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Determinants and Predictors of School Adaptation and Academic Achievement in Prematurely Born Children (*)

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The literature about the later outcome of preterm birth is rather controversial. While several studies have revealed high rates of incidence of some deficit of mental development — ranging from mild to severe handicaps — in groups of children born prematurely, other investigators have found that by and large the mental growth of the preterm children is comparable with that of their non-risk peers.

It is obvious that prematurity by no means represent a homogeneous condition and that there are many other factors upon which its long-term outcome may depend. In some of the recent follow-up studies a great number of such variables, like birthweight and whether or not (and to what extent) the infant was sick at birth, etc., have been taken into account. However, even the results based upon very refined perinatal risk scales (e.g. Parmelee's Obstetric and Postnatal Complication Scales) leave part of the contradiction unsolved. The predictive power of even these multiple criterious appears to be relatively short-lived, i.e., it rarely goes beyond a few years (Caputo, Goldstein & Taub, 1981; Cohen & Parmelee, 1983; Hunt, Tooley & Harvin, 1982; Littmann & Parmelee, 1978; Siegel, 1982; Sigman & Parmelee, 1979; Sigman, Cohen & Forsythe, 1981).

At the same time, it is important to keep in mind that preterm birth is frequently associated with poor social circumstances. It implies that if in a particular investigation it has not been taken into account that the incident rates of preterm birth itself in higher and lower social groups are different, the lower SES is quite likely to be over-represented in the preterm sample when compared to a randomly selected control group of full-term children. It might be a sufficient explanation for the poorer average performance of the preterm groups. In a number of recent studies the possibility of such a methodological short-coming has been ruled out by using preterm and control samples matched for SES — yet the inconsisteney of the findings has not disappeared totally.

Some of the longer follow-up studies allow a closer look at the contribution of environmental factores toward the developmental outcome of children born at medical risk. One of the most significant discoveries of these studies has been the role of age at which the

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outcome is assessed. The majority of the prematurely born children with good socioeconomic background, even if they were quite high-risk at birth and developmentally delayed in early infancy, gradually «catch up» later on, but those from socially disadvantaged families do not. As children get older the effects of environmental variables almost obliterate the impact of the perinatal complications (Drillien, 1964; Drillien et all., 1980; Werner et al., 1971, 1978, 1982). The main effects of developmental deviations caused by «reproductive casualty» (Pasamanick and Knobloch, 1966) seem to occur early in a child's life while in the later course of development his fate is increasingly influenced by the environment and there-after most deviations can be interpreted as «caretaking casualties» (Sameroff & Chandler, 1975; Sameroff, 1979).

Large-scale longitudinal projects in the USA have yielded results confirming the role of environment in the developmental outcome in preterm children and supplementing the picture with specific pieces of information. For example, it has been found that environment has the power to reduce or amplify problems related to prematurity as early as by 2 years of age (Sigman et al., 1971; Wallace & McCarton, 1985). In the San Francisco study (Hunt, 1981) the factor that correlated the most with the intellectual outcome in preterm children at 4-6 years was the parental educational level, while in the Staten Island study (Caputo et al., 1981) — in which the largest set of variables was used — the strongest correlates to intellectual functioning at school age (7-9 years) were social class and maternal education.

To date only a few studies have attempted to detect the ways in which environment exerts these effects, i.e., to identify the specific mechanisms of amplifying or, in contrast, counteracting the adverse impact of biological risk conditions. In the Los Angeles study in addition to SES the influence of caregiver-infant interaction as well as of the language background was found (Sigman et al.,1981) and the same project has succeeded in validating a cumulative risk score after the scale was modified to include caregiver-infant interaction measures (Sigman & Parmelee, 1979). Pederson et al. (1986) found that a mature, responsive maternal behaviour is a significant component of the good developmental progress (as indicated by an above-average MDI) in low-birthweight infants.

In an increasing number of projects involving prematurely born children the HOME inventory (Caldwell & Bradley, 1984) has been used to evaluate the potential influences of the home environment. Bradley et al. (1987) have reported that in addition to family social status, several HOME subscales covering social and physical stimulation were significantly correlated with the developmental status of the infant. Similarly, Siegel (1982) and Smith et al. (1982) have demonstrated that such HOME variables could account for the false positive cases of the prediction from perinatal risk conditions to the early childhood outcome. In the ligh of evidence provided by the latter three studies the variety of stimulation and the availability of appropriate objects for activity appear particularly important. With the use of a matched control group, in the same study Siegel found the relationship of environmental effects to outcome to be even stronger for the preterm than for the full-term group (Siegel, 1982).

IQ and the Social Class factor devalue the importance of this relationship and they conclude that PARI scores do not reflect an independent contributor to cognitive functioning.

Either the biological or the developmental conditions may be viewed as if they exerted influence on development independently of one another. In fact it is the view of development that can be found under-lying most traditional research of developmental psychology. Some authors called it the «main-effect-model» (Sameroff & Chandler, 1975; Sameroff, 1979), while others (e.g. Reese & Overton, 1970) refer to it as a «linear-mechanistic approach» to development. On the basis of this model one could expect that a biological insult in the individual's life should produce a defective person who remains defective for all his lifetime irrespective of environmental circunstances. However, such an inference is clearly not in conformity with the findings of follow-up studies on «at-risk» children. The perinatal medical risk scales have proved to be far from being reliable predictors in the long run, and although cross-age correlations for mental performance are higher and predictions for later IQ are somewhat better for at-risk samples than for normal samples,these are not high enough either to allow predictions for individual children (Kopp & McCall, 1982). As Sameroff (1979) argues, if continuity in intellectual development is found, especially intellectual deficit, it can probably be explained by one of two reasons. The child may have suffered such a severe brain damage that he is incapable of moving to a conceptual mode of thinking. If it is not the case there must be environmental conditions that promote deficient functioning in the child both early and late.

The classical Soviet developmental psychology (e.g. Leont'ev, 1959; Vigotsky, 1978) adopted a markedly different approach from as early as the 1930's. The underlying assumption of the Soviet model is that any environmental influence can take effect only by finding its way through the entirety of the individual's actual internal conditions, which, in turn, is itself a result of an interplay of organismic and previous environmental factors. Recently very similar thoughts have been expressed more articulately by Horowitz's (1969) and Lewis' (1972), also Lewis and Fox (1980) interactional model as well as in Sameroff and Chandler's (1975, 1979, 1982) transactional model. The main implication of these models for the development of «at-risk» children is that the two sources of risk, namely, the reproductive casualties and the caretaking casualties do not operate separately but in close interrelation with one another.

Unfortunately most of the research concerned with the mental development of prematurely born children is confined to the assessment of intellectual performance by IQ tests. A common finding of the few studies which include a more detailed analysis of the mental functioning in preterm samples is the high incidence of visual-motor impairment that may occur quite indenpendently of the general IQ scores. Caputo et. al. (1981) cite earlier studies in which preterm children were tested by the Bender Gestalt test in schoolage and were found to perform below the norm (Wiener et al. 1965 and 1968; Lis, 1969). The Bender Gestalt test was also used in the Staton Island study at the eigh-year follow-up and the prematurely born subjects again achieved significantly poorer scores than did their full-term counterparts (Taub et al., 1977; Caputo et al. 1981).

The sensitivity of the Bender Gestalt test to the deficits of mental functioning in preterm children has been confirmed by two Hungarian studies as well (Csiky et al., 1981; Falusné Székely, 1979).

In the California follow-up study visual-motor integration difficulties in very low birth weight (<1500 g) pretern children were indicated by the lag between their verbal and performance quotients achieved at eight years of age an the Wechsler Intelligence Scale for children (Hunt, 1981; Hunt et al., 1982).

A preterm sample of larger birthweight range (average 1705 g) followed up by Wallace et al. (1982) did not show similar discrepancy between the WISC verbal and performance scores at six years. Nevertheless, the same chidren performed lower than their chronological age in Beery's test of form reproduction measuring visual motor integration (VMI). In Siegel's study the very low birthweight preterm children had significantly lower scores on a variety of perceptual spatial and motor measures (including the Beery VMI and four WISC performance subtests) at 5-7 years of age than the full-term control group (Siegel, 1985; 1985a; 1985b).

It is a well known fact that a certain proportion of children who have IQs in the normal range experience serious learning problems in one or more school subjects. The reported incidence of such learning disabilities among unselected school-age populations ranges from 5 to 20% (Hunt et al., 1982; Siegel, 1985b). Studies relating prematurity to school performance have found much higher incidence rates of learning disabilities in samples of preterm children (Drillien, 1964; Drillien et al., 1980; Falushé Székely, 1979; Frances-Williams & Davies, 1974; Hunt et al., 1982; Siegel, 1983, 1985a and 1985b; Taub et al., 1977).

In view of the lack of long-term predictive power of the peri- and postnatal medical risk factors covered by these scales do not necessarily result in deficits of the later mental functioning, and, on the other hand, that the presence and the degree of these deficits are not always proportional to the severity of the biological insult, even a succesful short-term prediction would be a remarkable achievement of great practical importance in a population such as the prematurely born children which are at more-than-average risk for learning disabilities.

The significance of the identification of the precursors of school-age learning problems in preterm children are underscored by the fact that very often there are no clues to be found in the developmental course during infancy and early childhood that would render a child suspect of being a potential learning disabled, and unexpected problems may continue to occur as late as eight years of age (Hunt, 1981).

Until recently it had not seemed feasible to predict the later learning difficulties for an individual child (Mercer, 1979). Satz and his collaborators, however, with the use of a test battery at the age of 5 years, succeeded in detecting for example, which children were likely to develop reading difficulties (Satz et al., 1978). Siegel's (1985b) study in which preterm and full-term children were tested by the Satz Battery has confirmed the efficacy of this battery in predicting with considerable reliability not only reading but spelling and arithmetic problems as well.

Similar encourageing findings have been reported by Hungarian authors (Porkoláb Balogh, 1984; Porkoláb Balogh & Kósa, 1986; Kósa & Porkoláb Balogh, 1988). In the latter study the unevenness of the performance on various subscales of the same visual motor tests (Bender Gestalt or Frostig) as well as the discordant results achieved by the same child on different visual motor tasks, rather than simply the poor score on a single test, proved to be fairly good predictors of the learning disabilities that the children were to experience subsequently in their scholastic activity.

The purpose of our follow-up project involving prematurely born children is twofold. Firstly, we endeavour to identify as many as possible of the factors that determine the school-age outcome, in terms of mental development and scholastic performance, in this specific population. Secondly, we try to pinpoint a set of variables, reasonably limited to be pratical, that allows a reliable short-term prediction of learning difficulties. The project is in progress; the follow-ups are planned to continnue until the end of the general school period (which is normally around 14 years of age in the Hungarian educational system). The present report is concerned with the developmental outcome of our subjects at the school entry age (6 years) and their school adaptation and progress in the first school year.

1. METHOD

1.1. *Subjects*

The subjects were recruited from among the children born prematurely in the Heves County Hospital in Eger between 1976 and 1978. The children had been followed up by the hospital staff up to their sixth year of age. As being considered potentially at risk for school problems at the age of six years they were referred to a scholl-readiness examination to the local Educational Guidance Centre. Since then they have been followed up by our team.

Mean gestational age of the sample: 33,9 weeks (upper limit; 56 weeks); mean birthweight: 1885 grams (range: 900-2400 g). Only children who had attended nursery school prior to having reached the school entry age were enrolled in the project, which means that children with major physical or sensory handicap or severe mental retardation were not included. Otherwise the sample is unselected.

1.2. *Measures*

Biological variables: Prenatal history, gestational age,birthweight and perinatal risk conditions.

Environmental variables: SES (determined on the basis of parent education, profession and income), items of the HOME inventory (Caldwell & Bradley, 1984, 1985), parental attitudes (based on observation of parent-child interactions and inter-view on child rearing patterns by Sears, Maccoby & Levin, 1957).

Early development: Ages at which the milestones of the motor and mental growth were achieved.

Tests: Budapest-Binet IQ test; Goodenough's «Draw a Person» test; Bender Gestalt test (scored for angles, directions and relative position of parts according to the scoring system by Santucci and Galifret-Granjon, 1960); school entry test battery (comprising items of general knowledge, memory, verbal, logical, practical and drawing skills, attention, task-appropriate behaviour and achievement orientation).

Teachers' ratings (based on guided observations of the child's classroom behaviour and on the evaluation of academic achievements) for attention, visual and verbal memory, comprehensions, interest in school activities, speed of scholastic work, social adaptation, and progress in reading, writing and maths.

1.3. *Procedure*

Data about the pregnancy and the child's peri- and post-natal history and early development was provided by the hospital follow-up clinic. The children were first seen by our team at 6 years of age. The mothers were interviewed and were given a questionnaire in order to collect information on the physical and social aspects of the child's environment, including selected items from the HOME inventory.

The children were administered the tests listed above. The placement of the child (whether to enter school or to be put back to nursery school) was decided on the basis of the test results as well as on observation of the child's behaviour.

On those children who entered school, the teacher's ratings were collected at the end of the first school year. For each child a decison was made, in consultation with the teachers, about the next step in the educational course.

The children for whom school entry was not recommended at the age of 6 were seen again before the beginning of the next school year.

2. RESULTS

The mean Budapest Binet IQ of the subjects at six years of age was 96.5 which is well within the normal range. The scores of two children suggested mental retardation. As these cases represent 6.7 % of the total sample this finding indicates a higher incidence rate of mental retardation in this preterm group than in the general population. The small size of this sample excludes, however, any generalization of this data.

The mean Goodenough DrQ (Drawing Quotient) was lower: 89.5, with 16.6 % having DrQs<75 and 33.4 % DrQs<90. It means that the performance of 50% was below the normal score-zone.

The performances in the Bender Gestalt Test, scored by Santucci and Galifret-Granjon's (1960) method can not be expressed by a quotient. The breakdown of the scores relative to the average performances expected at various age levels is shown on Table 1. The poor achievement of the preterm group is apparent; their scores in the various measures of the Bender test lag 1 1/2 — 2 years behind the age norms, with the direction measure being the most critical.

The performances of the preterm group on the items of the school-entry test battery were compared, in the lack of standardized measures to scores obtained by a full-term control group matched for age, sex and SES. The preterm children as a group scored significantly lower than their full-term counterparts on the following measures: practical problem solving, drawing, visual memory, task-appropriate behaviour, concentration, achievement need, and social adaptation.

Correlations between biological and environmental variables, early developmental course, and test performances at age 6 are summarized in Table 2.

In addition to the expected relationship between the performances on various tests, significant correlations were found between the scores reflecting the environmental influences and the birth weight as well as each outcome measure (early development, Binet IQ, Goodenough DrQ, Bender Score). Early development could significantly predict the 6-years outcome measures. Birth weight only correlated with gestational age (as it is obvious) and with early development. The partial correlations corroborated the relationships, as existing independently from other factors, only between the environmental influences and both the Binet IQ (r=0.50) and the Goodenough DrQ (r=0.40), and between the early

TABLE 1

Breakdown of performances on the Bender-Gestalt test at 6 years of age
Percentages of the subjects of Sample II

Measure / Score	Total	Angles	Directions	Relative Positions
Below the 5-year norm	50	40	43.4	46.6
Appropriate for 5 years of age	36.6	16.6	36.6	30
Appropriate for 6 years of age	13.4	43.4	20	23.4

TABLE 2

Correlational Matrix

	Birth Weight	Gestational Age	Environment Score	Early Develop.	Bp. Binet IQ	Goodenough DrQ
Birth Weight						
Gestational Age	0.69					
Environment Score	0.25	0.06				
Early Develop.	0.42*	0.10	0.54*			
Bp. Binet IQ	0.28	0.09	0.77*	0.73*		
Goodenough DrQ	-0.09	-0.31	0.66*	0.45*	.64*	
Bender Score	0.31	0.05	0.50*	0.59*	0.58*	0.51*

* indicates the significant correlations

development and the Binet IQ (r= 0,54).

On the basis of the 6-years examination 24 children (80% of the total Sample II) were recommended to start school. Seven children out of these 24, however, were suspected of being candidates for school adaptation difficulties. They were put into so called compensatory first grade classes that function within the normal school. Four children (13%) were put back to nursery school for another year. The two children with mild mental retardation were placed in a special school for mentally retarded.

The «Ready-for-school» group (17 children) significantly differed from the rest of sample II (13 children) on the following measures: SES ($F=3,05$ $p<0.1$, two tailed); Bender scores — Total ($F=9,78$ $p<0.001$), Angles ($F=8,10$ $p<0.05$); Directions ($F=10,09$ $p<0.001$), Relative Position ($F=5,74$ $p<0.05$). Neither biological variables (gestational age or birth weight) nor early development discriminated between the two groups.

2.1. *Outcome at school*

At the end of the first school year each those children who were attending normal school (including those compensatory class) was designated, on the basis of the teachers' ratings, as either a «sucess» or a «failure» for each item of the teachers' questionnaire. On the major measure, that is, whether or not the child was recommended to continue to the second grade, four children were rated as «failure». All four were from among those who had been in compensatory class. The overall school achievement of the children who had previously been classified as belonging to the «Ready-for-School» group was judged as a «sucess» with no exception.

It does not mean, however, that these children can cope with the school requirements without noticeable difficulties. Actually, a considerable number of them-many more than in an average population-are rated by the teachers as problematic in one respect or the other.

As it is shown on Table 3 the problems occurring with the prematuraly born children during the first school year accumulate on items covering the speed of scholastic work, interest in school activity, attention, visual memory and acquisition of reading skills, but as many as 25% experience difficulties in writing and maths as well.

In order to reveal the relationship between the predictor-variables (biological and enviromental factors and the test performances at the 6-year follow-up), and the various components of school success, a stepwise discriminant function analysis was performed for each item.

The overall school success, i.e. whether or not a child was recommended to continue into the second class, was found to be significatly determined by two enviromental variables (SES and intellectual fostering) while none of the biological variables under study had any significant effect. As to the predictive value of the 6-year olds' test performances, scholastic achievement was best predicted by two of the Bender-Gestalt subscore (Angles) also clearly discriminated between the «school sucess» and «school failure» groups. The significance levels of the F values are summarized in Table 4.

As far as the biological variables are concerned, there was no significant difference between the «sucess» and «failure» groups in any of the 11 comparisons. On the other hand, out of the 11 computed F values, eight were significant for «intellectual fostering», five for «SES» and three for «parental attitude».

The majority of the F values for the 6-years test scores were significant. The stepwise discriminant analysis showed that any one of the outcome variables, that is, sucess or failure on any item of the teachers' evaluation, could be predicted by a single test score at 70-80% reliability. Both the Bender-Gestalt «Direction» subscore and the Goodenough «Draw a Person» quotient proved to be the best single predictor for four items, the Bender Gestalt «Relative Position» for two, and the Budapest-Binet IQ for one item. The predictive values could be increased (in certain items up to 100%) by inclusion of the other test results.

3. DISCUSSION

3.1. *Outcome of preterm children at school age*

Our follow up data on prematurely born

TABLE 3

Numbers of «failure» according to the teachers' ratings

	Children in First Classes Compensatory n=7	Ordinary n=17	Total n=24	%
Reading	7	3	10	41.7
Writing	5	1	6	25
Maths	4	2	6	25
Attention	7	3	10	41.7
Interest	5	6	11	45.8
Memory-Visual	7	3	10	41.7
Memory-Verbal	2	0	2	8.3
Speed of Work	7	8	15	62.5
Social Adaptation	5	4	9	37.5
Comprehension of Tasks	4	1	5	20.8

TABLE 4

Predictive Variables	Biological Variables			Environmental Variables			Test Performances at 6 Years				
Item of Teacher's rating	BW	GA	Preg.	SES	IF	PA	BIQ	GDrQ	BGAn	BGDir	BGRp
Recommended to Continue to 2nd Grade				**	**		**	*	*	**	**
Reading				**	*		*	**		*	
Writing							*	*		*	*
Maths				*	*	*	**				
Attention				*			*	*		*	
Interest					*			*		*	*
Memory-Visual							**	*	**	**	**
Memory-Verbal					*	*	*	*	*	*	*
Comprehension					*		*	*		*	*
Speed of Work				*	*		*	**		*	
Social Adaptation					*	*	*	**		**	*

Key for the abbreviations and signs used in the Table and in the figures:

BW: Birth Weight
GA: Gestational Age
SES: Socio-Economical Status
IF: Intellectual Fostering
PA: Parental Attitude
BIQ: Budapest-Binet IQ
GDrQ: Goodenough's «Draw-a-Person» Quotient
BG: Bender Gestalt Test
An: Angles
Dir: Directions
Rp: Relative Positions
* F value $p<0.05$
** F value $p<0.001$
** or * The best predictor test result

children provided corroborative evidence to those previous studies which have claimed that preterm children are at a greater risk of encoutering difficulties in coping with school requirements than are their full-term peers.

At the first grade reading appears to be the most critical school subject but the incidence of failure in learning to write and mathematics is also higher among the preterm subjects than in a general population. The academic performance of a rather high proportion of the school-age preterm children suggest some deficit in specific areas of the intellectual functioning, such as a delayed development of visual-motor integration and visual memory. In this respect the teachers' observations were very close to the evidence obtained by psychlogical testing (see a number of studies cited in the introduction). In addition to the lag in the intellectual development, the teachers note problems related to other components of the school progress, among whish the distractability of attention and the slow rate of task-relevant activity prevail. Interestingly, while the lack of concentration was found to contribute to the failure of intellectual achievement in preterm children by Hungarian investigators (Csiky et al., 1981), the literature on the whole reflects little interest in this issue (except for Douglas, 1960, and Siegel, 1985, who have mentioned the deficits of attention as being characteristic of a considerable number of school age preterm children).

3.2. *Interrelationships between variables*

In our sample of prematurely born children with a considerable diversity in respect to prenatal history, gestational age, birth weight, and peri- and postnatal events, enviromental influences seem to contribute toward the differential development of some abilities and behaviours related to school sucess to a much greater extent than did any of the biological factors under study. In addition to SES, enviromental characteristics which are supposed to foster intellectual development appeared to be effective, supporting in the findings of studies referred to earlier that demonstrated significant correlations between certain HOME measures covering similar aspects of the home environment and the intellectual outcome in preterm children (Bradley et al., 1987; Siegel, 1982; Smith et al., 1982; even if these studies were concerned with earlier age periods). Our data also lend some support to the claim concerning the role of parental attitudes (Cohen & Parmelee, 1983; Sigman et al., 1981; Pederson, 1986; Siegel, 1982; Smith et al., 1982). In sum, these findings can be interpreted as further evidences suggesting that perinatal risk conditions, such as preterm birth may have a differential impact on mental development, depending upon social-environmental factors. Advantaged family circumstances may reduce or even fully compensate for the adverse effects of perinatal risk, while a disavantaged environment my amplify these. A child whose central nervous system had been exposed to biological insults at an early stage of growth may well be more vulnerable to environmental hazards. It may worthwile to consider, on the analogy of the notion of the Minimal Cerebral Dysfunction, the possibility of a «Minimal Environmental Deficit», which term would cover the relative lack of development fostering influences. This may not be noxious for a child whose central nervous system is in an optimal condition but another who survived perinatal risks may not have the reserves to resist and make up for these «minimal environmental deficits».

3.3. *Predictive value of test performances*

Some of the tests, mainly those involving visul-motor integration proved to be fairly good predictors of learning disabilities of which prematurely born children are at a greater risk at school than their full-term counterparts. These results underpin the grounds for a more optimistic attitude about the feasibility of the prediction of learning difficulties (Porkoláb Balogh, 1984; Porkoláb Balogh & Kósa, 1985; Satz et al. 1978; Siegel, 1983 and 1985b). Even a reliable short-term prediction of such potential problems would be of paramount importance in a country like Hungary with an extremely scholastic achievement-oriented educational system, in order to save the children who are concerned from such environmental insults as a failure at school.

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