

Math Performance and Behavior Problems in Children Affected by Prenatal Alcohol Exposure: Intervention and Follow-Up

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ABSTRACT: *Objective:* Fetal alcohol spectrum disorders (FASD), resulting from maternal alcohol use during pregnancy, are associated with significant academic and behavior problems. Although affected children are common in clinical practice, information to guide recommendations about interventions with this high risk group is very limited. This study evaluated the persistence of effects of an intervention on the math performance and behavior of 54 children, 3- to 10-years, diagnosed with fetal alcohol syndrome or FASD. *Methods:* Children were randomly assigned to a 6-week Math intervention (n = 28) tailored to this clinical group or to a standard psychoeducational contrast group (n = 26). All caregivers received identical educational interventions to promote learning readiness and improve behavioral outcomes. In a previous study, participants were assessed before interventions and immediately following completion. In this follow-up study, participants were recontacted and reassessed at 6 months post completion to determine if positive results on math functioning and child behavior would persist after treatment discontinuation. *Results:* Focus was on 2 outcomes: (1) Math performance, assessed using standardized measures of math achievement and (2) Behavior problems as reported by caregivers on the Child Behavior Checklist (CBCL) and teachers on the Teacher Report Form (TRF). Experimental-group participants demonstrated significantly greater scores on math outcome measures than Contrast group members and CBCL and TRF behavior was improved over pretest scores in both groups. *Conclusion:* This 6-month follow-up confirms that both math skills and behavior of alcohol-affected children are improved significantly by interventions designed to meet their specific learning and behavior needs.

(*J Dev Behav Pediatr* 30:7-15, 2009) **Index terms:** prenatal alcohol exposure, fetal alcohol syndrome, math disability, behavior problems, intervention.

Since the identification, in 1973,¹ of the pattern of growth, physical features, and neurodevelopmental compromise associated with prenatal alcohol exposure, it has become apparent that alcohol-affected children have significant cognitive delays and academic problems.² In addition, many children diagnosed with Fetal Alcohol Syndrome or other Fetal Alcohol Spectrum Disorders (FASD) present with behavior disorders that require intervention.³ Until recently, despite the significance of these problems for children, parents and society,⁴ it was assumed that there is little to be done to improve outcomes for this high risk group. Both an inadequate understanding of children's specific cognitive deficits as well as lack of data on the effects of intervention with this clinical group may have contributed to this assumption. The few intervention studies currently published focus on social skill development,⁵ safety skills,^{6,7} or were carried out in South Africa within a socially deprived population.^{8,9} As a result, there is limited information, specific to this disorder that can

serve as a guide to professionals and parents in planning for educational interventions or in dealing with children's behavior problems.

As part of a multi-site, collaborative project funded by the Center for Disease Control and Prevention to stimulate intervention research with alcohol-affected children, we developed a psychoeducational program to address functional deficits in cognition and behavior that are common in this group.¹⁰ Although there were a number of areas of deficit that could have been targeted, for this study, the focus was on the poor math learning and performance that results from the effects of alcohol-related neurodevelopment deficits on cognition and behavior.¹¹⁻¹⁸

The goal of the intervention evaluated in the current study, the Math Interactive Learning Experience (MILE), was improvement of premath and mathematical skills in children, ages 3 to 10 years. The math instruction component was part of a comprehensive intervention that included caregiver education and school consultation, which were incorporated into the program to insure that all participants achieved readiness to learn before initiating math instruction. Attention was directed at providing caregivers with the tools to support children's self-regulation and to manage common behavior problems because behavior problems are common in clinically referred, alcohol-affected children.¹⁹ These *Caregiver Education* components are described in the Methods. In addition, when needed by the family, case management (e.g., trans-

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portation, social work services), and psychiatric consultation were provided.

The math-intervention program was developed to provide habilitative services targeted to the characteristics of alcohol-affected children and their needs within the learning situation. These cognitive deficiencies required a model of learning that would structure children's approach to material and compensate for visual/spatial weaknesses common in this group.¹⁹ To accomplish this goal, we incorporated several elements into the model. These included an active learning approach adapted from the "plan-do-review" methodology developed by the High-Scope Perry Preschool Project.²⁰ This methodology has demonstrated positive long-term consequences on academic achievement and educational attainment for high-risk children²¹ and has been beneficial in cognitive rehabilitation programs for children with acquired brain damage.²² Additional important elements included an individually-paced curriculum, which allowed a slower pace of instruction if necessary, manipulables and visual aids to support learning math concepts, immediate feedback regarding patterns of errors, and mediation of the experience to improve integration of information. Finally, to compensate for deficits in graphomotor skills^{23,24} that can interfere with math performance, we used materials from an existing program "Handwriting without Tears"²⁵ and adapted writing materials to target skill deficits among participants.

Participating families were assessed within a month of the completion of this math intervention¹⁰ and, although the MILE program lasted only 6 weeks, children randomized to the math treatment condition demonstrated greater gains on standardized tests than the comparison sample who received standard psychoeducational care through their school systems. To demonstrate that these differences were also clinically significant, we examined the extent to which children improved performance by at least one standard deviation on one or more of the outcome measures and found that those in the math treatment group were more likely than controls to make a clinically significant gain. At this evaluation, caregivers rated children's behavior for comparison with that reported before the intervention started. These data indicated that, in addition to improvements in math performance, children demonstrated fewer behavior problems. This result suggested that caregivers had been able to use knowledge gained at workshops on neurodevelopmental consequences of FASD, advocacy and behavioral management techniques in managing child behavior.¹⁰ These short-term outcomes suggested that targeted educational interventions were helpful in habilitating children with FASD.

Although, these results were encouraging, questions remain that are important in planning treatment and educational interventions for children with FASD. First, it is important to know whether improvements in children's math performance and behavior can be main-

tained over a period of time. It would not be surprising to find that a limited intervention had immediate beneficial effects that did not persist. A second question concerned the reports by caregivers of significant improvements in behavior. These improvements in behavior were reported for both the children in the math group and those who were randomized to the contrast condition. As both math group and contrast group caregivers participated in educational workshops, changes could be attributed to the effects of this training, including caregivers' increased knowledge of the disorder and of methods for managing child behavior; however, the changes could also be the result of a positive bias on the part of the caregivers who may have viewed children in a more positive light after participation in the study or who wished to cooperate with the experimenters (thus, a "demand characteristic" of the study). Given these remaining questions, we conducted a 6-month follow-up study with participating families to evaluate the following:

1. *Do effects of the math intervention persist after the end of active treatment?* We hypothesized that children randomly assigned to the math treatment would continue to demonstrate greater maturation in math skills as compared to children who received standard psychoeducational services during the same period;
2. *Are behavioral changes noted by caregivers persistent and are they observed in multiple settings (i.e., home and school).* This question was examined by obtaining input from children's teachers as well as from caregivers regarding children's current behavioral functioning. Information from a second source, such as the child's teacher, could clarify whether changes in child behavior were real and persistent or only perceived (or reported) by caregivers. In this 6-month follow-up, we hypothesized that the learning readiness components of the intervention program would be maintained in the form of improved parental and teacher perceptions of behavior as compared to pre-intervention (baseline) levels. If, at 6 months after the completion of the program, we are able to demonstrate consistent gains in performance of math skills as well as confirm reports of behavioral improvement, it would provide evidence that targeted interventions of this kind are effective in working with alcohol-affected individuals and their families.

METHODS

Participants

Children and caregivers were recruited from those who participated in the initial intervention study.¹⁰ In that study, children between the ages of 3 and 10 years with fetal alcohol spectrum disorders and their caregivers were recruited from the Atlanta metropolitan area, the majority from a multidisciplinary diagnostic clinic serving alcohol- and drug-exposed children. Clinic fami-

lies whose children qualified for the study were identified under a Health Insurance Portability and Accountability partial waiver. They were informed about the study by mail and asked to volunteer. In addition, children were recruited from the community through notices placed in local papers, mailings to school systems, pediatricians and developmental pediatricians, and talks at local meetings by study staff. Children were not eligible for the study if they had an IQ score <50, were diagnosed with mental health problems that would interfere with learning (i.e., autism, conduct disorder), or were not in a stable placement (i.e., with the same caregiver for 6-months and expected to remain there for the next 6-months). A previous diagnosis of Attention Deficit Hyperactivity Disorder was not an exclusionary criterion.

Overview of Procedures

After an initial screening, qualifying guardians completed a consent procedure approved by the Institutional Review Board of the Emory University School of Medicine and signed an informed consent document for their own and their children's participation (Fig. 1). Caregivers provided consent to contact children's teachers. Participants were required to have a clinical diagnosis of fetal alcohol syndrome (FAS) or partial FAS³ or significant levels of alcohol-related dysmorphology using a dysmorphia checklist²⁶ administered by a pediatric geneticist. In this Checklist, characteristics associated with FAS are listed and weighted based on their saliency for the diagnosis (e.g., hypoplastic philtrum is a "3"). The Checklist has been evaluated repeatedly as part of longitudinal research studies from birth to adolescence with individuals prenatally exposed to alcohol receiving higher total scores in comparison to nonexposed controls.^{26,27}

In order to establish "readiness to learn" in children, caregivers attended 2 workshops, the first to educate

parents about FAS and the neurocognitive impact of this disorder and to provide information about special education and methods for advocating for children, and the second to provide training on supporting behavioral regulation in children. The parent workshops were conducted by the investigators or graduate students in clinical psychology. Caregivers also were given an informational manual elaborating workshop content to use at home. In addition, case management and psychiatric consultations were made available to all participants throughout the intervention period based on participant need.

Math Intervention

After they completed 2 workshops, families were randomized to either the math intervention group or the standard psychoeducational treatment contrast group. Standard psychoeducational treatment consisted of a comprehensive neurodevelopmental evaluation and assistance with educational placement and development of the individualized educational plan within the context of their home school. In addition to these services, those in the math intervention group received 6-weeks of tutoring services. For individuals functioning from a kindergarten to a third grade level, the curriculum used was adapted from the High Scope Curriculum Series²⁸ but modified for individualized instruction. The preschool curriculum was developed separately by a staff special educator to parallel the instructional format adapted from the High Scope Curriculum. Caregivers in the math group also received individualized instruction in supporting math learning at home and weekly home assignments to complement the child's individualized tutoring sessions. Our project's special educator also met with the teachers of children in the math group to discuss the alcohol-related neurodevelopmental problems the participant had and the individualized educational goals for the program.

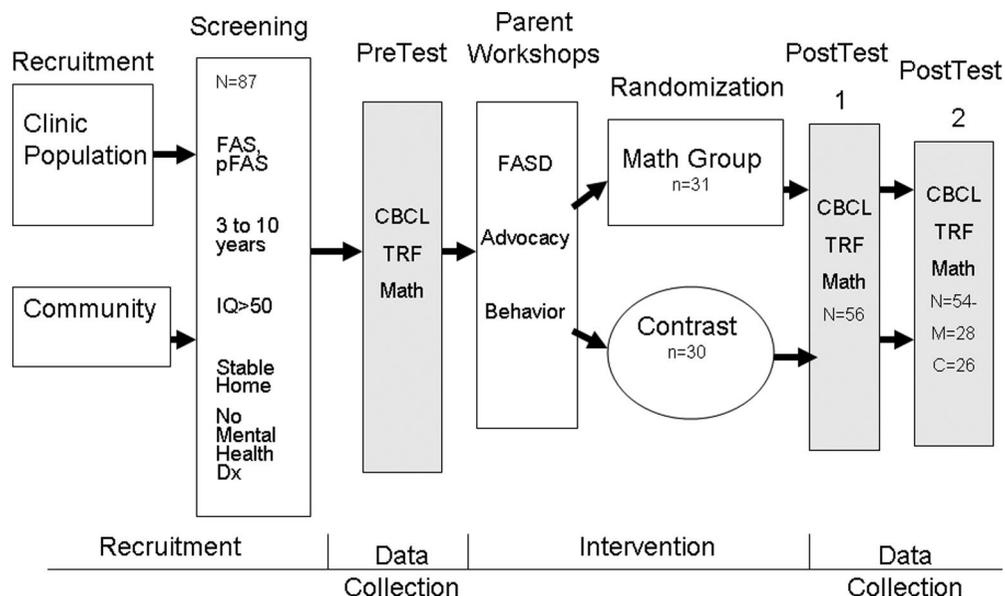


Figure 1. Schematic representation of the MILE research methodology including recruitment, data collection points and intervention.

Assessment Procedures

On enrollment and before the Parent Workshops, all children received a neurodevelopmental evaluation to guide educational planning and their caregivers completed behavior and demographic questionnaires. At the same time, questionnaires were sent to children's teachers and returned by mail. The children's evaluation included assessments of (1) cognitive functioning using the Differential Ability Scales;²⁹ (2) graphomotor functioning using the Beery-Buktenica Developmental Test of Visual Motor Integration³⁰ and (3) visual attention skills using the Nepsy.³¹ The pretest also included math measures that were later used in outcomes studies.

The longer-term outcome study reported here was conducted 6 months following the initial outcome study, which was scheduled within 4 weeks of completing the tutoring program. In order to control for time between assessments, a participant in the standard psychoeducational group (contrast group) was assessed in the same week as a participant in the math intervention group. Children were evaluated by a psychologist or psychology trainee blind to group status. Caregivers completed questionnaires and a structured interview while their child was being assessed. Teachers were sent questionnaires and these were returned by mail. Due to the passage of time, the Post Test 2 teacher was usually not the same person who returned the questionnaire at pretesting and only 74% of teachers returned questionnaires.

Satisfaction

At the completion of the program, caregiver experience was assessed using Likert scale responses to questions regarding their experiences with the specific treatment components of the program and overall satisfaction with the program.

Behavioral Outcomes

To measure caregivers and teacher perception of the children's behavior, the Child Behavior Checklist and the Teacher Report Form, respectively, were administered.^{32,33} The questionnaires include 100 problem behaviors that are rated as "not true," "sometimes true," or "very true" to derive T-Scores with a mean of 50 and standard deviation of 10 points. Items are clustered into subscales, which are then aggregated into summary scores, with higher scores reflecting more behavioral disturbance. An overall Total Problems score is reported as well as summary scores for Internalizing and Externalizing Problem Behaviors. Two versions of each questionnaire were used; those for children 1 ½ to 5 years, and for 5 to 17 years.

Academic Outcomes

For the 6-month follow-up (Post Test 2), we repeated the same measures of math achievement used before the intervention (Pretest) and in the immediate follow-up (Post Test 1). All children were administered the Test of Early Mathematical Ability, second edition,³⁴ a standardized test for assessing early mathematical development, and selected math related subtests from the Bracken Early Concept Scales Revised.³⁵ For children 5 and over,

the Key Math-R/NU,³⁶ a standardized test measuring several distinct areas of mathematical concepts, was also administered. Parallel forms of the KeyMath-R/NU were used to minimize practice effect. For children under 5 years, developmental testing of premath concepts such as more/less, same/different, intuitive numbering, conservation, and sequential organization of objects along intensity and magnitude was conducted. This measure was adapted from math concepts administered as part of the Bayley Scales of Infant Development, second edition.³⁷ Finally, the quality of number writing was assessed in all the children using an instrument developed as part of this study (The Number Writing Task³⁸). The instrument consists of 7 items that assess order, orientation, neatness, consistency, and general recognizability of the numbers.

RESULTS

Group Characteristics

Eighty-seven participants were consented initially and enrolled in the study but only 61 (70.11%) completed study requirements needed before randomization to one of the intervention groups. Of these, 56 completed Study 1 post testing and 54 participated in Study 2 post testing. The math group had 3 drop-outs. Two of the children dropped out before completing the intervention, 1 because of removal from the home by child protective services and the second, because the caregiver found keeping the appointments impossible due to travel and the care of another child. One participant in the math group failed to attend Post Test 2 but teacher data on the child's behavioral functioning was obtained. Within the contrast group, 3 families failed to return to either follow-up study or 1 failed to return to Study 2 only. Teacher data on behavioral functioning was obtained on 2 of these individuals for Study 2. Thus, at the 6 months follow-up we were able to evaluate 90.3% of the math group and 86.7% of the psychoeducational contrast group. The average duration between PreTest and Post Test 2 was about 13 months (Math Group: 403.5 [std = 51.7] days; Contrast group: 404.5 [std = 58.6]). There were no group differences in retention or time between testing.

Characteristics of participants in Study 2 are shown in Table 1. Comparisons yielded only 1 group difference, significantly lower birth weight in the math versus the contrast group.

Program Satisfaction

At 6 months following the completion of the intervention, caregivers in both the math intervention and contrast groups rated the overall Math Interactive Learning Experience program as being informative (Math: 96.0% math; Contrast: 95.7%) and helpful (Math: 96.0% Contrast: 91.3%) and over 80% from each group would recommend the program to others (Math: 80.0%; Contrast: 86.4%). Both groups reported that the program

Table 1. Characteristics of Sample (n = 54)

Variable	Groups		p
	Math n = 28	Psychoeducational Contrast n = 26	
Gender (% male)	57.1	65.4	ns
Child age at enrollment in years: M (SD)	6.5 (2.0)	6.2 (2.0)	ns
Primary caregiver age in years: M (SD)	43.9 (7.2)	44.7 (8.4)	ns
Race (% white)	64.3	50.0	ns
Custody (% adopted-non relative)	71.4	65.4	ns
% with two caregivers	71.4	57.7	ns
Number of adults in home	2.0 (.6)	1.7 (.5)	ns
Number of children in home	1.8 (1.7)	1.7 (1.8)	ns
Rank of gross household income (6 = 35,000–49,999)	6.5 (2.5)	6.2 (2.1)	ns
Dysmorphia score ^a	16.2 (6.7)	14.7 (7.3)	ns
Birth weight (g) (n = 50)	2159.2 (754)	2671.0 (951)	.039
Birth length (cm) (n = 39)	45.5 (6.6)	47.3 (4.7)	ns
Birth head circumference (cm) (n = 38)	32.0 (5.5)	32.6 (2.8)	ns
DAS ^b general cognitive ability	81.6 (12.3)	81.3 (14.7)	ns

^aThe Dysmorphia Score is the sum of the 30 weighted items on a standard pediatric dysmorphia checklist²⁸ used to identify alcohol-related dysmorphic features, where characteristics associated with the disorder are listed and weighted based on their saliency for the diagnosis (e.g., hypoplastic philtrum is a "3") and scores of greater than 10 are assumed to indicate alcohol-related dysmorphology. ^bDAS refers to the Differential Ability Scales.²⁹ Performance is measured using standard score that has a mean of 100 and a standard deviation of 15 points.

improved their knowledge of fetal alcohol syndrome (Math: 88%; Contrast: 91.3%), behavioral regulation skills (Math: 80%; Contrast: 78.3%), and advocacy (math: 72.0%; Contrast: 82.6%). There were no significant differences in these responses. More parents of children receiving math instruction and parental training for math stimulation felt that the program improved their ability to help their child study (Math: 80.0%; Contrast: 69.6%) and their child's study habits (Math: 60.0%; Contrast: 43.5%). Caregivers in the math group also were more likely to agree that they were empowered to ask for services for their child (Math: 80.0%; Contrast: 69.6%) but none of these group differences were statistically significant.

Math Treatment Effect

There was a range in children's ages and because of the necessary differences in the methods for assessing

math functioning, overall math development was determined by combining the raw scores (Table 2) of the Test of Early Mathematics,³⁴ selected math subtests from the Bracken Basic Concept Scale Revised,³⁵ and the Number Writing Task³⁸ using a principal components analysis with a varimax rotation. A math development factor was generated for the pretest that accounted for 92.7% of variance between math measures and for the 6-month post-test that accounted for 91.3% of variance. A multivariate analysis of covariance was then done on the Post Test math functioning scores. After controlling for math functioning before the intervention (Pretest) and overall intellectual ability, significantly higher gains were made by those in the math intervention group than by those in the psychoeducational group ($F(1,51) = 5.4, p < .02$, partial eta squared = .095). As was done previously, the clinical significance of these gains was explored by evaluating gain on the individual outcome measures. Such

Table 2. Raw Scores on the Various Math Outcome Measures by Group and Time

Variable	Math		Psychoeducational Contrast	
	Pretest	Post-Test 2	Pretest	Post-Test 2
Supplemental math ^a	8.3 (3.1)	15.3 (2.5)	8.0 (2.1)	11.8 (4.7)
Math subtests of Bracken	66.8 (6.0)	80.8 (4.9)	60.4 (6.2)	71.0 (5.1)
Test of Early Mathematics	23.0 (14.6)	30.1 (13.4)	20.7 (17.2)	27.2 (17.5)
Keymath ^b	32.9 (18.6)	48.9 (26.2)	31.1 (25.7)	46.7 (32.7)
Number Writing Task	24.2 (11.8)	28.3 (9.4)	22.1 (11.4)	23.8 (10.9)

^aFour participants from the math group and 6 participants from the psychoeducational contrast group received the Supplemental Math measure. ^bTwenty-one participants from the math group and 16 participants from the psychoeducational contrast group received the KeyMath measure.

gain was defined by performance at one and a half standard deviation units above the mean of the group. In this analysis, those in the math intervention group had more clinically significant gains from pretest performance (68.4%) than did those in the contrast group (38.5%, $X^2(1) = 3.6, p < .05$). Among the math treatment group, 25.0% made a clinically significant gain on 2 or more math measures and 39.3% made a gain on 1 measure as compared to 16% and 24%, respectively, of the contrast group (Table 2).

In addition, we examined these outcomes in comparison to those seen at the first post test which occurred immediately following the intervention to determine whether the improvements seen at that time were attenuated over the intervening months. These results are shown in Figure 1. Contrary to expectations, results were maintained and even, slightly, better than at the previous time point although the interaction of time of assessment and intervention group status did not reach significance ($F(1,46) = 1.7, p = .2$). It should be noted that both groups of children show change on these developmentally sensitive measures (Fig. 2).

It would be very helpful to understand which children were more likely to benefit from the intervention. Accordingly, an exploratory analysis of factors associated with treatment gain was done on a post hoc basis. In the math treatment group, those who made treatment gains were more likely to be younger (7.0 vs 8.7 $F(1,27) = 5.2, p < .03$) and have primary caregivers who were younger (41.8 vs 47.7, $F(1,27) = 4.9, p < .04$). There was a trend for those who made treatment gains to have more adults (2.1 vs 1.7, $F(1,27) = 3.6, p < .07$) and more children in the family (2.2 vs 1.0, $F(1,27) = 3.1, p < .09$). Gender had no impact on treatment outcome and there were no significant differences in the child's television viewing time, neurocognitive outcomes, including IQ scores, visual motor integration skills, or attentional skills, or in household income. Among the entire sample, those who made gains had significantly higher levels of alcohol-related dysmorphia than those who did not (17.9 vs 12.8, $F(1,54) = 8.3, p < .006$).

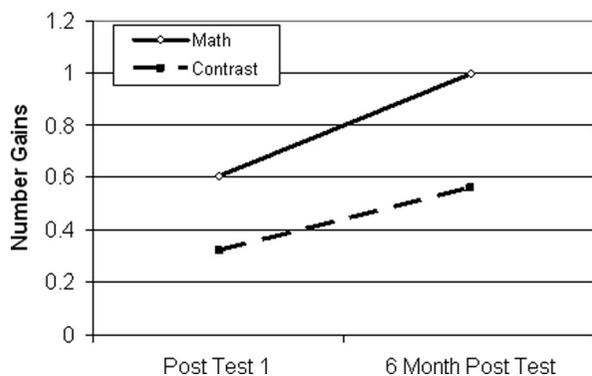


Figure 2. Average Number of Clinically Significant Gains by Intervention Group. Children randomized to the Math Condition show persistent gains on outcome measures over those in the Standard Psychoeducational Contrast group.

Readiness to Learn Outcomes: Behavior Problems

To evaluate the persistence of improvement in behavior, multivariate repeated measures analysis of variance was carried out on the pre and post intervention questionnaires collected from parents and teachers separately. Among the teachers, despite repeated requests, 8 of 29 did not complete the questionnaires in the Math group and 7 of 28 in the Contrast group, yielding 21 in each group which is an overall response rate of 74%. Within subject factors were behavioral measures from the Child Behavior Checklist (CBCL) and the Teacher Report Form (TRF) (internalizing, externalizing, and total problem behavior scales) and time (Pretest and Post Test 2). Treatment group (Math or Contrast) and age group (3-5 vs 6-9), to control for the different versions of the CBCL and TRF, were included as between subjects factors in the model. Caregiver responses on the CBCL indicated a significant multivariate reduction in behavioral disturbance across age groups and behavioral measures ($F(1,46) = 37.98, p < .000$; eta-square $d = .452$). Similarly, teacher responses on the TRF indicated a significant reduction in behavioral disturbances across age groups and behavioral measures ($F(1,38) = 5.40, p < .026$, eta-square $d = .124$). There were no significant effects for treatment group (that is, Math vs Contrast group) suggesting that the increased level of educational service and consultation with teachers in the Math group did not result in differential changes in parent or teacher perceptions of the children's behavior above that obtained from the Caregiver Education workshops and from participation in the study. For both groups of respondents, a significant multivariate interaction effect was found between time and age group (parent- $F(1,46) = 3.83, p < .056$, eta-square $d = .077$; teacher- $F(1,38) = 3.85, p < .057$, eta-square $d = .092$). Post hoc comparisons found that children ages 3 to 5 ($n = 13, 31\%$) had a greater reduction in behavioral disturbance than did those in the older age group ($n = 29, 69\%$) (Parent-6.91 vs 3.58; teacher-5.56 vs .05). Mean group differences are shown in Table 3. In a post hoc, exploratory analysis we examined which of the individual behavior problem scales making up the CBCL and the TRF summary scores showed changes following parent training. Only 4 of the individual scales are consistent between the younger and older forms so only the following scales could be evaluated: Anxiety/Depression, Somatic Problems, Aggression and Attention Problems. None of the individual scales on the TRF showed significant effect despite changes on the summary scores (Table 3); In contrast, on the CBCL, significant effects were noted on Somatic Problems (Pretest-Post Test 1, $t(54) = 2.49, p < .02$; Pretest-Post Test 2, $t(49) = 3.38, p < .001$), Attention Problems (Pretest-Post Test 1, $t(54) = 3.65, p < .001$; Pretest-Post Test 2, $t(49) = 4.75, p < .000$), and Aggression (Pretest-Post Test 1, $t(54) = 3.55, p < .001$; Pretest-Post Test 2, $t(49) = 5.37, p < .000$, and Post Test 1-Post Test 2, $t(49) = 2.04, p < .05$). For Somatic and

Table 3. Outcomes: Comparison of Parent/Caregiver and Teacher Responses at Pre and Post Test 2

Variable	Preschool		School-Age		All Ages	
	Pretest	Post-Test 2	Pretest	Post-Test 2	Pretest	Post-Test 2
CBCL ^a –total problems	64.0 (10.2)	57.4 (10.9)	68.2 (7.7)	64.2 (7.6)	66.1 (9.2)	60.8 (9.9)
CBCL ^a –internalizing problems	61.0 (11.3)	54.6 (11.7)	60.4 (10.7)	57.6 (10.2)	60.7 (10.9)	56.1 (10.9)
CBCL ^a –externalizing problems	64.1 (11.7)	56.5 (11.1)	67.0 (6.9)	62.7 (8.0)	65.6 (9.6)	59.6 (10.1)
TRF ^b –total problems ^c	61.3 (8.9)	56.3 (7.8)	63.1 (9.4)	62.7 (10.7)	62.6 (9.2)	60.7 (10.3)
TRF ^b –internalizing problems ^c	59.0 (9.7)	51.2 (10.1)	54.2 (12.3)	53.2 (12.0)	55.7 (11.7)	52.6 (11.4)
TRF ^b –externalizing problems ^c	61.7 (7.1)	57.4 (7.9)	60.7 (10.4)	60.7 (11.0)	61.0 (9.4)	59.7 (10.1)

TRF, Teacher Report Form; CBCL, Child Behavior Checklist. ^aAverage T-scores from the Parent Report Form of the Achenbach Child Behavior Checklist.^{32,33} ^bAverage T-scores from the Teacher Report Form (TRF) of the Achenbach Child Behavior Checklist.^{27,34} ^cNote the percentage of teachers responding for the Math group (72%) and the Contrast Group (75%).

Attention Problems, significant effects were seen by the first post test; however, Aggression levels declined at Post Test 1 and continued to decline.

DISCUSSION

Although it has become clear that fetal alcohol spectrum disorder (FASD) occurs frequently and, in many cases, leads to significant neurodevelopmental compromise, there has been limited attention to developing methods for improving children's educational and behavioral outcomes. Indeed, a recent comprehensive review³⁹ of the literature on interventions for children with FASD yielded only 10 papers of which only 3 could be described as experimental. The current study is a 6-month follow-up of an intervention targeted at improving behavior and preacademic and academic (specifically math) functioning in children ages 3 to 10. Information on study characteristics and immediate outcomes has been published previously.¹⁰ The current study provides evidence that the initial results were not transitory as might be a concern for such a short-term intervention. In addition, this study adds information collected from children's teachers about child behavioral outcomes to that provided by their caregivers to demonstrate that changes in behavior can be observed in more than 1 setting. These results support the argument that a targeted psychoeducational program can be effective in remediating academic deficits associated with prenatal alcohol exposure. In addition, it appears that providing parents with appropriate tools for working with their children can result in significant improvement in child behavior in both home and school; however, conclusions about improvement in behavior are more tentative than those about improvements in math since, for this part of the study, a pretest-post test design was used and there was no randomized contrast group.

The methods used in this program were adapted from those used with other high risk children and families. In choosing materials and curriculum, we kept in mind the need for a practical application because, ideally, methods of this kind could be used daily in schools and special education programs to support the learning of alcohol-affected children. For instance, all the teaching

materials used in the tutoring sessions were inexpensive and easy to acquire. Parents were taught how to enrich the math environment at home using everyday materials and games. While the one-on-one instruction of the children requires time, we were able to effect significant changes in learning and behavior with an intervention that totaled to less than 20 hours of direct instructions for both children and caregivers combined. Such an investment in young children and their caregivers is certainly feasible in both clinical and educational settings.

This study is an initial step in examining the response to treatment in alcohol-affected individuals. It has a number of limitations. The treatment effect (eta-squared) while significant and significant over time, is in the moderate range. It is certainly likely that, if we were able to provide a longer and more intense instructional intervention, that we could demonstrate a more comprehensive effect on children's academic functioning. It is also possible that the effectiveness of these methods is not specific to children affected by alcohol. Rather, it may be that most children with learning problems would benefit from tailored, individualized instruction of this type. Exploring any differences in response to intervention among different disability groups would be an excellent future study. Another limitation is that it is evident that the sample is self-selected to some degree. First, the majority of the sample was recruited from a diagnostic clinic, so that we cannot be sure that we would observe the same results in a nonclinical population. Secondly, a number of those recruited originally did not complete the prandomization protocol and, therefore, did not become part of the intervention study. It is likely that those who did not complete the process were caregivers who were not as highly motivated or who had fewer social and personal resources than those who persisted in the study. Since the involvement of parents is probably of central importance in positive outcomes for these young children, we cannot generalize these results to families without the same degree of commitment to the treatment process.

In carrying out this study and analyzing the results, a number of other issues were brought to our attention. As

noted in Results, it was evident in the exploratory analysis, that certain characteristics of the group were associated with more gains following the math intervention. These included the child's age (younger children showed more gains than older), caregiver's age (children of younger caregivers showed more gains), and being in a larger family (children in two-parent families showed more gains). Interestingly, children showing more physical effects of alcohol (higher dysmorphia scores) were more likely to make gains, a finding that is consistent with that of Streissguth et al⁴⁰ in another clinical sample. In contrast, ability level (IQ), and socioeconomic status were not factors contributing to improvements in outcome. Some of these results may be sample specific. For instance, children living with older grandparents may not have improved as much as those with younger (and more energetic) adoptive parents. In contrast, it is logical to assume that this particular intervention may be more suited to younger children and children who are more affected by alcohol exposure. It is also possible that older children, many of whom have a history of school failure and frustration with academics, may be less open to change over the limited intervention period. Future research should be directed at identification of such treatment modifiers.

In examining the changes in behavior noted over time on the Child Behavior Checklist and the Teacher Report Form, we were able to evaluate some of the subscales on these measures. For the majority of the subscales, parents reported the most significant behavior changes by Post Test 1 although aggressive behavior continued to decline over time and showed a significant difference between Post Tests 1 and 2. For teachers, perhaps because of the smaller sample size, only the summary scores (Externalizing) were significantly different. These conclusions about the areas in which behavior improved, while tentative, are consistent with our clinical observations of improved behavior and better caregiver/child relationships following intervention. Further exploration of these improvements in behavior would be valuable because alcohol-affected children have been reported to be difficult behaviorally and resistant to change.

It is encouraging that this second assessment of outcomes demonstrates a persistent effect of the intervention. We hope that this change in functioning indicates that the children in the math group acquired basic skills that will serve as a foundation to future learning in this area. In addition, the behavioral changes noted by both caregivers and teachers demonstrate that empowering caregivers with knowledge about the neurodevelopmental implications of FASD, providing them with the tools to work with the systems that they encounter, and methods for managing children's behavior can have very positive results.

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