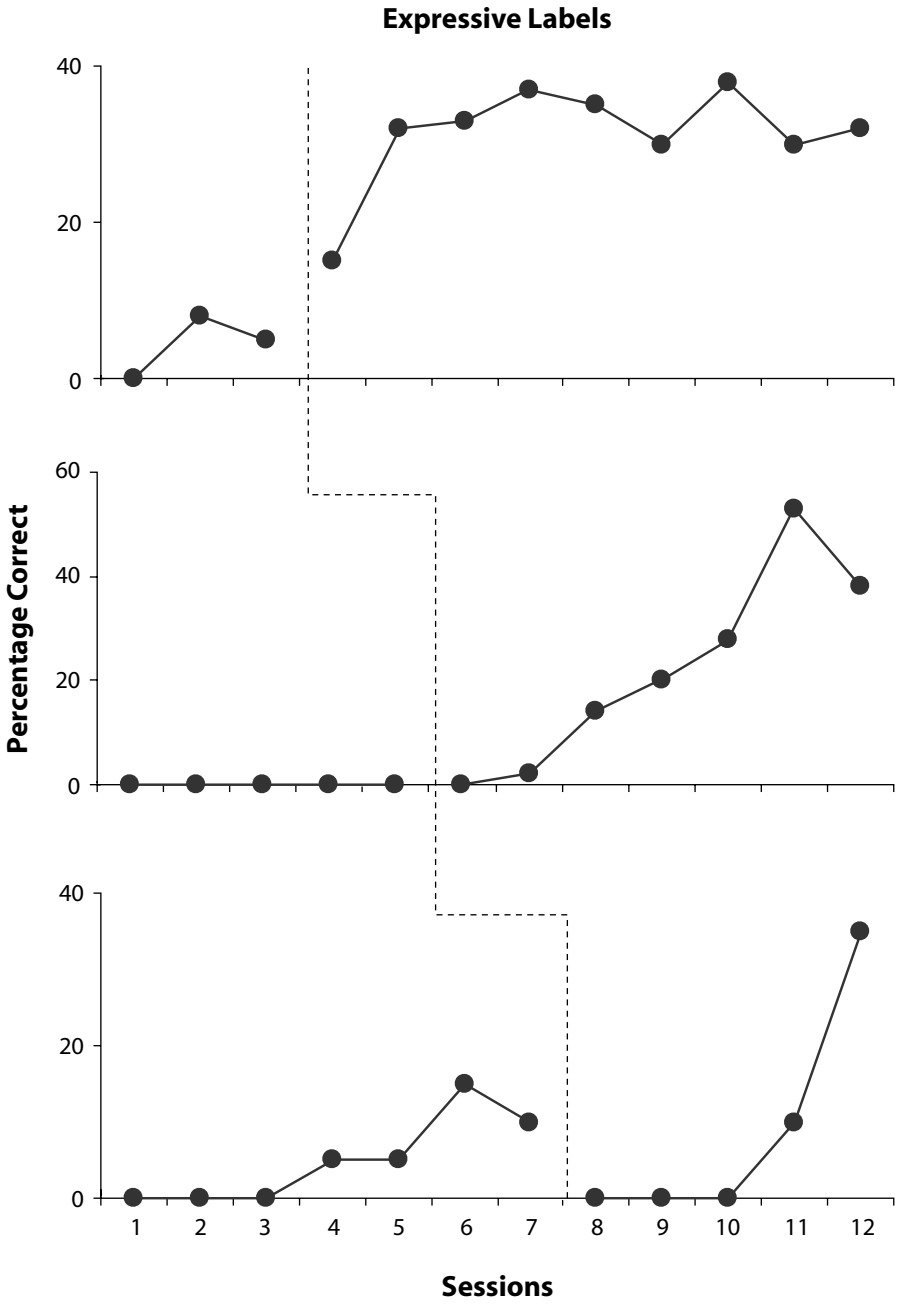

Figure 4 **Mean percentage of correct responding for expressive labels for all participants during baseline and after treatment. Top graph displays participants with a 6 week baseline, middle graph displays participants with a 12 week baseline, bottom graph displays participants with a 21 week baseline**

Table 1 **Intake and follow-up chronological age and standard scores or mental age scores for intensive clinic based group (*n* = 23) and intensive parent managed group (*n* = 21)**

Measures	*Clinic based ABA*		*Parent managed ABA*	
	Intake Mean (SD)	*Follow-up Mean (SD)*	*Intake Mean (SD)*	*Follow-up Mean (SD)*
Chronological age (months)	35.7 (6.2)	47.8 (5.8)	34.4 (5.7)	48.3 (6.1)
IQ	53.5 (15.1)	70.9 (19.6)	54.1 (15.1)	68.9 (22.1)
Visual-spatial IQ	74.8 (22.6)	89.4 (29.2)	76.2 (18.2)	82.1 (28.0)
Reynell comprehension[a]	20.0 (0.0)	26.7 (7.0)	20.7 (2.8)	28.4 (9.5)
Reynell expressive[a]	20.2 (1.0)	26.4 (6.1)	20.7 (3.3)	27.6 (7.6)
VABS	62.3 (6.8)	68.4 (14.5)	65.1 (10.4)	72.5 (17.3)

[a] Mental age. VABS = Vineland Adaptive Behavior Scales.

Because of the non-significant group differences, data for both groups were treated as one data set. As can be seen in Table 2, when assessing progress between intake and follow-up for all participants in both groups, significant improvement was found on all measures (i.e. IQ, visual-spatial IQ, Reynell language comprehension, Reynell expressive language, and Vineland adaptive behaviour, communication, social and motor skills).

Mean IQ increased by 16 points between intake and follow-up. Half the participants gained 15 IQ points or more (range 15 to 52); 39 percent of all participants gained 1–14 IQ points; 2 percent of all participants had

Table 2 **Intake and follow-up chronological age and standard scores or mental age scores for all participants (*n* = 44) in the intensive clinic based group and the intensive parent managed group**

Measure	*Intake Mean (SD)*	*Follow-up Mean (SD)*	*Change Mean*
Chronological age (months)	35.0 (6.0)	48.1 (6.0)	13.1
IQ	53.8 (14.9)	69.9 (20.6)	16.1***
Visual-spatial IQ	75.5 (20.3)	85.9 (28.6)	10.4***
Reynell comprehension[a]	20.3 (2.0)	27.5 (8.2)	7.2**
Reynell expressive[a]	20.5 (2.4)	27.0 (6.8)	6.5**
VABS standard scores:			
Communication	63.6 (10.1)	71.2 (21.3)	7.6**
Daily living	65.4 (7.5)	66.6 (12.3)	1.8
Socialization	67.1 (12.2)	72.1 (15.9)	5.0*
Motor	79.6 (15.2)	85.6 (20.0)	6.0*
Composite	63.5 (8.8)	69.9 (15.9)	6.4***

[a] Mental age. VABS = Vineland Adaptive Behavior Scales. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

a stable IQ; and 9 percent of all participants showed a decrease in IQ (range 4 to 18). The mean Reynell comprehension and expressive language age equivalents increased to 27.5 months and 26.95 months, respectively, at follow-up. At intake, none of the participants except one from the parent managed group achieved basal on the expressive subscale of the Reynell, and hence were assigned a mental age of 20 months. At follow-up, 17 participants in the clinic based group and 13 participants in the parent managed group scored above basal on the comprehension subscale of the Reynell. At follow-up, 17 participants in the clinic based group and 14 participants in the parent managed group scored above basal on the expressive subscale of the Reynell.

The Vineland composite standard score increased 6.4 points between intake and follow-up.

Association between pre-treatment and outcome measures

Unprotected Pearson correlations were conducted to assess whether intake measures were associated with outcome measures and with changes in scores. Data are exhibited in Table 3. All correlations between intake age and outcome measures, and intake age and changes in scores, were non-significant. Thus the age at which the children started treatment was not reliably associated with outcome or amount of change in scores. Intake IQ, visual-spatial IQ and adaptive behaviour were associated with follow-up IQ, visual-spatial IQ, Reynell language comprehension, Reynell expressive language, and adaptive behaviour. However, correlations between intake measures and treatment gains on IQ, visual-spatial IQ, and adaptive behaviour were non-significant (except association between intake visual-spatial IQ and change in IQ and changes in adaptive behaviour scores). Thus intake age, IQ, Reynell language comprehension, Reynell expressive language and adaptive behaviour were not reliably associated with improvement on these measures between intake and follow-up. In sum, the most consistent predictor of outcome was visual-spatial IQ as it predicted follow-up IQ, visual IQ, language comprehension, expressive language and adaptive behaviour as well as changes in IQ and adaptive behaviour.

Discussion

This study examined progress after 1 year of treatment for children with autism who received intensive, one-to-one, UCLA ABA treatment. Two types of service provision were compared. One was an intensive clinic based treatment model where all treatment personnel including tutors, senior tutors and programme consultants were provided by UK Young Autism Project. The other was an intensive parent managed treatment model where

Table 3 **Unprotected Pearson correlations of intake scores with follow-up scores and with changes in scores**

Follow-up measures	*Intake measures*											
	Age		*IQ*		*Visual-spatial IQ*		*Reynell comprehension*		*Reynell expressive*		*Vineland composite*	
IQ	–0.15	–0.02	0.66**	–0.08	0.77**	0.38*	0.21	–0.01	0.21	–0.00	0.56**	0.08
Visual-spatial IQ	–0.04	0.19	0.60**	0.05	0.70**	–0.00	0.15	0.13	0.23	0.30	0.41**	0.07
Reynell comprehension	0.15	n.a.	0.53**	n.a.	0.45**	n.a.	0.44**	n.a.	0.52**	n.a.	0.56**	n.a.
Reynell expressive	0.17	n.a.	0.48**	n.a.	0.50**	n.a.	0.38**	n.a.	0.43**	n.a.	0.43**	n.a.
Vineland composite	0.01	0.28	0.57**	0.22	0.62**	0.64**	0.12	–0.12	0.16	–0.05	0.53**	–0.01

The first number in each cell is the correlation between intake and follow-up scores; the second number is the correlation between intake scores and change in scores. * $p < 0.05$; ** $p < 0.01$. n.a. = not applicable; this is because participants scored below basal at intake and hence improvement could not be calculated.

intensive supervision by programme consultants was provided while tutors were recruited and managed by parents.

Between intake and follow-up, children in both groups improved significantly on IQ, visual-spatial IQ, language comprehension, expressive language, social skills, motor skills and adaptive behaviour. Mean IQ increased by 16 points between intake and follow-up. Eighty-nine percent of children showed an increase in IQ score. Fifty percent of all participants gained 15 IQ points or more; 2 percent (one participant) had a stable IQ; and 9 percent (four participants) showed a decrease. These findings are consistent with other investigators (Cohen et al., 2006; Eikeseth et al., 2002; 2007; Howard et al., 2005; Lovaas and Smith, 1988; Sallows and Graupner, 2005). Three participants who showed a decrease in IQ between intake and follow-up showed an increased mental age and one participant's mental age remained unchanged. For all four children, mean intake mental age was 18 months as compared to 21 months at follow-up.

No significant differences between the clinic based group and parent managed group were found on any of the follow-up measures. Thus, the efficacy of the two service models appeared similar. This finding is consistent with a recent study by Sallows and Graupner (2005), but different from that of Bibby et al. (2001). A reason for this may be that tutors in the present study received supervision at a considerably higher frequency as compared to the Bibby et al. (2001) study. In addition, all consultants in the present study were accredited according to the UCLA Protocol as compared to 21 percent in the Bibby et al. study (Mudford et al., 2001). While there is some need to be cautious in comparing findings across studies, these results suggest that publicly funded parent managed or clinic based programmes should meet criteria identified as effective, such as those outlined in the current study, rather than the variables that have been identified as less effective, such as those outlined in programmes studied by Mudford et al. (2001).

The parent managed service model required the parents to recruit and manage their own tutors in addition to managing their child's programme. Some parents may find it difficult, stressful, or too much of a burden to run a parent managed programme. Indeed, an important question is whether or not parents should be expected to administer and be responsible for their child's psycho-educational provision. However, this service model has increased access to this treatment and was included in this study because it was a demand led outreach service. Parent managed service was provided to families who resided outside the catchment areas for the clinic based service and because no other ABA clinic based services were available in those regions.

Due to the low number of participants, the study is somewhat underpowered to predict which participants would benefit most from ABA.

However, data suggest that the best predictor of outcome was intake visual-spatial IQ as it predicted follow-up IQ, visual-spatial IQ, language comprehension, expressive language and adaptive behaviour as well as changes in IQ and adaptive behaviour. Intake IQ predicted outcome on these variables but not changes in scores as a result of treatment. A possible limitation to the visual-spatial IQ was that five participants did not achieve basal on the test at intake. Thus the analysis excluded the participants who were lowest functioning.

Age at intake predicted neither treatment outcome nor gains in treatment. Similar findings have been reported by Eikeseth et al. (2002; 2007) and Lovaas and Smith (1988). However, other investigators have reported a relation between age at intake and treatment outcome (e.g. Harris and Handleman, 2000). Hence, further research to resolve the conflicting findings is warranted.

Children in the UK may be required to begin school as early as 4 years old, which is earlier than most other countries. In addition, academic skills are a priority early in the school curriculum. To prepare children for the statutory school attendance, it was necessary to focus on academic skills in the early stages of the programme, possibly at the expense of teaching other important skills such as play and social skills. Furthermore, some of the children in this study did not continue with treatment beyond the first year because they were required to attend school full-time.

To achieve a basal score on the Reynell Developmental Language Scales, skills of a 21 month level or above are needed. At intake, none of the children achieved a basal score for receptive language and only one child reached basal for expressive language. An intake score of 20 months was assigned to all children not achieving basal. However, examining the intake raw scores showed that, on average, the children achieved mastery on very few items on the Reynell. Hence, the changes in language functioning from intake to follow-up were larger than they appear because the starting point was closer to 0 than to the assigned 20 months.

Though the study had a number of strengths, such as independent and blind assessment, independent diagnosis confirmed by a reliable assessment instrument, specific intake criteria, single-case experimental control, and two intervention groups, the study also had limitations which should be considered. For example, the study lacked an alternative treatment or a no-treatment control group. Also, group assignment was based on participants' geographical location rather than being random. However, in a long-term study such as the present study, which is employing a treatment that has been empirically supported, it may well be unethical to conduct a randomized controlled trial. A solution to this ethical dilemma may be to conduct short term randomized studies comparing benchmark ABA treat-

ment to other treatment approaches. After completion of such a relatively brief trial period, the participants who had received the less effective intervention could get immediate access to the intervention that was demonstrated more effective. Further research could also include randomized studies comparing specific components of a particular treatment (e.g. Howlin et al., 2007; Kasari, Freeman, and Paparella, 2006, Yoder and Stone, 2006).

The present study reports positive effects of 1 year of ABA treatment. Previous studies have shown that the largest gains in IQ, language and adaptive skills often occur within the first year of treatment. However, research also suggests that children, on average, continue to make gains in these areas during the second and third year of treatment (Cohen et al., 2006; Eikeseth et al., 2002; 2007; Howard et al., 2005; Sallows and Graupner, 2005). Therefore, for children to reach their full potential and sustain their gains, treatment should continue beyond 1 year.

Acknowledgements

Preparation of this article was supported in part by grant R01 MH48863 (Multi-Site Young Autism Project) from the National Institute of Mental Health. We thank Tris Smith for helpful comments on earlier drafts of the manuscript.

Note

1 The term 'treatment' is used to describe the ABA intervention; however, the term 'teaching' is equally descriptive.

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