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ABSTRACT

The degree to which intellectual development can be enhanced by systematic early educational intervention, and the relative power of early versus later intervention as a preventive measure against mild retardation and academic failure, were the central issues tested in the Carolina Abecedarian Project. The project was designed for infants and children from socioeconomically disadvantaged families. It provided interventions at the preschool and primary school levels. A day care center provided direct instruction to infants and children and educational materials to parents. Parents used the materials at home with their children to supplement the primary school curriculum. Participants were 109 families of children who were free of conditions known to have genetic or infectious links to mental retardation and who came from homes with low levels of parental income and education or histories of social maladjustment. Duration and type of intervention were systematically varied. Each high-risk subject was matched with a same-sex child in his or her class. Findings demonstrated that early educational intervention could significantly benefit children at high risk for academic failure. Results suggest that intervention should begin in infancy. Children who appear to benefit most are those of mothers with very low intelligence. A total of 33 references are cited. (RH)

PRESCHOOL VS. SCHOOL-AGE INTERVENTION FOR DISADVANTAGED CHILDREN: WHERE SHOULD WE PUT OUR EFFORTS?

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Two generations ago, intellect was believed to be genetically fixed and immutable, but it is now widely accepted that intellectual development is to some degree malleable. Substantial recent evidence also exists to link environmental factors to borderline intelligence and mental retardation (Bradley, Caldwell, Rock, Ramey, Barnard, Gray, Hammond, Mitchell, Gottfried, Siegel, & Johnson, 1989). If intellectual level is subject to change through environmental manipulation, it follows that prevention of some forms of mental subnormality may be possible through environmental means. This should be especially true for mild mental retardation because, for the majority of individuals who are labelled mildly retarded, no known genetic anomaly or biological dysfunction can be identified as an underlying cause. It is therefore logical to suppose that a developmentally supportive environment might be a powerful mechanism for effecting positive intellectual or cognitive growth.

The degree to which intellectual development can be enhanced by systematic early educational intervention, and the relative power of early versus later intervention as a preventive measure against mild retardation and academic failure were the central questions experimentally tested in the Carolina Abecedarian Project, a program designed for infants and children from socioeconomically disadvantaged families.

The so-called "culture of poverty" is implicated in the development of intellectual subnormality because of the overrepresentation of retarded individuals

among the poor. Children from poor families are more likely to experience failure in school, and also more likely to be labelled as retarded and placed in special education classes. In earlier attempts to improve the chances that such children would succeed in school, large scale, intensive educational interventions, such as Head Start, were mounted. When the results of these early efforts failed to meet expectations for substantial and permanent positive changes, scientists speculated that perhaps the intervention came too late in the child's life and therefore missed critical developmental periods for enhancing cognitive growth. This argument was based on theories of J. McVicker Hunt (1961) and Benjamin Bloom (1964), both of whom postulated that early experience strongly influenced the rate and ultimate level of intellectual development, and that for maximum effectiveness, attempts to effect change in cognitive development should begin in infancy.

In the early 1970's the Mental Retardation Branch of the National Institutes of Child Health and Human Development granted funds to the Frank Porter Graham Child Development Center at the University of North Carolina to carry out a prospective, longitudinal study of early educational intervention. This study was to be a rigorously controlled experimental test of the efficacy of such intervention, if begun in infancy, for children from low-income families. From the outset it was a multi-disciplinary program, involving researchers from developmental psychology, pediatrics, special education, and psycholinguistics.

One of the key features of the project was random assignment of subjects to treatment and control groups. This feature was important because some previous studies of educational intervention with poverty families had treated only volunteer subjects, leaving open the question of a possible systematic bias from having intervened with children whose parents specifically sought educational experiences for them.

The Abecedarian preschool intervention was child-centered, that is, the children attended a day care center where they were directly taught by the staff; their parents were not provided with extensive preschool educational materials to use at home nor offered systematic job training or parenting classes. Children attended the daycare center until they were ready to enter public school kindergarten at age five. To increase confidence that developmental outcomes were attributable to the intervention itself, efforts were made to assure comparability of such factors as nutrition during the first year of life, medical care, and supportive social work services in both groups.

A second phase of intervention began when the children entered public school. The school-age phase more directly involved the parents in the intervention because its focus was on having the early elementary school curriculum supplemented through the use of educational materials designed to be taught to children in their homes by their parents. This phase continued for the first three years in elementary school. An endpoint evaluation took place when the children had completed the three years, and were approximately eight years old. The primary outcome variables were the children's scores on tests of intellectual development and academic achievement. There were also teacher ratings of classroom behavior and parent ratings of social adaptation and problem behaviors.

METHOD

Design

The design of the preschool study called for two equivalent groups of children. Because subjects were assigned to groups at or even slightly before birth, the basis for equating them had to be family demographic factors, including scores on a High Risk Index (HRI; Ramey & Smith, 1977). The subjects were randomly assigned in infancy either to the educational day care Intervention group (I) or to

the preschool Control group (C). There were four cohorts of subjects born in the years between 1972 and 1977.

Before entry to public school kindergarten, the Intervention and Control groups were re-randomized by equating pairs of children within groups on the basis of their Stanford-Binet IQ at 48 months, and then assigning one of each pair to a school-age intervention and the other to a school-age control group. Thus, half of each preschool group received the school-age intervention program. The resulting 4-cell design permitted a comparison of outcomes in children who had a total of 8 years of intervention, 5 in preschool and 3 in early elementary school (II), 5 years of intervention in preschool only (IC), 3 years of school-age intervention only (CI), and no educational intervention at all (CC).

In addition to the four school-age groups of high-risk children, each high-risk child had a same-sex, same-classroom match child randomly chosen for each of the three years in early elementary school. This cross sectional sample of children provided a local population sample to serve as a basis for comparison for levels of accomplishment in the high risk children.

High Risk Index

The High Risk Index (HRI) used to screen subjects for eligibility is given in Table 1. The HRI included factors previously reported in the literature to be associated with mild mental retardation and academic failure, such as low levels of parental education, low family income, and evidences of retardation or social maladjustments in family members. These factors were assigned weights according to consensual estimates of their importance, and a family's total score was the sum of applicable weights earned. A family had to score 11 points or more on the High Risk Index to be included in the study.

Insert Table 1, HRI

Prenatal clinics and social service agencies identified families who appeared likely to qualify for the study. These families were then visited by a member of the Center's staff who explained the project. A final determination of eligibility was made after the mother visited the Center where she was again interviewed and administered an intelligence test, either the Wechsler Adult Intelligence Scale or the Wechsler Intelligence Scale for Children, depending on her age.

Subjects

All children in the sample were full-term infants free from conditions known to have genetic or infectious links to mental retardation, but all were from homes with low levels of parental income and education, and/or histories of social maladjustment of one kind or another. A total of 122 families were invited to participate in the study; 109 families to whom 111 children were born enrolled, accepted their random group assignments, and took part. By the beginning of the elementary school phase, attrition had reduced this number to 96 children. Of these, 90 had IQ data collected at the end of three years in public school and 88 had scholastic achievement test data. Using the figure of 90 as the final sample size gives an attrition rate of 18.9%, or 1.46% per year over the thirteen year span from entry of the oldest subjects until the youngest reached the eight-year-old endpoint.

Table 2 shows selected demographic characteristics of the mothers in the study at the time of the child's birth. As may be seen in this Table, the mean High Risk Index score in both groups was well above the minimum 11 points needed for inclusion. The mothers tended to be young, to have less than a high school education, and to be single parents. Maternal ages ranged between 13 and 43; approximately 1/3 of the mothers were 17 years old or younger when their children

were born. Maternal IQs ranged from 49 to 124, with the mean falling at approximately 85 in both groups. Ninety-eight percent of all subjects were racially Black although race was not considered a risk factor on the High-Risk Index. The high proportion of Blacks reflects the demographic characteristics of the University town where the study was conducted. Almost no qualified Caucasians could be found within a distance that made participation feasible. (Subject families had to live within commuting distance of the Center to allow the child to attend the day care program.)

Insert Table 2 - Entry Demographics

Preschool Intervention

Infants in the preschool Intervention group could begin attending the Center as young as six weeks of age; mean age at entry was 8.8 weeks. The infant nursery accommodated up to 14 babies and was staffed by four caregivers. Curriculum materials to enhance cognitive, language, perceptual-motor, and social development were devised by Sparling and Lewis (1981) for use in this program. The items were assigned to children based on the curriculum developers' and teachers' assessments of the child's needs, and changed as the infant appeared to be ready for new challenges. These activities were fit into the child's daily schedule as natural events while infants paced themselves through the day. Toddlers likewise had flexible schedules for activities and nap times.

The preschool program became increasingly structured as children grew older. The classrooms for three- and four-year-olds resembled other high quality preschool programs, with centers for housekeeping, blocks, water play, books, art, and quiet corners for 1:1 teaching or solitude. Cooking and carpentry activities helped to teach a variety of concepts (Harms, 1980). Other curricula for older

preschoolers included the GOAL Math program (Karnes, 1973), the Peabody Early Experiences Kit (Dunn, Chun, Crowell, Dunn, Alevy, & Yachel, 1976), Bridges to Reading (Greenberg & Epstein, 1973), Pre-phonics training (Wallach & Wallach, 1976), and My Friends and Me (Davis, 1977).

Because a number of theorists have held that deficits (Blank, 1982; Tough, 1976) or differences (Labov, 1970; Heath, 1983) in the early language environments of disadvantaged children fail to prepare them for success in mainstream public schools, a special emphasis was put on language development in the Abecedarian Project. Teachers were extensively trained to make sure their verbal exchanges with the children were predominantly of the "informing/eliciting" type, rather than being orders and directives given by the adults to the children (McGuiness & Ramey, 1981).

Preschool Outcomes

A number of basic scientific questions regarding early development in general and development within this cultural subpopulation in particular were addressed as part of the preschool program. For example, studies of language development, health, mother-child interaction, and of young children's attachment to parents and daycare teachers were conducted, to name but a few. However, because the central question being addressed was that of the malleability of intellectual development, the children's performance on standardized tests of intellectual development provided the primary outcome measure for assessing the effectiveness of the intervention.

The outcomes from the preschool intervention have been reported in previous papers and will not be repeated here beyond saying that on standardized tests of intellectual development the treated children significantly outperformed the control children at every testing occasion after the infancy period through the preschool endpoint assessment, which occurred when children were 54 months of

age. On the McCarthy Scales of Children's Abilities (McCarthy, 1972) administered to children at 54 months, the Intervention group children's mean General Cognitive Index score was 101, 10 points higher than that of the Control group children's mean score of 91 points ($t = 4.00, p < .001$). Moreover, by the age of four years, children in the Control group were 6 times more likely to score within the mildly retarded range (IQ < 70) than were children in the Intervention group (Ramey & Campbell, 1984). The investigators made strong efforts to assure that the Intervention group children were not "taught the tests" upon which these outcomes were based. Tests were administered by persons not otherwise involved in the planning or delivery of the intervention program. Young children were tested with their parents present, not their teachers. Teachers were not allowed to see testing procedures, and were never given specific feedback about test results.

School-age Intervention

The Carolina Abecedarian Project is not alone in having demonstrated that children from socio-economically disadvantaged families, if given early educational intervention, outperform untreated controls on intelligence tests. However, many investigators have also reported that early intellectual gains failed to hold up once such children left intervention programs and entered public school (e.g., Lazar, Darlington, Murray, Royce, & Snipper, 1984) or that IQ gains were not reflected in greater academic achievement (Baroff, 1974). The Abecedarian investigators therefore desi; ed a second phase of intervention to be applied to half the preschool Intervention group and half the preschool Control group in order to learn to what extent early gains might be maintained in elementary school with and without a follow-through and/or what could be accomplished through early elementary school intervention alone. Half the preschool Control group, untreated in either phase, provided a basis for estimating the expected outcome for local high-

risk children, and a standard for comparison of the effectiveness of the various treatment conditions.

The rationale for the school-age intervention was that high-risk children might learn more slowly than average and as a result would benefit from extra adult attention and increased amounts of exposure to basic concepts in two key academic subjects: reading and mathematics. In addition, it was expected that the children would benefit from having their parents become involved in the educational process. The specific intervention program therefore consisted of providing the children this extra exposure and practice through having their parents use supplemental curriculum activities at home. These supplemental materials were developed by Home/School Resource Teachers.

To guarantee that the supplemental curriculum was of high quality and to enhance the program's credibility with classroom teachers, graduate level teachers with backgrounds in Special Education were recruited for the position of Home/School Resource Teacher (HST). The HSTs were therefore qualified to act as consultants to classroom teachers when problems arose.

After meeting with the classroom teacher to learn which concepts were currently being taught in school, the HST designed sets of home activities. She delivered these to the home, explaining their purpose and demonstrating their use to the family. The investigators hypothesized that this process of regular visits by a professional educator would lead high-risk parents to place greater value on the child's academic accomplishments and also encourage the parents to become active participants in the child's education. Another goal was to facilitate communication and establish trust between the high risk family and the school system. In her dual role working between home and school, the HST became an advocate for the family within the school system and for the school within the family.

Insert Table 3 showing Years 1,2,3, #'s

As may be seen in Table 3, the school-age intervention was intensive. The HST met every other week with the parent, usually in the home but occasionally at the parent's workplace or some other location. Although the child was not necessarily present, the focus of the visit was on how successfully the child had completed the previous set of materials, and on the delivery of new activities. The HST also conveyed any messages from the classroom teacher regarding the child's academic achievements or behavior in class. Parents sometimes shifted the focus of this home visit to themselves, however, revealing problems they were having or seeking advice. Accordingly, HSTs helped families with situations which otherwise made it hard for parents to devote energies to the child's school progress. Parents were helped to find jobs and decent housing as well as to secure medical care and other needed services. In one case a Home/School Resource Teacher arranged for a custodial grandparent to take adult literacy classes so that the child and his guardian learned to read at the same time.

In a typical year, over 60 different learning activities were prepared for each child. Many of these were original games devised by the Home/School Resource Teacher. In addition, work sheets to give practice in handwriting, phonics, and math facts were also extensively used. These were popular with some families because the completed sheets gave concrete proof of how hard they had been working. Parents were always asked how much time they spent on activities during the previous two weeks. For those parents who gave estimates, the average amount of time they reported working with their children on the activities was about 15 minutes a day. Often parents found it difficult to estimate amounts of time, but

reported working with their children several times per week. Few ever made negative comments about the activities or said they had not used them.

At first, the program planners had expected that having attractive activity packets made available would guarantee their acceptance and use. This did not always prove to be the case, however. Some parents stated they had little time to devote to such things; others seemed to lack confidence in themselves as teachers of their own children. In an effort to increase family interest and participation a system of extrinsic rewards was added to the program. These tangible rewards included gift certificates to local restaurants and memberships in book clubs where the child earned a new book each month.

A danger in programs where parents are asked to work with their children using school-like materials is that parents will become upset or punitive if the child has difficulty doing the activities. For this reason, the HST tried to make sure the home activities were designed in such a way that the child and parent would experience a high level of success when using them.

RESULTS

Intellectual

Because prevention of mild mental retardation was a major goal of this study, intellectual test scores constitute an outcome of major interest. Figure 1 depicts longitudinal scores on tests of intellectual development for the preschool Intervention and Control groups across the range of child ages from 6 to 96 months. A Time x Group x Time*Group multivariate analysis of variance for repeated measures shows a significant multivariate effect for Time, $F_{(3,81)} = 18.88, p < .0001$, and a significant multivariate Time* Group interaction, $F_{(3,81)} = 6.86, p < .0004$.

Insert Figure 1

Univariate tests of the time trends showed that the linear ($F_{(1,83)} = 38.31$, $p<.0001$), quadratic ($F_{(1,83)} = 31.22$, $p<.0001$), and cubic ($F_{(1,83)} = 31.00$ $p<.0001$) terms were all significant. The Group* linear interaction term was not significant, but both the Group*quadratic interaction ($F_{(1,83)} = 9.54$, $p<.002$) and the Group*cubic interaction ($F_{(1,83)} = 9.58$, $p<.003$) were significant. Thus, there was a significant effect for preschool treatment on the tested IQ levels of the children from 6 to 96 months. There was a linear change over time which did not differ for the two groups, but the depth of the inflection in the curve after the infancy period was significantly different, with the drop for the Control group being deeper and the Control group showing a greater degree of change toward the end of the period.

To determine whether there were detectable effects of the second phase of intervention on intellectual test scores, test scores in the longitudinal series collected at the beginning, middle, and end of the school-age phase, that is, scores on the Wechsler Preschool and Primary Scale of Intelligence (WPPSI; Wechsler, 1967) at 60 months, and the Wechsler Intelligence Scale for Children - Revised (WISC-R; Wechsler, 1974) at 78 and 96 months, were examined separately. The means and Standard Deviations for the scores by group are given in Table 4. The analysis

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Insert Table 4-school-age IQ

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strategy is the same as that used for the full longitudinal set of IQ data. The model tested was a3(Time)x2(Preschool Group)x2(School-age Groups)xTime*Groups multivariate analysis of variance for repeated measures. (Complete Wechsler test data exists at all three ages for 87 children.) The results showed a significant multivariate effect for time, $F_{(2,82)} = 4.51$, $p<.02$, and a significant difference between the preschool groups on mean IQ score across the three occasions $F_{(1,83)}$

= 6.90, $p < .01$. There was no effect for school-age group on mean IQ and no Group*Time interactions. Further analysis of the time effect revealed both significant linear ($F_{(1,83)} = 4.29, p < .05$) and quadratic trends ($F_{(1,83)} = 4.02, p < .05$). Thus, for the 60-96-month subset of scores alone, children who had preschool intervention scored higher than those who did not, but no effect of school-age intervention on intellectual test scores was seen. There was a slight downward trend in the scores and a deflection, possibly a test artifact, at 78 months, but these trends did not differ significantly across groups.

Finally, to determine the degree of difference in IQ shown between treated and untreated children at the point when all educational intervention ended, the 96-month IQ scores were analyzed separately, computing separate 2 (preschool groups) x 2 (school-age groups) analyses of variance for the WISC-R Full Scale, Verbal, and Performance IQ scores. The results showed a trend toward a preschool group effect for the Full Scale IQ ($F_{(1,86)} = 3.19, p < .08$), a marginally significant effect for preschool group assignment on the Verbal IQ ($F_{(1,86)} = 3.93, p < .051$), but no group differences on the Performance IQ. There were no effects for school-age group on any of the three scores and no interactions. The actual difference between the 2 groups in Full Scale IQ at 96 months was 4 1/2 points.

As to the prevention of mild mental retardation, the number of children who tested within the Mildly Retarded range at 96 months was too small to permit a statistical inference to be drawn. Only three children had IQs $\leq$ 70 points; one child had preschool intervention, two children did not. When the category was expanded to include children scoring within the Borderline range, IQ $\leq$ 80 points, there were 7 cases, 2 with preschool intervention, 5 without.

Academic Achievement

Even more than scores on standardized intelligence tests, academic outcomes represented a critical test of the success of the educational interventions

provided here. Achievement in two basic subjects, reading and mathematics, was considered most important. Both age-referenced and grade-referenced measures were used to compare academic outcomes among the various groups. The age-referenced measure held exposure to school constant when children were tested, and consisted of Age-referenced Standard Scores for Reading and Mathematics on the Woodcock-Johnson Psychoeducational Battery, Part 2: Tests of Achievement (WJ; Woodcock & Johnson, 1977) administered to all children by project personnel at the end of three years in school. The grade-constant measure was comprised of reading and mathematics scores on the California Achievement Test (CAT; 1978) administered by the schools to all pupils at the end of second grade. The CAT scores became part of each child's permanent record and were released to the project investigators by the children's parents. Both instruments yielded scores which could be converted to age-referenced or grade-referenced percentiles or to age-referenced or grade-referenced Standard Scores with means of 100 and SDs of 15.

Table 5 gives the WJ age-referenced percentiles and Standard Scores for reading and mathematics earned by the 4 groups of high-risk children at the end of three years in school and the same set of scores for the year 3 local population comparison (LPS) group. It also gives grade-referenced percentiles and Standard Scores from the California Achievement Test at the end of second grade for the 4 groups of high-risk children (the later scores were not available for the full set of LPS match children).

Inspection of the Woodcock-Johnson figures shows that the high-risk children scored well below the average levels attained by the LPS group in both reading and mathematics. Preliminary analyses showed highly significant differences between academic test scores of the LPS children and all high-risk groups, therefore more detailed statistical analysis was confined to testing for

differences among the four school-age groups of high-risk children. The change from the two-cell design of the preschool study to the four-cell design of the school-age phase dictated the use of an analysis strategy which maximized power to examine academic achievement outcomes. To accomplish this, a post hoc hierarchical order of scores was specified, i.e., a linear trend with academic achievement scores varying across the four groups from low to high as the length of educational intervention increased. Then a multivariate linear model followed by multivariate 2 (preschool group) x 2 (school-age group) models were tested.

Eighty-three of the 90 children still in the sample at the end of three years of school had complete sets of all four academic achievement test scores - i.e. scores on both the Woodcock-Johnson and the California Achievement Test for reading and mathematics. These children constitute the sample upon which the statistical analysis of the academic outcomes is based. The multivariate tests on these data showed a significant linear trend across groups for the grand mean of the four sets of Standard Scores ($F_{(4,76)} = 3.32, p < .02$), and a significant multivariate effect for preschool treatment, ($F_{(4,76)} = 3.62, p < .01$) but no statistically significant effect for school-age treatment.

Insert Table 5-WJ and CAT results

Each set of scores was next examined separately. The univariate tests on the WJ Reading scores showed that with exposure to school constant, there was an overall linear trend in the means across groups, $F_{(1,79)} = 11.09, p < .001$, and also a significant effect for preschool group, $F_{(1,79)} = 8,79, p < .004$, but no effect for school-age group and no interactions. For the WJ Mathematics scores, there was also a significant linear trend, $F_{(1,79)} = 4.05, p < .05$, but no statistically significant effect for either preschool or school-age group assignment.

The univariate tests for the CAT grade-referenced Standard Scores showed that for reading, there was a significant linear trend, $F_{(1,79)} = 8.18, p < .005$, a significant effect for preschool group, $F_{(1,79)} = 4.94, p < .03$, and a marginally significant effect for school-age group, $F_{(1,79)} = 3.50, p < .06$. For the CAT Standard Scores for mathematics, the linear term ($F_{(1,79)} = 7.13, p < .009$) and the preschool group term were significant ($F_{(1,79)} = 7.91, p < .006$); there was not a significant effect for school-age group.

Thus, all four sets of academic measures showed a linear increase in score as a function of the number of years of intervention, and 3 of the 4 sets of scores showed significant effects for preschool intervention. Only one of the 4 sets of scores showed a marginally significant effect attributable to school-age intervention, however.

The conclusions with respect to scholastic achievement are: first, that the hypothesized trend from lowest to highest scores as a function of increasing amounts of intervention is seen for both reading and mathematics achievement whether one examines the outcomes holding child exposure to school or grade-level constant. The risk of academic failure was most clearly seen when the children were evaluated by the more stringent criteria of age-referenced scores with exposure to school held constant; predictably, allowing those retained during the first two years the extra year to complete second grade before comparing the groups allowed for relatively better performance for all four high risk groups. Second, although the mean standard scores and percentiles both indicated that the children in this study scored slightly higher on mathematics than on reading, intervention appeared to have had a more powerful affect on achievement in reading than on achievement in mathematics. Third, preschool intervention had a stronger effect upon children's academic achievement than did the school-age intervention.

Retention in Grade

In the elementary schools attended by Abecedarian children, the most likely response when a child had serious academic difficulty was retention in grade, especially in the early years. As a result, many of the high-risk children in the study were held back at some point during the first three years. Figure 2 shows the numbers of children in each school-age group retained in grade across the first three years in public school. These data have been previously reported (Horacek, Ramey, Campbell, Hoffmann & Fletcher, 1987) and will not be considered in detail here beyond noting that the high-risk children fared worse than the local system-wide average for retentions in the early grades. In a typical year, the system-wide percentage of students retained in either Kindergarten, Grade 1, or Grade 2 was 12.34%. In contrast, children in the Abecedarian sample had an overall retention rate in the first three years of 32.6% (based on N = 92). When one examines the retention rates separately within the four school-age groups, it may be seen that the likelihood of being retained in the early years was a linear function of the number of years of intervention, $F_{(1,104)} = 5.16, p < .03$. Only 16% of the II group was retained in the first three years in contrast to 50% in the CC group.

Insert Figure 2 - Retentions by Group

Classroom Behavior

Even after three full years in public school, there were differences in classroom teachers' perceptions of the adaptive behaviors which appeared to be related to the children's early intervention experience. Teachers' views were measured using the Classroom Behavior Inventory (CBI) developed by Schaefer, Edgerton, and Aaronson (1977). This inventory contains 10 scales designed to measure 3 factors: Considerateness vs. Hostility, Academic Competence

(Curiosity/Creativity, Verbal Intelligence, Independence, Task Orientation, Distractibility, Dependence) and Introversion vs. Extraversion. Teachers completed this inventory on each child each year. The results given here are for the ratings made in the Spring of the third year.

The teacher's CBI ratings were analyzed using separate 2 (Preschool groups) x 2 (School-age groups) analyses of variance for each of the 10 scales. The results showed a trend for children who had preschool intervention to be rated higher on Verbal Intelligence than those who did not, $F_{(1,83)} = 3.06$, $p < .084$, and a marginal Preschool*School-age interaction for Curiosity/Creativity, $F_{(1,83)} = 3.84$, $p < .053$, with the children in the II and CC groups being rated highest on this scale.

On the negative side, however, teachers rated children with preschool intervention significantly higher on Hostility, $F_{(1,83)} = 4.29$, $p < .04$, and marginally lower on Considerateness, $F_{(1,83)} = 3.87$, $p < .052$. There was also a trend toward a Preschool*School-age interaction for ratings on Dependence, $F_{(1,83)} = 3.226$, $p < .076$. The suggestion of increased hostility in children having preschool intervention is consistent with a previous study (based on other, independently collected data) which showed that some children who had the Abecedarian preschool intervention were described by their teachers as more verbally and physically aggressive than Abecedarian preschool control children (Haskins, 1985). Although the five years of educational day care had positive effects upon the children's intellectual growth and academic achievement in early elementary school, it also appeared to have some negative consequences insofar as the children's classroom behavior was perceived by their public school teachers.

Parent Ratings

There were no detectable effects of either the preschool or school-age intervention on parent's descriptions of the children's behavior as measured by responses to the Child Behavior Checklist (CBCL; Achenbach & Edelbrock, 1979)

after the children had completed 3 years in public school. This instrument provides ratings of the child's adjustment or adaptation in four categories: range of Activities, Social Adjustment, School Progress, and Problem Behaviors. Ratings in each category may be expressed as T scores. Separate 2 (preschool groups) x 2 (school-age groups) analyses of variance were computed for the Activity, Social, School, and Problem Behavior T scores. The results showed that neither phase of the educational intervention had detectable effects upon the parent's view of their children's adaptation or level of problems. Moreover, all mean T scores were well within normal limits. It is interesting to note, in this regard, that although parent CBCL ratings of academic outcomes were not significantly different for the different groups of children, the ordering of the mean scores on this factor was similar to the children's actual levels of achievement.

Comparison with other preschool programs: the Milwaukee Project and the Perry Preschool

It is instructive to compare the outcomes of the Abecedarian program with those of other intervention programs. Two other early intervention programs were considered particularly relevant. The first, the Perry Preschool Project, targeted socioeconomically disadvantaged three and four-year olds, randomly assigning some to receive preschool education coupled with a family education program (Weikart, Bond, & McNeil, 1978). The second, the Milwaukee Project, was set in an urban ghetto area, and, like the Abecedarian study, provided intensive early intervention in a daycare setting for randomly assigned socioeconomically disadvantaged children, beginning in infancy. In addition, however, the Milwaukee program required that the children admitted have mothers with IQs of 75 points or lower (Garber, 1988).

All three programs found significant differences between treated and untreated children's IQs at age five, and all three found some erosion of group

differences after children entered school. The Milwaukee study, however, reported much greater differences in IQ levels of treated and untreated children, a difference at age 5 of 28 IQ points, compared with a difference of 8 points for Abecedarian study 5-year olds in the preschool Intervention and Control groups. Similarly, the Milwaukee project reported much larger group differences in IQ for treated and control subjects at 3 years of age, approximately 21 points, (Garber, 1988) than existed between preschool Intervention and Control subjects of the Abecedarian study at age 8 (approximately 4-1/2 points). The children in the Perry Preschool Project differed by 11 IQ points at age 5; by age 8, they did not differ at all.

From the outcomes of the three studies taken together, one would infer that intervention for disadvantaged children is more effective and lasts longer if it begins in early infancy. Although IQ gains were demonstrated when intervention began at age three, they dissipated more quickly than those which resulted from programs beginning in infancy. The intensity of the three preschool programs varied as well as their start-times and duration, however, which makes interpretation of the differences in their intellectual outcomes somewhat problematic.

It is even more difficult to explain the discrepancy in the amount of difference between in treated and untreated subjects in the Milwaukee and Abecedarian studies. The programs were comparable with respect to length of preschool intervention provided; both began in infancy, both provided full-day programs for treated children. Recent re-analyses of the Abecedarian preschool data by Ramey and Landesman (1988) have suggested that one reason for the apparent difference in outcomes for the two projects lies in the restriction of the Milwaukee sample to children with very low maternal IQs. Examining the differences in IQ between educationally treated and untreated Abecedarian children whose mothers had IQs within the retarded range (IQ < 70), Ramey and Landesman found a difference of 21 points on the General Cognitive Index of the

McCarthy Scales of Children's Abilities administered when children were 54 months of age. When, in the present study, the 96-month IQs for these children of low IQ mothers were compared, there was a difference between treated and untreated children of 13 points on the WISC-R Full Scale IQ. The 6 children of retarded mothers in the Preschool Intervention group had a mean IQ of 93.67 (S.D. = 7.00) at 96 months whereas the 5 such children in the Control group had a mean IQ of 80.20 (S.D. = 16.24). Because the numbers of subjects who actually had retarded mothers was so small, this finding must be interpreted with caution, but it does suggest that, had the initial groups of subjects in the Milwaukee Project and the Abecedarian study been more comparable with respect to maternal IQ level, the relative discrepancy between treated and control children's intellectual test performance might have been more similar in the two studies.

In none of the three longitudinal studies did the intellectual test scores of children in the preschool Control groups display the trend usually reported from cross-sectional studies of disadvantaged children, that is, a gradual trend downward as child age increases (Heber, Dever, & Conry, 1968). The Abecedarian longitudinal data for the preschool Control group indicated rather a sharp drop in tested intellectual level after the infancy period, followed by a gradual recovery toward "normal" at age 96 months. A slight rise in test performance when Control children enter public school has been found in the present study, the Milwaukee Project, and the Perry Preschool study. The rise began for the Abecedarian control children before school entry, however, and the reason for the rise is not fully understood. There are several possible explanations: one of particular salience is the fact that after the age of three years, many of the high-risk control children entered other preschools and daycare centers, and thus also had the benefit of some preschool education (Burchinal, Lee, & Ramey, 1989). An active Head Start program, and high quality preschools with scholarships for low-income children

were available to Control group preschoolers. Moreover, once Abecedarian children started public school, most entered a system where the typical child was intellectually above the national norm and thus their classrooms were likely to have been stimulating and challenging. The local public schools also provided a number of resources for all pupils having academic difficulties.

Scholastic Achievement Outcomes. The comparison of scholastic achievement is limited to that between the Milwaukee Project and the Abecedarian study because of differences in the way results were presented by the Perry Preschool Project. Both the Milwaukee Project and the Abecedarian study report outcomes in terms of percentiles and Standard Scores, but the Perry Preschool study reports scholastic outcomes in terms of percentage of test items passed, which gives no meaningful basis for comparison among the three studies. When the Abecedarian and Milwaukee studies are compared, the results show that Abecedarian children who had had educational intervention earned slightly higher percentile scores on reading and mathematics than did the treated Milwaukee children.

Procedural and methodological differences make precise comparisons of academic outcomes for the two studies difficult: Abecedarian children, with one exception, entered public school kindergarten at age 5, whereas Milwaukee Experimental children remained in their preschool program that year and entered public school as first graders. Milwaukee Experimental group children had a summer tutorial in reading and mathematics after they had completed first grade. Some Abecedarian II and CI children had summer tutorials in reading, but not all parents elected to have their children take part in such programs. Thus, it is difficult to know whether the more fair comparison is between the Milwaukee Experimental group children and the total Abecedarian preschool Intervention group, or between the Milwaukee group and the Abecedarian II, or IC group.

Inspection of the Abecedarian Woodcock-Johnson age-referenced percentiles and the Metropolitan Achievement Test results reported by Garber (1988) however, shows that Abecedarian children earned slightly higher percentile scores no matter which comparison is used. The figures are given in Table 6. On standardized tests of reading

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Insert Table 6, Milwaukee/ABC Academic scores

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achievement at the end of three years in public school, children in the total Abecedarian preschool Intervention group earned a mean score at the 38th percentile, while those in the Intervention-Control group alone scored at the 34th percentile, compared with the 25th percentile for the Milwaukee Experimental group. In mathematics, the total Abecedarian preschool Intervention group children scored at the 45th percentile and those in the Intervention-Control group alone at the 39th percentile, compared to the 22nd percentile for Milwaukee children. Thus, the more spectacular IQ test scores earned by the children in the Milwaukee Project relative to those in the Abecedarian study were not associated with a comparable superiority in scholastic achievement.

It is difficult to interpret the differences in scholastic achievement for many reasons. Different standardized tests were used in the two studies to measure this outcome. Moreover, the children were in different, undoubtedly dissimilar school systems. Garber (1988) described the neighborhood schools where his Experimental group children would have been enrolled as "obviously poor" (p. 256), and arranged to have most of them enroll in schools with better records of success. In contrast, the Abecedarian children were in a University town with a predominantly upper-middle-class, highly educated population. The level of competition faced by Abecedarian children in their classrooms was high, perhaps

higher than that in a large Mid-Western city with a less advantaged urban ghetto population. Because of such confounding factors, differences between the two studies in academic outcome cannot be interpreted with confidence.

Timing of Intervention

The question about optimal timing of intervention for disadvantaged children posed in the title of this paper can now be answered, at least insofar as positive effects on intellectual development and academic accomplishment is concerned. Preschool treatment had the more powerful influence on IQ and on scholastic success in reading and mathematics.

The higher levels of cognitive skill demonstrated by children having preschool intervention seems the most likely explanation for their better achievement in early elementary school. If the differences in academic accomplishment were attributable primarily to the supplemental curriculum provided in the school-age intervention, after three year's exposure to public school the CI children should have performed at about the same level as those in the II group, for both had the benefit of school-age intervention for all three years. This was not the case for reading, however. Children in the II group significantly outscored CI children in reading, being about seven standard score points higher on the WJ.

A second interesting comparison is that between academic outcomes for the IC and CI children, which permits a measure of relative achievement for children who had preschool intervention alone versus school-age intervention alone. Whether one examines WJ or CAT score means for these two groups, the mean scores always favor the preschool intervention alone (IC) group over the group who had school-age intervention alone (CI), but t-tests indicate that none of these differences attain the .05 level of significance.

The school-age program did have beneficial effects, as shown by the fact that a linear relationship was found between the number of years of educational intervention and scholastic accomplishment, with Standard Scores in both reading and in math increasing as a function of increasing years of intervention. Another way to make this point is to examine the WJ achievement scores using a 2 (preschool groups) x 2 (school-age groups) analysis of co-variance controlling for tested IQ at 60 months; the results show a trend toward an effect of the school-age treatment for reading ($F_{(1,86)} = 2.82, p < .09$). No such trend can be shown for achievement in mathematics, however.

The present results suggest that both phases of the intervention programs had a more powerful effect upon reading achievement than on mathematics. The reason for this outcome is not clear: perhaps the preschool emphasis on language development laid a stronger foundation for learning to read than for learning elementary concepts in mathematics; perhaps the more concrete subject matter of elementary seriation, counting, and simple addition and subtraction was easier for high risk children to acquire, although the outcomes for the Milwaukee school children would not support this supposition. There may have been something about the mathematics curriculum used locally that led to higher levels of achievement in this subject for all children in the primary grades. Favoring this explanation is the fact that mathematics scores for the LPS children were also higher than their reading scores.

CONCLUSIONS

The present study has again demonstrated that early educational intervention can significantly benefit children at high-risk for academic failure. It enhances intellectual growth and improves school performance. Taken together with results from other, similar experiments with disadvantaged children, the results suggest that

intervention should begin in infancy and that children who appear to benefit most are those born to very low IQ mothers.

Intensive intervention in the form of supplemental home curriculum in early elementary school does boost scholastic achievement but, at least as applied in this study, it appeared less effective than preschool intervention as a preventive measure against intellectual lags and school failure. There were suggestions that both phrases of educational intervention applied in this study had more impact upon achievement in reading than in mathematics.

We are continuing to pursue questions about the long term effects of the interventions, the factors correlated with such effects, and the processes and mechanisms associated with positive and negative outcomes for economically disadvantaged children. Follow-up studies of the Abecedarian subjects at age 12 and age 15 are underway to learn to what extent the effects of earlier intervention might still be apparent at the later ages. One fact is clear: disadvantaged children face enormous odds, but investments in their future can make a difference.

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Table 1

High Risk Index

Factor	Weight
Mother's educational level (last grade completed)	
6	8
7	7
8	6
9	3
10	2
11	1
12	0
Father's Educational level (last grade completed)	
6	8
7	7
8	6
9	3
10	2
11	1
12	0
Family income (per year)	
$1,000	8
1,001-2,000	7
2,001-3,000	6
3,001-4,000	5
4,001-5,000	4
5,001-6,000	0
Father absent for reasons other than health or death	3
Absence of maternal relatives in local area	3
Siblings of school age one or more grades behind age appropriate level or with equivalently low scores on school-administered achievement tests	3
Payments received from welfare agencies within past 3 years.	3
Record of father's work indicates unstable or unskilled and semi-skilled labor	3
Records of mother's or father's IQ indicate scores of 90 or below	3
Records of sibling's IQ indicates scores of 90 or below	3
Relevant social agencies in the community indicate the family is in need of assistance	3
One or more members of the family has sought counseling or professional help in the past three years	1
Special circumstances not included in any of the above that are likely contributors to cultural or social disadvantage	1

Table 2

Entry Level Demographic Data for Preschool Experimental and Control Families

Variable	Group Experimental (N=55)	Control (N=54)	Total (N=109)
1. Mean High Risk Index	20.08 (5.72)	21.14 (5.88)	20.75 (5.81)
2. Mean Maternal Age (years)	19.62 (3.87)	20.28 (5.77)	19.94 (4.89)
3. Mean Maternal Education (yrs)	10.46 (1.75)	10.00 (1.89)	10.23 (1.83)
4. Mean Maternal Full Scale IQ	85.49 (12.43)	84.18 (10.78)	84.84 (11.61)
5. Percent female headed family	78%	65%	72%
6. Percent Black	96%	100%	98%

Table 3

Summary of Home/School Resource Program by Years

	Year 1	Year 2	Year 3
1. Grade Level	Kindergarten	Grade 1	Grade 2
2. Number of children treated	46	46	45
3. Mean School visits	18.3	17.6	13.9
4. Mean Home visits	15.4	14.2	12.5
5. Mean Total contacts[a]	42.4	40.3	35.0
5 Ratings of parental acceptance of activities			
a. Positive	84%	82%	83%
b. Neutral	15%	16%	16%
c. Negative	1%	1%	0%

a. Includes all telephone calls, special visits to home, and "other" contacts for each family.

Table 4

Mean Wechsler Full Scale, Verbal, and Performance IQ Scores at 60, 78, and 96 Months by School-Age Group

Group	N		WPPSI Mean IQ (SD)	N	WISC-R Mean IQ (SD)	N	WISC-R Mean IQ (SD)
CC	23	Full Scale	94.48 (13.83)	22	92.77 (11.47)	22	95.09 (12.69)
		Verbal	94.00 (13.09)		93.23 (10.46)		93.09 (13.01)
		Performance	96.04 (13.82)		94.04 (14.47)		98.09 (13.76)
CI	21	Full Scale	92.76 (13.75)	21	91.71 (12.32)	20	91.40 (12.13)
		Verbal	93.62 (14.40)		93.95 (11.61)		92.10 (13.25)
		Performance	93.29 (12.79)		90.67 (13.40)		91.95 (12.29)
IC	24	Full Scale	102.50 (7.25)	22	98.86 (8.71)	23	97.78 (10.43)
		Verbal	103.46 (9.30)		99.36 (12.92)		96.91 (10.49)
		Performance	100.96 (7.38)		93.68 (12.89)		99.61 (12.21)
II	25	Full Scale	100.40 (13.69)	25	98.08 (14.86)	25	97.88 (13.09)
		Verbal	101.92 (13.25)		97.76 (16.43)		98.80 (13.28)
		Performance	98.56 (13.81)		94.76 (17.90)		97.60 (13.03)
LPS	65	Full Scale	116.68 (13.91)	78	110.50 (18.43)	84	114.32 (15.68)
		Verbal	117.31 (14.87)		111.45 (18.84)		114.33 (16.68)
		Performance	112.71 (13.12)		107.12 (16.41)		111.31 (15.18)

Table 5

School Year Three Age-Referenced Woodcock-Johnson Standard Scores and Percentiles and Second Grade Grade-Referenced California Achievement Test Standard Scores and Percentile for Reading and Mathematics Achievement by Group

Group	N	WJ SS	%	N	CAT SS	%
			Reading			
CC	20	82.80 (12.43)	19.10 (18.66)	19	92.00 (9.64)	32.32 (21.15)
CI	20	86.30 (11.14)	23.25 (20.49)	19	95.37 (10.51)	40.05 (21.99)
IC	23	92.17 (13.69)	34.87 (27.62)	21	96.24 (10.88)	42.57 (21.89)
II	24	95.75 (12.87)	41.46 (27.75)	24	102.08 (12.90)	53.25 (26.33)
LPS	82	106.60 (15.59)	62.20 (29.76)			
			Mathematics			
CC	20	91.20 (14.16)	32.60 (28.18)	19	96.63 (11.55)	43.11 (25.29)
CI	20	92.80 (14.89)	37.20 (29.12)	19	99.37 (12.12)	50.32 (23.56)
IC	23	94.96 (11.07)	39.09 (24.67)	21	106.81 (14.71)	63.14 (26.73)
II	25	100.28 (13.11)	51.16 (28.69)	25	105.36 (13.88)	60.60 (27.06)
LPS	82	112.98 (15.33)	74.20 (26.92)			

Table 6

Comparison of Third School Year Academic Achievement Scores for Abecedarian and Milwaukee Project Children

	Group					
	ABC Total Inter-vention	ABC II	ABC IC	Mil Exper-imental	ABC CC	Mil Control
Subject						
Reading						
	38.2	41.5	34.9	25.1	19.1	15.6
Math						
	45.4	51.2	39.1	22.6	32.6	10.4