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THE DEVELOPMENTAL PROFILE OF DISADVANTAGED 6 YEAR OLD CHILDREN

Hanan Costeff and Zvi Kulikowski

Introduction

The problem with developmental disadvantage among children of the lower socioeconomic classes has been the subject of many studies. It has been well established that an intelligence quotient of 50-70 is about five times more common in these classes than in the middle classes (Zigler, 1967; Drillien *et al.*, 1966). Ethnic groups whose members belong predominantly to the lower social class have a mean I.Q. about 15 points less (i.e. about one standard deviation) below those of more privileged groups (Faustlich *et al.*, 1987; Dreger and Miller, 1968). These observations have given rise to the concept of sociofamilial retardation and to debates on the basic cause of this phenomenon. While the psychological and educational deficits of lower class children have been documented in considerable detail (Dreger and Miller, 1968; Faustlich *et al.*, 1987; Jensen, 1969; Sameroff *et al.*, 1987; Werner *et al.*, 1971; Zigler, 1967), there is a dearth of findings on the growth and motor development of this population. The purpose of this study is to compare and correlate growth and motor status of lower-class children with their cognitive status.

Background

The study group was a single year's cohort of all 6 year old children completing kindergarten in an impoverished immigrant town in northern Israel. This town of about 4,500 population consisted almost completely of a single Jewish ethnic group of non-European (Moroccan) origin, of which virtually all belonged to a low socioeconomic class. Fathers were mostly unskilled workers or unemployed. Most mothers and some fathers were illiterate. The median number of children per family was 5.

* **Hanan Costeff, M.D.**
The Neuropediatric Unit, Loewenstein Hospital, Ra'anana and the Tel-Aviv University School of Medicine, Tel-Aviv, Israel.

Zvi Kulikowski, M.D.
The Hannah Khoushy Center for Child Development, Rothschild Medical Center, and the Abba Khoushy Technion School of Medicine, Haifa

* *Correspondence to Dr. H. Costeff, P.O.B. 5026 Ramat-Hasharon 47140, Israel*

Infant mortality was twice the national average. The well-known social difficulties of this town had led to governmental expansion of health, welfare and educational services. This included adequate nursery school facilities for most children from age 3, universal kindergarten attendance from age 5, and an active child health centre run by one of the authors.

Methods

Samples

The study group consisted of all the town's 99 six year old children completing the kindergarten year. Forty children attending two kindergarten classes in affluent middle-class Ashkenazi (European origin) neighbourhoods elsewhere in Israel were selected as the comparison group. The mean age of the children in the study group was 66.4 months, whilst that of the comparison group was 65.4 months.

All of the 99 six year old children of the study group were invited to the combined school readiness and paediatric examination the results of which are reported here. The forty children of the comparison group were examined by the same procedures, in the same month and by the same examiner.

Procedures

Children in both groups underwent a paediatric physical examination, measurements of height and head circumferences and a school readiness examination. The school readiness examination was designed to sample verbal ability, number concepts, visual motor skills (drawing and cube construction), motor skills and short-term auditory memory. It included the following tasks, similar to those described by Dubowitz *et al.* (1977), with scoring of performance as in Illingworth (1972):

Verbal abilities - three tasks:
1. The child was shown 7 colours and asked to name them.
2. He was asked to place an object under his chair, behind it, before it and beside it.
3. Following this he was shown a picture and requested to describe the simple action represented.

Number concepts - two tasks:
1. The child was asked to add 2 and 3, and to subtract 2 from 4.
2. If he failed to do this without visual aids, he was provided with blocks and asked to try again with their help.

Visual-motor abilities - 2 drawing tasks:
1. The child was presented with two geometric figures (a diamond and a rectangle with diagonals) and requested to copy them.
2. He was then asked to draw a boy or man (for boys) or a girl or woman (for girls). The human figure was scored for completeness by the Goodenough criteria as described in Illingworth (1972).

Visual-motor abilities - 2 cube construction tasks:
1. The child was presented with a

model of the 5-cube gate described in Illingworth (1972), given 5 additional cubes and asked to reproduce it.
2. He was then shown a model of 4 stairs built from 10 cubes and requested to dismantle the model and reproduce it.

Motor abilities - 2 tasks:
1. The child was asked to skip alternately on both legs after seeing a demonstration.
2. He was then asked to catch a 6 cm rubber ball thrown to him from a distance of 3 metres, and to dribble it at least 3 times.

Short-term auditory memory - one task:
1. The examiner asked the child to listen carefully and then enunciated 4 digits at the rate of one digit per second. The child was asked to repeat the digits in the same order. Three trials were given, and success in two trials was the criterion for a passing grade.

The above-described tasks sampled areas of development, such as verbal expression and understanding, in which lower-class children are known to receive less stimulation than middle-class children, as well as other areas, such as motor performance, in which their previous stimulation may be assumed to be equal to that of their middle-class peers. The areas of number concepts, drawing and block construction are probably between these two extremes in the degree of experiential difference between lower and middle-class children.

In all, the children of the study group and the comparison group were given 12 developmental tasks. Ninety-three of the 99 children of the study group were present on one of the days that examinations were performed; however, a number of them refused some of the required tasks. Only the drawing tasks were performed by virtually the entire group. The number failing to complete other tasks ranged from 13 in number concepts and skipping to 25 in demonstrating understanding of prepositions. By contrast, all the children of the comparison group completed all tasks, with a single exception in demonstrating understanding of prepositions.

Since refusal of a task may or may not reflect inability to succeed, the proportion of children succeeding in each was calculated in two different ways. TABLE II (A) reports only children who attempted the task. TABLE II (B) reports all children tested and interprets refusal as failure.

One-way analysis of variance was used to examine the differences between study and comparison groups for height, head circumference and the Goodenough score of the draw-a-man task. The remaining 11 developmental tasks were analysed for between-group differences by Chi-square.

The medical records of the study group in the child health centre were reviewed for illness, growth curves and reports of disturbances of pregnancy and/or labour. Unfortunately, comparable details were not available for the middle-class comparison group.

TABLE I
Performance of study and comparison groups in Goodenough draw-a-man score

Group:		Study			Comparison		
Sex	Age Yrs.	No.	Mean	S.D.	No.	Mean	S.D.
Female	5:6 - 5:11	28	12.0	2.9	8	13.8	2.0
Female	6:0 - 6:5	13	14.1	2.4	9	16.8	3.2
Male	5:6 - 5:11	25	10.5	2.7	14	13.0	3.7
Male	6:0 - 6:5	26	11.6	3.0	8	13.3	4.0

F (4/123 = 3.81 p < 0.01

Results

TABLEs I, II(A) and II(B) show the 12 developmental tasks offered to the study and comparison groups.

TABLE I presents their Goodenough draw-a-man scores, subdivided into two age groups: 6 years to 6 years 5 months and 5 years 6 months to 5 years 11 months, and by sex. The mean scores of the comparison group were 1.7 to 2.7 points higher than those of the study group. This difference was observed in both sexes and in each of the half-year age groups. It is equivalent to an age difference of 5-8 months, and on analysis of variance it is significant at the 0.1 level. Thus, on this task the lower-class children in the study group showed a mean developmental age about 10% lower than that of the children in the middle-class control group.

TABLE II (A) and II (B) summarise the results in the remaining 11 developmental tasks. TABLE II (A) gives the percentage of success among the children who completed each task, whether correctly or not. TABLE II (B) gives the percentage of success among all children who were offered the tasks, whether or not they attempted them. As stated above, the differences between the two groups were tested for significance by Chi-square. The tasks are ranked in order of Chi-square; thus, the first task listed is the one showing the greatest difference between the two groups, and the last one shows the smallest difference. The study group was significantly inferior to the comparison group in nine of the eleven tasks. This difference was a dramatic one in seven of the tasks, including both tasks in the gross motor area, two of three in the visuomotor domain, two of the three verbal tests and one of the two dealing with number concepts.

These findings may be summarised as demonstrating a striking inferiority of the study group to the control group in verbal tasks, cube construction, number concepts and gross motor performance, and to a lesser degree in graphomotor skills. The difference in gross motor performance was most dramatic. The two gross motor tasks were among the three in which the study group showed the greatest inferiority to the comparison group.

TABLE II (A)

Proportions (%) in study and comparison groups succeeding on 11 developmental tasks, ranked in order of differences between groups. Denominators are numbers of children completing task.

Task Group:	Study	Comparison	x^2	p<
Describes action in picture	17/74 (23%)	37/40 (93%)	50.3	.001
Skips	11/80 (14%)	30/39 (77%)	46.3	.001
Catches and dribbles ball	17/77 (22%)	26/40 (65%)	20.9	.001
Reproduces 4 stairs from 10 cubes	10/79 (13%)	19/40 (48%)	17.5	.001
Adds/subtracts to 5 with concrete aids	50/80 (63%)	38/40 (95%)	14.4	.001
Names 7 colours	50/79 (63%)	37/40 (93%)	11.5	.001
Copies 5-cube gate	50/79 (63%)	36/40 (90%)	9.5	.01
Understands 5 prepositions	58/68 (85%)	39/40 (98%)	4.1	.05
Adds/subtracts to 5 unaided	10/80 (13%)	12/40 (30%)	3.9	.05
Copies diamond and rectangle with diagonals	42/93 (45%)	25/40 (63%)	3.4	.1
Repeats 4 spoken digits	31/76 (41%)	13/40 (33%)	0.8	N.S.

N.S. = not significant

TABLE II (B)

Proportions (%) in study and comparison groups succeeding on 11 developmental tasks, ranked in order of differences between groups. Denominators are numbers of children offered task.

Task Group:	Study	Comparison	x^2	p<
Describes action in picture	17/93 (18%)	37/40 (93%)	60.9	.001
Skips	11/93 (12%)	30/40 (75%)	49.4	.001
Catches and dribbles ball	17/93 (18%)	26/40 (65%)	25.8	.001
Reproduces 4 stairs from 10 cubes	10/93 (11%)	19/40 (48%)	20.1	.001
Adds/subtracts to 5 with concrete aids	50/93 (54%)	38/40 (95%)	19.4	.001
Names 7 colours	50/93 (54%)	37/40 (93%)	16.9	.001
Understands 5 prepositions	58/93 (62%)	39/40 (98%)	15.8	.001
Copies 5-cube gate	50/93 (54%)	36/40 (90%)	14.5	.001
Adds/subtracts to 5 unaided	10/93 (11%)	12/40 (30%)	6.2	.05
Copies diamond and rectangle with diagonals	42/93 (45%)	25/40 (63%)	3.4	.1
Repeats 4 spoken digits	31/93 (33%)	13/40 (33%)	0.8	N.S.

N.S. = not significant

TABLE III
Head Circumference (HC) and height of study and comparison groups subdivided by sex and age: means ± standard deviation in cm.

	Study Group			Comparison Group		
	No.	HC	Height	No.	HC	Height
Girls 5:6 - 5:11	21	50.5 ± 1.1	113.9 ± 5.2	8	52.1 ± 1.1	115.0 ± 2.3
Girls 6:0 - 6:5	23	50.3 ± 1.3	114.2 ± 4.3	6	52.0 ± 1.5	117.5 ± 2.8
Boys 5:6 - 5:11	19	51.2 ± 1.6	114.1 ± 2.5	14	52.7 ± 1.1	118.4 ± 4.4
Boys 6:0 - 6:5	22	51.7 ± 1.3	114.4 ± 4.4	12	51.7 ± 1.5	119.3 ± 2.8

	F	D.F.	p<
Head circumference	32.24	1/117	.01
Height	20.48	1/117	.01

F = Variance ratio
D.F. = Degrees of freedom

The paediatric physical examination revealed no major pathology in either of the two groups. No evidence of malnutrition or chronic illness was found in the detailed health records of the study group. However, there was a striking difference between the two groups in height and head circumference. This is shown in TABLE III. Mean head circumference in the study group was 0.7 cm less than in the control group for boys and 1.7 cm less for girls. Mean heights in the study group was 3.4 cm less than in the control group. The difference between means of the two groups, both in height and in head circumference, is almost one standard deviation.

In view of the unexpected finding of smaller heads in the study group, with its possible implication of lesser brain growth in the study group, an attempt was made to replicate the finding in the following year's kindergarten classes. Results were virtually identical with those reported above. Mean head circumference in the study group was less than that of the control group by 0.8 cm ($p < 0.01$) in boys and 1.4 cm ($p < 0.001$) in girls.

Discussion

The above findings can be summarised in three statements:

1. The cognitive inferiority of the study group is pervasive, and it is seen in a variety of verbal and visuomotor tasks, despite efforts at early education in this community.
2. The purely motor inferiority of the study group is at least as great as is its cognitive inferiority.
3. The study group children are significantly shorter and have significantly smaller heads than the children in the comparison group.

The pervasive nature of the observed cognitive deficit in our study group is in accord with the literature showing low intelligence and school failure to be concentrated in families of the lower socioeconomic classes (Zigler, 1967; Jensen, 1969). This low intelligence has sometimes been ascribed to social and educational factors in the postnatal environment (Sameroff *et al.*, 1987; Werner *et al.* 1971). However, the motor inferiority found in this study seems not to have been previously emphasised. This finding probably can not be explained by differences in training and experience. There is no reason to believe that the study group children had less previous experience than their middle-class peers in hopping, skipping and ball-play. Thus, it seems likely that there was an innate difference of ability between the study group and the controls.

The additional finding of smaller heads which we observed in the study group may have far-reaching implications. Head growth in early childhood is a function of brain mass, which attains adult size at age 3 (Dobbing and Sands, 1973). There is no evidence that events after birth affect brain and head growth, with the rare exceptions of very severe early malnutrition (Grantham-McGregor *et al.* 1987) or catastrophic infantile brain damage. The medical records of the study group showed no sign of either of these. Therefore we suggest that the children of the study group had smaller brains than children of the comparison group, and that this difference in brain size was probably congenital.

The precise causes of the congenitally smaller heads in the deprived population are unclear. One possible hypothesis is that known pathological events of pregnancy such as toxaemia and uterine bleeding cause brain damage in the fetus (Costeff *et al.*, 1983). Such biologic insults are indeed more common in deprived populations (Pasamanick and Lilienfeld, 1955). However, confirmation of this hypothesis would require evidence that such pathologic events were common in the study group, and such evidence is lacking in our study.

Another possibility is that diminished fetal brain growth among lower-class children may be caused by noxious influences which are not usually recorded or reported, such as exhaustion and wife-battering during pregnancy, and environmental toxins such as lead, alcohol, drugs and nicotine. This possibility seems worthy of further study.

Since the differences in head circumference were associated with differences both in ethnic origin and in socioeconomic class between the study and comparison groups, one may wonder how much of the disparity of head circumference may be ascribed to origin and how much to social class. An answer is provided by a published study of head circumferences in four ethnic groups of Israeli children (Palti *et al.*, 1983) which included the two ethnic groups of our study; in that study ethnic origin had no effect on head circumference when socioeconomic status was held constant. Similarly, a study of U.S. preschool children (Owen *et al.*, 1974) showed that socioeconomic status was correlated with head circumference, whilst race (black vs. white) was not. These studies strongly suggest that the smaller heads observed in our study are associated with, and probably caused by, differences in socioeconomic status and not by ethnic (i.e. genetic) factors.

Additional evidence that this is a function of social class and not of ethnic derivation is the historical observation that the ethnic group which performed so poorly in our study was the most prestigious sector of world Jewry in medieval times, on the basis of its abundance of illustrious poets, physicians, philosophers and theologians. Furthermore, members of this same ethnic group who have immigrated to other countries (e.g. France) are mainly of middle-class status and show no anecdotal or other evidence of cognitive inferiority.

Summary

A cohort of 99 children aged 6 years from a highly disadvantaged socioeconomic background and a group of 40 middle-class peers of the same age were compared on a paediatric school-readiness examination. The disadvantaged children were inferior on a wide range of verbal, visuomotor and purely motor tasks; they also were shorter and had significantly smaller head circumferences than their controls. These findings suggest that social-class differences in childhood cognitive skills may in part be mediated by biological events which disturb prenatal brain development. Trauma during pregnancy and environmental toxins are proposed as possible causes worthy of further study.

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