Eur Arch Psychiatr Neurol Sci (1990) 239:384–390

European Archives of Psychiatry and Neurological Sciences

Behaviour Problems and Developmental Status of 3-Month-old Infants in Relation to Organic and Psychosocial Risks*

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Received March 15, 1989

Summary. In a prospective longitudinal study starting at birth 384 infants and their families were investigated. The subjects were distributed across the nine cells of a two-factorial design (3 × 3), factor 1 representing the degree of organic, factor 2 the degree of psychosocial risk. At age 3 months there was a significant influence of organic risk factors on all developmental parameters. Psychosocial risks were only relevant for cognitive development and behaviour problems. Organic high-risk children who adapted quickly after birth showed an especially good development status.

Key words: High-risk infants – Pathogenesis – Neuropsychiatric disorders – Longitudinal study

Introduction

The majority of children born with pre- and perinatal risks show a normal development (Sameroff 1979; Cohen et al. 1982; Field 1980; Hunt 1981; Siegel 1983; Smith et al. 1982; Meyer-Probst and Teichmann 1984; Hadders-Algra et al. 1988a, b). Some of them, however, and a certain number of children who suffered no pre- and perinatal risks, later develop learning disabilities, or emotional or behaviour disorders. In random population samples the number of school age children who develop child psychiatric disorders or learning disabilities is about 20% (Esser and Schmidt 1987). Identifying these children at an early stage of development and recording their pathogenesis could help to prevent or palliate these disorders.

In describing the pathogenesis of these children it is necessary to take into account important psychosocial risk factors of the family. These include psychiatric disorders of the parents (Blanz et al. 1987), low level of education, crowded living conditions, delinquency, troubled relationship between the parents (Rutter and Quinton 1977; Voll et al. 1982; Crnic et al. 1983a), emotional immaturity of mother (Field 1983), lack of social support and coping skills. Many older studies stress the correlation between organic and psychosocial risks (Pasamanick and Knobloch 1966; Birch and Gussow 1970) in that organic complications are more frequent in groups with a lower socioeconomic status. Furthermore, there are findings which show that the effect of organic risks in these groups is stronger (Werner et al. 1971; McDonald 1964; Rutter 1971, 1979; Rubin and Balow 1979), and that favourable psychosocial circumstances can compensate for the effect or organic risks (Sameroff and Chandler 1976).

Aim of the Study

The aim of the study is to determine the pathogenesis and course of neuropsychiatric disorders. Furthermore, the study seeks to generate hypotheses concerning prevention, early recognition and early treatment. In contrast to other studies a clear separation of organic and psychosocial influences is made. Furthermore, the psychosocial influences are described in a more comprehensive and sophisticated way, testing all known risk factors of possible importance within one study. Special emphasis is put on the parent-child interaction. The characteristics of the child are investigated in a multi-level approach considering neurophysiological variables as well as those of motor development, mental development and behaviour. Besides risk factors, preventive and compensatory factors are taken into account.

A prospective longitudinal study design was chosen, starting at birth and following the children and their families through the first 8 years of life. The two-facto-

* This research was supported by the Deutsche Forschungsgemeinschaft as a part of the Sonderforschungsbereich 258 "Risikomodelle psychischer Störungen"

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rial design (3×3) – factor 1 varying the degree of organic, factor 2 of psychosocial risks – allows the recognition of interactive effects and raises the probability of the occurrence of disorders. A total of 384 children and their families were recruited. After the initial investigation at birth, four waves at ages 3 months, 24 months, 4.5 years and 8 years are planned. The study began in 1986; during 25 months the sample was collected in two gynaecological and six neonatal clinics of the Rhein-Neckar region (Mannheim-Heidelberg). The examinations of the first wave (3 months) have been completed, and the first results are reported here.

Sample

Included were all first-born children (born or treated in one of the eight cooperating clinics) of German-speaking parents, who fell into one of the nine cells of the two-factorial design but did not have physical handicaps, obvious genetic defects or metabolic diseases. The rate of participation (recruited parents minus refusals) was 64.5%. The aim was to get 40 subjects in each of the five cells with at least one severe, i.e. grade 2 (psychosocial/organic) risk degree (0/2, 1/2, 2/2, 2/0, 2/1) and 30 subjects in each of the four cells with no severe risk degree (0/0, 0/1, 1/0, 1/1). The subjects were to be gathered consecutively until all cells were filled. Problems in obtaining enough infants with severe organic risks gave us the opportunity to overfill the cells without severe risks and to achieve an even distribution of the subjects over all cells, which has some statistical advantages. Sex was evenly distributed in each cell.

Methods

Definition of Organic Risks. In most studies organic risks are defined either by birth weight alone or by an obstetrical optimality score like the one of Prechtl (1968). Definition by birth weight has the advantage of an objective measurement, which, devided into few classes, leads to a rather good estimation of organic risks. A disadvantage of this procedure is the fact that, especially within the range of low birth weight (1500–2500 g), further complications are of greater importance. Besides, the use of only one risk factor means that the gathering of subjects is much more difficult.

Optimality scores, on the other hand, have other disadvantages.

1. Use of anamnestic information includes variables (e.g. adequate socio-economic status, married mother, more than three medical assessments during gestation) which are more likely to describe psychosocial than organic risks. This means that it is not possible to differentiate clearly between organic and psychosocial risk by using optimality scores.
2. The definition of many of the variables is not reliable because of either lack of criteria or dependence on the mother's recall.
3. Not all variables are available in each case. Availability depends on the diagnostic procedure of the particular clinic.
4. The multiple intercorrelations of the variables are unknown. They are believed to differ considerably. This leads to an uncontrolled weighting of the variables.

The definition of organic risks in our study had to meet several methodological and practical criteria: (1) no contamination with psychosocial risks; (2) objective data; (3) availability for each subject; (4) significant differences of the degree of severity between the risk groups; (5) no specific indicator of physical handicaps, chromosome defects or metabolic diseases.

Together with the cooperating gynaecological and neonatal clinics the following definitions were chosen:

No risk: Birth weight 2500–4200 g and a gestational age of 38–42 weeks, no signs of asphyxia and no operative delivery.

Moderate risk: Premature birth (1501–2500 g) or signs of risk of premature birth or EPH gestosis.

Severe risks: Birth weight less than or equal to 1500 g or clear case of asphyxia [pH $\leq$ 7.1, Cardiotokograhia score according to Fischer (1976) $\leq$ 4, lactate $\geq$ 8.00 mmol/l] or complications during the first 7 days of life (sepsis, proved by a positive blood culture; seizure; respiratory therapy). Additionally, infants in the severe risk group had to spend a minimum of 7 days on the neonatal ward. These criteria were sufficient to single out all infants with severe neonatal complications, who were treated in one of the six cooperating clinics.

Special group: Those who fulfilled the criteria of severe risks but adapted so quickly that they were not transferred to the neonatal ward.

Definition of Psychosocial Risks. The basis of the definition of psychosocial risks was the Family Adversity Index (FAI) of Rutter and Quinton (1977), which has proved to be highly significant for child psychiatric disorders (Voll et al. 1982; Blanz et al. 1989). The FAI was adapted to the specific situation of young families (we included only first born children) and elaborated by new concepts, which have become relevant in the genesis of psychiatric disorders such as social integration and support, severe chronic stress and coping.

Eleven psychosocial risk factors were defined as follows.

1. Low education level of parents, i.e. unskilled or semi-skilled job (inter-rater reliability: kappa = 1.0)
2. Crowded living conditions, i.e. more than 1 person per room or not more than a total of 50 m^2 (kappa = 1.0)
3. Moderate or severe psychiatric disorders of the parents according to DSM III-R (kappa 0.98)
4. Delinquency or institutional care in the history of the parents (kappa = 1.0)
5. Troubled relationship between the parents, i.e. frequent and long-lasting troubles, separations, lack of emotional care (kappa = 1.0)
6. Early parenthood, i.e. 18 years old or less at birth of the child or relationship between the parents had existed for less than 6 months at the time of conception (kappa = 1.0)
7. One-parent family (kappa = 1.0)
8. Complete rejection of pregnancy (kappa = 1.0)
9. Lack of social integration and support, i.e. lack of friends and lack of help by relatives (kappa = 0.71)
10. Severe chronic difficulties lasting more than 1 year (kappa = 0.93)
11. Lack of coping skills, i.e. inadequate coping with stressful events of the last year, e.g. denial of obvious problems, withdrawal, resignation, overdramatization (kappa = 0.67)

No risk means that none, moderate risk means 1 or 2, and severe risk means 3 or more of these 11 risk factors were present.

An even distribution of the 362 subjects across the nine risk combinations was achieved. Twenty-two additional subjects belong to the special group of quickly adapted high-risk children.

Assessment at Age of 3 Months (Corrected for Duration of Gestation). Assessment of motor development included a neurological examination adapted from Prechtl and Beintema (1976), Vojta (1984), Flehmig (1983) and Touwen (1976) and the Bayley Motor Scale (Bayley 1969). The standardized neurological examination showed an adequate inter-rater reliability ($r = 0.90$). Assessment of cognitive development included the Bayley Mental Scale (Bayley 1969).

Assessment of psychopathology was based on behaviour ratings of a number of temperament dimensions. The behaviour ratings were obtained in two ways: within the frame of a standardized

parent interview and during live observations in four standardized research settings on two different days in both familiar (home) and unfamiliar (clinic) surroundings by trained raters. From nine temperament scales (adopted from Thomas et al. 1968) 13 symptoms were derived which were supplemented by eating and sleeping disorders. The mean of the five ratings (four from observation, one from parent interview) was calculated for each of the nine temperament dimensions and cut-off points were made. Five scales were unipolar; four were bipolar. Each bipolar dimension led to two symptoms. In a special study satisfactory inter-rater reliability of the ratings could be demonstrated. When the criterion of correspondence was defined as a difference of zero points on the five-point scales between the ratings of the two observers, a mean kappa of 0.68 (range 0.51–0.84) resulted. However, when allowing a difference between the rating scores of maximum one point, all kappa coefficients reached 1.0. Furthermore, the infants' behaviour proved to be sufficiently stable over time despite a significant situation-related fluctuation. The results underscored the importance of including a variety of situations when studying infant behaviour problems. Neurological examination and the Bayley test were conducted by different investigators. The psychopathology rating of each infant was made by four different observers.

Table 1. Frequencies of behavioural symptoms (%)

	Moderate problems	Severe problems
Attention deficits	23.2	0.6
Hyperkinesis	22.4	0.8
Dysphoria	21.8	1.1
Dysrhythmicity	17.1	3.3
Irritability	19.9	0.3
Sleeping disorder	15.2	4.4
Eating disorder	13.3	3.3
Contact disorder (introversive)	14.6	0.0
Hypersensitivity	13.5	0.0
Low tolerance level	12.2	0.0
Resistance to changes	9.4	0.0
Slow adaptability	9.1	0.0
Hypokinesis	6.1	0.6
Apathy	6.1	0.3
Contact disorder (disinhibition)	1.9	0.0

Results

Descriptive Statistics of the Dependent and Independent Variables

Independent Variables

The distribution of organic risk (OR) factors shows premature birth or signs of risk of premature birth to be the most frequent variable (53.6% of all 362 subjects); 14.6% of the mothers suffered from EPH gestosis; 12.7% of the infants had a birth weight under 1500 g; significant signs of asphyxia showed 9.1% (4.4% CTG score ≤ 4, 2.5% lactate ≥ 8.0 mmol/l, 2.2% pH ≤ 7.10). Neonatal complications occurred in 28.1% of the infants (17.4% respirator therapy, 5.5% seizure, 5.2% sepsis).

Distribution of the psychosocial risk (PR) factors showed that lack of coping was the most frequent variable (40.3%); 28.7% of the families showed severe chronic difficulties; 25.7% were very young parents; 21% of the parents showed psychiatric disorders; 20.4% had a low educational level; 20.5% had been delinquent or were in institutional care; 15.7% had rejected the pregnancy and seriously thought about abortion; 11.9% lived in a troubled relationship; 10.5% of the mothers lived alone with their child, 9.4% under crowded conditions; 3.9% had no friends and no help from their relatives.

As expected, owing to the factorial design the intercorrelations of the independent variables OR, PR and sex were near zero (-0.04 to $+0.02$).

Dependent Variables

Of the sample, 19.9% were rated as having significant or severe neurological disorders, 53% slight disorders; 15.5% were rated as having significant or severe behaviour problems, 23.8% as having slight disorders. Due to the proportion of at-risk children in this sample, the mental and motor development indices (Bayley 1969) are rather high (mental 106.5; motor 102.1). From similar results of other research groups (Rauh et al. 1988; Crnic et al. 1983b), it can be concluded that the use of the norms of the Bayley test leads to scores that are too high. Table 1 shows the frequencies of the 15 behavioural symptoms. Attention deficits, hyperkinesis and dysphoria were the most frequent ones.

The intercorrelations of the dependent variables show the highest coefficients between Motor Development Index (MDI) and Psychomotor Development Index (PDI) (0.50), and PDI and the degree of neurological disorders (-0.49). Remarkably strong was the relation between behaviour problems and the mental (-0.40) and neurological status (0.31). All correlation coefficients are highly significant ($P < 0.001$).

Influence of the OR and PR on the Dependent Variables

All of the following analyses were done by three-way ANOVA (or logit analyses) with OR, PR and sex as independent variables. The number of subjects in all calculations was 362, with the exception of the calculations including the special OR group ($n = 384$). The figures presented below show only the effects of OR and PR because hardly any relevant effect was found for the third factor (sex).

Motor Development

Neurological Disorders. The degree of neurological disorders as a dependent variable was highly significantly influenced by the OR factor ($P < 0.0001$, 16.4% explained variance). A slight influence of PR was observed too ($P < 0.031$), although the extent to their explained variance (1.6%) was only a tenth of that of the OR factor (see Fig. 1). No sex effect and no interactions were observed. A look at the rates of significantly or severely disturbed infants (Table 2) underscores the effects of the OR factor ($\chi^2 = 48.26$, $P \leq 0.000$). The PR factor did not reach statistical significance ($\chi^2 = 3.53$, $P \leq 0.186$). Within the OR factor the main increase of neurological disorders was observed from moderate (degree 1) to severe (degree 2) OR.

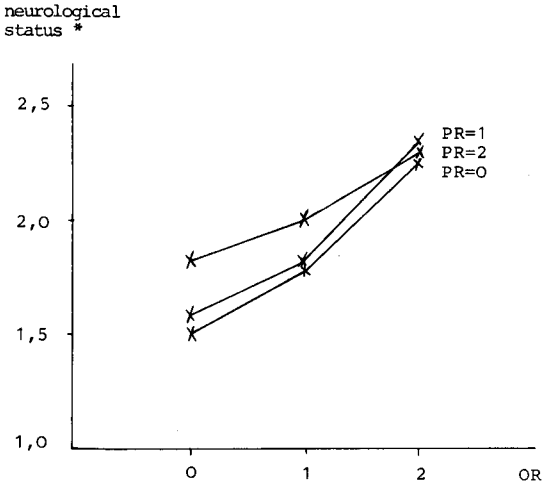

Fig. 1. Influence of organic risks (OR) and psychosocial risks (PR) on neurological disorders. * The higher the scores the more severe the neurological disorders. 0 = No risk; 1 = moderate risk; 2 = severe risk

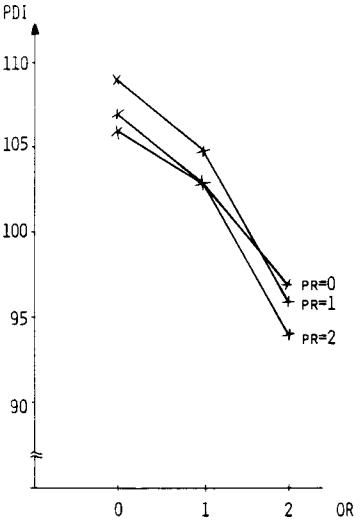

Fig. 2. Influence of organic risks (OR) and psychosocial risks (PR) on the Psychomotor Development Index. 0 = No risk; 1 = moderate risk; 2 = severe risk

Table 2. Percentage of neurologically disordered infants with organic (OR) and psychosocial risks (PR)

PR \ OR	0	1	2	
0	2.6	6.8	34.2	14.2
1	5.6	14.7	41.5	21.6
2	6.8	19.5	43.5	23.7
	5.1	13.4	40.0	

0 = no risk
1 = moderate risk
2 = severe risk

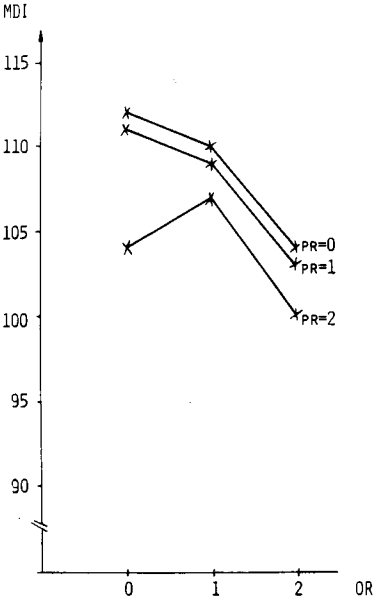

Fig. 3. Influence of organic risks (OR) and psychosocial risks (PR) on the Mental Development Index. 0 = No risk; 1 = moderate risk; 2 = severe risk

Psychomotor Development Index. As was the case with the neurological disorders a similar strong effect of the OR factor ($P < 0.0001$, 12.4% of explained variance) was seen here. No psychosocial effect and no interaction could be demonstrated but a (comparably small) sex effect ($P < 0.008$, 1.7% of explained variance) was found (see Fig. 2). Two-thirds (33) of the 52 infants with a PDI less than 84 (Bayley norms) came from the high OR group. Of the 5% of subjects ($n = 17$) with the lowest PDI (≤ 77), three-quarters ($n = 13$) came from the high OR group.

Mental Development

As can be seen in Fig. 3 both a significant psychosocial ($P < 0.008$) and organic effect ($P < 0.0001$) occurred; the variance explained by the latter (4.6%) was nearly twice that explained by PR (2.6%). No sex effect and no interaction between the risk factors were observed. Of the 17 infants with an MDI below 84 (Bayley norms), 15 came from the high OR group. Within the range from the 5th to the 15th percentile (sample norms), 19 (58%) of 33 came from the high PR group.

Behaviour Problems

Looking at the sums of behavioural symptoms as a dependent variable (Fig. 4) both a significant organic ($P < 0.0001$) and psychosocial influence ($P < 0.0001$) was observed. The explained variance for the PR factor (4.4%)

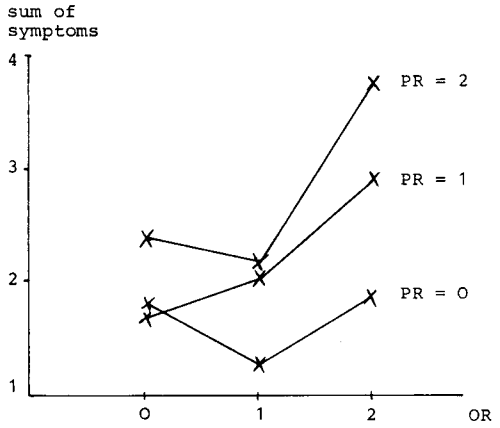

Fig. 4. Influence of organic risks (OR) and psychosocial risks (PR) on the number of behavioural symptoms. 0 = No risk; 1 = moderate risk; 2 = severe risk

Table 3. Percentage of infants with at least significant behavioural problems with organic (OR) and psychosocial risks (PR)

PR \ OR	0	1	2	
0	5.3	4.5	10.5	6.7
1	13.9	14.7	24.4	18.0
2	18.2	9.8	34.8	21.4
	12.7	9.2	24.0	

0 = no risk
1 = moderate risk
2 = severe risk

was as high as for the OR factor (also 4.4%). No sex effect and no interaction were observed. The distribution of rates of significantly or severely disturbed infants leads to comparable results (OR: $P<0.009$; PR: $P<0.005$; see Table 3). Along the PR factor the ratio of disturbed infants climbs from 6.7 over 18.0 to 21.4%, along the OR factor from 12.7 over 9.2 to 24.0%. The main increase was for the PR factor from degree 0 (no risk) to degree 1 (moderate risk) and for the OR factor from degree 1 (moderate risk) to degree 2 (severe risks).

Characteristics of Rapidly Recovered High-Risk Infants

Twenty-two of the infants who suffered from high risks recovered so quickly that they were not transfered to the neonatal ward. These infants were equally distributed across the three PR groups [6(0)/9(1)/7(2)] but not across sex groups (7 ♂ / 15 ♀). Because of the nearly complete absence of sex effects (only for the PDI subscore), this should not create marked differences concerning the dependent variables. Table 4 shows the interesting results. The neurological status and the behaviour problems were comparable with those of the moderate risk group. As regards motor and mental development indices, this group showed absolutely the best results of all risk groups and better than those without any risk! On account of the low number of subjects only differences between the special group and the high-risk group were statistically significant. As a statistical procedure Scheffe' tests following one-factorial analyses of variance were used for PDI and MDI, and logit analyses for neurological disorders and behaviour problems.

Predictive Value of Single Risks

Looking at the most powerful predictors for the developmental status of 3-month-old infants, correlations ($r_{p\,bis}$)[1], were calculated for each of the psychosocial and organic risks with the dependent variables. Table 5 shows these correlations, representing all which exceed 0.10, which corresponds to a level of significance of 0.05 (2 alpha). Owing to the high number of correlations the level of significance had to be adjusted. The adjusted level of significance corresponding to $P \leq 0.05$ was below 0.006, which is equivalent to a correlation coefficient of 0.15. As can be seen, only a few psychosocial risks reach such significant predictive power. This predictive power is restricted to MDI and behaviour problems. Six of the organic risks reach significant predictive power, which is mainly concentrated on the motor developmental status represented by the neurology and the PDI. The most stringent organic risk (significant correlation with all

[1] Violation of the assumption of a normal distribution did not matter with respect to the number of subjects, which could be demonstrated by comparing calculations with rank correlation methods

Table 4. Charcteristics of rapidly recovered high-risk children compared with other organic risk groups

	(0) None ($n = 118$)	(1) Moderate ($n = 119$)	(2) Severe ($n = 125$)	(r.r.) Rapidly recovered ($n = 22$)	r.r. Group differs significantly from the following risk groups
Neurological disorders (%)	5.1	13.4	40.0	13.6	(2) ($P<0.05$)
Psychomotor Development Index	107.3	103.9	95.5	111.1	(2) ($P<0.05$)
Mental Development Index	108.7	108.7	102.4	115.4	(2) ($P<0.05$)
Significant behaviour problems (%)	12.7	9.2	24.0	9.1	None

Table 5. Predictive value of single psychosocial and organic risks I (single correlations r_{pbis})

	Neurological status	PDI	MDI	Sum of symptoms
Low educational level			0.18	0.13
Crowded living conditions			0.13	0.19
Psychiatric disorder				0.12
Delinquency/institutional care			0.10	
Troubled relationship				
Early parenthood			0.12	0.10
Incomplete family			0.16	0.15
Rejected pregnancy			0.12	0.13
Lack of social integration				
Severe chronic difficulties				
Lack of coping skills	0.14	0.14	0.19	0.21
Premature birth or signs of risk of premature birth	0.30	0.23	0.12	
EPH gestosis				0.11
Birthweight ≤ 1500 g	0.35	0.21	0.19	0.20
pH ≤ 7.10				
Lactate ≥ 8.0 mmol/l				
CTG score (Fisher) ≤ 4	0.14	0.16		
Respiratory therapy	0.36	0.27	0.12	0.13
Seizure	0.21	0.26	0.14	0.15
Sepsis		0.15		

Table 6. Predictive value of single psychosocial and organic risks II (standardized beta weights)

	Neurological status	PDI	MDI	Sum of symptoms
Low educational level			0.14	
Crowded living conditions				0.19
Psychiatric disorder				
Delinquency/institutional care				
Troubled relationship				
Early parenthood				
Incomplete family			0.12	
Rejected pregnancy	0.11			
Lack of social integration				
Severe chronic difficulties				
Lack of coping skills		0.10	0.19	0.21
Premature birth or signs of risk of premature birth	0.16	0.16		
EPH gestosis				0.10
Birthweight ≤ 1500 g	0.24		0.18	0.19
pH ≤ 7.10				
Lactate ≥ 8.0 mmol/l				
CTG score (Fisher) ≤ 4		0.13		
Respiratory therapy	0.36	0.27		
Seizure	0.16	0.20	0.14	0.15
Sepsis				
Explained variance in % (R^2)	0.23	0.16	0.12	0.13

four dependent variables) is low birth weight (below 1500 g). Altogether the correlations of single risks remain low, which means that none of these alone can well predict the developmental status at age 3 months.

Applying multiple regression analyses the resulting standardized beta weights (Table 6) underline the relative significance of the organic risks in comparison with the psychosocial risks. The total percentages of explained variance remain low, which was to be expected because of the low single correlations.

Summarizing Conclusions

In a prospective longitudinal study starting at birth all measurements of developmental status at 3 months were dependent on the grade of severity of organic risks. The influence of these factors was especially relevant for the motor skills. This is in line with the findings of other authors (e.g. Greenberg and Crnic 1988; Rauh 1984). OR factors also influence the early cognitive and behaviour development.

The effects of psychosocial risks are still comparatively low, which is obviously due to the short socialization period. Their strongest influence was seen on behaviour problems, in which they explained the same proportion of variance as the organic factors. A significant effect on the mental developmental status could also be demonstrated, although it remained below the organic influence.

Sex differences on the whole were not very important. They could only be shown to have a slight effect on motor skills.

Substantial interactions between organic and psychosocial risks were not observed. This is an indicator of an additive connection of these variables concerning the developmental parameters. Also there was no statistical interaction between organic risks and sex. This means that at this age there is not sex-specific effect of the organic risks on developmental measures. The same could be demonstrated for the psychosocial risks and sex. Our experiences during the collection of sample also show that there is no connection between severe organic risks and sex. Our sample included all first-born German children with severe organic risks in the Rhein-Neckar region and it was also difficult to arrive at the aimed-for number of boys and girls.

In general, the variance which could be explained by both the psychosocial and the organic risks was quite low (maximum 23%). This is probably due to the comparatively low reliabilities of measurements in infancy. Moreover, there are many variables (e.g. attitudes of the parents, life events, mother-infant interaction) which were investigated by the project during a 4-h interview with the parents and a videotaped mother/child interaction but which have not yet been included in the analyses. These variables, especially the quality of mother/infant interaction can enhance the amount of explained variance particular of mental development and behaviour problems (Esser et al. 1989).

The quite good developmental status of quickly adapted high-risk infants was of interest. If these results can

be confirmed by the further development of these children, quick adaptation to organic stress may be a sign of exceptionally good coping and lack of vulnerability.

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