CHAPTER 5

Neurological Assessment

The various procedures we employed in trying to quantify the performance or the quality of our school-age study population, the results of which are reported in the two previous chapters, share one characteristic which makes interpretation of these results difficult for us, since our main interest lies in identifying their practical, clinical implications. The difficulty is that all these procedures are attempting to measure functions which reflect the end-product of the interaction between two quite different types of factor. The first factor is the organic structure of the child's nervous system at school age, which may have been determined in part by the effects of the abnormalities of intra-uterine growth which are our primary interest (and in part by confusing factors such as the child's sex, or clinical complications of the perinatal period). The second factor is the psychological mechanisms by which the functioning of this organic structure may have been modified (either enhanced or impaired) by environmental factors operating between the time of birth and the time of the examination. The child's social class of origin can be regarded as an indicator of such environmental factors. The analyses and discussions in the two previous chapters have attempted to identify the relative contribution of these various factors to the generally impaired performance and quality of the children in the two extreme abnormal groups, which are almost uniformly more impaired in the very light-for-dates than in the short-gestation group.

Procedure

In this chapter we report the results of procedures which we considered to be relatively, or in some cases entirely, unaffected by the psychological mechanisms referred to above. It should be easier, therefore, to attribute any differences directly to the organic effects of the respective abnormalities of intra-uterine growth. The types of performance we were testing are thought to depend largely upon the intactness of the relevant parts of the nervous system.

The examination was carried out by a research psychiatrist with paediatric experience, and followed the psychologist's assessment. The children had had a good chance to settle down and it was possible to achieve good co-operation in almost every case. The procedures themselves were not confined to the standard components of a classical neurological examination, such as testing of reflexes, tone and simple sensation; they consisted mainly of a series of carefully specified tasks, each intented to measure a different neurological function, and in each of which the child's performance could be rated on a three-point scale (1 denoting no abnormality, 2 doubtful abnormality and 3 definite abnormality). The functions tested and rated at the ages of five, six and seven years and descriptions of the procedures themselves are included in the unpublished Appendix. Some comment is necessary about the traditional distinction between 'soft' and 'hard' neurological signs, which we have retained in our analysis. We defined 'hard' signs as those in which an abnormal score appeared clearly to indicate an abnormality of structure, and were exemplified by cranial and other nerve palsies, and unequivocal abnormalities of spinal reflexes. 'Soft' signs were generally considered to have a less evident structural basis and were exemplified by the presence of choreiform movements of the upper limbs when the child stood for 30 seconds with the arms outstretched and eyes closed (Prechtl and Stemmer 1962).

'Soft' signs are so named for a variety of reasons: they may, for example, be difficult to elicit; their occurrence may not be reliably repeated; or they may appear to represent a mere developmental disorder due to uneven maturation of the nervous system rather than any definite neuro-anatomical abnormality (Rutter *et al.* 1970). Supporting the concept of a developmental delay are findings that 'soft' signs may occur in apparently normal children, especially in younger children (Kinsbourne 1973) and reduce with age (Peters *et al.* 1975); they are commoner in boys (Adams *et al.* 1974) and in children with lower intelligence levels (Klonoff *et al.* 1969); and their improvement with maturation is seen first in gross motor function and subsequently in finer movements (Peters *et al.* 1975). While improvement with age does not rule out either subtle or diffuse brain damage as a significant aetiological factor, the relationship of 'soft' signs with known forms of cerebral dysfunction is at best indirect; they correlate poorly with EEG abnormalities (Capute *et al.* 1968), but are observed relatively frequently in the broad range of 'at risk' groups (Kalverboer 1975) and in children showing disorders of learning (Gubbay *et al.* 1965) and of classroom behaviour (Stine *et al.* 1975).

No matter how debatable the status of 'soft' signs, we found ourselves compelled to follow the lead taken by other workers studying the development of children at risk. It has often been contended that abnormalities of intra-uterine growth may be a source of diffuse insult to the brain, giving rise to diffuse neurological sequelae. Indeed, most studies of children of low birthweight have reported an excess of both 'hard' and 'soft' neurological signs, and have tended to view the former as clearcut and the latter as circumstantial evidence of organic brain damage. We are in agreement with other investigators (Rutter *et al.* 1970, Peters *et al.* 1975) in holding that, given a systematic neurological examination, so-called 'soft' signs may indeed be reliably elicited, and we take note of the caution advocated by Kalverboer (1975) over their interpretation.

Altogether, 17 functions were tested at the age of five years. 10 at six years, and at seven years there were nine tests for soft signs and 20 for imitation of gestures (the results of which were summarised to give a Total Gesture Score) (Bergès and Lézine 1963). There is an element of increasing complexity in the gesture imitations, so that a child's performance may be limited by his intellectual capacity.

Results

In terms of individual items there are few significant differences between the groups, perhaps partly because of the small range of possible scores of most of the tests. The items for which there is at least one significant difference between the groups are summarised in Table 5.1. The short-gestation group's abnormality score is significantly higher for two items and the very light-for-dates group's for six items, compared with the controls. Finger agnosia and hopping along a line are the only items for which there are significant differences at both five and seven years. There were no significant differences in any of the items administered at six years.

To obtain a better over-all comparison, we have also added together the scores for all the 'hard' items to give a total score for these at age six; with the 'soft' items we summed five items at five years, six at six years and eight at seven years. The resulting Total Scores for which there are significant differences between our groups are shown in Table 5.2. The same pattern emerges—the very light-for-dates group

TABLE 5.1

Neurological abnormality: items showing at least one significant difference*

	Random control (*a*)	Short gestation (*b*)	Rather light-for-dates (*c*)	Very light-for-dates (*d*)	Significant differences $p<0.05$	Significant differences $p<0.01$
At 5 years						
Finger agnosia	1.0	2.9	2.8	2.9	a/b, a/c, a/d	—
Constructional apraxia	1.2	1.3	1.2	1.4	—	a/d
Hopping along a line	1.3	1.6	1.4	1.5	a/b	—
At 7 years						
Tactile agnosia	2.5	2.7	2.6	2.8	—	a/d
Choreiform movements	1.8	2.0	1.9	2.1	a/d	—
Hopping along a line	1.1	1.9	1.8	1.9	a/d	—
Double simultaneous stimulation	1.2	1.3	1.2	1.4	a/d	—

In addition, a significantly higher proportion of the very light-for-dates had impaired visual acuity in the non-dominant eye (but not in the dominant eye) as compared with the controls, at seven years.

*Mean scores at five and seven years (no significant differences at age six years).

TABLE 5.2

Neurological abnormality: total scores showing at least one significant difference*

	Random control (*a*)	Short gestation (*b*)	Rather light-for-dates (*c*)	Very light-for-dates (*d*)	Significant differences $p<0.05$	Significant differences $p<0.01$
Total for 'soft' items						
at 5 years	5.8	6.1	5.8	6.4	—	a/d
at 6 years	6.6	6.6	6.6	7.0	—	a/d
at 7 years	12.7	14.2	13.3	14.5	—	a/b, a/d
Total for 'hard' items						
at 6 years	4.1	4.1	4.1	4.4	—	a/d, b/d, c/d
Gesture Score						
at 7 years	29.2	33.5	29.6	34.6	c/d	a/b, a/d

*Mean total scores for 'soft' and for 'hard' items, and for gesture.

have a significantly higher Total Abnormality score than the control group in all five instances, and the short-gestation group in only two instances.

Discussion

The pattern that emerges from our neurological assessment is remarkably similar to that recorded in the previous two chapters for the results of the psychological and behavioural assessments. There are significantly more abnormalities in both extreme abnormal groups than in the controls, but even more in the very light-for-dates than in the short-gestation group. In the only instance where there is a significant difference between the two extreme groups, the very light-for-dates children show more abnormalities in the score for 'hard' items at six years than do those in the short-gestation group (Table 5.2). In view of the fact that the neurological assessment procedures we used are considered to reflect the organic potential of the brains of the children tested, with relatively little modification of performance by environmental factors operating through psychological mechanisms, these findings provide further support for the proposition that the abnormalities of intra-uterine growth in which we are interested are capable of modifying the organic structure of the children's brains. However, they could well have interacted with other biological factors, so we compared the findings in boys and girls. We also wanted to discover whether these procedures really are relatively immune to modification by environmental factors operating during early childhood, so we also assessed the effect of the child's social class of origin.

The results summarised in Table 5.3 show that there are indeed very marked and interesting differences between the effects of our abnormalities of intra-uterine growth upon boys and girls. The boys in both abnormal groups have very significantly higher total abnormality scores than the corresponding controls, both for 'soft' and for 'gesture' items. There are no such differences among the girls, whose neurological status appears to have been unaffected by their abnormalities of intra-uterine growth. This finding is similar to those summarised in Table 4.8 (p. 45), in which the higher behaviour abnormality scores in the abnormal groups were confined to the boys at both five and seven years of age.

The effects of social class, summarised in Table 5.4, are equally interesting. The abnormality scores of the children in the control group show an obvious upward step-wise trend in the case of the 'gesture' items as we move from classes I and II to III and then to IV and V, and the difference between the extremes is statistically significant. In the case of the 'soft' items, however, although there is a definite trend in the same direction, the absolute differences in the scores are so small as to be negligible and are nowhere near statistically significant. In other words, it would appear that our expectation of relative immunity from environmental modification is confirmed in the case of the 'soft' items, but the 'gesture' neurological items show a significant social-class gradient, though rather less steep than those of the psychological, behavioural and psychiatric assessments. This steep gradient for 'gesture' items, with a negligible gradient for the 'soft' scores, is also seen in the light-for-dates group in Table 5.4, but not in the short-gestation group.

Our general conclusions are that the findings reported in this chapter confirm

TABLE 5.3

Neurological abnormality related to sex*

	Random control (a)	*Short gestation (b)*	*Light-for-dates (c)*	*Significant differences*† *p<0.05*	*p<0.01*
Boys					
Total for 'soft' items	13.1	14.7	14.7	—	a/b, a/c
'gesture' items	28.8	35.2	33.3	—	a/b, a/c
Girls					
Total for 'soft' items	12.3	13.4	13.2	—	—
'gesture' items	29.7	31.2	31.2	—	—

*Mean total scores for 'soft' and 'gesture' items at age seven years.
†No significant differences between sexes.

TABLE 5.4

Neurological abnormality related to social class*

		Random control (a)	*Short gestation (b)*	*Light-for-dates (c)*	*Significant differences* *p<0.05*	*p<0.01*
Total for 'soft' items						
Classes I and II	(1)	12.4	(13.3)†	13.6	a/c	—
III	(2)	12.7	14.2	13.9	—	a/b, a/c
IV and V	(3)	12.9	14.2	14.2	a/c	—
Total for 'gesture' scores						
Classes I and II	(4)	24.8	(31.67)	28.7	—	—
III	(5)	29.1	34.3	32.3	a/c	a/b
IV and V	(6)	30.7	32.9	33.1	—	—
Significant differences p<0.05		1/3, 4/6	—	—		

*Mean total scores for 'soft' and 'gesture' items at age seven years.
†The mean scores within brackets are based on only two children: the numbers of children in the other cells range from 14 (in social classes I and II) to 110 (in social class III controls).

the impaired performance of the children in the extreme abnormal groups reported in the previous two chapters. They also confirm the relatively greater vulnerability of the boys, as compared with the girls, to the adverse effects of abnormalities of intra-uterine growth. This latter finding is reminiscent of the observation by Neligan *et al.* (1974) that the adverse effects of breech delivery in the children from whom we selected our study population was confined to the boys, but in that case analysis of variance showed the adverse effects to be due to associated factors rather than to the mode of delivery itself. We must therefore restrain ourselves from deciding that the evidence in favour of long-term organic effects of our two extreme abnormalities of intra-uterine growth is so strong as to be conclusive, until the relationship has been subjected to multivariate analysis of all the relevant factors (see Chapters 8 and 9).