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BRIEF REPORT

Brief Report: Relative Effectiveness of Different Home-based Behavioral Approaches to Early Teaching Intervention

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Abstract The effectiveness of home-based early behavioral interventions for children (2:6–4:0 years old) with autistic spectrum disorders was studied over 9–10 months. Measures of autistic severity, intellectual, educational, and adaptive behavioral functioning were taken. There was no evidence of recovery from autism. High-intensity behavioral approaches (mean 30 h/week) produced greater gains than low-intensity programs (mean 12 h/week). Lovaas- and complete application of behavior analysis to schools approach-type interventions produced largest gains [similar to gains produced by longer-term clinic-based applied behavior analysis (ABA) programs]. Within the high-intensity groups, increased temporal input on the program was not associated with increased gains in the children. The results from clinic-based ABA trials were partially replicated on a home-based sample, using children with greater autistic and intellectual impairments.

Keywords Applied behavior analysis · Early teaching intervention · Home-based · Intellectual functioning · Educational functioning · Adaptive behavioral functioning · Temporal intensity

Introduction

Much current debate has centered on applied behavior analysis (ABA) as an intervention for children with autistic spectrum disorders (ASD). This approach has been outlined in a variety of sources (e.g., Lovaas, 1981; Lovaas & Smith, 1989). As originally described, this approach involves a discrete-trial reinforcement-based teaching method, delivered on a 1:1 basis, for 40 h a week, over a three year period. The outcome-effectiveness of this intervention reported by Lovaas (1987) was remarkable; children undergoing this approach made gains of up to 30 IQ points, and just under half of these children were not noticeably different from normally developing children after three years of the intervention. The gains noted for a group of children receiving a high-intensity intervention (40 h/week) were much more pronounced than in those children undergoing the same treatment for less time/week (10 h/week or less). The relatively high intensity of the program (i.e., 40 h/week) has been taken as axiomatic to the success of the program by many adherents to this approach (see Lovaas, 1987; Mudford, Martin, Eikeseth, & Bibby, 2001). Although some studies have replicated the relative benefits of high-intensity programs (e.g., over 30 h/week) compared to low-intensity programs (e.g., Smith, Eikeseth, Klevstrand, & Lovaas, 1997; Smith, Annette,& Wynn, 2000), other studies have shown that gains are made with less than 30 h/week (Sheinkopf & Siegel, 1998).

Despite the encouraging results, a number of critiques have focused on problems both with the internal and external validity of Lovaas (1987) study (see Gresham & MacMillan, 1997; Connor, 1998). In terms of the internal validity of Lovaas (1987) study, different IQ tests were used at baseline and at follow up to assess the children's intellectual functioning. This practice may well reduce the reliability of the measurement (Magiati & Howlin, 2001). In terms of

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the threats to the external validity of the study, the reliance on IQ as a sole psychometric measure of functioning may be questioned, given that IQ is not necessarily the main problem in autistic functioning. In fact, when Salt et al. (2002) measured behavioral change rather than IQ, there were no gains at all after one year of a home-based intervention program (albeit with a much less intensive program than suggested by Lovaas, 1987). Second, the sample chosen for the study reported by Lovaas (1987) were verbal, relatively high-functioning, participants, who may have performed equally well with any intervention. Smith et al. (1997) studied more severely impaired children, and noted only marginal IQ gains. Finally, the study reported by Lovaas (1987) was a 'clinic-based' study, and may not generalize to interventions as they are typically used in the home. This issue has been highlighted in a number of recent reports of home-based ABA programs, which have questioned the extent to which the results of clinic-based assessments can be generalized to the type of ABA program that occurs in the home (see Mudford et al., 2001). The available evidence on this topic has produced mixed results. Sheinkopf and Siegel (1998) noted that home-based programs did perform well relative to controls. In contrast, Smith et al. (2000) found such gains were only found when the program was located close to the supporting clinic, and Salt et al. (2002) found no gains in a parent-led approach.

The initial aim of the current study was to systematically replicate the original study by Lovaas (1987) in a home-based setting. To this end, a group of children receiving a high-intensity intervention (around 30 h/week) were compared to a sample receiving a lower-intensity intervention (around 10 h/week). The sample of children employed also was more severely impaired than that studied by Lovaas (1987), and more typical of the samples presenting to local authorities in the UK (see Connor, 1998). In addition, a broader range of outcome measures than employed by Lovaas (1987) were utilized; including measures of intellectual functioning, educational functioning, and adaptive behavioral functioning.

Following the report by Lovaas (1987), a number of alternative behavioral interventions have been developed, and home-based ABA programs can take one of a number of forms (see Mudford et al., 2001). Two of these approaches have received some attention; the verbal behavior approach (Sundberg & Michael, 2001), and the complete application of behavior analysis to schools approach (CABAS, Greer, 1997; Twyman, 1998). The verbal behavior approach is a discrete-trial approach to the treatment of autism that focuses primarily on the development of verbal responses. The approach emphasizes the development of verbal operants, rather than on words and their meanings (see Skinner, 1957), and on the independent training of speaker and listener repertoires. The CABAS approach provides teacher training, supervisory support, and administrative support to implement a teaching system. This system employs a combination of ABA technologies, which include direct instruction, precision teaching, and a personalized system of instruction for staff and parent training. The CABAS approach stresses the importance of learn-units (opportunities to learn), and emphasizes the interaction of teacher and student as the unit of analysis, rather than focusing solely on the child's response to a discrete-trial prompt. However, neither of the latter two approaches has been directly compared to the Lovaas approach for ASD problems, and neither has much published evidence regarding its efficacy. The second aim of the current study was to examine preliminary evidence for the differential effectiveness of these three ABA approaches.

Method

Participants

Participants were selected on the basis of four criteria: they were 2:6–4:0 years old at the start of the study, they were at the start of their intervention, they received no other major intervention during the period of the assessment, and they had a diagnosis of ASD. A total of 27 participants were sampled, and are described in Tables 1 and 2. Inspection of these data shows that the participants in the high- and low-intensity interventions (Table 1), and in the three types of high-intensity intervention (Table 2), were well matched. None of these differences proved to be statistically significant, all $F < 1$.

Assignment to group was on the basis of the intervention being offered to the child in their particular area. For example, if a child was in an area that offered a high-intensity approach, then that child was assigned to that group. The areas involved in the study offered a similar socio-economic profile to one another. Thus, although the allocation to group was not truly random, the child's characteristics did not influence group assignment. This is seen in the well-matched profile of the groups. Ethical approval for the study (University College London Hospital Trust Ethics Committee) was granted on this understanding.

Table 1 Baseline measures for participants in high- and low-intensity intervention groups Numbers of participants, and their age at baseline. Means and standard deviations for Psycho-educational Profile (*PEP-R*), British Ability Scale (*BAS*), and Vineland Adaptive Behavior, measures (all standard scores, mean = 100, standard deviation = 15)

	High intensity	Low intensity
Participants	14 males	13 males
Mean Age (months)	42.9 (14.8)	40.8 (5.6)
Autistic Severity: GARS Autism Quotient	89.1 (14.7)	95.1 (11.6)
Intellectual Functioning PEP-R: Overall Score	57.2 (17.8)	49.3 (13.2)
Educational Functioning BAS: Cognitive Ability	60.1 (22.4)	52.4 (9.9)
Adaptive Behavior: Vineland Composite	59.3 (10.1)	56.5 (4.4)

Interventions

All the interventions were home-based ABA programs, and all offered mostly 1:1 teaching provided by a number of tutors under the guidance of an ABA Supervisor. Typically, a session would last 2–3 h, and comprise ~8–14 tasks per session. These tasks would last typically about 5–10 min each, and would be repeated until some criterion performance was reached. Each task would be separated by a 5–10 min break. The programs used an antecedent (question/task), behavior (response) sometimes prompted if necessary, and consequence (reinforcement, usually a tangible such as food, but also praise and activities) procedure. No aversive stimuli were used in any of the programs.

High-intensity Interventions

The programs offered training of between 20 and 40 h/week. The programs were provided by a range of organizations, who offered either: 'Lovaas' interventions (Lovaas, 1987), 'Verbal Behavior' programs (Sundberg & Michael, 2001), or CABAS-based approaches (Greer, 1997). Each program was supervised by tutors trained in that approach, and provided supervision on average once every 2 weeks. The various programs were conducted according to the appropriate manuals, and as directed by the program supervisor.

Low-intensity Intervention

These programs were similar to the generic ABA program described above, and offered between 10 and 20 h of intervention a week. Up to four, three h home-based sessions each week of direct 1:1 teaching for the child were carried out by trained assistants.

The key characteristics of the different interventions, along with a description of their main features reported by tutors and parents in post-study questionnaires are shown in Tables 3 and 4.

Measures

Gilliam Autism Rating Scale

The Gilliam Autism Rating Scale (GARS; Gilliam, 1995) comprises four subtests (stereotyped behaviors, communication, social interaction, and developmental disturbances), which combine to give an Autism Quotient. High-scores mean greater autistic severity [mean = 100 (average autistic severity), standard deviation = 15]. The Autism Quotient has an internal reliability of .96. The GARS has high-criterion validity with other tools, for example, the Autism Behavior Checklist (.94).

Psycho-educational Profile (revised)

The Psycho-educational Profile-Revised (PEP-R; Schopler, Reichler, Bashford, Lansing, & Marcus, 1990) measures functioning in seven developmental domains: imitation, perception, fine and gross motor skills, eye-hand coordination, and nonverbal and

Table 2 Baseline measures for participants in the three high-intensity ABA interventions Numbers of participants, and their age at baseline. Means and standard deviations for Psycho-educational Profile (*PEP-R*), British Ability Scale (*BAS*), and Vineland Adaptive Behavior, measures (all standard scores, mean = 100, standard deviation = 15)

	Lovaas	Verbal behavior	CABAS
Participants (gender)	4 males	5 males	5 males
Mean Age (months)	47.5 (13.5)	38.0 (9.9)	44.2 (20.5)
Autistic Severity: GARS Autism Quotient	93.0 (19.9)	87.6 (11.1)	87.4 (16.1)
Intellectual Functioning PEP-R: Overall Score	58.0 (30.7)	50.2 (7.7)	63.6 (12.4)
Educational Functioning BAS: Cognitive Ability	72.0 (30.6)	48.0 (4.6)	62.8 (23.9)
Adaptive Behavior: Vineland Composite	59.8 (16.7)	58.2 (6.5)	60.0 (8.6)

Table 3 Characteristics of the high- and low-intensity interventions

	High intensity	Low intensity
Mean Intervention (h/week)	30.4 (5.0)	12.6 (2.3)
Range (h/week)	20–40	11–20
1:1 teaching (h)	27.0 (5.8)	12.2 (2.5)
Group teaching (h)	3.4 (3.6)	.5 (.9)
Tutors	4.2 (1.3)	3.1 (1.0)
Family tutors	.6 (.7)	.6 (.8)

Table 4 Characteristics of the three high-intensity ABA interventions studied The mean number of hours input, type of teaching (individual versus group), mean number of tutors and family members involved in the program, and number of different service providers are all shown

	Lovaas	Verbal behavior	CABAS
Mean intervention (h/week)	33.0 (5.3)	30.2 (2.9)	28.6 (6.5)
Range	28–40	26–34	20–35
1:1 teaching (h)	29.5 (6.1)	23.8 (4.3)	28.2 (6.4)
Group teaching (h)	3.5 (3.9)	6.4 (4.3)	.4 (.6)
Tutors	5.3 (1.0)	3.0 (.7)	4.6 (1.1)
Family tutors	1.0 (.8)	.2 (.5)	.8 (.8)

verbal conceptual ability. The test also gives an overall developmental functioning score, that can be converted into an overall score [e.g. (mental age/chronological age) × 100]. The internal reliability ranges from .85 (perception) to .98 (cognitive verbal performance), and the total development score has high-criterion validity with other tests for intelligence, such as the Merrill Palmer Scale (.85), and the Bayley Scale (.77).

British Abilities Scale

The British Abilities Scale (BAS II; Elliott, Smith, & McCulloch, 1996) is a battery of tests of cognitive abilities, which index educational achievement. For the current purposes, the Early Years Battery was employed, involving the verbal comprehension, early number concepts, picture matching, and naming vocabulary subscales. The raw scores can be converted into a standard score (mean = 100, standard deviation = 15), which represents early educational achievement.

Vineland Adaptive Behavior Scale

The Vineland Adaptive Behavior Scale (VAB; Sparrow, Balla, & Cicchetti, 1984) assesses children's day-to-day adaptive functioning. Scores from four domains of adaptive behavior (communication, daily living skills, socialization, and motor skills) can be converted to standard scores, and a composite overall score can be derived based on sum of scale standard scores (mean = 100, standard deviation = 15). The internal reliability of the overall composite score is .93.

Procedure

After identification, the children were visited by an educational psychologist (blind to the nature of the program in operation), and the first set of measures taken (this assessment took about 120–180 min to complete). The educational psychologist administered the PEP-R and the BAS directly to the children, and helped the parent to complete the Vineland and the GARS measures. After 9–10 months, the same measures were taken by the educational psychologist and parent, and both the family and the tutors delivering the intervention were asked to fill in separate questionnaires concerning the nature of the intervention that the child had experienced.

Results

High Versus Low-intensity Programs

The GARS score for the high-intensity group, reflecting the overall autistic severity reduced only by 2.2 (± 7.8 SD) points, compared to a slight increase for the low-intensity group (1.6 + 6.2 SD). Neither change was statistically significant, both $t < 1$, and the difference between the group was not statistically significant, $t(25) = 1.41$, $p > .10$.

Figure 1 shows the group-mean changes and effect sizes in the three outcome measures for both the high- and low-intensity intervention groups. Inspection of

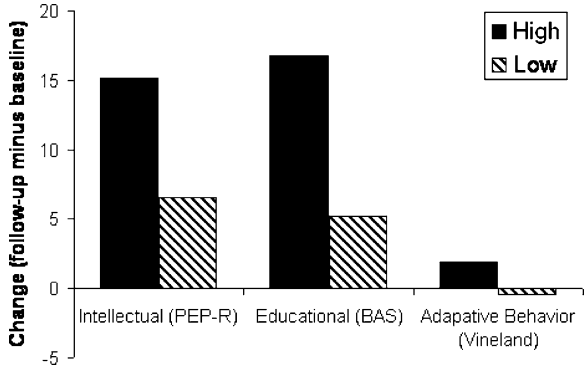

Fig. 1 Mean changes in standard scores (follow-up score minus baseline score) for the three child-outcome measures; intellectual functioning (PEP-R), educational functioning (BAS), and adaptive behavior (Vineland). High-intensity group = 20–40 h/week, low-intensity group = 10–20 h/week; *$p < .05$ relative to baseline, **$p < .01$ relative to baseline

these change data for the high-intensity group shows statistically significant gains for intellectual functioning (PEP-R, $t(13) = 3.49$, $p < .01$), and for educational functioning (BAS, $t(13) = 4.29$, $p < .01$). The low-intensity group produced moderate gains for intellectual functioning, but only the gains for the educational functioning were statistically significant relative to baseline, $t(12) = 2.43$, $p < .05$. Neither the high- nor low-intensity group produced substantial gains in adaptive behavioral functioning.

Figure 1 also shows the effect sizes for the two groups for each outcome measure. These effect sizes were calculated by dividing the change score by the original standard deviation of the sample (see Dunlop, Cortina, Vaslow, & Burke, 1996). The size of the effects followed the size of the probabilities for the *t*-tests; these effect sizes were large for the high-intensity group, and moderate for the low-intensity group, for the intellectual and educational measures, and sizes of effect were both small for the adaptive behavior measure (see Cohen, 1988group45597.utcpndar vaseledonly the(efrencni)-9.atenbethdathescosedforbed4(ucational)]TJ0 -1.2

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Table 5 Statistical significance (paired *t*-test against zero), and effect sizes (*ES*), for gain scores for the three high-intensity ABA interventions studied on each outcome measure

	Lovaas	Verbal behavior	CABAS
Intellectual Functioning (PEP)	$t(3) = 2.98$, $p < .05$, ES = .91	$t(4) = 1.52$, $p > .21$, ES = .82	$t(4) = 2.82$, $p < .05$, ES = 1.11
Educational Functioning (BAS)	$t(3) = 2.07$, $p > .10$, ES = .58	$t(4) = 1.91$, $p > .10$, ES = 3.74	$t(4) = 4.03$, $p < .01$, ES = 3.74
Adaptive Behavior (Vineland)	$t < 1$, ES = .03	$t < 1$, ES = .18	$t(4) = 1.07$, $p > .30$, ES = .53

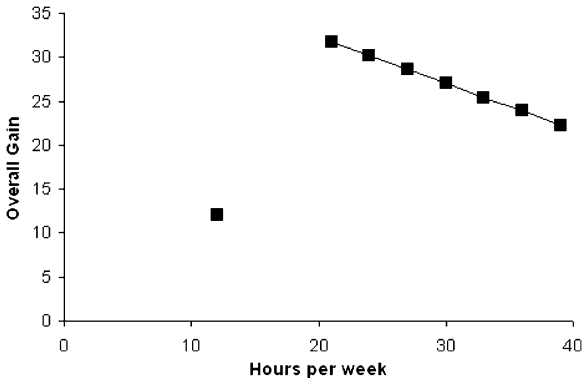

Fig. 3 Relationship between child-outcome gain (mean gain for all three measures) and temporal input of intervention (h/week) represented as the regression equation for the children receiving the high-intensity interventions

ing, and the ABA programs faired relatively poorly on this measure relative to the other two outcome measures (see also Salt et al., 2002). Another, feature of the current results that is worth some comment is the failure to note change in the autism severity rating across treatment. This finding contrasts strongly with that of Lovaas (1987). However, the current study was of a much shorter duration than the latter study, and further longer period study of the programs would be needed before firm conclusions could be drawn on this matter.

These results were obtained in a home-based sample of relatively severely autistic children (much more severely impaired than the original study reported by Lovaas, 1987, in terms of autistic severity, and IQ functioning), and show that such interventions can work when based outside a clinic. To this end, the results also support the findings of Sheinkopf and Siegel (1998), and alleviate some of the concerns expressed by Mudford et al. (2001) concerning whether the effectiveness of the ABA approach would be able to be replicated in a home-based sample.

It should be noted that although the high-intensity intervention group produced generally better results than the lower-intensity group, these differences were not always statistically significant. This finding brings in question the strong reliance placed on the temporal input of the program as key to its success. Moreover, closer analysis of the relationship between the temporal input of the program and the overall gains made by children receiving that intervention shows no clear pattern between temporal input and the gains made. The high-intensity group did better than the low-intensity group, but within the high-intensity group there was an inverse relationship between the temporal input and the gains. This finding implies that the suggested 40 h/week input may not be optimal, and once over a certain level of temporal input, perhaps around 20 h a week, there are diminishing returns for increasing the temporal input of a program. This finding is also supported by cross-experimental comparison of the relationship between hours input and gains made. Several studies (e.g., Sheinkopf & Siegel, 1998; Smith et al., 2000) have demonstrated stronger effect sizes than the study by Lovaas (1987), even though they have used less than the 40 h a week.

In terms of the comparative improvements across the three types of high-intensity ABA intervention, the present results show that overall the CABAS approach appeared to produce superior gains (in terms of statistical significance and effect sizes) than the other two approaches. Of course, these results are based only on a small sample of participants in each of the ABA programs. The statistical power of the current study to detect differences is not particularly great. However, analysis of effect sizes goes some way to overcome this problem as these effect sizes appear to be moderate to large when there is a statistically significant effect. Obviously, a greater number of participants studied over a somewhat longer time period will be beneficial to this analysis, but these preliminary findings are promising. In addition, it would be beneficial to have a finer grained analysis of the day-to-day tasks and activities given to the children in each of the approaches to see precisely how the approaches differed from one another, and which are the important specs of each program. However, given this was a study designed to see how these interventions worked in a natural setting, this was beyond the scope and aims of the current report.

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