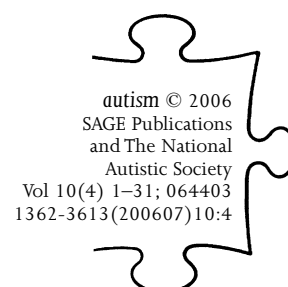# Long-term outcome of social skills intervention based on interactive LEGO© play

DANIEL B. LEGOFF *Bancroft NeuroHealth, USA*

MICHAEL SHERMAN *Bancroft NeuroHealth, USA*

ABSTRACT   LEGO© building materials have been adapted as a thera-
peutic modality for increasing motivation to participate in social skills
intervention, and providing a medium through which children with
social and communication handicaps can effectively interact. A 3 year
retrospective study of long-term outcome for autistic spectrum
children participating in LEGO© therapy (N = 60) compared Vineland
Adaptive Behavior Scale socialization domain (VABS–SD) and Gilliam
Autism Rating Scale social interaction subscale (GARS–SI) scores pre-
and post-treatment with a matched comparison sample (N = 57) who
received comparable non-LEGO© therapy. Although both groups made
significant gains on the two outcome measures, LEGO© participants
improved significantly more than the comparison subjects. Diagnosis
and pre-treatment full-scale IQ scores did not predict outcome scores;
however, Vineland adaptive behavior composite, Vineland communi-
cation domain, and verbal IQ all predicted outcome on the VABS–SD,
especially for the LEGO© therapy group. Results are discussed in terms
of implications for methods of social skills intervention for autistic
spectrum disorders.

ADDRESS   *Correspondence should be addressed to:* DANIEL B. LEGOFF, *Bancroft
NeuroHealth, 425 Kings Highway East, Haddonfield, NJ 08033-0018, USA. e-mail:
dlegoff@bnh.org*

A number of authors has recently highlighted the importance of address-
ing the core social deficits in therapeutic and educational interventions for
individuals with autistic spectrum disorders (e.g. Harris and Handleman,
1997; Klin et al., 2002; Koegel et al., 2001), especially with regard to the
long-term outcome for high-functioning autism (HFA) and Asperger's
disorder (Klin and Volkmar, 2000; Nordin and Gillberg, 1998). Although
there is considerable research-based evidence of the deficits and idiosyn-
cracies of social functioning in individuals with Asperger's disorder and
HFA, there are considerably fewer data on effective interventions for these

deficits (cf. Gray and Garand, 1993; Kunce and Mesibov, 1998; Lord, 1995; Mesibov, 1992). There has been a number of studies of the long-term behavioral and cognitive outcomes for intensive behavioral intervention (Birnbrauer and Leach, 1993; McEachin et al., 1993; Sheinkopf and Siegel, 1998; Weiss, 1999), but few studies have looked at long-range social adaptation (Nordin and Gillberg, 1998; Szatmari and Streiner, 1996). Fewer still have provided data on long-term efficacy of specific treatment methodologies for improving social competence in HFA and Asperger's disorder (Venter et al., 1992).

A potentially promising approach to improving social competence in children with autistic disorders has been described elsewhere (LeGoff, 2004), indicating at least short-term significant gains in social development resulting from LEGO©-based interactive play groups. Briefly, the approach capitalizes on the inherently rewarding nature of LEGO© activities for many children with autism. Participants first learn a set of 'LEGO© Club' rules and develop LEGO© building skills, including collaborative building, in individual therapy. They are then introduced to a group of peers, including some group members who do not have social skills deficits. The group meets on a weekly basis for 90 minutes and during that time engages in collaborative LEGO© building activities and other projects, tailored to the skill level of the participants. The tasks are analyzed and different responsibilities are assigned to group members (e.g. one child is given a set of directions and acts as the 'engineer'; another child has the pieces needed to build the set and acts as the 'supplier'; and another child is the 'builder', who is given the task of putting the pieces together, following the directions of the engineer). There is an emphasis on verbal and non-verbal communication, joint attention and task focus, collaborative problem-solving, sharing and turn-taking (switching roles during the task).

The initial outcome study (LeGoff, 2004) assessed three measures of social competence – self-initiated social contact, duration of social interaction and reductions in stereotyped behaviors – at baseline and during a 3 month or 6 month waiting-list period, followed by 3 month and 6 month treatment phases. Analysis of variance indicated significant gains on all three measures at both the 3 month ($F = 9.15$, $p < 0.01$, $N = 47$) and 6 month period ($F = 13.57$, $p < 0.01$, $N = 21$), over the pre-treatment and waiting-list levels.

The question remained, however, whether the gains observed on specific short-term measures would affect a wider range of social behaviors in a variety of social contexts, and whether these gains would be sustained over a longer period.

The current report presents LEGO© therapy outcome data reflecting changes in a broader range of social skills and autistic behaviors over a 3

2

year period compared with outcomes for comparable levels of social skills interventions which did not utilize LEGO© materials. A pre/post control-group design was used, with the control group made up of a matched sample of children referred for assessments only. The matched controls were children who had similar diagnoses and demographics to the LEGO© therapy participants who were receiving mental health, educational and other therapeutic services of comparable form and intensity. The goal of this study was to assess, first, whether LEGO© therapy had an enhanced beneficial impact compared with other methods of intervention; and second, whether benefits would be sustained over a longer period and would generalize to a broader range of skills and social development.

Method

Subjects

Both groups of participants were referred to a private multidisciplinary autism disorders clinic for assessment and/or treatment services by the state departments of health and/or education (the practice had contracts with the state to provide assessment and treatment services). Diagnoses were made on the basis of comprehensive evaluations by a pediatric neuropsychologist, a child psychiatrist, a child psychologist, and a speech pathologist, all of whom were specialists in autism spectrum disorders. The LEGO© group (N = 60) comprised children who had participated in both individual and group sessions continuously for at least 3 years (36 months), and for whom initial and follow-up assessment data were available.

The evaluations included use of standardized assessment instruments: the Vineland Adaptive Behavior Scales (VABS: Sparrow et al., 1984); either the Wechsler Preschool and Primary Scale of Intelligence–Revised (WPPSI–R: Wechsler, 1989) or the Wechsler Intelligence Scale for Children–Third Edition (WISC–III: Wechsler, 1991); and the Gilliam Autism Rating Scale (GARS: Gilliam, 1995). The comparison group (N = 57) comprised children who were referred for annual mental health assessments but who were receiving therapy services from other providers. Their assessment data also included both the VABS and the GARS, and either WPPSI–R or WISC–III, administrations of which spanned at least 3 years, during which time they were continuously receiving mental health and other educationally related remedial services compara-ble to those being given to the LEGO© therapy participants. Participants in the control group were selected from a larger pool based on age, sex, diagnosis and levels of mental health and other services, in order to provide a matched comparison sample for the LEGO© therapy group (see Table 1).

Table 1 **Group characteristics**

	LEGO© group		Control group	
Age (years:months):				
Mean	9:3		10:1	
SD	1:6		1:4	
Gender:				
Male	49	(81.2%)	47	(82.5%)
Female	11	(18.3%)	10	(17.5%)
Diagnosis, axis I:				
Autistic disorder	26	(43.3%)	24	(42.1%)
Asperger's disorder	27	(45.0%)	28	(49.1%)
PDD-NOS	7	(11.7%)	5	(8.7%)
Diagnosis, axis II:				
No diagnosis	41	(68.3%)	39	(68.4%)
Mild MR	16	(26.7%)	15	(26.3%)
Moderate MR	2	(3.3%)	3	(5.3%)
MR unspecified	1	(1.7%)	0	(0.0%)

No differences significant.

All of the children in the control group received both individual and group therapy on a weekly basis, comparable to the children in the LEGO© therapy condition; however, their mental health interventions used traditional materials, not LEGO©. Both groups received similar levels of speech-language, occupational and physiotherapy services, provided by the Department of Education Special Services (see Table 2), and both were receiving a similar number of hours of therapeutic aide support (one-on-one paraprofessional support) from contracted providers from the same agencies. Participants who started on a new psychiatric medication or changed medications (other than minor changes in dosage) during the 3 year treatment interval were excluded. An attempt was made to match participants in both groups on psychiatric medications. Mean number of hours per week of special education support and therapy services, and numbers on different medications, were compared using Student's *t*-tests and χ^2 analyses, respectively (see Table 2).

Measures

Data were collected *post hoc* from clinical files. The dependent measures were chosen to reflect overall social adaptation, as well as reduction in socially inappropriate behaviors. The Vineland Adaptive Behaviour socialization domain (VABS–SD) was used to assess social competence (cf. Klin et al., 2002). GARS social interaction (GARS–SI) scale scores were also available,

Table 2 **Provision of mental health and other therapy services**

	LEGO© group (N = 60)		Control group (N = 57)		t-test	
	Mean	SD	Mean	SD	Mean	SD
Hours per week						
Individual therapy	1.18	0.43	1.30	0.75	−1.71	0.10
Group therapy	1.59	0.35	1.61	0.39	−0.20	0.84
Family therapy	0.82	0.66	1.05	0.67	−1.91	0.06
Therapeutic aide	11.93	13.40	12.07	15.13	−0.53	0.85
Speech-language therapy	1.29	0.41	1.35	0.54	−0.19	0.84
Occupational therapy	1.24	0.89	1.19	0.88	0.18	0.84
Physical therapy	0.21	1.17	0.57	1.31	−0.67	0.51
Psychiatric medications	No.	%N	No.	%N	χ^2	$p >$
Antipsychotics	14	23.3	15	26.3	0.62	0.43
Psychostimulants	18	30.0	17	29.8	0.46	0.51
SSRI	9	15.0	8	14.0	1.92	0.17

and these were considered to provide an acceptable measure of autistic-type social behaviors. The GARS ratings were made by the first author, based on observations of the children and clinical interviews with parents. VABS data were available from special education triannual assessments and ratings were made by child social workers who were independent of the study.

It was predicted that children who participated in the LEGO© therapy condition would show greater gains in overall social competence (VABS–SD), as well as decreased autistic behaviors (GARS–SI) compared with the control group. LEGO© therapy was intended to be effective with children of all levels of developmental functioning and communication ability, and therefore it was predicted that overall adaptation, IQ, diagnosis and communication ability would not significantly affect treatment outcome. Secondary analyses to test this hypothesis used children's pre-treatment Wechsler full-scale IQ scores (FSIQ), and VABS adaptive behavior composite (VABS–ABC), to determine whether treatment outcome was affected by intelligence and/or developmental level. (Note that IQ scores were based on administrations of either the WPPSI–R or the WISC–III, depending on the age of the subject at the time of initial assessment.) Diagnosis was also used as a grouping variable and, as noted above, diagnoses were based on multidisciplinary assessments. Language abilities were assessed using two measures: VABS communication domain (VABS–CD) and Wechsler verbal IQ (VIQ) scores.

Design and data analysis

The study used a 36 month pre- and post-treatment series design with a treatment and comparison group (with two diagnostic groups within each treatment condition). Group assignment was not random and participants were assigned to the different groups on an *a priori* basis depending on parent and IEP team decisions. Individuals in the comparison group were chosen on the basis of their having had two complete triannual assessments, and matching the LEGO© therapy subjects on subject and treatment variables. Descriptive data and sample mean comparisons are provided on relevant subject and treatment variables in Tables 1 and 2.

The main hypothesis, that LEGO© therapy participants would make greater gains in social competence than the control group, was assessed by examining VABS–SD and GARS–SI scores before and after a 36 month treatment period. Then 2 × 2 ANOVAs (pre- versus post-treatment by LEGO© versus control group) were used to assess the difference between the pre- and post-treatment scores for the two dependent variables (DVs). Binomial regression analysis was used to assess the strength of the relationship between difference scores and group membership.

To assess the extent to which diagnosis affected treatment outcome, pre- to post-treatment difference scores for the two dependent measures were entered into two 2 × 2 (diagnosis by treatment condition) ANOVAs. The impact of IQ and developmental level on treatment outcome for the two treatment groups was assessed by use of two separate regression analyses for each treatment and diagnostic group, with predictor variables, pre-treatment full-scale IQ (FSIQ) and VABS adaptive behavior composite (VABS–ABC), predicting pre- to post-treatment changes, first in VABS–SD and then in GARS–SI scores. Similarly, the effect of communication skills on treatment outcome was assessed by use of multiple regression analyses, with pre-treatment VABS communication domain scores (VABS–CD) and verbal IQ (VIQ) predicting changes in VABS–SD and GARS–SI for each group.

Results

Main analyses

Overall, the children in both the LEGO© and control group conditions showed significant improvement on both the VABS–SD and the GARS–SI (see Table 3). Both the initial 2 × 2 ANOVAs showed a main effect for pre- versus post-treatment for both VABS–SD ($F(121) = 17.92$, $p < 0.001$) and GARS–SI ($F(121) = 20.96$, $p < 0.001$). There was also a significant main effect of treatment condition for both variables, with GARS–SI showing a stronger difference between groups ($F(121) = 4.80$, $p < 0.001$) than

VABS–SD ($F(121) = 2.89$, $p < 0.01$). The VABS–SD ANOVA revealed a significant interaction effect of treatment condition by pre- versus post-treatment ($F(119) = 2.53$, $p < 0.05$). An examination of cell means indicated that the LEGO$^©$ subjects had made significantly greater gains on this variable than had the control group (LEGO$^©$ group VABS–SD difference = +20.68; comparison group VABS–SD difference = +10.77; $t(115) = 3.11$, $p < 0.01$ *post hoc* comparison, equal variances not assumed). This finding indicates that the LEGO$^©$ group improved by twice as much as the comparison sample on the VABS–SD. Note that the comparison group had a high degree of variability of outcome on the VABS–SD, relative to the average amount of change on this variable. This may reflect the fact that the comparison subjects were not receiving a standardized intervention, and there were likely uncontrolled effects of different treatments, and different therapists, in addition to individual participant differences. There was also an interaction effect found for GARS–SI scores ($F(119) = 3.63$, $p < 0.01$), and again, an examination of cell means revealed that the LEGO$^©$ therapy participants had improved on this variable significantly more than the control sample (see Table 3): $t(115) = 4.96$, $p < 0.01$ (equal variances not assumed).

A binomial regression analysis determined that positive changes in the outcome measures were more strongly related with LEGO$^©$ therapy versus the comparison group ($R = 0.439$, $p < 0.01$). This result reiterates the main analyses which found that improvements on the two outcome measures were higher in the LEGO$^©$ group in this analysis combining the two variables in one predictive formula. The binomial regression analysis allows an assessment of the strength of the effect of LEGO$^©$ therapy over and above the standard forms of treatment provided to the comparison group ($R^2 = 0.193$, or 19.3 percent). Regression coefficients for the individual difference scores revealed that outcome on both measures was significantly correlated

Table 3 **VABS–SD and GARS–SI scores pre- and post-treatment**

	VABS–SD		GARS–SI	
	Mean	SD	Mean	SD
LEGO$^©$ group (N = 60)				
Pre-treatment	62.27	13.43	11.53	1.75
Post-treatment	82.95	12.85	7.93	1.46
Difference	+20.68	10.32	–3.60	1.38
Comparison group (N = 57)				
Pre-treatment	59.95	16.48	11.00	1.72
Post-treatment	70.72	15.61	8.70	1.66
Difference	+10.77	10.97	+2.30	1.45

with group membership: $(R(VABS–SD) = 0.228, p < 0.03, R^2 = 0.052;$ $R(GARS–SI) = 0.416, p < 0.01, R^2 = 0.173)$.

Secondary analyses

Mean GARS–SI and VABS–SD change scores for the LEGO© and comparison groups with diagnostic subgroups (autism and Asperger's/PDD-NOS) are presented in Table 4. The 2 × 2 ANOVA of VABS–SD scores revealed a significant main effect of treatment condition $(F(121) = 3.00, p < 0.01)$, with LEGO© participants showing larger difference scores overall. There was no main effect of diagnosis $(F(121) = 0.16, p > 0.85)$ and no interaction effect $(F(119) = 0.26, p > 0.65)$, indicating that diagnosis did not affect outcome on this measure for either treatment group. The 2 × 2 ANOVA of GARS–SI difference scores also showed a main effect of treatment condition $(F(121) = 4.97, p < 0.01)$, with the LEGO© group subjects showing larger pre/post differences, but again, no main effect of diagnosis $(F(121) = 1.63, p > 0.20)$ and no interaction effect $(F(119) = 0.43, p > 0.51)$.

Pre- and post-treatment Wechsler IQ and VABS–CD mean scores for both groups are presented in Table 5 (note that the groups did not differ on pre-treatment IQ or VABS–CD scores, $t < 1.0$). Regression analyses are shown in Table 6. The effect of communication skills, as measured by VABS–CD and VIQ, on VABS–SD difference scores for all subjects $(N = 117)$ was statistically significant, $R = 0.352, p < 0.01$, accounting for 12.4 percent of variance in outcome values for this DV $(R^2 = 0.124)$. Within the LEGO© group $(N = 60)$, the relationship between VABS–CD, VIQ and VABS–SD change scores was even stronger $(R = 0.511, p < 0.001)$, accounting for 26.1 percent of the variance in difference scores. In the comparison group $(N = 57)$, the regression analysis indicated a much weaker relationship among these variables, accounting for only 11.3 percent of the variance, but this was still statistically significant $(R = 0.336, p < 0.05)$.

Table 4 **VABS–SD and GARS–SI change scores within diagnostic groups**

	VABS–SD		GARS–SI	
	Mean	SD	Mean	SD
LEGO© group				
Autistic disorder (*N* = 26)	+21.45	10.05	–3.82	1.56
Asperger/PDD-NOS (*N* = 34)	+19.91	10.30	–3.43	1.26
Comparison group				
Autistic disorder (*N* = 24)	+11.96	11.08	–2.29	1.42
Asperger/PDD-NOS (*N* = 33)	+9.58	10.88	–2.32	1.55

Table 5 **Pre- and post-treatment Wechsler IQ mean scores and Vineland communication domain mean scores**

| | Pre-treatment | | Post-treatment | |
	Mean	SD	Mean	SD
LEGO© group (N = 60)				
FSIQ	84.6	16.6	90.6	15.8
VIQ	82.0	21.6	86.3	16.9
PIQ	90.7	17.5	99.3	16.8
VABS–CD	67.2	17.4	75.0	11.4
Comparison group (N = 57)				
FSIQ	85.7	17.9	87.1	18.8
VIQ	83.3	18.8	79.9	19.0
PIQ	89.3	18.7	90.3	18.1
VABS–CD	65.4	19.2	70.5	16.9

Table 6 **Regression analyses of VABS–CD and VIQ predicting VABS–SD and GARS–SI difference scores for subjects with autistic disorder and Asperger/PDD-NOS diagnoses in both LEGO© and comparison groups**

| | VABS–SD | | | | GARS–SI | | |
	N	R	$p <$	R2	R	$p <$	R2
Overall	117	0.352	0.010	0.124	0.151	0.340	0.023
LEGO© group	60	0.511	0.001	0.261	0.195	0.331	0.038
Comparison group	57	0.336	0.004	0.113	0.317	0.060	0.100
Autistic disorder	50	0.229	0.227	0.052	0.359	0.021	0.129
Asperger/PDD-NOS	67	0.458	0.001	0.210	0.179	0.378	0.032
LEGO© autistic	26	0.566	0.021	0.320	0.356	0.257	0.127
LEGO© AS/PDD-NOS	34	0.457	0.019	0.209	0.108	0.818	0.012
Comparison autistic	24	0.280	0.319	0.078	0.378	0.116	0.143
Comparison AS/PDD-NOS	33	0.798	0.004	0.637	0.167	0.856	0.028

For GARS–SI difference scores, the relationship with VABS–CD and VIQ overall (N = 117) was not significant, R = 0.151, $p > 0.34$. In the autistic disorder group, however, GARS–SI outcome was significantly correlated with initial VABS–CD and VIQ scores, R = 0.359, $p < 0.05$, and this relationship was found in both the LEGO© (R = 0.356) and comparison samples (R = 0.378). Consequently, it appears that communication ability predicts treatment outcome for autistic behaviors across treatment approaches. There were important differences in outcome measures between the autistic disorder subgroup and the Asperger's/PDD-NOS subgroup. Communication ability as measured by the VABS–CD and VIQ were significantly correlated

with outcome on the VABS–SD for both LEGO$^©$ ($R = 0.457$, $p < 0.02$) and comparison participants ($R = 0.798$, $p < 0.01$). It is important to note that for these subjects who had generally intact language and cognitive functioning, communication abilities strongly predicted outcome on the VABS–SD ($R^2 = 0.637$), suggesting that for non-LEGO$^©$ methods of intervention for this population, communication skill is a limiting factor for successful social intervention. Although this relationship was still significant for the LEGO$^©$ group, the amount of variance accounted for by language variables in VABS–SD outcome was much smaller ($R^2 = 0.209$).

Discussion

The results presented above substantially support the main hypothesis of the study: that LEGO$^©$ therapy participants would show relatively greater improvement in a broad range of social skills and a reduction in autistic-type social behaviors over a 3 year period compared with matched controls. Although all participants showed statistically significant gains following the 3 year treatment period, on both the VABS–SD and the GARS–SI, LEGO$^©$ subjects made greater gains.

On the GARS–SI, the LEGO$^©$ subjects showed an average decrease of 3.6 points, compared with the non-LEGO$^©$ group whose scores *increased* by 2.3 points. On the VABS–SD, LEGO$^©$ therapy participants improved by 20.68 points on average, while the comparison group improved by an average of 10.77 points. Regression analysis also revealed that the variance in outcome accounted for by treatment condition overall was 19.3 percent.

As was predicted, LEGO$^©$ therapy outcome was not significantly affected by diagnosis. Children with either autistic disorder or Asperger's and PDD-NOS diagnoses did equally well in both treatment conditions. In general, there was a tendency for higher-functioning participants (i.e. those with higher IQ and Vineland scores) to do better on outcome scores of overall social adaptation (VABS–SD), while initial functioning was not as predictive of changes in autistic social behaviors (GARS–SI).

The impact of pre-treatment communication functioning on treatment outcome was somewhat complex. A previous study (LeGoff, 2004) found that LEGO$^©$ therapy participants with communication deficits improved significantly on measures of social behavior but not as much as participants without language difficulties. In the current study, treatment outcome for all subjects was correlated with pre-treatment VIQ and VABS communication domain scores, but only on the VABS–SD, not the GARS–SI. Closer examination of this relationship indicated the following: (1) pre-treatment language functioning was more important for outcome in LEGO$^©$ therapy than in the comparison group; (2) language scores predicted improvements on the

10

VABS–SD more for the Asperger's/PDD-NOS group than for the autistic disorder participants overall.

The first finding is consistent with the previous study results, indicating that the particular methodology of LEGO© therapy works better for children who are able to communicate effectively. It should be noted that this is evident only with regard to the more general social adaptation benefits (VABS–SD), and not with regard to decreases in autistic social behavior (GARS–SI). It is also important to note that participants with language impairment in both this and the previous study still showed significant gains. The second finding may reflect the fact that there was less variability of language functioning in the autistic disorder group and therefore less of a differentiating factor in terms of outcome. This hypothesis was supported by the fact that the autistic disorder group had much smaller standard deviations of VIQ ($SD = 13.47$) and VABS–CD ($SD = 11.16$) than the Asperger's/PDD-NOS group (VIQ $SD = 19.98$; VABS–CD $SD = 17.40$).

Though the results of the current study are encouraging, there are nevertheless a number of limitations that restrict the confidence one can have in the results. First, group assignment was non-randomized and there remains the possibility that the groups had some unidentified difference which could have resulted in one group doing better than the other, independent of the difference in treatment method. A further potential confound is the fact that the treatment groups had different therapists. Replication studies in which different therapists are used, and the effect of therapist differences on outcome is assessed, need to be done in order to definitively rule this out.

Second, there is limited information concerning the interventions provided to the comparison group, although the fact that individuals in this group showed significant improvements on both outcome measures and the context of the interventions (provision of remedial services to special education children within the public school system) made it likely that the participants were receiving services consistent with best-practice guidelines.

Third, there is the possibility that the subjective ratings of progress may have been influenced by extraneous factors. For instance, the GARS ratings were made by the first author, along with parents, and there may have been a tendency to rate greater progress in familiar LEGO© therapy participants than in subjects who were seen only for annual assessments. The Vineland data were also based on parental report, although rated by workers.

The outcome data presented by the current study should be seen as complementary to the findings of a previous initial study (Le Goff, 2004), which used a more stringent waiting-list control group design.

One of the most important aspects of the LEGO© therapy project was the improvement in social adaptation and the evidence of improved social

competence in natural settings. The previous and current data indicate that improvements in social competence generalize beyond the therapy setting itself, and are reflected in adaptive social behavior. The fact that the current project was done in the context of special education services suggests that the results could have important implications for educators. Social competence is clearly an important aspect of education in the broader sense of providing children with the skills necessary to adapt to and function independently within their communities (Harris and Handleman, 1997; Kellegrew, 1995).

The potential for use of LEGO© therapy within the school system is evident. Initial studies of the educational benefits of LEGO© materials have been promising (e.g. Noble, 2001), and certainly it would be beneficial to generalize the use of these materials for the purposes of social as well as educational skill development. Utilization of the school system where children spend most of their days during the critical years of development makes the most sense in terms of efficacy overall, as well as cost-effectiveness. Social skills interventions based on LEGO© therapy could be easily adapted to school settings where currently social skills interventions are not always optimal – or available.

Conflict of interest statement

The authors have no direct or indirect affiliation with the LEGO© company, and received no support, financial or otherwise, from LEGO© for this research or in any other way. Bancroft Neurohealth also has no connection or affiliation with the LEGO© company, and has not received any financial or other support from LEGO© or its affiliates.

References

BIRNBRAUER, J.S. & LEACH, D.J. (1993) 'The Murdoch Early Intervention Program after 2 Years', *Behavior Change* 10: 63–74.

GILLIAM, J.E. (1995) *Gilliam Autism Rating Scale (GARS)*. Austin, TX: Pro-Ed.

GRAY, C.A. & GARAND, J.D. (1993) 'Social Stories: Improving Responses of Students with Autism with Accurate Social Information', *Focus on Autistic Behavior* 8: 1–10.

HARRIS, S.L. & HANDLEMAN, J.S. (1997) 'Helping Children with Autism Enter the Mainstream', in D.J. COHEN & F.R. VOLKMAR (eds) *Handbook of Autism and Pervasive Developmental Disorders*, 2nd edn, pp. 665–75. New York: Wiley.

KELLEGREW, D.H. (1995) 'Integrated School Placements for Children with Disabilities', in R.L. KOEGEL & L.K. KOEGEL (eds) *Teaching Children with Autism*, pp. 127–46. Baltimore: Brookes.

KLIN, A. & VOLKMAR, F.R. (2000) 'Treatment and Intervention Guidelines for Individuals with Asperger Syndrome', in A. KLIN, F.R. VOLKMAR & S.S. SPARROW (eds) *Asperger Syndrome*, pp. 340–66. New York: Guilford.

KLIN, A., JONES, W., SCHULTZ, R., VOLKMAR, F. & COHEN, D. (2002) 'Visual Fixation Patterns during Viewing of Naturalistic Social Situations as Predictors of Social Competence in Individuals with Autism', *Archives of General Psychiatry* 59: 809–16.

KOEGEL, R.L., KOEGEL, L.K. & MCNERNEY, E.K. (2001) 'Pivotal Areas in Intervention for Autism', *Journal of Clinical Child Psychology* 30 (1): 19–32.

KUNCE, L. & MESIBOV, G.B. (1998) 'Educational Approaches to High-Functioning Autism and Asperger Syndrome', in E. SCHOPLER, G.B. MESIBOV & L.J. KUNCE (eds) *Asperger Syndrome or High Functioning Autism?*, pp. 227–62. New York: Plenum.

LEGOFF, D.B. (2004) 'Use of LEGO© as a Therapeutic Medium for Improving Social Competence', *Journal of Autism and Developmental Disorders* 34: 557–71.

LORD, C. (1995) 'Facilitating Social Inclusion', in E. SCHOPLER & G. MESIBOV (eds) *Learning and Cognition in Autism*, pp. 221–39. New York: Plenum.

MCEACHIN, J.J., SMITH, T. & LOVAAS, O.I. (1993) 'Long-Term Outcome for Children with Autism Who Received Early Intensive Behavioral Treatment', *American Journal on Mental Retardation* 4: 359–72.

MESIBOV, G.B. (1992) 'Treatment Issues with High-Functioning Adolescents and Adults with Autism', in E. SCHOPLER & G.B. MESIBOV (eds) *Social Behavior in Autism*, pp. 265–303. New York: Plenum.

NOBLE, M. (2001) *The Educational Impact of LEGO Dacta Materials*. Sheffield: Sheffield–Hallam University.

NORDIN, V. & GILLBERG, C. (1998) 'The Long-Term Course of Autistic Disorders: Update on Follow-Up Studies', *Acta Psychiatrica Scandinavica* 97 (2): 99–108.

SHEINKOPF, S.J. & SIEGEL, B. (1998) 'Home-Based Behavioral Treatment of Young Children with Autism', *Journal of Autism and Developmental Disorders* 28 (1): 15–23.

SPARROW, S.S., BALLA, D.A. & CICCHETTI, D.V. (1984) *Vineland Adaptive Behavior Scales*. Circle Pines, MN: American Guidance Service.

SZATMARI, P. & STREINER, D.L. (1996) 'The Effect of Selection Criteria on Outcome Studies of Children with Pervasive Developmental Disorders (PDD)', *European Journal of Child and Adolescent Psychiatry* 5 (4): 179–84.

VENTER, A., LORD, C. & SCHOPLER, E. (1992) 'A Follow-Up Study of High-Functioning Autistic Children', *Journal of Child Psychology & Psychiatry* 33: 489–507.

WECHSLER, D. (1989) *Wechsler Preschool and Primary Scale of Intelligence–Revised*. San Antonio, TX: Psychological Corporation.

WECHSLER, D. (1991) *Wechsler Intelligence Scale for Children–Third Edition*. San Antonio, TX: Psychological Corporation.

WEISS, M.J. (1999) 'Differential Rates of Skill Acquisition and Outcomes of Early Intensive Behavioral Intervention for Autism', *Behavioral Intervention* 14 (1): 3–22.