RIJKSUNIVERSITEIT TE GRONINGEN

A NEUROBEHAVIOURAL STUDY IN PRESCHOOL CHILDREN

proefschrift

Ter verkrijging van het doctoraat in de sociale wetenschappen aan de Rijksuniversiteit te Groningen op gezag van de Rector Magnificus Dr. A. Wattel in het openbaar te verdedigen op donderdag 28 februari 1974 des namiddags te 4 uur

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Errata: de volgende zinstorende fouten dienen te worden verbeterd:

Pag.60/61: De zin "At the bottom of the tables 12 to 16, in which factor loadings are given, the variables which are excluded from the analysis of the behavioural structure are mentioned." vervalt. De volgende zin op p.61 luidt dan: "Most of the categories which were omitted were used in specific analyses (e.g. the relationship between the number and the different types of body postures (locomotion patterns) was separately analysed to investigate the "variability versus stereotypy" in the motor behaviour of the child)."

Pag.76 : In de tekst van fig.7 moet 39 worden vervangen door 30.

STELLINGEN

bij het proefschrift "A Neurobehavioural Study in Preschool Children", A. F. Kalverboer.

1. De methode van directe observatie en kwantitatieve analyse van gedrag in "taak-vrije" situaties biedt belangrijke mogelijkheden voor het vroegtijdig signaleren van ontwikkelingsrisico's bij kinderen.

2. Er bestaat niet één syndroom "Minimal Brain Dysfunction".

3. Bij de opzet van gedragsobservaties dient in het oog te worden gehouden dat "objectief" gelijke omgevingen voor proefpersonen een geheel verschillende betekenis kunnen hebben.

4. De toepassingsmogelijkheden in de klinische ontwikkelingsdiagnostiek van de theoriën van Piaget betreffende de ruimtelijk-constructieve en cognitieve ontwikkeling zijn tot dusver zeer onvoldoende benut.

5. Het gebruik van de term "arousal" ter verklaring van zoiets als "algemene geneigdheid tot reageren" is een voorbeeld van een pseudo-fysiologische verklaring van gedrag.

6. Onderzoeken met zogenaamde actometers kunnen nauwelijks enig inzicht opleveren in het verschijnsel van "overbeweeglijkheid" bij kinderen.

7. De mogelijkheden om processen die in de ontwikkeling van het menselijk individu over lange tijdsperioden verlopen in kortdurende experimentele onderzoeken te simuleren verdienen meer systematisch dan tot nu toe te worden nagegaan.

8. In empirisch onderzoek dienen analysetechnieken aan problemen te worden aangepast, niet omgekeerd.

9. "Too often, I think, high-powered mathematical tools are used where the data are not yet suitable".
W. Riss (1971): Brain Behaviour Evolution, 4, 439-462.
Zo is het.

10. De algemene toepassing van schoolvorderingentoetsen in de hoogste klasse(n) van de basisschool, welke wettelijk alleen voor de selectie voor de H.A.V.O./V.W.O. zijn vereist, leidt er toe dat belangrijke onderwijsdoelen van het basisonderwijs onvoldoende tot hun recht komen. Een dergelijke situatie doet zich in de gemeente Groningen voor.

11. Ethologen waren niet de eersten die systematisch gedragsonderzoek bij de mens verrichtten en zij zullen ook wel niet de laatsten zijn.

12. De bijna compulsieve behoefte om elk op enig symposium of congres uitgesproken woord in druk te doen verschijnen leidt tot grote aantallen wetenschappelijk gezien volstrekt overbodige publicaties. Bovendien verleidt zij participanten tot het publiceren van artikelen, waarvan ze het verschijnen achteraf dikwijls ten zeerste betreuren.

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1. INTRODUCTION

One of the most remarkable clinical concepts is that of M.B.D., originally indicating "minimal brain damage", at present "minimal brain dysfunction". The term is generally used to identify schoolaged children within the normal range of intelligence, who present behaviour and/or learning problems which are assumed to be connected with "minimal" C.N.S.-dysfunction. Terms such as over- or hyperactivity, short attention span and lack of concentration, impulsivity, lability of mood, and irritability purport to describe disorders in the behavioural organisation, frequently observed in such children, while deficits in the perception and integration of spatial and temporal relationships are also often reported, usually in connection with reading and/or writing difficulties. "Soft" neurological signs, such as minor deficiencies in motor-coordination, reflex asymmetries, mild visual or hearing impairments, dyskinesia's (such as choreiform jerks, athetoid movements), general clumsiness, poor fine or gross visuo-motor coordination, signs of a delayed motor development are also frequently part of the syndrome.

Few problem-areas have evoked as much interest in specialists of such widely varying disciplines as physics, psychology, education and biochemistry, as the M.B.D. "syndrome". At the same time however, hardly any concept in the clinical nomenclature has occasioned so much controversy and confusion.

What has led to this broad interest and what is the background of the confusion and controversy?

In order to better understand the present situation it may be helpful to briefly retrace the history of the concept.

The wide interest in the M.B.D. problem is partly due to convergences in educational, psychological and medical thinking during the last fifty years, attended by refinements of methods and techniques for assessment and guidance in each of these disciplines.

In the field of education there was a shift from subject-centered to child-centered teaching. Commencing in the early years of this century new guiding principles for the teacher developed from painstaking observations of the child's free exploration of his physical environment (Montessori, Decroly) and from reflexion on his social activity (Parkhurst). The child came to be considered as an active individual, who learned by exploration (Montessori) and who should be confronted with "meaningful structures" (Decroly). Gestalt psychology in particular profoundly influenced educational practices.

Educational thinking was influenced not only by general "laws" concerning the child's mental development, but also by a concern for individual abilities and limitations, leading to the foundation of special schools for children with learning problems. Initially, criteria for the selection of children requiring special consideration were crude, but they gradually became more refined and objective, not least as a result of important developments in the field of psychodiagnostics. Starting with Binet in 1905 who was required to find a method that would discriminate between lazy and incapable children, psycho-metric methods became increasingly helpful in the determination of the most suitable learning environment for the child. Originally, intelligence tests were assumed to indicate the child's "general intellectual potential". Only gradually more relativistic opinions on the value of test-scores developed. Children were crudely categorized as mentally deficient or mentally defective, backwards, subnormal or slow-learning, normal, gifted or superior, labels which were adapted to the available resources.

Reflecting the growing complexity of the society, schools made increasing demands on their pupils: knowledge of the traditional skills and tools was no longer sufficient for the child; he should be able to find intelligent solutions for new problems. These more complex scholastic standards, the refinement in diagnostic tools and the development of institutions for special education led to the identification of groups of children with learning problems, previously unrecognized or not manifesting themselves.

After approx. 1940 interest in specific learning and behavioural disorders that might relate to basic deficits in perceptual, perceptuomotor or cognitive functions considerably increased. At the theoretical level by far the most important contribution was made by Piaget, who developed a differentiated theory on the integration of "organic" (motor, sensory-motor) and mental (spatial-constructive, cognitive) functions during human ontogeny. There was a growing knowledge and recognition of the essential role of the child's "organismic make up" in the development of his adaptation to the social and physical environment. Specific learning problems were attributed to basic defects in the integration cf motor and perceptual information.

At about the same time of these developments in education and psychology there was a considerable change in neuropsychological thinking, which evolved from the previous "mechanistic" and "connectionistic" models to the idea that the nervous system functions as a differentiated whole in continuous interaction with the environment (Boring, 1960). Lashley is one of the first representatives of this theoretical movement, which owes much to Gestalt psychology (Beach et al. 1960). The nervous system is considered as "a composite of many interacting systems" and Lashley expresses the view that "the nets active in rhythmic and spatial organisation are apparently almost co-extensive with the nervous system" (Lashley 1930, 1951). Although a certain functional differentiation is not denied it is the essence of the theory that the organism acts as a whole: "within certain regions of the brain with relatively specific functions (e.g. the visual cortex) there exists equipotentality" (Lashley, 1950). Lashley and followers consider temporal and spatial integration of perception and motor activity as the essential function of the C.N.S. (Lashley, 1958).

Contemporary neuropsychological thinking as examplified by Luria (1973) considers the C.N.S. as a totally active, integrated system, responsible for the refined adaptation of the behaviour to environmental variations. Diffuse damage to the cerebrum may particularly lead to disorders in the organisation of complex behaviour, such as those described in so-called M.B.D. children.

There is a remarkable similarity in Piaget's and Lashley's thinking, indicated by their common view that in all activities the organism is totally involved. Lashley gives the example of the perception of verticality, whereby information about changes in position and motion in the visual field must be continuously integrated with information about the body posture and the tonic activity in the muscles.

Developments in clinical thinking underly some current views on neurobehavioural relationships in children. Briefly traced, these developments are the following:

Firstly, there is the effect that descriptions of phenomena associated with demonstrable brain pathology in adults have had on thinking about developmental disturbances. The "aphasia" literature in particular, focussing attention on disorders in receptive and expressive language in relation to brain disorder has affected the development of the M.B.D. concept. Disorders in the acquisition of spoken and written language become considered as analogues of such aphasic phenomena in adults (Strother, 1973). When hard evidence for brain damage is lacking in children presenting such developmental disorders, the label M.B.D. is generally used to suggest the organic background. Although earlier terms, such as developmental "aphasia" and developmental "agraphia" were gradually replaced by more neutral ones, such as "dyslexia" and "linguistic retardation", such dysfunctions still remained to be considered as signs of C.N.S. disorder, even when independent neurological evidence was lacking (Strother, 1973; Wedell, 1973). A similar development occurred in connection with other phenomena related to adult brain pathology, such as "functional retrogression" and "loss of abstract reasoning ability". By analogy developmental delays and persistent concrete modes of thinking became also in themselves considered as signs of C.N.S. disorder, although it was realised that developmental disorders were different from signs of functional disintegration in brain damaged adults.

There is a significant number of children, who have severe difficulties in acquiring spoken and written language, unaccountable for on the basis of lack of intelligence, primary sensory, motor and emotional disorders, or lack of environmental stimulation. M.B.D. becomes a usual "diagnosis" for such cases, as well as for children presenting unexplained discrepancies between the "actual" level of performance and the assumed potential.

Another important influence on the development of the M.B.D. concept has been descriptions of the behavioural consequences of known brain damage in children. As typical symptoms in children after encephalitis (Hohman, 1922; Bond, 1932) and after head-injuries, (Strecker and Ebaugh, 1924; Blau, 1937) behavioural disorders are reported such as lack of motor inhibition, extreme unselectivity in attention, emotional lability, irritability, often without intellectual impairment.

The concept of "a continuum of degrees of damage" (Strother, 1973) led to the view that minor C.N.S. disorders would be likely to manifest themselves in the disorganisation of the child's complex behaviour, even in the absence of unequivocal neurological signs. Etiological studies (initially retrospective, later also prospective), indicating relationships between complex behaviour disorders of the M.B.D. type and risk factors early in development, gave some indirect support to this view. Such findings don't justify however the "reversed" reasoning that behaviour disorders in themselves are sufficient evidence for brain damage or brain dysfunction. Strauss and associates are generally held responsible for the introduction of this sort of reasoning. They initially identified a number of psychological characteristics distinguishing brain-injured from non brain-injured mentally retarded children (Strauss and Kephart, 1940; Strauss and Lehtinen, 1948), whereas they later assume that the presence of such characteristics in themselves indicates brain damage.

These various developments all contributed to the view of "minimal brain damage" as a primary causative factor in the development of complex learning and/or behaviour disorders in children. Replacement of the term "minimal brain damage" by "minimal brain dysfunction" was more an indication of modesty than a contribution to the insight in the problem of neurobehavioural connections in children.

> In this respect the Oxford-conference in 1962 was important (Bax and MacKeith, 1963). Participants agreed that the term "minimal brain damage" should be abandoned, because of lack of evidence that structural defects formed the basis for the behavioural disorders the group was discussing. No agreement was reached, however, about another term to cover this heterogenous group of children. The editors issued the proceedings of the meeting under the title of "minimal cerebral dysfunction". This label together with "minimal brain dysfunction" replaced the earlier tag of "minimal brain damage".

A barrier to further interdisciplinary study is the discrepancy in refinedness and standardization of methods and the different level of abstraction of measures applied in the various disciplines. In medicine a major problem is the assessment and evaluation of slightly deviant neurological functions, for which the term "soft signs" was introduced. However, as indicated by Rutter et al. (1970) the term "soft" is most confusing, because it may qualify at least three types of phenomena:

1. Signs of developmental delay in functions such as speech, language, motor coordination, perception etc.

2. Signs due to both neurological and non-neurological factors (nystagmus, strabismus).
3. Slight abnormalities (generally minor examples of classical neurological signs) which are difficult to detect, such as slight asymmetries of tone, etc.

The indication "soft" may refer either to the inconsistency of the phenomena, the unreliability of their measurement, or to their dubious validity as indicators of the integrity of the C.N.S.

It makes little sense to relate in clinical studies the presence of such soft neurological signs to psychometric examination results and then to base the selection of didactical strategies on the outcomes of such studies. However, there are a number of developments in medicine, psychology and education which may lead to more fruitful interdisciplinary studies of neurobehavioural relationships in children.

In medicine methods for the standardized and comprehensive assessment of minor neurological dysfunctions and normative data, necessary for the interpretation of such phenomena become gradually available. Clinical research and practice more and more focus on problems related to the early detection of risk and the prevention of disorders. Behavioural problems are no longer solely considered as symptoms of underlying diseases, but also as factors in the psychosocial adaptation of the child.

Psychology is evolving from a one-sided interest in task performance to a growing interest in the behavioural organisation. Ethology provides a strong impetus for such a reorientation. In psycho-diagnostics there is a growing inclination to design assessment procedures in such a way as to define the most suitable modes of treatment.

In education treatment programs are being structured on the basis of explicit principles derived from observations of behaviour in and outside formal learning situations, and from a careful analysis of learning processes. Methods are being developed for the objective evaluation of the effect of treatment procedures.

However, although methods for neurological and behavioural assessment in children have been considerably improved, there remain a number of inherent difficulties, arising from the multiple determination of behavioural disorders in children and difficulties in interpretation of neurological findings in the developing organism. In the discussion at the end of this report I will expend on this problem.

What is the present state of knowledge and what seems to be the most fruitful approach in the study of neurobehavioural relationships in children?

Signs of neurological dysfunction (inclusive EEG abnormalities) are found consistently more often in children presenting learning and/or behaviour disorders of the M.B.D. type than in matched controls (Schain, 1970; Hughes, 1971; Werry, 1972; Satterfield et al., 1971; Myklebust, 1973). Children are termed hyperactives, underachievers, M.B.D.-cases, etc.; the neurological concomitants include soft signs, unspecified EEG disorders, longer latency and lower amplitude evoked cortical responses etc. An excellent review of the evidence is given by Walzer and Richmond (1973). More signs of neurological dysfunction have also been found in delinquent boys and blind children than in normal children (Wolff, Hurwitz, 1966).

In a large number of epidemiological studies complex learning and behaviour disorders of the M.B.D. type have been reported as sequelae of pre- and perinatal complications, such as anoxia and hypoxia (Rosenfeld & Bradley, 1948; Fraser & Wilks, 1959; Schachter & Abgar, 1959; Knobloch & Pasamanick, 1966) prematurity or dysmaturity (Knobloch et al., 1956) toxic factors, such as lead poisoning (Mellins & Jenkins, 1955) and infective diseases (Lurie & Levy, 1942; Hohman, 1922), and malnutrition in infancy (Richardson et al., 1973), suggesting a neurological basis for such disorders. However, outcomes of various studies are far from unequivocal, partly due to methodological differences (Gottfried, 1973).

To date there is only one study which demonstrated behavioural differences between groups distinguished solely on the basis of neurological dysfunctions. This is the study by Wolff and Hurwitz (1973), in which children presenting choreiform dyskinesia received less favourable behavioural ratings from teachers than non-choreiforms. Rutter, Graham and Birch failed to find such associations (1966).

There is a lack of experimental studies, but no shortage of clinical-impressionistic articles in the area of Minimal Brain Dysfunction (Zimet and Fishman, 1970). This has been extensively discussed in a previous survey (Kalverboer, 1971c).

By far the best clinical neuropsychiatric study into the significance of brain disorders for behavioural development is that by Rutter et al., reported in "A Neuropsychiatric Study in Childhood" (1970). However, they focus on psychiatric characteristics of children with cerebral palsy, epilepsy, and a number of other unequivocal pathological conditions. They refrain from studying "the group of less well-defined, borderline neurological disorders", which are just those disorders typically reported in relation to the M.B.D. concept.

As far as objective measurement of behaviour is concerned, one of the best studies is that by Schulman et al. (1965) on relationships between behavioural, psycho-metric and neurological measures in a group of 35 retarded boys. They introduce a number of objective measures for the evaluation of behavioural aspects, such as inconsistency, distractability, hyperactivity and emotional lability. However, they relate their behavioural findings to global ratings of brain damage derived from psychometric tests (W.I.S.C.), EEG's, and neurological examinations, the validity of which ratings as indicators of brain damage may be seriously doubted. Schulman is by no means the worst offender in using subjective and arbitrary measures. Similar usage, employing such terms as "organicity", "brain damage", and "brain dysfunction", can be found in recent literature (e.g. Sainz, 1966; Paine, 1968; Wender, 1971). Birch (1964) suggests that "medical and psychological examiners tend to use one another as the essential independent proof of the validity of their inferences".

Written in 1963, this statement still largely holds. Often it is impossible to obtain a direct and unequivocal proof of brain damage or brain dysfunction. Birch and Demb (1953) point out that, as a result, the clinical diagnosis of brain damage in children with adjustment problems is made more often than not, on essentially behavioural grounds.

Benton (1962) argues that many studies, intended to disclose "state of the organism-response" relationships, only reflect "response-response" relationships. In the words of Benton: " that is to say, they relate characteristics of psychological test performance to behavioural characteristics as clinically observed". Although it may be very useful to establish such relationships, they don't tell us anything about the consequences of brain damage, because an independent criterium for brain damage is lacking.

What conclusion can be drawn from a study of the available literature? Terms such as M.B.D. (minimal brain dysfunction) and S.L.D. (special learning disorders) refer to a group of children heterogeneous with respect to the disorders they present and the possible etiology of their adaptational problems. There is no scientific evidence linking behavioural disorders and independent signs of neurological dysfunction in children which would justify including them all in one "minimal brain dysfunction syndrome" (Schulman, 1965; Rutter, Graham and Birch, 1966; Werry, 1968). Even the relationships among the behavioural features themselves seem to be much weaker than generally assumed (Routh & Roberts, 1972). Often such relationships seem to depend more on the perceptual and cognitive schemata of the observer than on the factual behaviour of the child.

Many M.B.D. studies show fallacies, such as the following:

a. Biased groups, often groups of children referred to outpatient clinics because of behavioural and/or learning disorders.
b. Dubious criteria for brain damage or brain dysfunction.
c. Lack of standardization of methods for neurological and behavioural assessment.
d. Built-in correlations between data from different assessments.
e. Relating poorly defined so called soft neurological signs to complex behavioural disorders.

Clinical descriptions and psychometric data almost exclusively concern school-aged children presenting learning and behavioural problems. Data are lacking relating children's "free-field" behaviour to their neurological condition, although problems reported by parents often concern daily life adaptation.

The study of young children (preferably before school-age), not selected because of their adaptational problems but on the basis of their neurological make up, may be particularly fruitful.

In the light of the above discussion the best strategy in M.B.D. studies in children seems to be to analyze in detail the behavioural repertoire in relevant situations and to relate findings to those obtained in comprehensive neurological assessments. This is what this study attempts to do.

2. STATEMENT OF THE PROBLEM

The general focus of this thesis is on one of the core problems in "minor brain dysfunction" (M.B.D.), namely that of the rôle of minor neurological dysfunctions (often confusingly referred to as "soft signs") in the development of problem behaviour in children.

The material to be presented was collected during the course of a follow-up study which was one of a series of follow-up studies carried out at the Department of Developmental Neurology in Groningen since 1956.

In previous studies the focus has been on relationships between obstetrical and neonatal neurological findings (Prechtl, 1968), between neurological findings early and later in the child's development (Dijkstra, 1960; Prechtl, 1965; Touwen, 1972) and on the development of neurological functions in the course of the first postnatal weeks (Beintema, 1968). To allow for a fruitful investigation of these problems standardized methods for neurological assessments have been developed (Prechtl and Beintema, 1964; Touwen and Prechtl, 1970).

In this follow-up study which started in 1965 a new problem was systematically explored, namely that of the relationships between on the one hand neurological and on the other hand psychological and behavioural aspects (see Figure 1, flow diagram). For that purpose psychometric assessments, descriptions of the behaviour in home and school situations, and direct observations of behaviour in task and free-field settings were obtained at preschool age and resulting data were related to neonatal and preschool neurological data. This thesis deals with only that part of the total material which bears on relationships between neurological findings and "free-field"[1)] behaviour at preschool age (see flow diagram).

1) In a strict sense the term "free-field" behaviour should be applied only for the behaviour in a natural environment. In human as well as in animal research this term is also used for the behaviour shown by a freely moving subject in a laboratory-setting where the subject is only limited by the specific structure of the environment. In this report the term is mainly used in this last connotation.

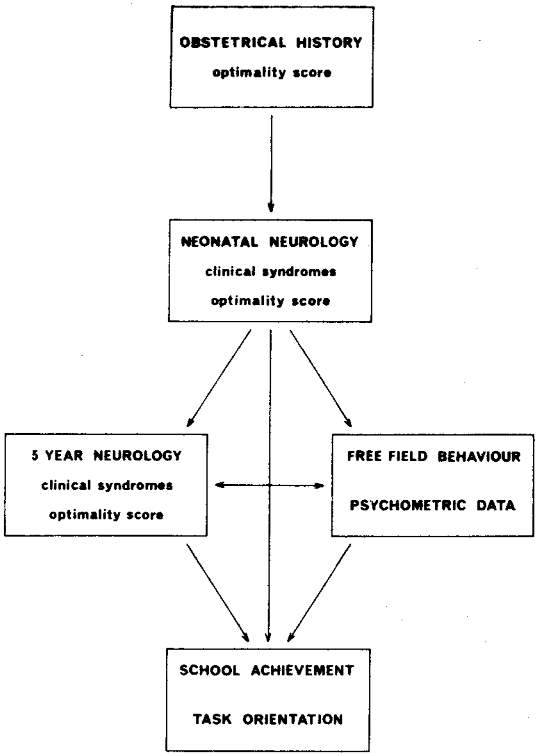

Figure 1: Flow diagram of the follow-up study.

There are two major differences between this study and most previous studies concerning the M.B.D. problem.

A. <u>Composition of the sample</u>

Most clinical M.B.D. studies deal with school-aged children in whom behaviour and/or learning problems had developed. The present study concerns 150 preschool aged children who were not selected on the basis of complaints by parents or teachers about problems in adaptation, but solely on the basis of perinatal criteria, details of which are given in chapter 4-1. At preschool age the group showed sufficient variation in minor neurological symptomatology to allow for a study of neurobehavioural relationships at that age. According to common clinical standards none of the children showed major neurological pathology and all were living in their own homes (Two cases with severe neurological disorders, due to interval complications, were excluded from the analyses).

B. Methods of behavioural and neurological assessment

Basic premises in designing this study on "free-field" behaviour were that neurobehavioural research in children should take cognisance of the complex determinants of behaviour, and allow for an objective and systematic registration and analysis of behaviour and nervous functions.

To meet these requirements data from standardized neurological assessments were related to those from systematic and detailed observations of the child's behaviour. The study was "blind" in that examiners had no knowledge of each others data nor of background data that might have biased them.

This is aimed to be an exploratory study. Therefore, children were observed in a variety of differently structured environments, so that neurobehavioural connections might have the best opportunity to show up. Environments differed with respect to their familiarity, the presence of other persons, and the amount and kinds of available toys. These aspects have been shown to be particularly important in modifying the behaviour in normal children of various ages (Arsenian, 1943; Rheingold, 1969; Hutt, 1970; Gershaw and Schwarz, 1971; Kalverboer, 1971), whereas they distinguished between children with and without upper C.N.S. lesions in free-field studies by Hutt, Hutt and Ounsted (1965).

Categories have been developed for the description of motor, visual, and verbal aspects of the behaviour. They allowed for a detailed analysis of aspects, such as the child's exploration of the environment, his contact with the mother, his play behaviour, etc.

Observational conditions and behavioural measures are described in detail in chapter 4-7.

In summary the general question studied is as follows:

What are the relationships between neurological findings and "free-field" behaviour, directly observed in variously structured environments, in a group of preschool aged children with a variety of minor neurological dysfunctions but without serious neurological handicaps and not selected because of behavioural problems?

Before coming to the actual experimental study some considerations must be given to the observational method employed.

3. OBSERVATION OF "FREE-FIELD" BEHAVIOUR AS A METHOD IN THE STUDY OF PROBLEM BEHAVIOUR IN CHILDREN

3-1 "Direct observation" as an approach in developmental studies

After the ages in which the child was considered as a small adult followed by a period of speculation on child development, the child became object of more systematic study in the second half of the 18th century.

In the early days of child psychology direct observation of the behaviour of single infants or children (in general children or relatives of the investigators) was the main source of information on child development (Pestalozzi, 1774; Tiedemann, 1787; Darwin, 1877; Preyer, 1882). Darwin expressed the opinion that "by careful observation of the infant and child, one would see the descent of man".

Although sometimes containing valuable information, these "biographical" studies were too unsystematic and too much biased by theoretical prejudice, to be good sources of scientific knowledge.

Systematic study of children started with Hall (1891), who developed questionnaire methods to study larger groups of children, and received a strong impulse when Binet initiated the development of standardized methods of measuring intelligence. It turned out to be possible to objectively assess cognitive functions in the child. However, a number of behavioural phenomena, especially those related to emotion and social behaviour, seemed to resist a more objective and quantitative approach. As a consequence, many challenging ideas about child development such as those relating to the consequences of sensory deprivation or the implications of an inconsistent social environment in early ontogeny have stayed at the level of "unproven" opinions.

Methodologically there was the ideal of the strictly controlled experiment, in its purest form holding constant all but one of the independent variables. Such an approach was unsuited to the study of more complex behaviour patterns in relatively unstructured environments. Naturalistic observations of behaviour therefore became unpopular with students of child development. At best, systematic observation was considered as an inevitable preliminary phase before hypotheses could be formulated (de Groot, 1961; Underwood, 1957). The real scientific part of the study was the experiment, in which specific stimulus-response relationships were studied removed from the "natural" context.

Although many basic problems of cognitive and emotional development may require such a highly controlled experimental approach, in many instances objectivity is achieved at the expense of a loss in relevance to behavioural phenomena in "natural" environments.

Since 1960, things have changed rapidly. Bell could find, for example, in the 10-year period before 1956 only two studies in which parent-child interaction was directly observed (Bell, 1964); from that year on the number of observational studies on social interaction steadily increased. At present we reach the situation, as Bell mentions, in which "direct observation might even be seen as an end in itself".

Ethology, with its emphasis on the observation of free-field behaviour and the analysis of the behavioural structure, and its postulation of hypothetical organizing systems gave a strong impetus to this "back to nature movement" in human research. It came to be realized that the biological significance of human behaviour could be fruitfully looked at from an evolutionary point of view. Observational methods developed in ethology are coming to be used in the study of human behaviour.

It is interesting to note that apart from ethology another, very different factor has led to a renewed interest in direct observation as a method "in its own right" in the study of human behaviour, namely the sharp increase in popularity of behaviour therapy. This statement may seem contradictory because behaviour therapy is largely based on a rather limited S-R model. However, the necessity of considering the behavioural and environmental context and the historical background of disorders is being increasingly stressed by authors, such as Barendrecht (1969) and Goldfried and Kent (1972). The latter emphasize the importance of the development of efficient measurement procedures for assessing behaviour-environment interactions in order to obtain base-rate values and to estimate objectively changes due to modification procedures. The authors stress the necessity of the right sampling of observation situations (on the basis of a situational analysis) and behavioural aspects to be observed: "The concept of content validity is particularly relevant for behaviour assessment". This remark is particularly pertinent to the study of problem children, where the question arises as to whether generalisations about behaviour in other social and physical environments can be made from observations in clinical settings.

3-2 Clinical application of the method of "free-field" observation

In standard psychological examinations, reliability of results depends largely on the child's ability and willingness to maintain a constant level and direction of attention and task orientation during the assessment period. Providing these criteria are met, the results may give a valid estimation of the child's cognitive abilities. However, children who are started to be "hyperactive", "distractable" and "impulsive", may not perform well at assigned tasks because of their task orientation problems. Yet these are exactly the aspects of behaviour that the parents and teachers often complain about. Should they not be closely observed and systematically analyzed instead of being dismissed as "irritating" epiphenomena?

The most valid way of tackling such problems would in theory be to observe directly the child's behaviour in his natural environment. However, such observations would be very time consuming, require long adaptation periods and observation conditions would lack standardization and would not lend themselves to experimental manipulation. An approach however, which may be particularly applicable in the clinical assessment of problem children is that of the observation of the unrestricted child in a more controlled environment.

The typical design of such observations in stylized environments is that

a. The subject does not receive specific instruction and his behaviour is only limited by the general structure of the physical and social environment. Introductions to observation situations serve in general to make them acceptable or predictable (e.g. by providing general information about the further procedure of the observation).
b. The behaviour repertoire is described in objectively defined catego-

ries. As much as possible interpretations as to the emotional "background" of the behaviour are avoided in the first instance. Later one can reflect on the child's motives.

Essential in such a laboratory approach is that environmental features can be systematically varied.

Environmental features particularly important in structuring children's behaviour are the unfamiliarity versus the familiarity of the environment (Arsenian, 1943; Hutt, 1967; Rheingold, 1969; Kalverboer, 1971), the presence or absence of familiar persons or objects (Arsenian, 1943; Rheingold, 1969; Kalverboer, 1971; Gershaw & Schwarz, 1971), and the degree of complexity of the situation (Rheingold, 1969; Hutt, Hutt & Ounsted, 1965). There is a growing number of studies, mainly concerning young and/or handicapped children, which throw light on the complicated relationships between these factors and behaviour. Relationships have been demonstrated between free-field behaviour and age (Hutt, Hutt & Ounsted, 1965), socio-economic class (Collard, 1971), home or institutionalised rearing (Collard, 1971), brain-damage (Hutt, Hutt & Ounsted, 1965), and sex (Hutt, 1970). Up till now standardized studies have been scattered and have mainly concerned infants and preschool children.

One of the first clinical applications of the method of free-field observation was reported by Ounsted (1955). He describes his first attempts to "crudely quantitate the defects of attention" by "letting the child run wild in the consulting room and recording and timing the duration of different activities carried out by the unfettered child".

To quote Ounsted

> "The child was released in a clinic side-room containing a small number of objects - wooden spatulae, an old tin, a teddy, some paper, a couch with blankets, etc. The mother, nurse, and doctor stood silent and made no interventions. Each activity made by the child was noted, and the duration of each line of behaviour was timed. Observations continued for five to fifteen minutes at each visit. The conditions of test were occasionally varied by making the test in more complex environments".

Later Hutt, Hutt and Ounsted (1963) developed this method further by designing an observation room with a one-way screen, and a block-pettern on the floor, so that systematic observation and registration of movement patterns could be obtained. Using this technique, they studied the free-field behaviour in children "with and without upper central nervous system lesions", which they individually observed in four situations of increasing complexity: with the room empty, with only blocks present, with blocks and a passive observer, and with blocks and an actively participating observer. Behaviours such as locomotion, attention span, and manipulation of fixtures were quantitatively scored from audio-tape recordings and films. There are close similarities between their experimental design and that in the "free-field" observations in this study.

3-3 Limiting factors in designing observational studies

A large number of factors may affect a child's behaviour and must therefore be standardized or controlled in observational studies. A number, which were identified in pilot studies, may be mentioned: Minor variations in experimental instructions may dramatically affect the behaviour of the child, because they influence his expectations. For example, does he expect to stay with the mother or to be separated from her, to play with attractive toys or to be examined by a doctor, to go home after a short or a long time? In a similar way, parents can influence the child's expectations and, thus, his behaviour in the experimental situation.

Particular "fixed" characteristics of the laboratory setting may also influence the child's behaviour: is the room soundproof? Is there a one-way screen or a block-pattern on the floor? What sort of fixtures are present? Such factors may have different effects on groups being compared. For example, in a pilot study I observed that the presence of a one-way screen had a different effect on the behaviour in preschool boys and girls (Kalverboer, 1971a). In a situation with the mother in an unfamiliar room, boys showed more motor and visual reactions towards the one-way screen than girls. Even in well-controlled laboratory studies it is sometimes overlooked that particular features of the fixed environment may affect children quite differently.

Also of importance is the sequence in which the different observational conditions are arranged. Whether the child just been separated from his mother or has played with attractive toys, are factors which may strongly affect the adaptation to subsequent situations. In preliminary studies I observed that the child's introduction to the observation room strongly affected his behaviour in the course of the observation. When there was the opportunity for the child to become acquainted with the environment in the presence of the mother, the child was less easily upset during the rest of the observation than when the child had been put alone in the unfamiliar room (this observation is in agreement with results obtained by Rheingold, 1969, in infants). In the individual observation of young children it is thus particularly important to proceed gradually from conditions in which the child feels secure through the presence or the access to a supporting figure, to conditions in which such a figure is absent. As a consequence of such a strategy it may be impossible to randomize the order of the various observations.

3-4 Problems in categorization

In a sophisticated discussion of classification problems Hinde (1971) points out:

> "The study of behavior places the investigator immediately in an inescapable predicament: it demands the use of classificatory categories, but these inevitably falsify reality. To study behaviour we have to name items of behaviour, the external factors which influence it and the processes which supposedly determine it. Naming involves classifying items together into categories, with the implication of discontinuities between the categories: we must therefore be constantly aware of the extent to which our categories really do represent discontinuities, and how far they are a matter of convenience. Furthermore, our categories must be defined in terms of specific criteria, and the nature of these will make them relevant to some problems and not to others".

From this it follows that for each "definition in objective terms" a number of more or less arbitrary decisions have to be made. This is inherent to the application of discrete categories for the description of continuously varying behavioural phenomena (Hinde, 1971). For instance, the category "to run" is applied to a number of patterns of locomotion, which though they may slightly differ, have some characteristics which distinguish them from other patterns of locomotion. The application of one label for slightly differing patterns is based on the similarity of all such patterns to an "ideal" pattern of running, which is stronger than the similarity to other defined patterns of locomotion. Categorization inevitably leads to a certain imprecion in the description of the behaviour.

The choice of a classification system will vary according to one's interest in the "morphology", the function, or the causation of behavioural patterns (Hinde, 1966). Two examples may illustrate this point:

1. Quantitative assessment of locomotion by counting the number of squares traversed by the child in a room with a block pattern on the floor, provides information about one particular aspect of motor activity. However, it does not reveal whether locomotion is part of the pattern of "exploration of the room" or of the child's play-activity. To determine such relationships, other variables such as manipulation of fixtures, visual scanning or fixation of aspects of the environment, should be recorded simultaneously.
2. In preliminary studies of preschool children it was observed that girls followed a different strategy in obtaining information about their environment than boys. In girls, visual exploration tended to change over time from "scanning" to "fixation of particular features", whereas in boys the order was reversed. This finding could only be obtained because "visual scanning" and "visual fixation" were scored as distinct categories rather than one general category "visual exploration".

A detailed description of behaviour patterns is especially essential in the study of complex disorders such as hyperactivity, and disorders in selective attention. The use of video-audio recordings increases the power of the method considerably, because it enables the investigator to refine his categorization in pilot studies and allows for a reliable application of detailed categories to complex behaviour.

3-5 The problem of "crucial" variables

In free-field observations should one select specific elements of behaviour or try to give a comprehensive description of the behaviour repertoire?

The proper answer to this question will depend on the aim of the study and the knowledge of the behavioural structure. When discrimination between an experimental and a control group is the only aim, (e.g. between children under a certain drug regime and untreated children), it may suffice to know whether changes in a specific behaviour element and theoretically or empirically related to success in treatment. However, little new insight will be obtained into the relationships between treatment and outcome by only measuring the changes in such an isolated element of the behaviour repertoire. All that can be elucidated is whether a certain treatment affects behaviour, not how it works.

3-6 Free-field observations in neurobehavioural studies

Systematic information on functional disorders in children with learning and/or behaviour problems has mainly been obtained in psychometric studies. Knowledge has accumulated concerning cognitive, spatial-constructive, perceptual, speech and language disorders in this category of children. Much less is known concerning their attention and their short and long-term memory, whereas hardly any systematic data are available about their adaptive behaviour in "task-free" situations.

However, it rarely occurs that a child presents learning disorders as an isolated phenomenon. In most instances such disorders are only symptoms of more serious problems evident in all aspects of the child's social and emotional behaviour. Furthermore, parents frequently indicate that suspect signs had shown up already at a much younger age in the child's daily life activity.

In essence, the processes involved in formal learning procedures, are similar to those involved in the child's adaptation to daily life situations. On the one hand, the individual tries to solve new problems by making use of strategies derived from previous experiences of his social and physical environment (In Piaget's terms this is the process of "assimilation"). On the other hand, the child modifies his strategies on the basis of new experiences (this is the process of "accomodation" in Piaget's terminology). Therefore the strategies employed by the child in his exploration of a novel environment or in his play-activity might provide indications about his likely behaviour in formal learning situations. This was already clearly recognized by Montessori, possibly one of the first human ethologists, who felt that the child develops by exploring the environment, whereas the main task of the teacher was to properly structure the child's environment on the basis of close observation of his spontaneous behaviour. In task-free situations not only learning strategies, but also emotional reactions and disorders in selective attention might be identified that might handicap the child in task-oriented situations.

Relating neurological findings to data derived from the direct observation of behaviour may be more meaningful than attempting to correlate neurological findings with impressions about the behaviour obtained by the use of global and indirect methods, such as questionnaires or interviews. Questions that might be studied include

- do difficulties in maintaining balance interfere with the child's goal directed activities,
- are inconsistencies in motor functions associated with fluctuations in the child's constructive behaviour,
- is neurological "dysmaturity" connected with problems in the adaptation to strange and novel situations.

3-7 Concluding remarks

Appropriately used the method of free-field observation allows for a refined analysis of complex behaviour. However, the limitations of the method should not be overlooked. As stated by Hinde (1966) it is too naieve to suppose that the behaviour repertoire as a whole can be objectively measured. Besides the subjectivity that perception of behaviour inevitably introduces, limitations arise due to the steps in the procedure that have to be followed: in the selection of observation situations, the registration of the behaviour, the description in terms of predefined categories, the use of statistical methods, and the description of the results information may be lost. Only by carefully designing observations may one hope not to lose too much important information.

Making allowance for these limitations, free-field observation can provide valuable information about problem behaviour in young children and is therefore particularly suited to neurobehavioural studies aimed at the early detection of children "at risk".

4. THE FOLLOW-UP STUDY AT PRESCHOOL AGE: SAMPLE, MEASURES AND DESIGN

4-1 Composition of the sample

Because this study is part of a larger follow-up project concerned with relationships between obstetrical and neonatal neurological findings and data at a later age, the primary criteria for the selection of subjects were as follows:

a. full term delivery (38 to 42 weeks gestation),

b. birth weight more than 2500 grams,

c. complete obstetrical and neonatal neurological records,

d. no severe neurological disorders in the neonatal period.

The records of children born in 1962 and 1963 were considered, and 180 cases fulfilling the above primary criteria were selected for possible study.

Fifteen children were excluded from the final group, because their families had moved out of the area. Fifteen others could not be included in the final sample for the following reasons:

Five parents refused at the first request, six did not appear on the day of the assessment after initial promise, two children were ill and two could not be examined because they were too upset.

There were therefore 150 children in the final sample, of whom 75 were boys and 75 girls.

4-2 Obstetrical and neonatal neurological characteristics of the group

Because hospital delivery in the Netherlands generally occurs on medical or social indication, our group carries a higher risk for obstetrical and neurological complications than the Dutch population in general. A categorization in obstetrical risk groups (Prechtl, 1968) is given in Table 1 for boys and girls separately.

Table 1 Obstetrical risk groups

	Low risk	middle risk	high risk
Boys	27	43	5
Girls	14	53	8
Total	41	96	13

Risk groups on the basis of number of non-optimal obstetrical conditions - low risk 0 or 1, middle risk 2 to 6, and high risk 7 or more. No significant difference between boys' and girls' distributions ($\chi^2 = 5.86$, df: 2, $.05 < p < .10$).

In previous analyses relationships were found between neonatal neurological optimality scores and obstetrical risk scores (based on number of non-optimal obstetric conditions) in a group of over 1300 cases (Prechtl, 1968).

Neonatal neurological examinations were carried out according to the method described by Prechtl and Beintema (1964), which is particularly designed for the neurological assessment of full-term newborn infants.

In addition to the clinical diagnosis a score for neurological optimality was assigned to each child in our study in a way analogous to the classification of the obstetrical data. The optimality score is used as an indicator of the integrity of the nervous system to avoid the difficulties involved in normal-abnormal discrimination (see Prechtl, 1972, for a discussion of this classification-problem).

Table 2 gives the classification in neonatal neurological optimality groups for boys and girls separately.

Table 2	Neonatal neurological optimality groups		
	High	intermediate	low
Boys	33	23	19
Girls	39	16	20
Total	72	39	39

Groups are composed on the basis of the number of optimal conditions - high 37 or more, intermediate 33 to 36, and low 32 or less out of 42 optimal conditions. No significant difference between boys' and girls' distributions ($X^2 = 1.78$, df: 2, $.30 < p < .50$).

Two children with severe neurological handicaps (spastic hemiplegia, oligophrenia), acquired after interval-complications (meningitis, encephalitis) were excluded from the analyses at preschool age. Two other children were later added to replace them. Excepting these cases, none of the children suffered from physical or mental disorders for which professional help had been requested. However, in approx. 25% of the group interval complications which carry a risk of producing a damage to the nervous system had occurred (Touwen, 1971).

4-3 Reasons for re-examining children at preschool age

Preschool age was preferred for this follow-up examination for the following reasons:

a. At preschool age decisions have to be taken concerning the further school training of the child. Identification at this age of children at risk of developing behaviour or learning problems may lead to prevention of more serious disorders.

b. At preschool age, children are in a rather stable social situation. Approx. 95% of the study group had attended a kindergarten for half a year or longer. Kindergarten teachers were able to provide useful information about the social adaptation of the child and his task-orientation in the kindergarten. Further, a relatively good adaptation to the hospital situation was to be expected, because the child was already used to an environment other than the home.

4-4 Some characteristics of the group at preschool age

I.Q. scores

In Table 3 intelligence quotients at preschool age are given. No significant differences were found between Stanford-Binet IQ's and Draw a Man IQ's in boys and girls. In boys Draw a Man IQ's are significantly lower than Stanford-Binet IQ's ($p < .05$).

Table 3 Intelligence Quotients at preschool age

	Boys (N=75)		Girls (N=75)		Total group (N=150)	
	M	S	M	S	M	S
Stanford-Binet IQ	104,7	13,7	103,3	13,2	104,0	13,4
Draw a Man IQ	89,8	14,3	94,5	10,6	92,1	12,8

School-training and socio-economic class of the parents

Data on school-training of the parents and socio-economic class are given in the Tables 4 and 5.

Table 4 School-training of parents

	Father (N=150)		Mother (N=150)		Combined	
	nr	%	nr	%	nr	%
Insufficient data	5	3.3	1	0.7	6	2
School mental deficiency	-	-	-	-	-	-
School special learning probl.	-	-	1	0.7	1	0.3
Elem. school (not finished)	2	1.3	2	1.3	4	1.3
Elem. school (finished - one or more grades failed)	16	10.7	26	17.3	42	14
Elem. school (finished without failing)	43	29.3	41	27.3	85	28.3
School for manual skills (not graduated)	41	27.3	42	28	83	27.7
School for manual skills (graduated)	12	8	16	10.7	28	9.3
Highschool (not graduated)	18	12	11	7.3	29	9.7
Highschool (graduated)	7	4.7	10	6.7	17	5.7
Highschool + prof. training	6	4	-	-	6	2
University	-	-	-	-	-	-

Table 5 Socio-economic class (as indicated by the father's occupation)[1)]

Socio-economic class		nr	%
I	(upper-middle)	3	2.0
II	(middle-middle)	13	8.5
III	(lower-middle)	80	53.7
IV	(upper-lower)	44	29.3
V	(lower-lower)	9	6.9
	no data available	1	0.6

The socio-economic conditions in this group are slightly below those of the Dutch population in general, probably due to the specific criteria for referral to the University Hospital for delivery.

1) Classification according to: J.J.M. van Tulder: Sociale stijging en daling in Nederland, III, 1962, Stenfert - Kroeze, Leiden.

Intactness of the family

Of the 150 children in our group, 146 were living with their own parents. Four children lived alone with their mother, because the father had died (2 cases) or the parents were divorced (2 cases).

Place of residence

Eighty-six children (57%) lived in the city or the suburbs of Groningen, a provincial town of approx. 170.000 inhabitants, 22 (15%) in country-towns, 36 (24%) in small villages or hamlets, whereas 6 (4%) lived at isolated spots in the country.

Birth rank

At the time of the follow-up examinations 21 (14%) were "only children", 63 (42%) the oldest, and 51 (34%) the youngest children in their family, whereas 15 (10%) were "in between".

Kindergarten attendance

Only 9 children (6%) were not attending a kindergarten at the time of the follow-up examination. Children in Holland start attending the kindergarten at 4 years old. The normal practice for the child is to attend at 8.30 in the morning and stay until 11.30 and return again in the afternoon from 2 till 4. These rather long Dutch kindergarten hours perhaps account for the easy way in which the children responded to the longest test situation. There were only 3 (2%) who were regularly kept home from the kindergarten during afternoons because of fatigueness (This was a much lower number than had been expected on the basis of discussions with kindergarten teachers).

Change of residence

Eighty-one children (54%) had not changed residence during the past 5 years, 14 (9%) had moved 3 years or longer ago, 37 (24,7%) between 1 and 3 years ago, and 18 (12%) less than 1 year ago. All these changes of residence were within the same area, generally within the city of Groningen, from more central parts of the town to new suburbs.

Age-range

We had attempted to keep the age-range as narrow as possible to prevent an effect of age-variation on the results. However, some scatter in the ages was inevitable. The ages ranged from 4;11 to 5;5 years. The exact distribution of ages is given in Table 6.

Table 6 Age range in the follow-up sample

Age in years and months	Boys	Girls	Total
4;11	4	1	5
5;0	11	14	25
5;1	18	25	43
5;2	17	11	28
5;3	10	9	19
5;4	13	13	26
5;5	2	2	4
N	75	75	150

4-5 General procedure

4-5-1 Preparation by the social worker

The procedure in contacting the families for participation was the following:

1) Approximately three weeks before the date of assessment parents received a written request to participate in the study with the information that a social worker of the Department would contact them.
2) Approximately one week later the social worker visited the family to inquire into their willingness to participate, to make a definite appointment for the examination and to collect initial data about the social situation of the family.
3) Again one week later the social worker sent a reminder to the family.

Parents were informed about the general purpose of the study ("we need to know more about the development of children born in this hospital to provide better guidance for parents and children"). They were also told that results would be discussed with them ("the child will be carefully examined, problems can be discussed and when necessary you will be advised about further steps to be taken"). (Treatment and further guidance were not given by the staff-members of the Department; if necessary parents were referred to the appropriate outpatient department of the hospital).

Parents were requested not to upset their children by informing them too early about the visit to the hospital and to assure the non-threatening character of the procedure. The mother was asked to accompany the child on the day of the examination (all measures were taken to prevent the child from becoming scared, thus, no white coats or instruments were in sight). The parents' permission was asked for us to contact the kindergarten to get information about the child's behaviour. The questionnaire to be submitted to the kindergarten teacher was shown first to the parents to prevent any suspicion. All parents cooperated.

4-5-2 Data collected at preschool age

Apart from the free-field observations information about the following aspects was obtained:

The social background of the child

The mother reported about the socio-economic situation of the family (precoded interview), and about her perception of the family's socio-economic situation (card-sorting procedure), whereas the social worker also gave her impressions about the family situation (precoded questionnaire).

The child's behaviour in the home environment

A written questionnaire was completed by the mother concerning the child's social behaviour in the home situation. The list has been specifically designed for the description of behaviours possibly related to minor nervous dysfunction (Schaefer, Droppleman, Kalverboer, 1966).

The child's behaviour in the school environment

A similar questionnaire was completed by the kindergarten teacher about the child's behaviour in the kindergarten. Such a list was also completed by the teacher for a control child, matched for sex, socio-economic class and age.

The medical history of the child

An interview on somatic aspects of the child's development including the presence of interval-complications was conducted by the neurologist, using a precoded form.

The psychological history of the child

An interview was conducted by the psychologist concerning the development of the child, focussing on social behaviour (interaction with peers and parents), language, play behaviour, etc., using a precoded form.

The mental development of the child

Psychological tests of perceptual, spatial-constructive, cognitive and language functions were administered. The Stanford-Binet intelligence test, the Bender-Gestalt test, the Draw a Person test, the van Alstyne test, the Frostig test for visuo-motor development and the block design subtest from the Snijders-Oomen non-verbal intelligence scale were given to all children. Also systematic observations of the child's behaviour during the test procedure were made.

Further a number of experiments were carried out concerning the child's behaviour under time stress and during tasks of varying complexity, whereas data on hand-preference during the performance of a visuo-motor task were also collected.

Results of these examinations and experiments will be published elsewhere. In this report only those pertinent to the analysis of the neurobehavioural relationships will be mentioned.

4-5-3 Time schedule on the day of the assessment

The complete assessment of each child, always in the same sequence, lasted from approx. 9 o'clock a.m. till approx. 3 o'clock p.m. Precautions were taken to prevent the examiners having foreknowledge of each other's assessment results or obstetrical and neonatal neurological data.

While the child was psychologically tested by a psychological assistant the mother was interviewed in succession by the social worker and the psychologist. After a pause of approx. thirty minutes the child was neurologically examined, after which the free-field observations and experiments were carried out. During these observations the medical history of the child was obtained by the neurologist. The day concluded with a discussion with the parents about the results of the assessments.

4-6 The neurological variables

4-6-1 The assessment of minor nervous dysfunctions

Focus in this study is on behaviour in relation to "minor nervous dysfunction". This term will be used in the connotation of Touwen and Prechtl (1970), to refer only to those functions assessed in a neurological examination. The assessment of such functions may give indications about the integrity (the intactness) of the C.N.S. (Prechtl, 1972). Disorders in complex behavioural functions, such as those generally included in the "minimal brain dysfunction" concept, are not included in this definition.

The assessment and evaluation of minor signs of nervous dysfunction in children presents a number of problems. They emanate primarily from difficulties in distinguishing between normal variations in nervous functions and minor neurological dysfunctions, a problem compounded in children by the normal changes in the developing organism. A thorough knowledge of changes in neurological functions during ontogeny is therefore indispensable.

In recent years much progress has been made in refining the measurement and the interpretation of neurological data in children. Knowledge has accumulated about the normal development of neurological functions. However, convincing data as to the pathological significance of many so called "minor neurological signs" are still scarce. Therefore the discrimination between neurologically "normal" and "abnormal" is difficult.

To avoid this difficult discrimination, the concept of "optimality" was applied (Prechtl, 1968; Touwen, 1971). A number of nervous functions were semiquantitatively assessed by the method described by Touwen and Prechtl (1970). For 52 items of the neurological examination optimal ranges have been defined by Touwen (1972). Items and ranges are given in Appendix I. By summation of the number of optimal items an "overall" optimality score and optimality scores for special groups of neurological items could be obtained. Not all functions which are included in the neurological examination contribute to optimality scores, because an optimal range could not be defined for all items.

4-6-2 The neurological optimality score

Each child obtained an "overall" optimality score which is taken as a general measure for the integrity of the nervous system. This score equals the number of items out of the predetermined list of 52 on which the child's score is within the previously defined optimal range.

For further analysis the neurologist distinguished between a high score group (48 to 52 optimal conditions), an intermediate score group (44 to 47 optimal conditions), and a low score group (43 or less optimal conditions, the lowest score being 36). Cut-off points between groups were set in order to obtain a sufficient number of cases in each group and independent of results of behavioural observations. The groups are represented in Figure 2 for boys and girls separately.

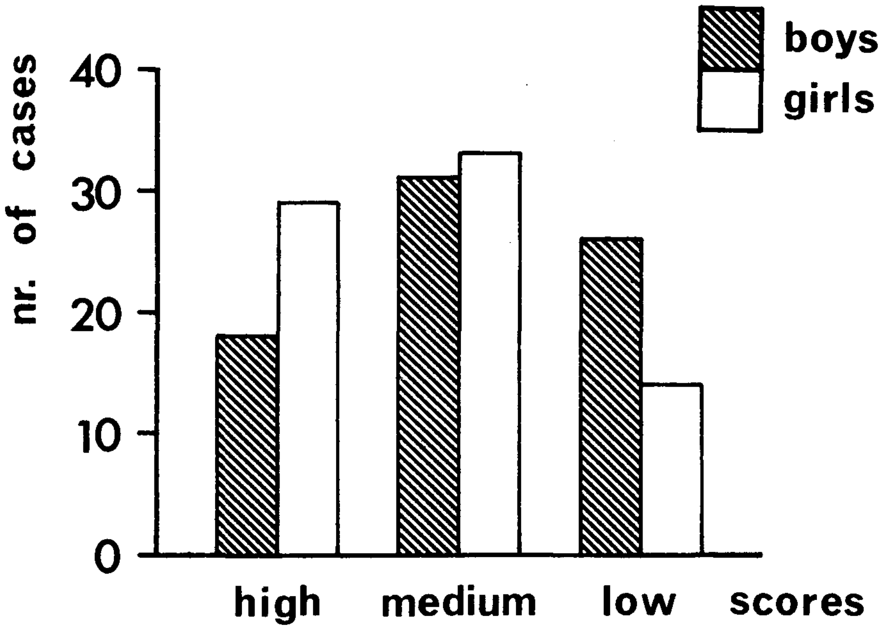

Fig. 2 Neurological optimality groups at preschool age. Groups are composed on the basis of the number of optimal conditions (see text). Difference between boys' and girls' distributions significant below .05 level (X^2 = 5.83, df: 2).

I used these groups in a preliminary analysis (discussed in section 7-5-1), to get a first impression of neurobehavioural relationships in this preschool group.

4-6-3 Functional categories of neurological items

Items were grouped by the neurologist on the basis of clinical criteria, supported by cluster- and factor-analysis (Touwen and Kalverboer, 1973). The following neurological groups, represented in the Tables 7a-f, are included in this analysis,

a. sensorimotor
b. posture
c. coordination
d. choreiform movements
e. maturation of responses
f. maturation of functions

Table 7 Functional categories of neurological items: sex differences

sensorimotor

	Number of non-optimal items									
	0	1	2	3	4	5	6	7	8	9
No. of boys	18	13	10	11	9	5	5	2	1	1
No. of girls	31	17	12	3	5	5	-	2	-	-

Difference between boys' and girls' distributions significant below .02 level. (X^2 = 16.60, df: 6); 6 to 9 were combined because of too low frequencies.

posture

	Number of non-optimal items					
	0	1	2	3	4	5
No. of boys	42	20	6	5	-	2
No. of girls	49	14	7	4	2	-

No significant difference between boys' and girls' distributions (X^2 = 2.17, df: 3, $.50 < p < .70$); 3 to 5 were combined because of too low frequencies.

coordination

	Number of non-optimal items					
	0	1	2	3	4	5
No. of boys	35	26	9	2	2	1
No. of girls	41	19	12	3	-	-

No significant difference between boys' and girls' distributions (X^2 = 2.49, df: 3, $.30 < p < .50$); 3 to 5 were combined because of too low frequencies.

choreiform movements

	Number of locations			
	0	1	2	3
No. of boys	12	14	25	24
No. of girls	27	9	25	14

Difference between boys' and girls' distributions significant below .05 level. ($X^2 = 9.49$, df: 3, $p < .05$).

maturation of responses

	Number of non-optimal items				
	0	1	2	3	4
No. of boys	17	28	10	13	7
No. of girls	23	31	11	8	2

No significant difference between boys' and girls' distributions ($X^2 = 8.70$, df: 4, $.05 < p < .10$).

maturation of functions

	Number of non-optimal items							
	0	1	2	3	4	5	6	7
No. of boys	3	4	3	10	13	16	22	4
No. of girls	9	12	10	13	11	11	7	1

Difference between boys' and girls' distributions significant below .01 level. (6-7 combined for X^2 computation; $X^2 = 21.66$, df: 7).

Items included in each of these categories are listed in Appendix II.

The "sensorimotor" category includes items on muscle tone, threshold and intensity of responses. The main deviations observed in this category at preschool age are minor signs of hypotonia, symmetrical in 30%, asymmetrical in 35% of the children presenting non-optimal signs in the sensorimotor category. Only in a few cases slight hypertonia was observed (approx. 10% of the children presenting sensorimotor deviations).

The category "posture" contains items on the body posture during standing, walking and sitting. The main deviations (70%) observed in this category at preschool age were lateralizations without definable deviations in muscle tone and hypotonia (25%). Only in a few cases a slight hypertonia was observed.

The category "coordination" contains two sorts of closely related functions, balance of the trunk (represented by responses such as response to push) and coordination of the extremities (represented by kicking against the hand of the examiner, the fingertip-nose test, etc.). Approx. 30% of the disorders in coordination concern the first, 70% the second aspect. Non-optimality indicates that there is some impairment in motor coordination without a further qualitative differentiation.

"Choreiform movements" ("small jerky movements which occur irregularly and arhythmically in different muscles", Touwen and Prechtl, 1970) are evaluated in the fingers, arms, trunk and face. Non-optimality refers to the number of locations at which choreiform dyskinesia is observed.

The category "maturation of functions" concerns the age-appropriateness of complex functions, such as walking, hopping, standing on one leg, etc. Non-optimality indicates that there is a maturational lag in such functions.

The category "maturation of responses" concerns the age-appropriateness of a number of specific reactions. Non-optimality indicates that there is some persistence of infantile responses or a certain delay in the development of responses.

From the foregoing it may be concluded that non-optimality in one of these neurological categories may have different meanings. However, in view of the variety of neurological phenomena in this (relatively small) preschool group, further refinement of scores would not have been fruitful.

I used these six neurological groups in a more detailed analysis on neurobehavioural relationships at preschool age described in section 7-5-4.

In Table 8 correlations among these neurological groups are given. They are generally low and indicate that sensorimotor functions particularly relate to posture, coordination and maturation of functions and responses, that coordination relates to both maturation categories, and that the categories maturation of functions and responses are related to each other.

Table 8 Correlations between neurological categories (N=150)

	Sensori-motor	Posture	Coordi-nation	Chorei-formity	Matur. of functions	Matur. of responses
Sensorimotor	-	.25*	.33*	.17	.32*	.39*
Posture	-	-	.02	.10	.17	.19
Coordination	-	-	-	.04	.33*	.29*
Choreiformity	-	-	-	-	.03	.04
Maturation of functions	-	-	-	-	-	.32*
Maturation of responses	-	-	-	-	-	-

* significant below .01 level (two-tailed)

4-7 Considerations in designing the observations and selecting the behavioural categories

This is an exploratory study. Its main purpose is to analyse free-field behaviour and to relate findings to those obtained in independent neurological examinations at the same age.

Because of this aim of the study, children were observed in a variety of environments and behaviour was described in detail. The observational conditions differed as to a number of aspects, important in structuring the behaviour of preschool children.

On the basis of background data derived from the M.B.D. literature, free-field studies in children and animals and pilot studies of my own, six observational conditions were selected which differed with respect to the familiarity of the environment, the presence of a familiar person, and the complexity of the environmental stimulation. Conditions and instructions are presented on page 41 and following, and in App. IV.

It was the intention that behavioural categories should allow for a detailed description of the child's behaviour with respect to physical and social aspects of the environment (room, toys, mother) and to the own body. They should be defined in objective terms, as little as possible contaminated by preconception about the "intention behind the behaviour".

Background data for the selection of such categories were rather scarce and come mainly from the previously mentioned series of studies by Hutt, Hutt and Ounsted in children with brain disorder and studies by Berkson on stereotyped movements in mentally defective children. Information from those studies and data derived from clinical descriptions and studies of M.B.D. children and a number of pilot studies of my own led to the selection of the behavioural categories defined in Appendix V, which were scored from video-audio recordings. They represent aspects of motor, visual and verbal behaviour, which allow for a detailed description of the child's behaviour.

Purposely, no global behavioural categories, such as "exploration" or "contact with mother" were applied in the video-analysis. Previous studies had demonstrated that these were not "unitary" concepts (Hutt, 1970; Kalverboer, 1971). Behaviours traditionally included in such "conglomerates" can have quite different functions, depending on the structure of the environment and the phase of the observation in which the behaviour occurs. Moreover, I wished to obtain detailed information about the way in which the child explored the room, contacted the mother, reacted towards the one-way screen or the toys, etc. Because of the complex determination of the adaptive behaviour in children, the implications of minor dysfunctions of the C.N.S. for complex behaviour might be so subtle, that they only may be revealed in detailed analyses of the behaviour repertoire.

A short characterization of each of the observations follows.[1)]

Each child spent the first three minutes together with the mother in the empty room (see Figure 3, room-plan). The child had not been in this room previously. Behaviour thus could be observed related to the aspects of novelty, and strangeness of the environment. In an unfamiliar environment exploratory activity and "distress" reactions can be expected (Berlyne, 1960; Arsenian, 1943; Rheingold, 1968). This situation was deliberately chosen so that such behaviour might be observed in relation to the contact behaviour with the mother (Kalverboer, 1971). Pilot studies had indicated, that in this group of children the mother needed to be present in this initial phase of the observation, to avoid <u>severe</u> distress reactions and to maintain the cooperation of the child in later sessions. This is in agreement with experiences by Rheingold, Arsenian and others, who report that the mother serves as a security base or a base for operations.

[1)] Details of the design of the observations are given in section 4-8-2 (p.41), and in Appendix IV.

ROOM - PLAN

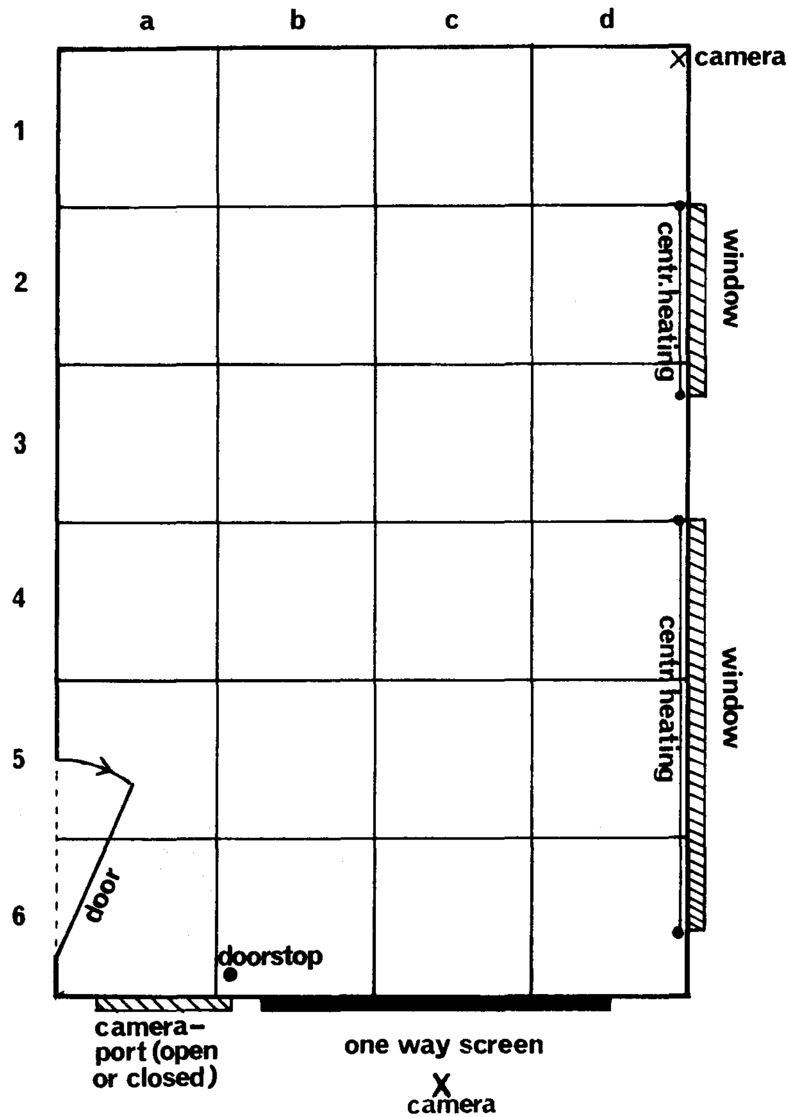

Figure 3. Plan of the observation room. The squares represent the block pattern on the floor.

After a thirty minute session in which experimental tasks are given to the child in a relaxed atmosphere, the child is required to wait alone in the empty room for three minutes. Then follows a ten minute period, during which the child plays with blocks in the presence of a passive observer, after which follows a further three minute period when the child is alone.

These two conditions "alone" are introduced to observe the child in a situation with a low level of environmental variation (a mild form of sensory deprivation), which situation is mildly stressing, because of the child being alone in the room. Amount and patterning of room-and body-oriented activity may provide information about possible effects of minor neurological dysfunctions on the child's adaptation in a less favourable situation. The child's habituation to such a situation may be indicated by comparing the child's exploratory and body-oriented activity during the first and the second time alone in the empty room.

In the condition "with blocks and a passive observer" the child's "selective" behaviour can be observed when confronted with relatively homogeneous material. This condition allows for estimating the constructive level, as well as the consistency of the child's play-activity and the time during which he is engaged in such activities. Such observations may indicate, in how far the child is able to maintain orientation to a specific task. An interesting aspect is further, whether elements of the motor activity, such as the child's locomotion and his changes in body posture, are incorporated in the play activity or interfere with it.

Because this observation is rather early in the procedure, and the attractiveness of the blocks may be rather low for a number of children (as indicated in pilot studies), an observer is present to prevent the child from becoming upset.

The condition "for the second time alone in the empty room" is followed by one, in which a standard set of varied and attractive toys is placed in a standard position on the floor. During this fifteen-minute observation the child's "selective" behaviour in a relatively complex and stimulating environment can be observed. Also in this condition connections between the child's gross motor activity and level and consistency of the play behaviour may be observed.

In the last observational condition, all the toys which were present in the previous conditions, are removed, except one toy to which the child had paid the least attention. The duration of this observation is five minutes. Purpose is to observe how the child adapts to a mildly "frustrating" situation.

The six conditions differ in complex ways. Not only the specific structure of the environment but also the transitions from one condition to the other may affect the child's behaviour. No systematic randomisation of conditions could be realized. In some instances the order of conditions was even essential for the definition of the condition, e.g. the condition with one toy necessarily follows the condition with the variety of toys. Therefore, no answers can be given to questions, such as: What is the effect of the presence of the mother on the child's initial adaptation, of the complexity of toys on the level and consistency of the play activity, etc.

4-8 Practical design: observational conditions and behavioural categories

4-8-1 Room and recording procedure[1)]

The children were observed in the Department of Developmental Neurology in an air-conditioned, well-illuminated observation room (size 4.80 x 3.20 metres) with a checker-board pattern on the floor (see Figure 3). The walls of the observation room were painted dull green to prevent reflection. This room was purposely similar to the one employed by Hutt, Hutt and Ounsted (1965). The size of each square on the floor is 80 x 80 cm, which in studies of others and in my preliminary studies proved to be the optimal size (Hutt and Hutt, personal comm.). Smaller squares may give too many boundary-problems, larger squares too much loss of information about the spatial position of the child.

During observations, video-equipment and one of the camera's were placed in an adjacent room, which was separated from the observation room by a wall with a one-way screen (size 0.60 x 1.50 metres) through which the video-recordings were made (to ensure a good recording and to prevent the child from looking through the screen the adjacent room was darkened during the recording procedure).

A second camera with a wide angle lens was placed in fixed position in a corner of the observation room, opposite to the one-way screen. This arrangement meant that the child was always within the reach of at least

1) For details about video and audio equipment see the technical note in Appendix III.

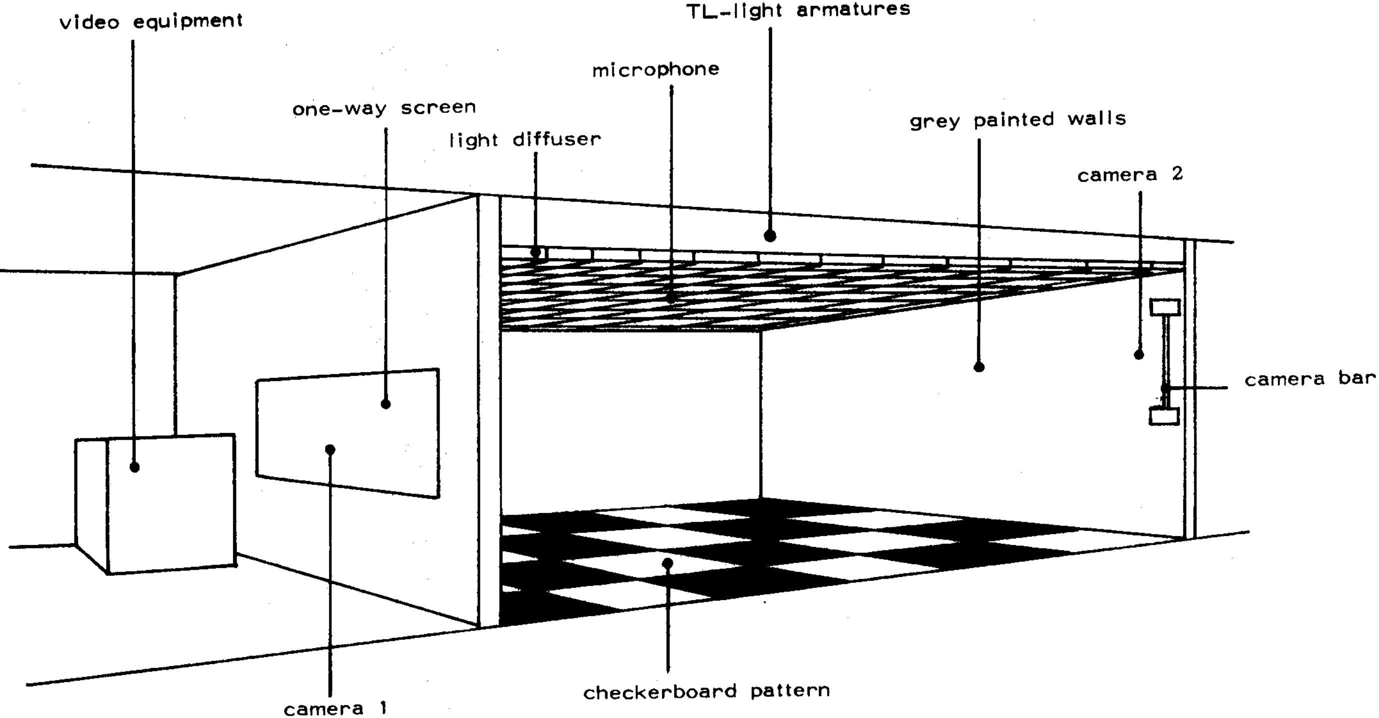

Figure 4 Schematic representation of observation and registration room.

one of the two camera's.

Sound was recorded by a hidden microphone. A Sony video-recorder was employed and the entire observation of a particular child was recorded on one tape. On one of the two audio-channels of the video tape was a 10-second time-signal (necessary for an exact time-sampling), whereas on the other audio channel sounds from the room were recorded (vocalization, sound during play, etc.).

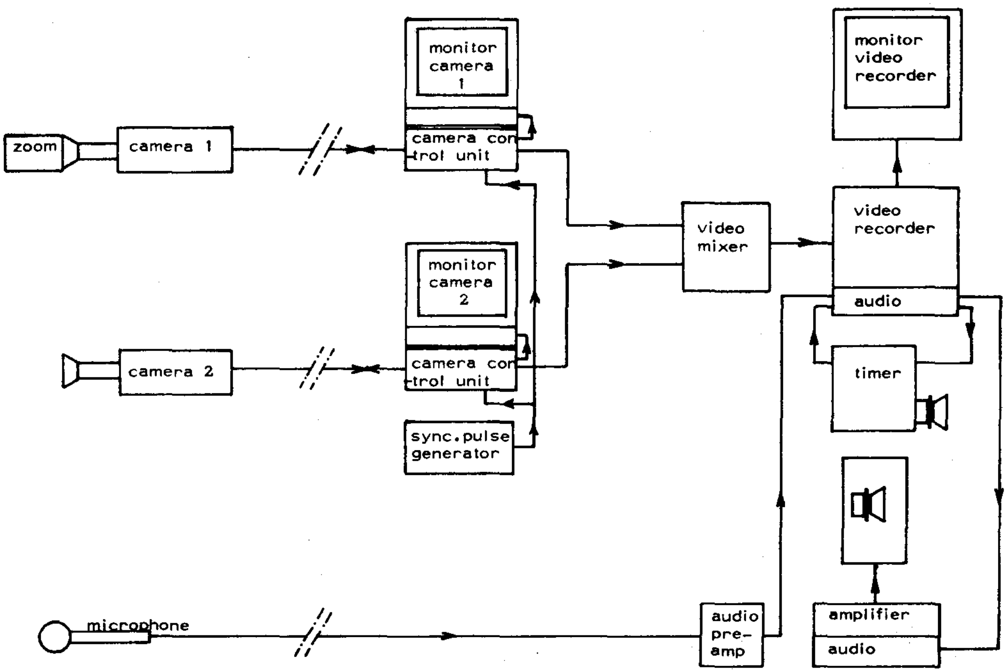

Figure 5. Video-audio connections.

4-8-2 Experimental situations and instructions

Before the observation started, the mother was informed about the video-recording of the child's behaviour. She was requested not to inform the child about it before the observation was finished (all mothers conformed to this request).

Video-recording started as soon as the door of the observation room was opened by the experimenter to let mother and child in for the first observational session. Behaviour was continuously recorded during the entire observation of 65-70 minutes. After the session, the mother and child were shown the video-equipment and the child watched himself playing.

Each child was observed in six conditions, always in the following sequence:

1. Together with mother in the empty room (3 min.). The mother was sitting on a stool on square a_4 (see Fig. 3) and was asked not to interfere with the child's behaviour.
2. Alone in the empty room (3 min.).
3. With a box of blocks on square b_2 and a passive observer sitting on square d_6 (10 min.).
4. Alone in the empty room (3 min.).
5. Alone with a variety of toys (15 min.).
6. Alone with one "non-motivating" toy (5 min.): only the least manipulated toy of the previous condition was left in the room.

In all observational conditions the child was allowed to move around freely.

N.B.: Between the sessions "with mother in the empty room" and "alone in the empty room for the first time" a number of experimental tasks were given to the child, lasting approx. 30 minutes. Tasks were performed in direct contact with the examiner in an atmosphere as relaxed as possible, so that, in general, children felt quite at ease at the end of that session.

In all observations the door was left unlocked. When a child tried to leave the room during an observation, he was quietly asked to stay. Only when a child was dramatically upset (indicated by crying or screaming) the observation was terminated or replaced by a less "threatening" observation. This proved to be necessary in three cases, always in the conditions "alone in the empty room".

Standardized introductions were given to each of the observational conditions. They were phrased to help the child feel at ease; his behaviour was structured as little as possible, the examiner aiming to make the procedure predictable and non-threatening for the child.

The exact instructions to each of the observational conditions are given in Appendix IV.

4-8-3 Behavioural categories, applied in the observation of video-recordings

4-8-3-1 Definitions

Detailed categories, applied in the observation of video-recorded behaviour, were partly developed in pilot studies by my own, partly derived from studies carried out by Hutt et al. (1963), Berkson (1969), and McGrew (1972). Details on definition and measurement are given in Appendices V to IX.

In chapter 6 on the structure of the behaviour relationships between these behavioural variables will be discussed. More complex behaviours, consisting of combinations of related variables will be labelled as "behaviour patterns".

Categories are, as far as possible, defined in descriptive terms. Only in a few behaviours, such as "gestures" and "exploratory play" is the function of the behaviour suggested by the label.

4-8-3-2 Scoring procedure

Behaviour was scored from video-audio recordings on predesigned sheets. In Appendices X and XI protocol sheets are given designed for the observation of behaviour in sessions with and without play-material. The total duration of each observation is divided in 10-second epochs, marked by auditory signals on the tape. Behaviour was continuously scored by two cooperating assistents, one giving an oral description of the behaviour, the other filling in the protocol-sheet according to the oral accounts.

The observer described the behaviour as "closely" in time as possible, her coworker wrote down the spoken comments, lowering one row on the protocol-sheet after each 10 second signal (A small time lapse is inevitable, but can be kept to a minimum by using slow-motion playing when behaviour changes too quickly).

Only two or three variables could be scored at a time, so that one recording had to be repeated three to five times (depending on the particular observation) before behaviour was completely described. Recordings of all 150 children were scored by the same two observers. The author himself did not participate in this scoring procedure to avoid bias. He only participated in controlscorings to check whether shifts in the application of behavioural categories had occurred. It took approximately twelve man hours to score all observations in one child, because in a number of categories (such as in those concerning the play activity) behaviour was continuously described, and not scored in precoded categories; this procedure allowed for a more flexible analysis in these categories than the application of a more rigid system of precoding.

Results in this study are mainly based on total scores, that represent frequencies or durations (in seconds) of behaviours in each of the observational conditions.

A frequency score is obtained by counting the number of times that a certain behaviour has occurred during an observation or the number of 10 second epochs during which it has been observed.

This last procedure was followed to simplify scoring in a number of variables in which a "coarse-grained" analysis was sufficient. Such variables are: tactile, visual and verbal contact with the mother, and vocalisation in the play situations (see Appendix V). In a pilot analysis of 20 completely scored cases, approx. the same relationships were found between behavioural variables, with the use of this simplified scoring method as with a method of precisely counting events.

The time during which children showed particular behaviour was estimated on the basis of the number of 10 second epochs or parts of 10 second epochs, during which such a behaviour had been observed. The exact measurement of the duration of behaviours would have been a too time consuming procedure (E.g., when visual fixation and scanning both occurred in the same 10 second epoch, each behaviour obtained a duration score of 5 seconds; in case of 3 mutually exclusive behaviours each obtained a score of 3 1/3 second. The total duration score was rounded off after summation).

Scores in most categories were directly derived from the protocols. However, in the variables "spatial contact with mother" and in all the play activity variables, one additional step was necessary.

Spatial contact with mother: in this category two scores were given, one longest and one shortest distance score, on the basis of the instructions given at the schema in Appendix XII. The correlation between these two contact measures was .97. Therefore only one of them (the shortest distance score) was included in the "overall" analysis.

The play activity was continuously described on the protocol. from such written descriptions, the numbers of play activities and of toys handled by the child, and scores for the level of the various play activities, were derived, according to the definitions in the Appendices V, VII and VIII.

In the categories "locomotion" and "visual behaviour" some arbitrary decisions had to be taken to guarantee a consistent application of the definitions.
In the category "locomotion" such a decision concerned the spatial position of the child with respect to the boundaries between blocks:

When the child's position was on a boundary, it was scored according to the following convention,
a) in positions in which both feet supported the body, the score was determined by the position of the right foot,
b) in a sitting posture the score was determined by the block on which the buttocks were (When the buttocks were on the boundary of two blocks, than the right part of the body determined the position score),
c) in a lying position, by the block on which the trunk was,
d) in other instances the position score was determined by the position of the supporting part of the body.

Visual behaviour was considered as "visual fixation", when the glance was one second or longer in one direction, otherwise it was scored as "visual scanning" or "looking straight ahead".

5. PILOT STUDIES AND PRELIMINARY ANALYSES

In this section I will first briefly discuss a number of pilot observations and analyses which were necessary for the designing of the free-field observations in the follow-up study at preschool age (5-1). Further, results of preliminary studies on the reliability of the scoring and coding of behavioural categories will be discussed (5-2).

5-1 The design of the observations

Decisions concerning the observational design were made on the basis of pilot studies which took about 1½ years. They were necessary to find an "optimal" solution for problems such as:

- the design of the observational conditions, e.g. the kinds of toys to be used, the presence or absence of persons, the standardization of instructions, etc.,
- the sequence and duration of observations,
- the choice of behavioural categories and the operationalization of behaviours to be recorded.

Children from the following categories were included in these preliminary studies:

a) Children from a kindergarten in the city of Groningen were observed in school situations as well as in the standard playing room in our laboratory (N=30).

The function of these observations was to determine which toys were selected by "normal" preschool aged children from a larger set of toys, how long these children played with various types of toys etc. On the basis of this information toys were selected which differed with respect to their "attractiveness" (as measured by the duration of the child's play activities), and determined what would be the "optimal" length of play observations in the laboratory-setting.

b) children of different ages with various neurological handicaps, mainly in- and out-patients of the Child Neurology Department of the University Hospital in Groningen (N=30).

These observations were necessary to determine whether a preliminary set of behavioural categories, developed on the basis of observations of undisturbed children, could also be applied to describe behaviour in children with neurological handicaps. On the basis of information gained in these observations, categories were modified or added in order to make them suited for the description of a wide variety of behavioural phenomena.

c) A group of preschool aged children (N=30), selected from the records in the Department of Developmental Neurology. This group is comparable with the final group of 150 children studied with respect to age, socio-economic class, acquaintance with the hospital situation, obstetrical and neonatal documentation,etc.

On the basis of these analyses decisions were made concerning,

- the time-schedule for the examinations and interviews on the day of the assessment,
- the definition of behavioural variables,
- the recording procedure,
- the introduction of the child and the mother to the various parts of the behavioural observation, etc.

One of the main problems that had to be solved was how to avoid the child becoming upset in situations in which he would be separated from the mother or would experience a mild degree of deprivation or external stress (e.g. during waiting alone in the empty room or during staying alone in the room with one non-attractive toy). Furthermore, these observations served to optimalize the video-recording of the behaviour and to improve the reliability of the scoring procedure.

An important preliminary study concerned the reliability of the scoring of behavioural categories, operationalized as the frequency of occurrance per observational condition. In the next section the main results of this analysis will be given.

5-2 Reliability of behavioural measures

5-2-1 Procedure

To estimate the reliability of the scoring and coding of the behaviour 15 complete recordings, each including all six observational conditions, were scored twice from video-audio recordings.

In this section I will use the term scoring for the procedure of describing the observed behaviour on the protocol-sheets, partly in terms of predefined categories, partly in terms of a continuous registration of the child's activities. The term coding is used for the process of deriving data, which can be put on punch-cards, from the protocols. Most behavioural categories were already precoded on the protocol-sheet. However, a number of scores had to be derived from the continuous descriptions of the child's activities (e.g. play activity measures, number of body postures and movement patterns).

In this reliability study three different procedures were followed:

a) Ten complete observations were scored from video-audio recordings by two observers, independent of each other. Scores of both observers were coded by the same person.

This procedure shows in how far scores given by two different observers are interchangeable (interscorer reliability). It indicates to what extent categories can be applied unequivocally and objectively. This information may be useful for the possible application of these categories in future studies.

b) Five complete observations were scored twice on two sessions six weeks apart from video-audio recordings by two cooperating observers, and coded by a third person. For convenience this procedure was also followed in the study itself. Since this is so and the same people made the observations in the reliability study as in the follow-up project the results of this reliability study may be most indicative of the reliability of scores in the follow-up material. However, this procedure gives only limited information about the unambiguity of the behavioural definitions per se, because communication between observers could affect the scores given.

c) After all the data in the preschool follow-up group had been collected a third study was performed to assess the reliability of the coding procedure itself. For this purpose 120 protocols, all concerning the condition: "with mother in the novel, empty room", were coded by two different assistants independent of each other. This particular observational condition was chosen because it contained, apart from the variables related to the play activity, all the behavioural measures which were applied in my study. No formal reliability study of play measures was carried out. Instead, play variables were scored of ten complete protocols by three people independently and scores were compared. On that basis final decisions on the coding of play variables were made.

5-2-2 Measures for the reliability estimation

Because the analysis in this study does not require alloc ation of events to specific time intervals, the best way to express agreement is by correlating scores assigned by different observers or in different scoring procedures (Costello, 1973). Therefore, product-moment correlations between the scores assigned to the same subjects by different observers were computed. To be sure that a systematic difference did not exist between the scores of each of the observers, I also compared means and standard-deviations of the scores of each observer. Results of these analyses are presented in Table 9. Because correlations can be inflated considerably by a large number of "double zero's (both scorers not having observed that particular behaviour), this number is also presented in the table.

Correlation coefficients for the interscorer reliability (first procedure)and the score-rescore agreement (second procedure) were generally computed over scores, derived from all the observational conditions. However, for a number of variables coefficients are also computed separately for empty room and play conditions. In a few categories this was inevitable, because they were only applied in specific conditions.

In a number of variables reliability estimates were derived from sumscores over observational conditions of varying lengths (lasting 3', 5', 10' or 15'). Such sum-scores are the basic data used in the analyses of neurobehavioural relationships at preschool age. However, in some categories (e.g. the play activity measures) the number of sumscores, available for the reliability analyses, was too small to give meaningful results. Therefore, the total duration of play sessions was divided into three minute epochs. In a number of reliability analyses such three minute scores were introduced instead of scores over total observation sessions. For the same reason one minute scores were used in the reliability estimation of the contact variables.

5-2-3 Interscorer reliability: video-audio recordings scored by two different observers independent of each other.

Correlation coefficients were computed for all the observational conditions together (pooled) as well as for the empty room and play conditions separately.

Table 9 Reliability of the scoring of free-field behaviour from video-audio recordings[a)]

Categories	Interscorer reliability: Pairs of scores	Double zero's	r*	Condition	Score-rescore agreement: Pairs of scores	Double zero's	r
1. Locomotion	130	8	.99	pooled[c)]	65	2	.99
Locomotion	30	2	.99	empty room			
2. Changes of body postures	130	6	.79	pooled	65	4	.92
Changes of body postures	30	3	.77	empty room			
3. Types of body postures	60	0	.87	pooled	23	0	.95
Types of body postures	30	0	.87	empty room			
4. Changes of locomotion patterns	130	11	.86	pooled	65	4	.92
Changes of locomotion patterns	30	0	.92	empty room			
5. Types of locomotion patterns	60	0	.84	pooled	23	0	.92
Types of locomotion patterns	30	0	.91	empty room			
6. Movements towards one-way screen	130	98	.90	pooled	65	14	.93
Movements towards one-way screen	30	4	.87	empty room			
7. Additional movements (discrete)	130	101	.82	pooled	65	17	.63
Additional movements (discrete)	30	14	.96	empty room			
8. Additional movements (contin.)	60	28	.82	pooled	23	11	.56
Additional movements (contin.)	30	16	.84	empty room			
9. Types of additional movements	60	36	.67	pooled	23	10	.62
Types of additional movements	30	14	.72	empty room			
10. Gestures	130	104	.80	pooled	65	50	.92
Gestures	30	17	.83	empty room			
11. Manipulation of fixtures	30	16	.83	Play	23	11	.91
Manipulation of fixtures	30	6	.61	empty room			
12. Types of manip. fixtures	30	6	.43	empty room	11	5	.50
13. Manipulation of own body/clothes	60	8	.80	pooled	23	5	.84
Manipulation of own body/clothes	30	0	.82	empty room			
14. Visual fixation (nr)	130	70	.96	pooled	65	23	.97
Visual fixation (nr)	30	0	.87	empty room			
15. Looking around (= vis. scanning)(nr.)	130	72	.89	pooled	65	38	.87
Looking around (= vis. scanning)(nr.)	30	2	.83	empty room			
16. Looking straight ahead (nr.)	130	96	.83	pooled	65	48	.83
Looking straight ahead (nr.)	30	5	.72	empty room			

* Pearson product-moment correlation

Categories	Interscorer reliability: Pairs of scores	Double zero's	r	Condition	Score-rescore agreement: Pairs of scores	Double zero's	r
17. Sounds (non verbal)	60	50	.88	pooled	23	17	.90
Sounds (non verbal)	30	26	.86	empty room			
18. Verbalisation	60	43	.74	pooled	23	16	.71
Verbalisation	30	22	.96	empty room			
19. Crying	60	56	.00	pooled	–	–	– [b]
20. Spatial contact Ch-M	10(30) [d]	0	.84(.91)	Mo	5(15)	0	(.82) [d]
21. Tactile contact Ch-M (discr.)	10(30)	2(9)	.90(.92)	Mo	5(15)	0(6)	(.72)
22. Tactile contact Ch-M (contin.)	10(30)	4(17)	.69(.74)	Mo	5(15)	1(3)	(.70)
23a. Visual contact Ch-M	10(30)	0(8)	.74(.89)	Mo	5(15)	0	(.76)
23b. Visual contact with mother or observer	39	5	.84	Mo	16	2	(.96)
24. Verbal contact with mother or observer	20	5	.89	Mo	8	0	(.?) [b]
25. Tactile contact M-Ch	10(30)	5(18)	.75(.78)	Mo	–	–	– [b]
26. Verbal contact M-Ch	10(30)	6(20)	.90(.92)	Mo	–	–	–
27. Play activity level I	100	45	.73	Play	40	19	.75
28. Play activity level II	100	18	.83	Play	40	6	.86
29. Play activity level IIE	100	24	.70	Play	40	14	.69
30. Play activity level III	100	6	.87	Play	40	2	.90
31. Play activity level IV	100	71	.91	Play	40	35	.99
32. Tidying up activity	100	82	.90	Play	40	36	.89
33. Changes in play activity	70	5	.83	Vartoys	28	1	.84
34. Nr. of manipulated toys	50	5	.82	Blocks+Vartoys	20	0	.73
35. Changes in level of play activity	100	17	.80	Play	40	12	.84
36. Types of manip. toys	10	0	.90	Vartoys	5	0	– [b]
37. Longest play activity (dur.)	17	0	.74	Vartoys	10	0	.88
38. Absence of play activity (nr.)	100	60	.81	Play	40	20	.84
Absence of play activity (dur.)	100	60	.98	Play	40	20	.87

a) Because there were no significant differences between mean values of any of the variables these values are not presented.

b) Insufficient data available for reliability estimation.

c) "Pooled" indicates that reliability coefficients are based on three minute scores from all six observational conditions.
"Empty" indicates that reliability coefficients are based on three minute scores, obtained in "empty room" conditions (alone or with mother).
"Play" indicates that reliability coefficients are based on three minute scores, obtained in all three play conditions.
"Vartoys" is condition with variety of toys, "Blocks" is condition with blocks.

d) Numbers between parentheses refer to control reliability analyses based on 30 or 15 pairs of one minute scores.

The variables 1 to 19 in Table 9 were scored in each of the six observational conditions. They concern: gross body activity, visual exploration, manipulation of fixtures, manipulation of body/clothes and sounds (vocalisation and crying).

The variables 20 to 26 were only scored in the condition "with mother in the empty, novel room, with the exception of the variables 23 and 24, which were also scored in the condition with blocks. These variables concern aspects of the contact with the mother or the observer.

Scores for the variables 27 to 38 were only obtained in the play conditions. These variables concern the duration, level and consistency of play activity.

Reliability coefficients are computed over different numbers of measures. Furthermore, a large and varying number of double zero's were found in some variables. As a consequence, these coefficients differ as to their meaningfulness and stability. In a few variables the number of measures available for the analysis was too small for the computation of a reliability coefficient.

The following results were obtained:

1) <u>Motor activity measures</u> (variables 1 to 10 in table 9)

Reliability coefficients are generally slightly higher in the "empty room" conditions than in those with toys. However, in all instances they are satisfactory for my purposes, ranging from .72 (types of additional movements) to .99 (locomotion) in "empty room" conditions and from .67 (types of additional movements) to .99 (locomotion) when all conditions are pooled. A few are inflated by a large number of double zero's (e.g. additional movements, movements towards one-way screen and gestures). One of the most general causes of discrepancy was that minor behavioural changes (e.g. in body-posture, in locomotion pattern or in position in space) led to a different classification by one, but not by the other observer. Such discrepancies occurred, even when strict criteria were set to avoid inconsistency.

Differences in reliability of measures between empty room and play conditions are partly caused by "spontaneous" differences in the observer's focus of attention, when she observes behaviour in these two kinds of situations; in play conditions the observer is generally focussing on the play activity, whereas in the "empty room" conditions focus is more on the general motor activity and the exploration of the room. Repeated observation of such recordings probably compensated insufficiently for this difference in attentional focus.

2) Manipulatory activity (variables 11, 12, 13 in table 9)

The reliability coefficients are relatively low for the variables "manipulation of fixtures" (.61) and "types of manipulated fixtures" (.43) in the empty room conditions. Closer inspection of the protocols shows that this low reliability is mainly due to uncertainties as to the discrimination between "additional movements" and "manipulation of fixtures". In some instances behaviours, such as "tapping or banging at the wall", are considered as "additional movements" by one observer, as "manipulation of fixtures" by the other. Confusion resulted from a lack of prior agreement on the significance of sensory orientation for the category "manipulation". Agreement improved, when the sensory orientation to the fixture manipulated was included in the definition of "manipulation of fixtures".

Agreement on "manipulation of body and clothes" is high in all observational conditions (empty room .82, pooled .80).

3) Visual orientation to the non-social environment (variables 14, 15 and 16 in table 9)

In the categories "visual fixation", "visual scanning" (= looking around), and "looking straight ahead", agreement was sufficiently high in all observational conditions with coefficients generally above .80. This rather high agreement does not imply that the exact direction of the gaze can easily be determined, but only that two independent observers can satisfactorily agree about the rather crude discrimination between the categories in this study.

4) Contact behaviour (variables 20 to 26 in table 9)

Only ten pairs of three minute scores were available for the reliability estimation in these variables. The impression from the data is that spatial, tactile and verbal contact can be scored rather reliably (coefficients .84, .90, and .89), whereas the reliability of visual "contact" scores is slightly lower (.74). I performed an additional reliability analysis on 1-minute scores. Thirty pairs of scores were available in each category. The results of this analysis confirmed the data presented above: coefficients ranged from .74 to .90, with visual contact as the lowest. When data, regarding "visual behaviour" towards the mother and the observer (in the block condition) are combined, the reliability coefficient becomes relatively high (.84). Nevertheless it is difficult to score "visual contact" from video-audio recordings, partly because "sender" and "receiver" are often not both on the screen, partly because the estimation of the direction of the gaze is difficult in itself (Elgrin and von Cranach, 1969; Jaspers et al., 1973).

5) Play activity (variables 27 to 38 in table 9)

The interscorer agreement is high in all variables which concern the level, consistency and duration of play-activity. Coefficients are around or above .80, except in two play level variables (non-specific handling of toys, .73, and exploratory play, .70) and the variable "duration of longest play activity" (.74). In a few instances observers had difficulties in discriminating between "exploration of toys" and "constructive play at a low level". Minor differences in the verbal description of the play activity sometimes led to differences in coding (Play level scores were abstracted from the continuous play activity recording on the protocol-sheets).

The high agreement in the variable "changes in the level of play activity" (.80 and .83) indicates that observers could reliably distinguish between different play activities. In a few play level variables reliability estimates have been inflated by a high number of double zero's.

In summary, interscorer agreement is generally high, particularly in measures related to motor and play activity. The agreement is slightly lower in "visual orientation" variables. In a number of categories (e.g. the contact measures) further reliability studies are necessary, because there were too few scores in this material. Undoubtedly, the reliability of the observation of certain behaviour patterns is affected by the particular context in which that behaviour occurs. Some variables, reliably scored in the empty room conditions, have rather low reliability coefficients in play conditions, and vice versa. Evidently, such differences are due to differences in focus of attention during the observations. Only in a few categories were discrepancies between observers due to ambiguities in the operationalization of behaviours (e.g. manipulation of fixtures).

5-2-4 Score-rescore agreement: five video-audio recordings, scored twice by two cooperating observers on two sessions six weeks apart.

Because only a few recordings were available for this part of the reliability study only one reliability coefficient was computed for each category, based on three minute scores from all the six observational conditions (pooled). These correlation coefficients are also presented in Table 9.

Score-rescore coefficients are generally slightly higher than interscorer coefficients, resulting from the interaction between the observers (e.g. "manipulation of fixtures" in which the coefficient is .91 in the score-rescore analysis and .83 and .61 in the interscore reliability analysis).

In some categories (e.g. the contact measures) too few observations were available for a meaningful estimation of the reliability. One could, of course, obtain more scores by using smaller time units, e.g. ten second epochs. However, outcomes of such analyses would bear little relevance to a study, in which the results are based on scores over much longer time periods.

5-2-5 Reliability of coding: 120 protocols of the condition "with mother in the novel empty room", coded twice by different assistants over the same time units as used in the coding of the follow-up material.

Results of this reliability study are given in Table 10. Obviously reliability is high both in variables which were precoded on the protocols, and in those which had to be "abstracted" from the descriptions of the child's activities on the basis of predefined criteria, such as the variables related to the level of play activity and some contact variables (e.g. spatial contact). With only a few exceptions correlations are above .80. Agreement is the lowest in the variables "movements towards the one-way screen" and "number and types of additional movements", coefficients ranging from .60 to .80 in these variables.

No significant differences between means and standard deviations were found in any of the variables.

5-2-6 Concluding remarks

1) The interscorer reliability as well as the score-rescore agreement are satisfactory, most coefficients reaching values of .80 or higher. Reliability is particularly high in the categories concerning motor and play activity. Some discriminations, such as between "manipulation of fixtures" and "additional movements", were difficult. In a number

Table 10 Reliability of the coding procedure (N=120)

Categories	Reliability coefficient 1st min.	2nd min.	3rd min.	total period
Locomotion	.98	.96	.97	
changes in body postures	.96	.95	.91	
types of body postures				.86
changes of locomotion patterns	.95	.92	.94	
types of locomotion patterns				.94
movements towards one-way screen	.80	.79	.63	
additional movements (discrete)	.75	.74	.60	
additional movements (contin.)				.78
types of additional movements				.74
gestures	.85	.83	.85	
manipulation of fixtures	.94	.92	.96	
types of manipulated fixtures				.93
manipulation of body/clothes	.89	.93	.93	
visual fixations (nr)	.89	.92	.93	
looking around (= visual scanning)(nr)	.98	.96	.84	
looking straight ahead (nr)	.92	.98	.93	
sounds				.79
verbalisation	.94	.96	.95	
crying				.99
spatial contact child-mother	.87	.93	.94	
tactile contact child-mother	.86	.88	.86	
tactile contact child-mother (contin.)				.86
visual contact child-mother	.87	.96	.89	
visual contact with mother or observer	.92	.96	.90	
verbal contact with mother or observer	.90	.95	.95	
tactile contact mother-child	.95	.85	.89	
verbal contact mother-child	.90	.96	.94	

Because no significant differences between means were found these values are not given in the table.

of variables too few scores were available for a meaningful analysis. In these variables further reliability analyses will be necessary.

2) The intercoder reliability is generally high, so that discrepancies between scores will not be due to the unreliability of the coding procedure. This is particularly important in those instances in which scores were derived from the continuous written recordings of the child's activities. No reliability coefficients were obtained concerning the intercoder agreement in the play activity measures. However, the rather high interscorer and score-rescore agreement in these play variables may indicate that they can also be reliably coded.

6. THE STRUCTURE OF THE BEHAVIOUR

6-1 Steps in the analysis

To handle the many scores, data reduction is necessary. This process has to be based on knowledge of the relationships between aspects of the behaviour repertoire. Once these relationships are known, "complex" behaviour patterns can be defined, whereas differences between groups of children on behavioural categories can be interpreted with reference to the rest of the behaviour repertoire. Comparison of groups with respect to isolated aspects of the behaviour, without knowledge of the general structure, may lead to serious misinterpretations. Therefore I started with the study of the relationships among the behavioural categories, applied in the video analysis (defined in Appendix V).

In order to study these relationships I followed the procedure represented in the flow diagram in Fig. 6.

In column A the main steps in proceeding from the definition of behavioural categories (A_1 in the flow diagram) to the description of the behavioural structure (A_{13}) are given.

In column B control analyses are mentioned; they concern the reliability of procedures, the internal consistency of measures, the completeness and frequency distributions of data, their experimental dependence and the appropriateness of statistical methods.

In column C consequences of the control analyses are indicated whereas in column D statistical methods are listed.

Because the flow diagram is to a large extent self-evident, only a few remarks will be given (letters and numbers refer to those in the diagram).

C2/3 Since studies on the reliability of the scoring procedure could not be finished before the scoring of video-recordings in the follow-up study had started, the results thereof mainly influenced the interpretation of the data and only occasionally the definition and scoring (undoubtedly results of these reliability studies will be useful for designing future observational studies). On the other hand, the analysis of the intercoder agreement did have a direct effect on the coding procedure in this follow-up study, in that a number of behaviours were redefined on the basis of these results (e.g. "additional movements" and "reactions towards the one-way screen").

Figure 6 Flow diagram: steps in the analysis of the behavioural structure

A. MAIN STEPS	B. CONTROL STEPS	C. CONSEQUENCES	D. STATISTICAL METHODS
1. definition of behavioural categories			
2. scores in behavioural categories on protocol sheets (10'' scores)			
	2/3. determination of a. interscorer reliability b. score-rescore agreement	2/3. improvement of definitions, changes in the observation and registration procedure, etc.	B2/3 and B3. Pearson's PM correlation + T-test for differences between means + F-test for differences between variances; control for double zero's
3. sumscores on punch cards (1' - and 3' - scores)	3. c. intercoder reliability		
4. sumscores for separate observational conditions on punch-cards (3'-, 5'-, 10'- and 15'-scores)	4. frequency distribution of sumscores for separate behaviours per observational condition	4. decisions with respect to a. missing data b. low frequency variables	
		4/5. removal or lumping of categories	
	5. inspection for 'experimental dependence' of variables		
6. product moment correlations on selected variables per observational condition	6. rank-difference correlation in one observational condition		A6. Pearson's PM correlation B6. Spearman rho rank-difference correlation

		6/7. PM correlation maintained as a basis of further factor and cluster analysis	
7_1. cluster analysis 7_2. factor analysis + rotation (behavioural categories per observational condition)	7_2. factor analysis + rotation in one condition on the basis of rank-difference correlations 7_3. partial correlation	7_3. improvement of the definitions of clusters	A7_1. Johnson's hierarchical cluster analysis (diameter and connectedness method) A7_2 and B7_2. factor analysis (principal components + varimax rotation) B7_3. partial correlation (first order)
8. definition of behaviour patterns per observation			
9. computation of standard scores per behavioural category per observational condition			A9 and A10. Z-scores + summation
10. summation of standard scores	10_1. frequency histograms; test for normality of distribution 10_2. estimation of internal consistency	10. evaluation of correlations, etc.	B10_1. X^2-test on normality of distribution B10_2. coefficient for internal consistency
11. intercorrelations between behaviour patterns			A11. Pearson's PM correlation
12_1. factor analysis + rotation 12_2. cluster analysis			A12_1 = A7_1 A12_2 = A7_2
13. behavioural structure: description of relationships between patterns			

A4 Scores in behavioural categories (as defined in Appendix V) over total observational conditions are the basic data in the study of the behaviour. Only in a few analyses (not included in this report) were scores over smaller time periods used; those analyses mainly concerned the consistency versus inconsistency of the behaviour in the course of an observational session and will be reported elsewhere.

C4 In a few subjects data were incomplete, due to technical difficulties during the registration (in particular with the sound registration). The following measures were taken to minimize the disturbing effect:

- application of correlation programs that only took into account the available scores. This occurred in the observational condition "with mother in the novel empty room", in which in 13 cases auditory information was missing.
- substitution by the "mode" (= the score of the highest frequency) in those categories in which only a few scores were missing.

$C4_b$ A complicating factor is the low incidence of a number of behaviours, e.c. crying, gestures. Such rare behaviours may be clinically interesting, but may inflate correlations considerably. Therefore most of these low frequency behaviours were excluded from the overall analysis and only used in the study of specific relationships.

B5 Some variables are "experimentally" dependent of each other, e.g. "locomotion" (numbers of blocks, covered by the child) and "patterns of locomotion"; "visual fixation", "visual scanning" and "looking straight ahead"; "number of body postures" and "types of body postures"; and "number of visual fixations" and "duration of visual fixations". Scores in such categories cannot vary independently. As a consequence correlations between such variables may be strongly inflated. By lumping and omitting categories, I tried to eliminate such dependences. E.g. the categories "changes in body posture" and "changes in locomotion patterns" were combined, whereas the categories "looking straight ahead", "types of body postures", "types of movement patterns" and a number of "duration" categories were excluded from cluster and factor analysis. Some variables however, although experimentally dependent, were maintained because of their importance in the description of the behaviour (e.g. visual fixation, visual scanning and the play level categories). ~~At the bottom of~~ the tables 12 to 16, in which factor loadings are given, the variables which are excluded from the analysis of the behavioural structure are mentioned. Most of these categories were used in specific analyses (e.g. the relationship between the number and the different types of body postures (locomotion patterns) was separately analysed to investigate the "variability versus stereotypy" in the motor behaviour of the child). Results of such specific analyses will not be formally reported in this thesis.

A6, B6 Product-moment correlations were applied in the analysis of relationships between categories. As a control in a part of the material rank-order correlations were also computed (Spearman-Rho).

$A7_{1,2}$ To study the behavioural structure methods of factor and cluster analysis were applied. Differences in outcomes of these two analyses turned out to be negligible. Behaviour patterns were defined on the basis of these results, correlations between variables, and clinical considerations .

$B7_{3}$ In some instances partial correlations were computed to rule out the effect of common relationships between variables. E.g. in play conditions a number of behaviours, such as "reactions towards the one-way screen" and "manipulation of fixtures" only occurred when the child was not active with the toys. By "partialling out" the category "absence of play activity" the correlation between such variables dropped considerably. Such partial correlations were taken into account in the definition of behaviour patterns.

A8 In the composition of behaviour patterns not only statistical criteria were taken into account but also strong weight was given to factors, such as the comparability of behaviour patterns (I tried to keep the composition of patterns in the various conditions as similar as possible) and the meaningfulness with regard to clinical problems. As a consequence the internal consistency of some of these patterns may be rather low.

In a few instances highly correlated behaviours are not included in the same pattern, because they differ with respect to their environmental orientation (e.g. "visual contact with mother" and "manipulation of fixtures"). As a consequence some high correlations may exist between behaviour patterns which are observed during the same sessions.

A9 In order to establish scores for behaviour patterns, the raw scores in behavioural categories were transformed into standard scores (Z-transformations) and summed. To the sum 500 was added in order to avoid negative scores.

6-2 Relationships between categories and the determination of patterns

This section concerns the relationships between the behavioural categories used in the video-audio analysis (Appendix V). Behaviour patterns will be distinguished mainly on the basis of this analysis. Relationships between these patterns in the various observational conditions will be discussed. The composition of behaviour patterns is shown in Table 11 (internal consistency measures are given in the last column).

Behaviour patterns were distinguished on the basis of evidence from different sources, such as correlations between behavioural categories, results of cluster and factor analyses, frequency distributions, and a number of "clinical criteria", indicated in chapter 6-1. In the text the main correlations will be mentioned (correlations between the categories in each of the observational conditions are given in App. XIII to XVIII).

The structure of the behaviour will be described for empty room and play conditions separately. In the text abbreviations are used to indicate the various observational conditions,

Al 1 : first time alone in the empty room,
Al 2 : second time alone in the empty room,
Mo : together with mother in the novel, empty room,
Blocks : with blocks and a passive observer,
Vartoys: alone with a variety of toys, and
Onetoy : alone with one non-motivating toy.

6-2-1 The behavioural structure in the empty room conditions: correlations in App. XIII (Mo), XIV (Al 1), and XV (Al 2).

a) In all empty room conditions a pattern of "exploration of the room" was defined. Components of this behaviour pattern are: "locomotion", "changes in body posture and movement pattern", "number of visual fixations" and "manipulation of fixtures". These behaviours are exactly those, which are included in Berlyne's definition of "specific exploration", the function of which is "to afford access to environmental information that was not previously available" (Berlyne, 1960, p.79).

Table 11 — Composition of behaviour patterns

Categories	Behaviour patterns	obs. cond.	components	internal consist. 1)
A. Empty room conditions				
1. locomotion 2. changes in body posture/ loc. pattern 3. visual fixations 4. manipulation of fixtures	room exploration	Mo Al 1 Al 2	1, 2, 3, 4 1, 2, 3, 4 1, 2, 3, 4	.74 .56 .59
5. movements tow. one-way scr. 6. visual orientation tow. one-way screen	one-way screen reactions	Mo Al 1 Al 2	5, 6 5, 6 5, 6	.52 .53 .54
7. looking straight ahead 8. looking around (vis. scanning) 9. additional mov. (discr.) 10. additional mov. (contin.) 11. manip. of body/clothes	passive waiting	Al 1 Al 2	7, 8, 9 7, 8, 9	.72 .56
	body oriented activity	Al 1 Al 2	10, 11 10, 11	.56 .75
	passive waiting/ body oriented act.	Mo	7, 8, 10, 11	.63
12. spatial contact 13. tactile contact	close contact	Mo	12, 13	.53
14. visual contact	visual contact	Mo	14	-
15. verbal contact	verbal contact	Mo	15	-
	B. Play conditions			
16. play act. level I 17. play act. level II 18. play act. level IIE 19. nr. of play activities 20. changes in level of play act.	low level play	Blocks Vartoys Onetoy	16, 17, 20 16, 19, 20 16, 19, 20	.53 .62 .53
	exploratory play	Vartoys	17, 18	.48
21. play act. level III 22. longest play activity	high level play	Blocks Vartoys Onetoy	21 21, 22 21, 22	- .48 .63
23. no play activity	no play activity	Blocks Vartoys Onetoy	23 23 23	- - -
24. locomotion 25. changes in body posture/ movement patterns 26. manipul. of fixtures 27. mov. tow. one-way screen	gross body act.	Blocks Vartoys	24, 25 24, 25	.68 .88
	room oriented act.	Onetoy	24, 25, 26, 27	.75
28. manipul. of body/clothes 29. addit. movements (contin.) 30. addit. movements (discr.) 31. crying 32. vocalisation 33. looking straight ahead 34. looking around	body oriented act. ("distressed")	Blocks	28, 29, 31	.70
	non specific act.	Vartoys	30, 32, 29	.68
	passive waiting (body orient. act.)	Onetoy	28, 29, 33, 34	.72

1) coefficient α (Nunnally, 1967)

Correlations among these categories are positive in all the three empty room conditions. Coefficients range from .24 to .48[1] in the condition with mother. However, the internal consistency is lower in the two conditions alone in the familiar room, than in the condition with mother in the novel room, mainly as a consequence of the rather weak relationships between "manipulation of fixtures" and the other components of the pattern in the Al 1 and Al 2 conditions (correlation coefficients ranging from .11 to .35). There is good evidence from the direct observation of the behaviour that in a number of children the manipulation of fixtures may have a different function when the child is in an unfamiliar environment together with the mother than when he is alone in a familiar environment. In the novel room with mother manipulation of fixtures is generally an aspect of the "inspective" behaviour, whereas in the familiar room this behaviour may be a kind of diversive activity ("diversive activities are those not elicited by any specific stimuli but which are resorted to in the absence of novel or interesting stimulation"). By such behaviours the child tries to vary the sensory input in a non-stimulating environment (Hutt, 1970). There seems to be a shift from "investigation" to "invention" in the course of the observation. Such a change in function of manipulatory behaviour is in agreement with results reported by Corinne Hutt, obtained in observations in preschool children of behaviour with respect to a novel object.

b) The following behaviour pattern I distinguished is "reactions towards the one-way screen", components of which are "movements towards the one-way screen" and "duration of visual fixations" (correlations between these elements range from .36 to .38). This correlation confirms the impression in the direct observation that visual fixations of the one-way screen tend to be longer than those of other aspects of the room. However, it should not suggest that all long visual fixations are directed at the screen.

Children reacting frequently towards the one-way screen in the condition with mother also tend to show a high amount of room exploration ($r = .54$, see App. XIX), which connection is lacking in the conditions Al 1 ($r = .12$) and Al 2 ($r = -.02$), when the room is more familiar to

[1] A correlation of .22 is significant at 1% level, two-tailed (130 to 150 cases are included in these analyses).

the child. This difference suggests, that in the novel room reactions towards the one-way screen are in general investigatory activities, whereas when the child is alone in the familiar room he tends to use the one-way screen to structure his own activity. This is also indicated in the direct observation of the behaviour: in the unfamiliar room together with mother many children try to look through the screen, they touch the surface etc., whereas in the conditions alone the one-way screen elicites inventive behaviours, such as making faces to oneself, putting out ones tongue, taking specific ballet-postures, etc., which behaviours are much less frequent, when the child is together with mother in the novel room.

Despite high correlations with room exploration, one-way screen reactions are defined as a separate pattern because of the specific structuring effect of the screen, suggested in preliminary studies (Kalverboer, 1971a).

c) In the empty room with mother further the pattern of "passive waiting, accompanied by body-oriented behaviour" could be defined. Children tend to look straight ahead, not to move around in the room, and to show behaviours which are not directed to the environment, such as "body manipulations" and "continuous additional movements". Also visual scanning of the room belongs to this pattern (correlations between the different components range from .20 to .48). Body-oriented activities, termed "autistic gestures" by Arsenian (1943) and "gestures" by Hutt, Hutt & Ounsted (1965) are generally considered as signs of distress. "Visual scanning"as opposed to "visual fixation" evidently relates to a rather high level of insecurity.

A behaviour pattern, similar to this passive waiting pattern, has been described by Arsenian (1943) and termed "non-motile withdrawal" (without crying). In Arsenian's study this pattern indicates a moderately high level of insecurity. In his as well as in my observations, the passive waiting pattern is frequently seen in children who stay close to the door or close to the mother.

In the conditions Al 1 and Al 2 a distinction is made between the behaviour patterns of "passive waiting" and "body-oriented activity". These patterns are slightly related in the Al 1 condition ($r = .30$), and not in the Al 2 condition ($r = .08$). (App. XIX).

Close observation of the behaviour in the familiar room (especially in the Al 2 condition) strongly suggests that the low statistical relationship between the patterns of "passive waiting" and "body-oriented activity" seems to result from a difference in function of these two patterns, in that waiting passively is a common reaction in such a non-stimulating environment, whereas body-oriented activities may indicate that the child feels distressed . The first pattern is a reaction to the lack of novelty, the second to the aspect of uncertainty in this situation. When the child is together with mother in the unfamiliar room, both patterns seem to indicate distress . Similar changes in function of identically defined behaviour patterns have been reported by Hutt and Hutt (1970), e.g. regarding manipulatory activities.

In some instances the discrimination between behaviour patterns is strongly determined by differences between specific components. For instance, negative correlations between general and segmental body activities determine to a large extent the discrimination between patterns of "room exploration" and "body-oriented activities".

d) Three patterns of contact behaviour can be distinguished in the condition with mother in the novel room. First, a pattern of "close contact" with mother is observed. Children stay close to the mother (they get high scores for "spatial" contact) and touch her frequently or keep in touch with her during a longer period of time. The two components of this pattern, "spatial" and "tactile" contact, are highly correlated ($r = .49$). Children, who keep close to the mother tend to behave passively, generally showing body-oriented behaviours and little exploration of the environment. Keeping close to the mother seems to be a sign of distress.

Differences are found in the way "visual contact" and "verbal contact" on the one hand and "close contact" on the other, relate to other aspects of the child's behaviour repertoire. There is a weak relationship between visual contact with mother and the exploration of the room ($r = .22$), whereas children who wait passively tend to have little visual contact with the mother ($r = -.30$). No relationship exists between verbal contact with mother and exploratory activity. Such connections were found in a preliminary study in a group of 20 preschool children from a socio-economic level higher than that of the group reported here (Kalverboer, 1971a). Those children explored the room in continuous verbal interaction with their mother, expressing their impressions by verbal communication, whereas in the present group verbal contact between mother and child is much less frequent, although the experimental instructions were similar. Other studies have indicated that less verbal coding of experiences occurs in lower socio-economic class families (Tulkin and Kagan, 1972, find that middle class infants experienced more verbal stimulation from their mothers at home than lower class infants).

As might be expected results of factor and cluster analyses, which are not reported in detail in this thesis, confirm the results of the correlation analyses. For the condition "with mother in the novel empty room" such analyses were also carried out for boys and girls separately, to investigate whether the behavioural structure was different in both sexes). Outcomes proved to be highly similar, there being only slight differences in the contributions of the various factors to the variance: in the boys behaviours related to the exploration of the room, in the girls body-oriented behaviours were found in the factors which explained the highest amount of common variance.

In summary, in all empty room conditions a number of behaviour patterns, between which meaningful relationships exist, could be defined. As shown in Appendix XIX, "one-way screen reactions" and "room exploration" are strongly related patterns (r = .54) in the condition with mother. Both patterns obviously have a function of investigation of the environment.

When the room has become familiar to the child (in the AI 1 and AI 2 conditions) correlations between "room exploration" and "one-way screen reactions" drop to .12 (AI 1) and -.02 (AI 2), due to the fact that the one-way screen reactions are no longer of an "inspective", but of a "diversive" nature.

In the novel room, passive waiting accompanied by body-oriented activity, indicates distress and is commonly observed in children who seek and maintain proximity to their mothers (r = .36) and show little visual contact with them (r = -.30). Children who explore the room tend also to look more often in the direction of the mother (r = .22).

In the AI 1 and AI 2 conditions the pattern of "passive waiting" is strongly opposed to that of "one-way screen reactions": children, who wait passively, hardly never show reactions to the one-way screen (r = -.78 in the AI 1 and -.73 in the AI 2 condition). Waiting passively seems to be a common boredom reaction in such a non-stimulating environment.

6-2-2 <u>The behavioural structure in the play conditions</u>: correlations in App. XVI (Blocks), XVII (Vartoys), and XVIII (Onetoy).

The following behaviour patterns were distinguished in the play conditions:

a) The most differentiated play behaviour is observed when there is a variety of toys available. The most primitive pattern is that of "<u>low level play</u>": children handle the toys unspecifically (throwing toys away, knocking them on the floor, etc.) or show simple play activities which are largely determined by external qualities of the play material (such as putting blocks in holes, piling up blocks without observable planning, etc.). In this pattern there are frequent switches from one play activity to another. Such behaviour is observed in all play conditions, although the composition of the low level play pattern is slightly different in the various play conditions, mainly due to differences in types and amount of toys. Components of this pattern are: non-specific handling of toys (level I), simple constructive play (level II), number of play activities and changes in level of play activity. Correlations between components range from .21 to .33 in the Block condition, from .21 to .39 in the Vartoys condition and from .21 to .46 in the Onetoy condition.

b) In all play conditions a pattern of "<u>high level play</u>" can be distinguished: children play constructively with one single toy or with different toys (Appendix V, play activity level III and IV). Examples of such activities are building a tower, dressing or undressing a doll, moving a car into a garage, tanking, parking etc. Also phantasy play with one or more objects is included in this category which is characterized by an inventive use of the material. In two of the play conditions (Vartoys and Onetoy) constructive play of this type is associated with relatively long play activities (r = .46 in both conditions).

c) A pattern termed "<u>exploration of toys</u>" is specifically found in the Vartoys condition: children investigate the toys, e.g. by opening or closing the door of a car (often repeatedly), by turning a screw of a tanker off and on, etc., or play with the toys in a rather stereotyped way, being involved in activities such as putting blocks in holes etc. In the Blocks and Onetoy conditions the last sort of activities are part of the pattern of "low level play", whereas they are included in the pattern of "exploration of toys" in the Vartoys condition. The behaviour represents a non-creative way of handling the material. The pattern correlates negatively with constructive play and positively with non-specific handling of toys.

d) An aspect of play behaviour clearly discriminating between children is the time involved in playing, identified in each play condition by the duration of its opposite, the variable "no play activity". Authors such as Arsenian (1943) consider a short duration of play activity as a sign of distress. In my data short play durations are observed in children showing signs of distress, such as body-oriented activity and retreat behaviours (e.g. standing close to the door). However, in other not-playing children room-oriented behaviour without signs of distress has been observed.

e) A pattern termed "room-oriented behaviour" was restricted to the Onetoy condition: children showing this pattern are not involved in playing, they tend to move around, make movements towards the one-way screen, manipulate fixtures in the room and show a variety of body postures and movement patterns. Only in the Onetoy condition do correlations between these categories remain significantly above zero when the variable "no play activity" is partialled out. In the other play conditions, such behaviours observed in children not involved in playing, are isolated activities not belonging to one single pattern. This is confirmed by the low correlations among them especially when the variable "no play activity" is partialled out.

Although the pattern "room-oriented behaviour" in the Onetoy conditions contains the same variables as the exploratory patterns in the empty room conditions, its function appears to be different. Observation of the child in this Onetoy condition shows that its function is largely diversive, suggested by such behaviours as manipulating fixtures without looking at them, simply moving around, etc. The child attempts to vary the sensory input to avoid boredom (Hutt, 1970).

f) In the Blocks condition, but not in the other play conditions, a pattern of "body-oriented activity", indicating distress, can be defined: children manipulate their own body, some of them cry or show rocking movements. Correlations between these aspects stay significantly positive when the variable "no play activity", to which they all relate, is partialled out. The observation of this pattern in the Blocks condition, and not in the other play conditions, may relate to the low attractiveness of the blocks.

A number of children evidently expected to get more attractive toys to play with, with the result that they were only marginally involved in activities with the blocks.

g) In the Blocks and Vartoys, a pattern termed "gross body activity" could be separately defined (in the Onetoy condition gross body variables are included in the pattern of room-oriented behaviour). Children typically show much locomotion, associated with frequent changes in body posture and movement patterns. These are strongly connected aspects, as indicated by the correlations between them (in the Blocks condition r = .52 and in the Vartoys condition .78 between locomotion and changes in body posture and locomotion patterns).

In the Onetoy condition gross body activity is specifically related to room-oriented behaviours, whereas in the other play conditions variation in the amount of gross body activity may directly relate to the play behaviour. Children spending much time in moving around, tend to play inconsistently and at a low level. This is indicated by positive correlations between behaviour patterns (App. XIX), ranging from .23 to .37 between gross body activity on the one hand and low level play and exploratory play on the other hand in the Blocks and Vartoys conditions, and by negative correlations of -.35 and -.25 with the high level play patterns in the Blocks and Vartoys conditions. Evidently, gross body activity is not integrated in play activities of a higher constructive level. Further inspection of this connection may provide interesting insights in adaptational problems in relation to hyperactivity in children.

h) A pattern confined to the Vartoys condition, termed "non-specific activities", had the components "additional movements" and "vocalisation". These behaviours are particularly observed in children not involved in playing and may be considered as "diversive" activities.

i) Finally, in the Onetoy condition a pattern of "passive waiting, associated with body-oriented activity" could be distinguished: children look straight ahead or about them; they manipulate their own body or show continuous additional movements such as rocking movements; in a few of them thumb sucking was observed.

Results of factor and cluster analyses confirm the impression from the correlation matrices that connections between categories in these play conditions are generally low.

In summary, behaviour patterns were defined in the three play conditions (Blocks, Vartoys, Onetoy), between which meaningful relationships exist, as follows from Appendix XIX. These concern orientation either towards the toys (play level and play duration patterns), the room (room-oriented activities), or the own body (body-oriented activity), or else they lack a specific orientation (passive waiting, non-specific activity, gross body activity).

6-2-3 Relationships between behaviour patterns in the various observational conditions

The interesting problem which remains, concerns the relationship between behaviour patterns in different observational conditions. Information about such connections may demonstrate, whether behaviour in one environment can be predicted from the observation of the behaviour in another.

6-2-3-1 Relationships between identically defined behaviour patterns

Positive correlations are generally found between the occurrance of identically defined behaviour patterns in the different observational conditions, indicating that there is a certain degree of consistency in the children's behaviour (correlations are given in App. XIX).

Low but generally significant correlations are found between the following behaviour patterns:

1. "room exploration" in all empty-room conditions (.23 to .35)[1)]
2. "one-way screen reactions" in all empty room conditions (.16 to .29)
3. "body-oriented activity" in all empty room conditions and in the block condition (.16 to .30)
4. "gross body activity" in the Blocks and Vartoys conditions (.44)
5. "no play activity" variables in all play conditions (.14 to .33)
6. "low level play" patterns in all play conditions (.10 to .27)
   Also "exploratory play" in the Vartoys condition relates to these low level patterns (.19 to .23)
7. "high level play" patterns in all play conditions (.14 to .25)

No significant correlations are found between the patterns of "passive waiting". This behaviour pattern may relate most strongly to specific features of the environment.

1) Between parentheses the range of the correlations among these patterns. A correlation of .18 is significant at 5 per cent, of .23 at 1 per cent level, two-tailed (N=117).

These results indicate that in the group as a whole there is some consistency in the behaviour over the various conditions. However, the relevance of it should not be overestimated, because correlations are only occasionally above .35. Further, these correlations do not permit conclusions about the individual consistency of the behaviour.

6-2-3-2 Relationships between differently defined behaviour patterns

The following relationships between differently defined behaviour patterns may be mentioned (correlations are given in App. XIX).

a. "Room exploration" in the condition with mother in the novel empty room is related to "gross body activity" in the conditions Blocks, (r = .37) and Vartoys (r = .30), and to "room-oriented behaviour" in the Onetoy condition (r = .24). This connection is partly due to the fact that the category "gross body activity" is included in both the "room exploration" and "room-oriented behaviour" patterns.

   Further, there are some weak relationships between on the one hand room exploration in the empty room conditions and on the other hand the duration of play activity and the amount of exploratory play in the Vartoys condition, indicated by correlations ranging from .17 to .32. Although weak, the relationship to "exploratory play" is interesting, because it suggests that at least in some children a tendency to explore the environment may be a rather consistent characteristic, observable in the child's inspection of an empty room as well as in his play activity.

b. Also some significant, although low, correlations exist between the contact behaviour of the child in the situation with mother and his behaviour in other situations: staying close to the mother in the novel room relates to a low amount of exploratory activity when the child is alone for the first time (r = -.19) and for the second time (r = -.22), and to frequent manipulation of the own body and clothes and shorter engagement in playing in some of the play conditions (correlations around .23). These results give hardly any support to the general notion that reactions of children in a new environment may give indications about their reaction tendency in other situations: correlations are far too low to allow for individual predictions.

c. Of all variables "no play activity" in the Vartoys condition has the strongest connection to patterns in other conditions. Long durations of play activity in the Vartoys condition relate to,

a) a high amount of room exploration and a low amount of body-oriented activity in empty room conditions,

b) relatively long play durations in the Blocks and Onetoy conditions, and

c) relatively little close contact with the mother.

All correlations between "no play activity" and the other variables range from approx. $\pm .20$ to approx. $\pm .40$.

6-2-4 Concluding remarks

In conclusion, relationships between behaviour patterns in the different observational conditions are generally weak. They indicate that in the group as a whole consistency of the behaviour over the various conditions is low: most significant correlations range from .20 to .35, indicating that scores have 4 to 12 per cent variance in common; one would have little success in trying to predict behaviour in one category by knowledge of that in another. To detect how relationships between behaviour patterns might differ in subgroups of children methods other than correlational techniques are required. The following section deals with an attempt to identify subgroups on the basis of their behavioural and neurological scores with the application of a program of profile analysis.

7. FREE-FIELD BEHAVIOUR IN RELATION TO SEX AND NEUROLOGICAL CONDITION

7-1 Introduction

In this chapter results of the analysis of neurobehavioural relationships will be presented.

For the following reasons boys' and girls' data were separately analysed:

a. Behaviour and learning problems that might be related to the C.N.S. disorder are much more frequent in boys than in girls.
b. More minor neurological dysfunctions are reported in boys than in girls (Stemmer, 1964; Wolff and Hurwitz, 1966).
c. Several authors (e.g. Wolff and Hurwitz, 1973; Bell, 1971) stress the necessity to analyse neurobehavioural data separately for boys and girls, because relationships may be different in both sexes. Wolff and Hurwitz state: "any generalizations applied to all children that are based on an examination of either males or females alone must be viewed with suspicion".
d. Preliminary analyses suggested that not alone might neurobehavioural relationships be stronger in boys than in girls but that the kinds of relationships might also be different (Kalverboer, 1971b; Kalverboer et al., 1973).

Therefore in this section data will be presented on differences between boys' and girls' free-field behaviour and how these possible differences relate to the neurological condition will be briefly discussed.

Then I will report on neurobehavioural relationships for boys and girls separate. Firstly data will be presented of preliminary "global" analyses, in which groups have been distinguished on the basis of their "overall" neurological condition, as indicated by their optimality scores. (see chapter 4-6). Finally results of a profile analysis will be presented, in which an attempt is made to identify groups of children characterized by specific associations of neurological and behavioural scores. A method of profile analysis is applied, which will be described in some detail in the next paragraph.

7-2 The method of profile analysis

Latent profile analysis has been described by Gibson (1959) as the generalisation to quantitative data of latent structure analysis (Lazarsfeld, 1950). According to Gibson (1962) latent profile analysis of intercorrelations among variables divides the total sample into a set of subsamples or latent classes, for each of which its size and its profile of standard score means on the various variables is given. These latent profiles are then to be compared and interpreted with respect to the kinds of people they characterize. The latent profile model attributes all observable covariation among the variables to variation between the latent classes, so that within - class variation is, by definition, statistically independent (local independence).

The original purpose of the method was to discover traits, tendencies or dispositions which might underly variation of phenomena (Lazarsfeld and Henry, 1968). Mårdberg (1971) applied the method for the description of data. He states: "the method is particularly applicable in exploratory studies, in which the aim is to develop previously unknown profile-constellations". This is also the way in which I applied the method. No normality of distributions of scores is required.

Skewness, and curvilinearity of relationships contribute to triple-correlations which are used in the discrimination of profiles. In the program developed by Mårdberg and applied in my study no statistical test for "local independence" is included. Therefore hypotheses can not be tested about "underlying dimensions": its use is restricted to the description of data.

To determine how many profiles should be extracted from a set of data one has to define reasonable criteria. I used the following:

a. Standard deviations of variables in the profiles should be as small as possible. To achieve this, successive analyses were carried out on the same data, deriving a different number of profiles on each occasion. That analysis was selected in which standard deviations of components were the lowest. This criterion guarantees that groups represented by such profiles are relatively homogeneous.
b. The number of cases per profile should not be lower than four. This limit was chosen, because of my interest in the general rather than in the individual nature of the relationships sought.

According to the definitions given in chapter 4-8 the term behaviour pattern refers to combinations of related categories, to which labels are applied, such as "room exploration", "low level play", "body-oriented activity" etc. The term behavioural or neurobehavioural profiles refers to groups of children characterized by specific associations between behavioural variables or between neurological and behavioural variables combined.

7-3 Behavioural profiles in the group as a whole

Figure 7 shows the results of the first and most general analysis of behaviour patterns derived from all observational conditions. Only those preschool children were included in the profile analyses to be reported which had complete behavioural records in all six observational conditions (N=117).

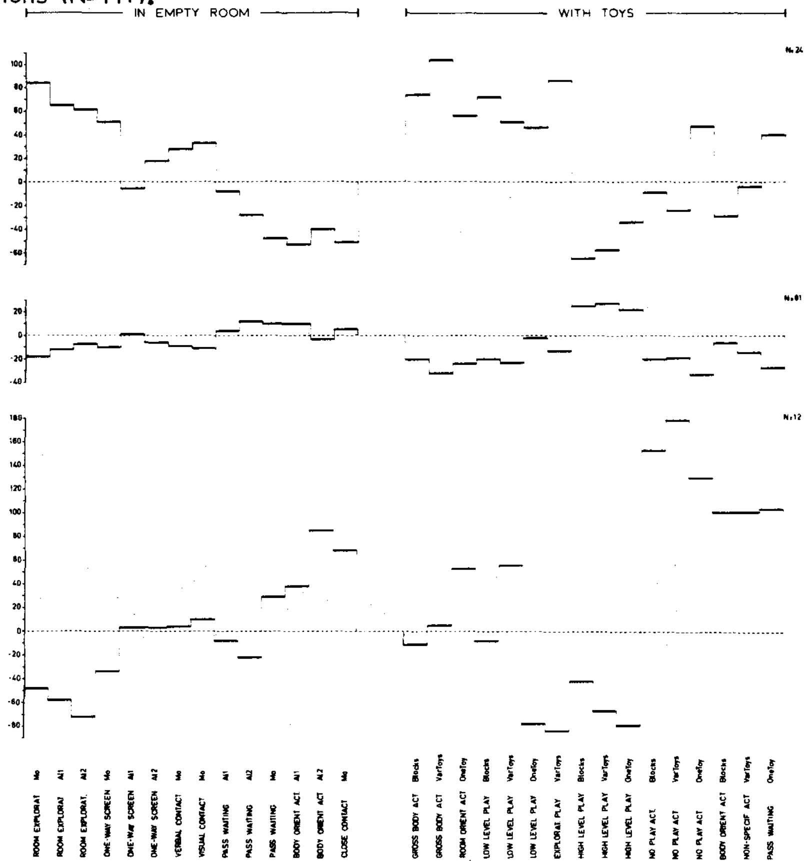

Fig. 7 Behavioural profiles to which all the 30 behaviour patterns defined in the 6 observational conditions contribute.
The vertical axis indicates standard score means (x 100) of the group of children comprising that profile on the variables included in the analysis. The zero-level represents the standardized mean of the total group included in the analysis. Consequently, the distance from the horizontal axis indicates the contribution of a particular variable to the discrimination between profiles, whereas the position below or above the horizontal axis indicates whether a score is relatively low or high in comparison to that in the group as a whole.

†30

Three profiles could be identified, labelled as "Exploration", "Non-Exploration" and "General" respectively.

The "Exploration" profile includes 24 children (21% of the group). They typically show a high amount of room exploration or other room-oriented activities, such as reactions towards the one-way screen in the empty room or with a non-motivating toy. They usually play at a low level with much gross body activity.

The 12 children (10% of the group) in the "Non-exploration" profile show quite different behaviour patterns. They react passively with a high amount of body-oriented behaviour when the room is empty or the toys are not attractive, whereas the total time spent in playing tends to be short. They keep close to their mother in the novel room.

The "General" profile contains 81 children (69% of the group), which are characterized by scores around the group-mean in all patterns, except those related to the level of play activity: they play at a level slightly higher than the group as a whole, as an effect of the relatively low levels of play activity in the two other groups.

The most interesting finding is, that inconsistent play at a low level is found both in children with high as well as in those with low amounts of exploratory activity in the empty room. However, the behaviour during playing is quite different in these two groups of children: children in the "Exploration" profile move around in the room a great deal with many changes of body postures and movement patterns, whereas children in the "Non-Exploration" profile show a much more passive type of behaviour, paying less attention to the toys.

7-4 Sex differences

7-4-1 Behavioural profiles

Table 12 gives the number of boys and girls in each of these three general behavioural profiles (fig. 7).

The sex distribution over the profiles deviates significantly from the distribution to be expected by chance (X^2 = 15.3, df: 2, $p < 1\%$). This difference is mainly determined by the large number of boys in the "Exploration low level play" profile, 21 boys versus 3 girls. No difference in the number of boys and girls is found in the Non-Exploration profile. As a consequence the number of girls is slightly higher in the general profile (35 boys versus 46 girls). This result

Table 12 Sex distributions in the behavioural profiles (N=117)

Profile \ Sex	Boys	Girls
I Exploration	21	3
II General	35	46
III Non-Exploration	5	7

$X^2 = 15.3,\ p < .01$

I-II, X^2: 14.6, $p < .001$; I-III, X^2: 8.4, $p < .01$; II-III, p:ns.

is to some extent in agreement with data reported by C. Hutt (1966, 1970), who observed more "explorers" among boys in relation to a novel object and more "non-explorers" among girls.

7-4-2 Behaviour patterns

A more detailed comparison of the behaviour of boys and girls in this group can be made on the basis of behaviour patterns (see Figure 8 and Table 13).

Significant sex differences are found in all observational conditions. They show a consistent pattern, different in empty room and play conditions.

7-4-2-1 How boys and girls behave in the empty room

Together with the mother in the novel empty room, boys spend more time in exploring the room (p = 3%) and talk more frequently to the mother (p< 1%) than girls. As indicated in previous analyses, the patterns of "exploration" and "verbal behaviour" are closely related: the child explores the room in continuous verbal contact with the mother, especially during the first minutes (Kalverboer, 1971). Interestingly enough, in the following observation condition (for the first time alone in the empty room), more passive waiting is observed in boys than in girls, a difference due to a much sharper decrease in exploratory activity in boys than in girls.

In all empty room conditions more body-oriented behaviour is observed in girls than in boys. This difference is most pronounced in the con-

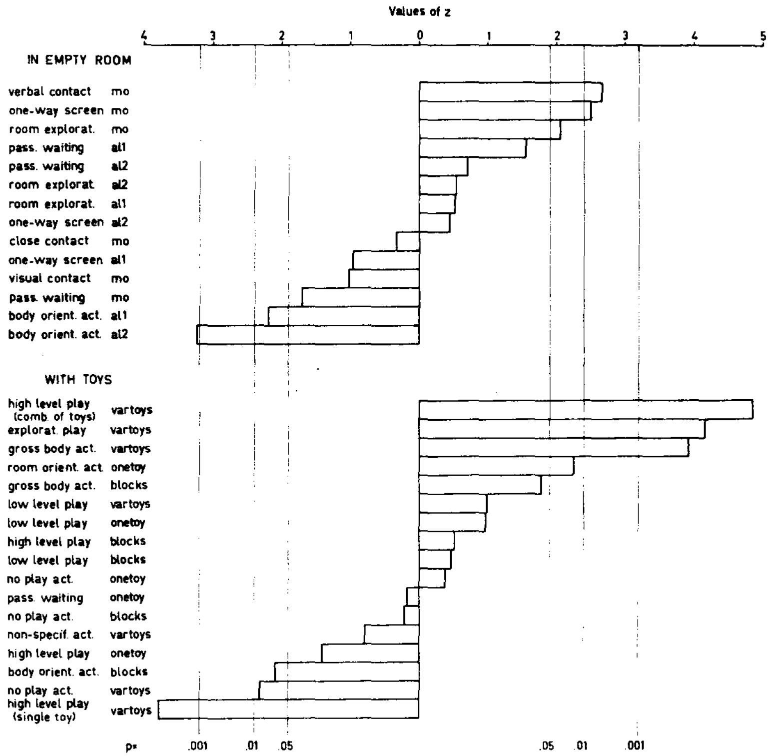

Fig. 8 Behaviour patterns: differences between boys and girls (N_{boys} = 71–75, N_{girls} = 69–72, numbers not always the same, due to incomplete data in some variables). Bars to the right indicate higher scores in the boys, to the left higher scores in the girls (Mann-Whitney U test, p two-tailed).

dition "alone in the empty room", due to an excess of body manipulation in girls. Previous analyses strongly indicate that this behaviour is a sign of "discomfort" (Kalverboer, 1971).

Behavioural differences between the sexes are detailed in Table 13, in which the basic categories directly scored from the video-recordings are compared. They show that particularly manipulative exploration is much more frequent in boys than in girls, especially in the novel room and for the first time alone in the familiar room ($p < 1\%$). In the novel

Table 13 Behavioural categories: differences between preschool boys and girls in the six observational conditions. (N, see Fig. 8).

	Mo	Al 1	Al 2	Blocks	Vartoys	Onetoy
1. Locomotion				++	+++	+++
2. Changes in body posture		+		++	+++	+++
3. Types of body postures	+	+		+++	+++	++
4. Changes in locom. pattern				+++	+++	++
5. Types of locom. patterns				+++	++	
6. Additional mov. (discr.)		+	+	+	--	
7. Types of addit. movements		+	+		---	
8. Gestures	++					
9. Mov. tow. one-way screen	++			-		
10. Manip. of fixtures	+++	+++	++			+
11. Types of fixt. manip.	+++	+++	+			
12. Manip. of own body/clothes	--	---	---	---	-	
13. Visual fixation (nr.)	+					
14. Visual scanning (dur.)	--					
15. Tactile cont. with mother						
16. Spatial cont. with mother						
17. Visual cont. with mother						
18. Verbal cont. with mother	++					
19. Sounds				+	+++	
20. Absence of play act, (dur.)					--	-
21. Longest play act. (dur.)					---	
22. Nr. of toys, handled					+++	
23. Types of toys, handled					+++	
24. Changes lev. play act.					++	
25. Changes type play act.					+++	
26. Play act. level I (unspec. handling of toys)						++
27. Play act. level II (low construct.)					+++	
28. Play act. level II (explor. of toys)					+++	--
29. Play act. level III (high constr. one toy)					---	--
30. Play act. level IV (high constr. several toys)					+++	
31. Tidying up					---	

+ more in boys
- more in girls

	p(two-tailed) Mann-Whitney U test
+ or -	5-10%
++ or --	1- 5%
+++ or ---	1%

room girls show more visual scanning than boys, who spend more time in fixating specific aspects of the environment, often prior to manipulation. Detailed observation reveals that as a group the boys show a slightly different pattern of gathering information about the environment than girls: boys tend to start with looking at specific aspects of the environment, whereas girls tend to scan the room visually before looking closely at specific fixtures. Perhaps girls feel more tense and distressed in this laboratory setting than boys, as suggested by the relationship between visual scanning and signs of discomfort reported in the preceeding chapter.

Interestingly enough in the empty room conditions no differences between boys and girls are found in the amount of locomotion. Also "close" contact with mother does not discriminate between boys and girls.

7-4-2-2 <u>How boys and girls behave in play conditions</u>

Differences in the play conditions concern the amount of gross body activity, as well as the level and the duration of play activity. In all play conditions the boys show more gross body activity than the girls ($p = 1\%$ in the variety of toys condition, $p = 5\%$ in the condition with blocks and $p = 3\%$ in the condition with one non-motivating toy), whereas the level of play activity is generally slightly lower in the boys than in the girls. More passive behaviour and signs of discomfort are observed in the girls than in the boys in the block conditions.

In summary, differences between boys' and girls' free-field behaviour are evident in empty room as well as in play conditions. However, the similarities between the boys' and girls' behaviour are much stronger than the differences. This is also indicated by results of a profile analysis of behaviour in each of the six observations separately. From the 19 profiles, which could be identified, there are only 2 in which the distribution of boys and girls differs significantly from that in the total group: one "low level play, gross body activity" profile in the condition with a variety of toys (31 boys versus 12 girls, $X^2 = 10.34$; df 1, $p < .001$), and one similar profile in the condition with blocks (17 boys versus 6 girls, $X^2 = 9.72$; df 1, $p < .01$).

7-4-2-3 Do differences between boys' and girls' behaviour relate to their neurological status?

One might wonder whether differences between boys' and girls' free-field behaviour are not partly due to neurological differences. Some preliminary data on this problem have been reported (Kalverboer et al., 1973). Behavioural categories were compared in boys and girls with low optimality scores as well as in boys and girls with high optimality scores. Between the boys and girls with high optimality scores differences in amount and variability of gross motor activity were found in only two of the conditions (Blocks and Vartoys), whereas between non-optimal groups such differences were present in each of the six experimental conditions: boys with low optimality scores invariably showed more changes in body postures and movement patterns than low-scoring girls, irrespective of the presence of play objects. This was mainly an effect of the inconsistency in motor activity in the boys with low optimality scores, something not found in the other groups. In other words, only in boys with low optimality scores inconsistency in motor behaviour was observed irrespective of the specific structure of the environment, whereas in the other groups changes in body postures and locomotion patterns were primarily related to the play activity.

In random samples more minor neurological dysfunctions are found in boys than in girls. Therefore, differences in neurological condition may partly account for behavioural differences commonly found between the sexes. However, more detailed analyses will be necessary to answer this question.

7-5 Neurobehavioural relationships in boys and girls

7-5-1 Preliminary analysis: optimality groups

In a preliminary analysis groups were compared which differed with respect to their "overall" neurological optimality scores: A high score group (48 or more out of 52 optimal conditions), an intermediate score group (44 to 47 optimal conditions), and a low score group (36 to 43 optimal conditions). Details are given in section 4-6-2 and Appendix I. Cut-off points between groups had been set by the neurologist in order to obtain a sufficient number of cases in each group and independent of results of behavioural observations.

The purpose of this analysis was to get a first impression of the significance of the neurological condition for the child's free-field behaviour. Only the main results will be summarized as they have been published in more detail elsewhere (Kalverboer, 1971b; Kalverboer et al., 1973).

Neurobehavioural relationships were stronger in boys than in girls. They partly concerned different aspects of the behaviour and were observed in different kinds of environments.

In the boys, differences between optimality groups were mainly observed in the Al 2 and Onetoy conditions. In particular the amount of exploration and the level of play activity discriminated between neurological groups. However, behavioural differences between boys with higher and lower neurological scores were not consistently in one direction, but related to the structure of the environment. As long as the room was relatively unfamiliar, most exploratory activity was shown by boys with low neurological scores. However, when the child was acquainted with the environment (for the second time alone), boys with low optimality scores behaved most passively and had evidently lost interest in the environment. Similar differences, although less pronounced, were found between neurological groups in the girls. This is illustrated in Figure 9 for one of the main aspects of the exploratory activity, visual attention to fixtures in the room. These results suggested that boys and girls with low optimality scores need more variation of environmental stimulation to remain attentive than groups with a more favourable neurological condition.

Another difference in the boys concerned the level and duration of play activity in the three conditions with toys. In the Onetoy and Blocks conditions boys with low optimality scores played at a lower level than groups with more favourable scores. However, when there was a variety of toys available just the reverse was observed: boys with the lower neurological scores played at a higher constructive level than others. The data indicated that as a group boys with an unfavourable neurological condition function quite well when the environment provides sufficient stimulation, whereas their level of functioning drops below that of controls in a non-stimulating situation.

Analyses on behavioural categories, directly scored from the video recordings, showed that in particular measures for the inconsistency of the motor activity, such as changes in body postures and loco-

VISUAL EXPLORATION

(1^{st} and 2^{nd} time alone in empty room)

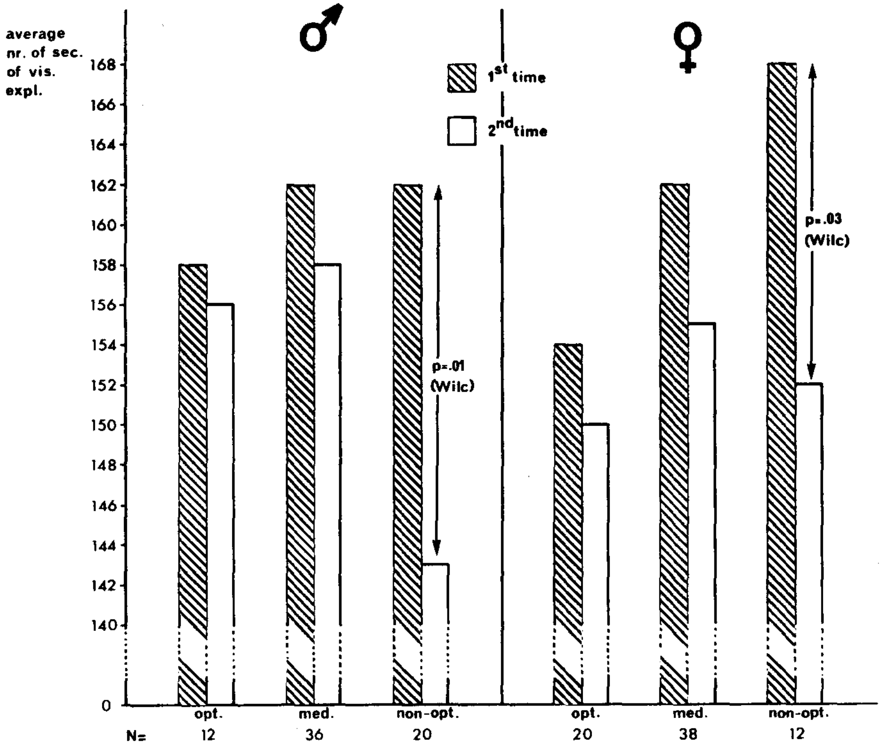

Fig. 9 Average time spent in visual exploration during the first and second times alone in the empty room. The drop in amount of visual exploration reaches significance only in the non-optimal groups (Wilcoxon two-tailed).

motion patterns, discriminated between the optimality groups in the boys (Kalverboer, 1971b).

Differences between neurological groups in the girls were weaker and less consistent than in the boys. They mainly concerned the contact with the mother in the novel empty room: girls with high optimality scores kept closer to her and presented more signs of distress than girls with low scores. The last group reacted more frequently towards the one-way screen and explored the room more intensively. Such differences were not found between optimality groups in the boys.

The data indicated that observational conditions and aspects of the behaviour which discriminated between optimality groups were partly different in boys and girls. In boys minor neurological dysfunctions seemed to affect the behavioural organization in particular in environments with a low level of sensory input, whereas in girls the strongest discrimination was found in an unfamiliar situation with an opportunity for social support.

In this preliminary analysis groups were compared which differed with respect to their "overall" neurological optimality scores. However, the optimality groups are heterogeneous with respect to their neurological symptomatology, whereas cut-off points between groups had been arbitrarily set. Quite different aspects of nervous functions contribute to the optimality scores. Minor disorders in motor coordination, choreiform dyskinesia, or difficulties in sensorimotor integration may differ as to how they affect the behavioural organization.

Especially in the girls neurobehavioural relationships were inconsistent. This may be partly due to the heterogeneous composition of the optimality groups. More differentiated analyses are necessary to get clarity about these neurobehavioural relationships. To that purpose profile analyses were carried out in which more differentiated neurological measures are introduced. The result of these analyses are reported in the next section.

7-5-2 Neurobehavioural profiles

7-5-2-1 Variables included in the analyses

Results of profile analyses in which neurological as well as behavioural variables are included, are given for boys and girls in the Figures 10 to 16 for each of the conditions in which the children were observed. The following neurological categories, each composed of a number of items, are included in these analyses,

1. sensorimotor
2. maturation of functions
3. maturation of responses
4. choreiform movements
5. coordination
6. posture

These neurological categories are described in section 4-6-3, their components are listed in Appendix II, and the correlations between them are given in Table 8 (p. 35).

Items from two of them, "maturation of functions" and "maturation of responses", were not included in the neurological optimality scores which were applied in the analysis discussed in the previous section. Each child obtained an "optimality-score" for each of these neurological categories. The more "non-optimal" items, the lower the score in that particular category (in the graphs they move below the zero line).

The behaviour patterns defined in each of the observational conditions are included in the profile analysis together with these neurological categories.

Neurobehavioural relationships were analysed in boys and girls separately. To facilitate comparison of results, data of both sexes are given in the same figures. Detailed data concerning the discrimination between neurological and behavioural measures in the various profiles are given in Appendix XX (means and t-values indicating differences between them).

7-5-2-2 Neurobehavioural profiles in the empty room conditions

With mother in the novel empty room (Mo)

Two neurobehavioural profiles were distinguished in each sex group. They are given in Figure 10. In essence, relationships between neurological and behavioural patterns are similar in boys and girls. However, only in the girls do neurological variables contribute substantially to the discrimination between groups, while in the boys' groups neurological scores hardly differ. The maturation categories contribute most strongly to the neurological discrimination in the girls, whereas choreiform movements do not at all.

Behaviourally, children with low neurological scores ($N_{boys} = 39$, $N_{girls} = 26$) are characterized by a high amount of exploratory activity and many reactions towards the one-way screen, whereas those with higher scores ($N_{boys} = 22$, $N_{girls} = 30$) behave more passively and keep close to the mother. In the boys there is also a difference in amount of verbal and visual contact with the mother which is most fre-

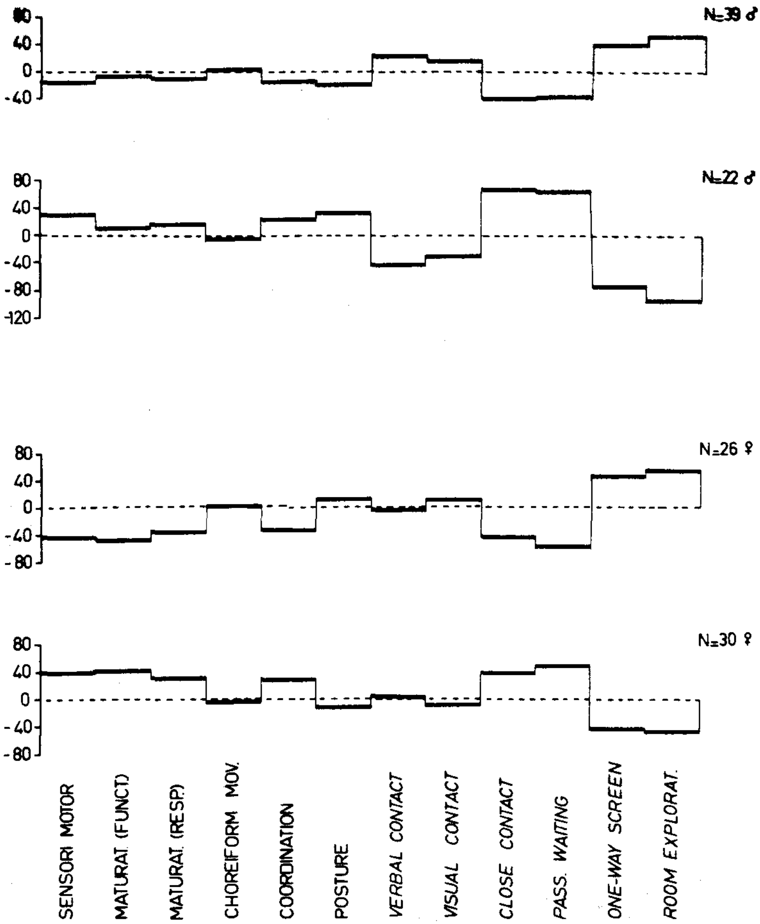

Fig. 10 Neurobehavioural profiles in the condition "together with mother in the novel empty room". Boys' and girls' data were separately analysed. Neurological variables are to the left, behavioural to the right. See also legend Fig. 7.

quent in those with the lower neurological scores.

The data confirm the more global results in the preliminary analysis on optimality groups in that they suggest that the aspect of "unfamiliarity" may be particularly important for the behavioural discrimination of neurological groups in girls.

For the first time alone in the empty room (Al 1)

Neurobehavioural profiles are given in Figure 11. Two profiles were distinguished in each sex group.

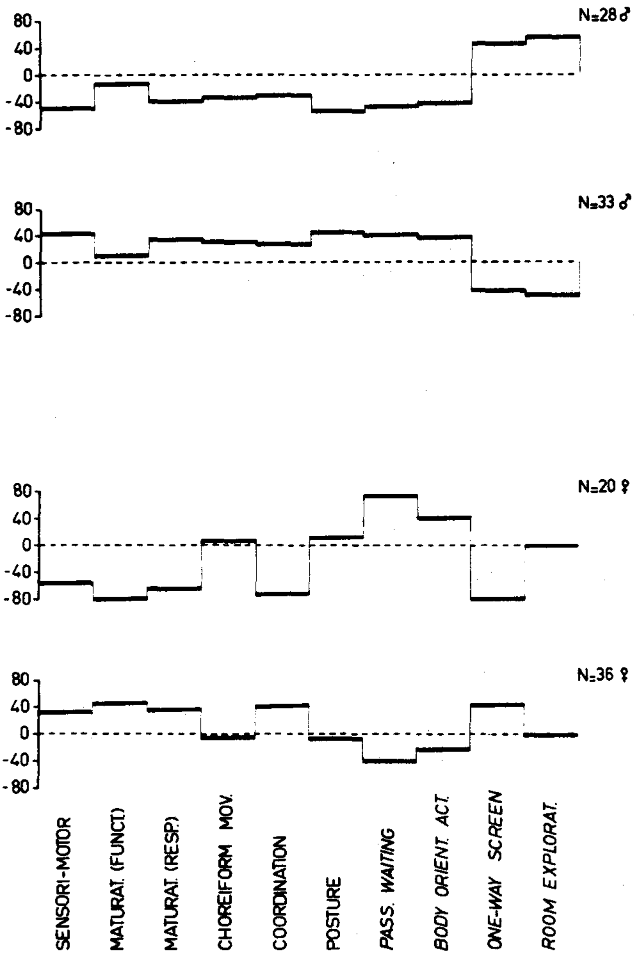

Fig. 11 Neurobehavioural profiles in the condition "for the first time alone in the empty room". See legend Fig. 7 and 10.

In this condition, in which the environment is already familiar to the child different neurobehavioural relationships are found in boys and girls. In boys the group with the low neurological scores (N=28) shows the highest amount of room exploration, paying much attention to the one-way screen, while those with high scores (N=33) typically show more passive and body-oriented behaviours. In girls, however, the situation is somewhat reversed, in that girls with the lower neurological scores (N=20) are the most passive group, paying less attention to the one-way screen and showing more body-oriented behaviour than those with higher scores (N=36). Most of these girls were in the group of the "explorers" in the previous condition with mother.

In the boys all neurological categories, except maturation of functions, contribute to the distinction between groups. In the girls, just as in the previous condition, "choreiform movements" and "posture" do not contribute to the discrimination.

For the second time alone in the empty room (Al 2)

After the session with blocks the child is for the second time alone in the empty room for three minutes. In that condition neurobehavioural relationships are again approximately similar in boys and girls (see Figure 12).

In both sexes children with low neurological scores (N_{boys} = 15, N_{girls} = 19) typically show a pattern of passive waiting. Children with high neurological scores (N_{boys} = 46, N_{girls} = 37) pay much attention to the one-way screen, whereas especially in the boys other features of the environment are explored. In this condition, all neurological variables except "choreiform movements" contribute to the neurological discrimination in the girls. In the boys the categories "posture", "sensory motor", and "maturation of responses" are the most important.

These differences in patterns of exploration and passive waiting suggest that in an environment with a low level of stimulation, children with an unfavourable neurological condition lose interest more quickly than those with a more favourable neurological condition.

7-5-2-3 Neurobehavioural profiles in the play conditions

In all play conditions meaningful associations were found between

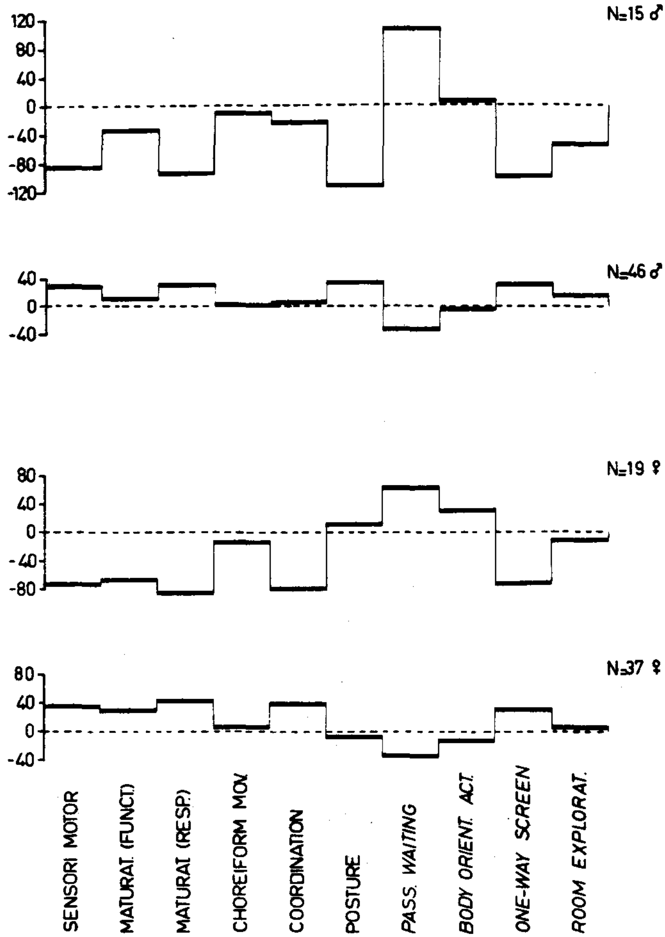

Fig. 12 Neurobehavioural profiles in the condition "for the second time alone in the empty room. See legends Fig. 7 and 10.

neurological findings and behaviour. More profiles could be distinguished than in the empty room conditions, so that results give a more differentiated impression of the neurobehavioural relationships.

With blocks and a passive observer (Blocks)

Neurobehavioural profiles are given in Figure 13.

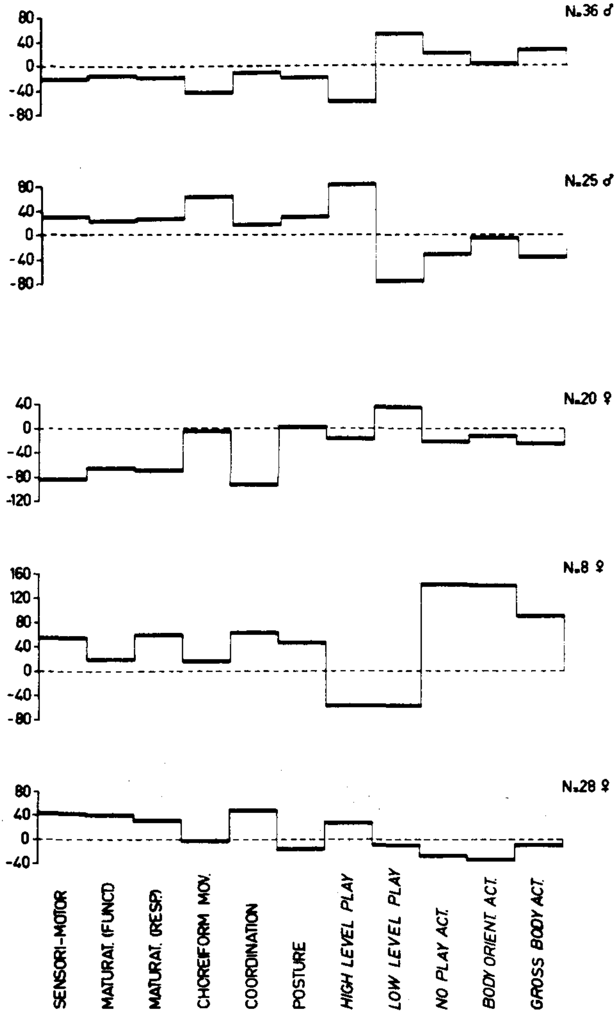

Fig. 13 Neurobehavioural relationships in the condition "with blocks and a passive observer". See legends Fig. 7 and 10.

They show that there exists a connection between the child's neurological status and the level of playing with the blocks: In both sexes, groups with unfavourable neurological scores (N_{boys} = 36, N_{girls} = 20) typically show many activities of a low level, such as throwing blocks away or simply piling up them. In the boys low level play is typically connected with much moving around and a short duration of playing, which is not the case in the girls.

In boys with high neurological scores (N=25) much constructive play is observed; they play quiet and relatively long.

In the girls two different behaviour patterns were found in association with favourable neurological scores. One of these groups (N=8) shows little involvement in playing and much body-oriented and gross body activity. The other group (N=28) typically shows play activity at a high level, being involved in longer play periods than the group of girls as a whole. Neurologically, in the boys choreiform dyskinesia contributes more than any of the other variables to the discrimination between groups. (See App. XX).

This result suggests that there is a specific relationship between choreiform dyskinesia and the quality of the child's constructive play. This is confirmed by correlations in the boys of -.42 and +.26 between measures for choreiform dyskinesia on the one hand and for high and low level play on the other, as found in previous analyses. Such correlations do not exist in the girls, and are among the highest in the whole material.

With a variety of toys (Vartoys)

In this condition two profiles were distinguished in each sex group. In contrast to results in other play conditions, boys with low neurological scores (N=25) show more constructive play at a high level and play longer than those with high scores (N=36). In the group with high scores more non-specific behaviour (see Table 11 and App. V) and gross body activity than the group with low scores. Similar results were already found in the comparison of optimality groups, mentioned in the section 7-5-1. They suggest that in boys with an unfavourable neurological condition the level of functioning is positively affected by the variety and attractiveness of toys. They further indicate that neurological dysfunctions may have quite a different effect on the behavioural organization in situations with and without a high amount of stimulating input.

Such a difference in relationships between play activity level and neurological status is not found in the girls. Just as in the condition with blocks the level of play activity is the lowest in girls with low neuro-

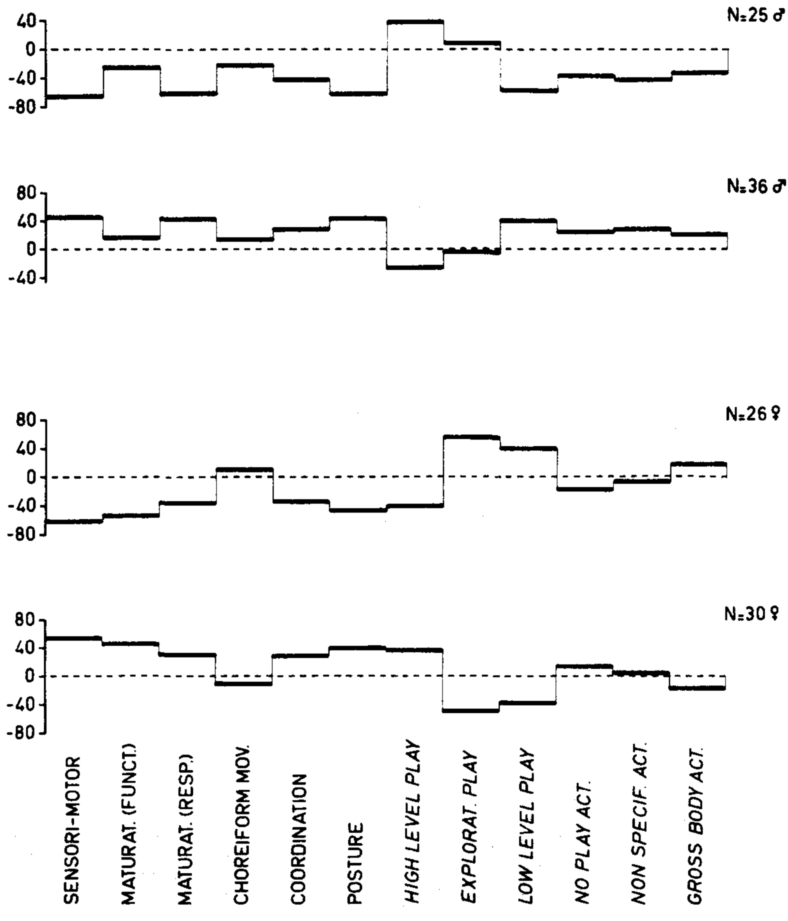

Fig. 14 Neurobehavioural profiles in the condition "with a variety of toys". See legends Fig. 7 and 10.

logical scores (N=26). They show more exploratory play and play at a low level than girls with high scores. In the high score group (N=30) more high level play is seen whereas they are slightly longer involved in playing than the girls with low neurological scores.

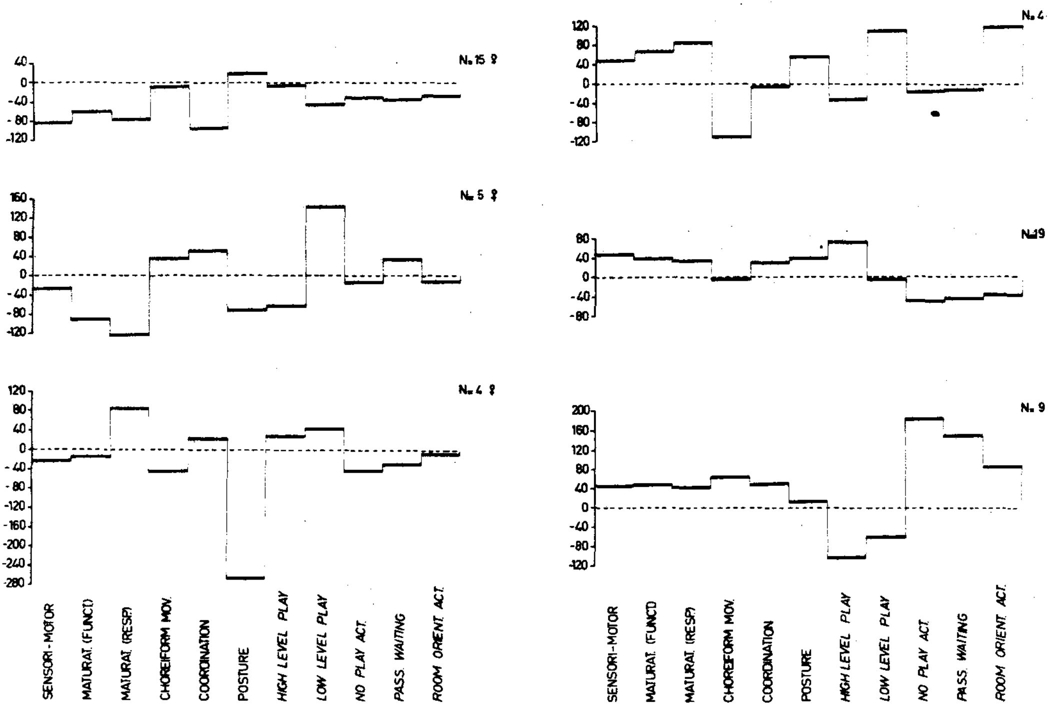

Fig. 16 Neurobehavioural profiles in girls in the condition "with one non-motivating toy". See legends Fig. 7 and 10.

Four other girls have low scores in posture and a few signs of choreiform dyskinesia. Behaviourally these children play slightly longer than the average of the group, while they are not distinguished from the other children in the other behaviours. The girls represented by the two other profiles have low scores in most of the neurological variables. In a group of five girls with non-optimal signs in the categories "maturation of functions", "maturation of responses" and "posture" play is at a low level and they tend to behave passively. The other group of fifteen girls have low neurological scores, except for choreiformity and posture, and show less low level play and shorter play durations than other girls.

7-5-2-4 Summarizing remarks

Neurobehavioural profiles provide a differentiated and meaningful picture of the relationships between neurological and behavioural variables in this group of preschool children.[1] They confirm the general notion that there is not a fixed relationship between neurological condition and behaviour, but that such relationships partly depend on the nature of the situation to which the organism is exposed .

Neurobehavioural relationships in girls are stronger and more similar to those in boys in this profile analysis than in the previous inter-optimality group comparisons, discussed in section 7-5-1. This may be partly due to the inclusion of the maturation categories which particularly contribute to the neurobehavioural discrimination in the girls.

Neurological dysfunctions contribute otherwise to the neurobehavioural discrimination in empty room and play conditions. As compared to children with high neurological scores, children with low scores typically show a higher amount of exploratory activity in an unfamiliar environment, followed by a greater decrease in such activities on later exposure to a similar environment. A decrease in amount of exploration occurs earlier in the observational procedure in the girls (in the Al 1 condition) than in the boys (in the Al 2 condition).

Close contact with mother is more to be observed in girls with high than with low neurological scores.

In the play conditions the main results are as follows:

1. In relation to favourable neurological scores two sorts of behaviour are typically observed,
   behaviour characterized by little involvement in playing and much body and room-oriented activity, and
   behaviour characterized by a high level and long duration of play activity.
2. In boys, low neurological scores relate to a low level of play activity

1) It is difficult to compare results of profile analyses in different observational conditions, because numbers in the groups change at each occasion. Some further indications about neurological differences between groups follow from data in App.XX in which means and t-values are given.

in the Blocks and Onetoy conditions, however, to a relatively high level of playing in the Vartoys condition. Such a difference is not found in the girls.

3. Neurological dysfunctions contribute in a different manner to the neurobehavioural discrimination in the various conditions in boys than in girls. Data which specify these relationships are summarized in Table 14.

Table 14 Neurological variables ranked according to their contribution to the distinction between neurobehavioural profiles.
Rank number in each condition and sum of ranks.[a)b)]

Boys

Neurol. var. \ cond.	Mo	Al 1	Al 2	Blocks	Vartoys	Onetoy	Sum of ranks
Posture	(1)	1	1	3	2	3	11
Sensorimotor	(2)	3	2	2	1	(4)	14
Matur. responses	(4)	2	3	4	3	2	18
Choreiform mov.	(6)	4	(6)	1	(6)	1	24
Coordination	(3)	5	(5)	(6)	4	(6)	29
Matur. functions	(5)	(6)	(4)	5	(5)	(5)	30

Girls

Neurol. var. \ cond.	Mo	Al 1	Al 2	Blocks	Vartoys	Onetoy	Sum of ranks
Matur. functions	1	4	1	2	2	1	11
Sensorimotor	2	3	4	1	1	4	15
Coordination	4	1	2	4	5	2	18
Matur. responses	3	2	3	3	4	3	18
Posture	(5)	(6)	(5)	(6)	3	(6)	31
Choreiform mov.	(6)	(5)	(6)	(5)	(6)	(5)	33

a) Rank numbers are based on analyses in which two profiles were determined.

b) Variables in parentheses do not contribute substantially to the discrimination between profiles.

These data show that,

a. in girls the categories "sensorimotor", "maturation of functions", "maturation of responses" and "coordination" contribute to the distinction between groups in all behavioural conditions. The categories "posture" and "choreiform movements" contribute little or nothing to the distinction between groups.

b. In boys the categories "posture", "sensorimotor", and "maturation of responses" contribute to the distinction between profiles in all conditions, while "coordination" and "maturation of functions" do not contribute in any of them.

c. In boys there were some intriguing findings in relation to choreiform movements. This category has the lowest contribution of all neurological variables in four observational conditions, but the highest in the Blocks and Onetoy conditions. This may indicate that choreiform dyskinesia specifically affects the organization of the boys' behaviour in conditions with a lack of variation in environmental stimuli.

7-5-3 Intervening variables

Neurobehavioural profiles indicate how, in subgroups of children, variables are related to each other. However, numerous factors may have affected the associations between neurological findings and behaviour: neurological and behavioural variables belong to a much larger complex of mutually dependent factors.

The effect of the sex differences has already been eliminated by the separate analysis in boys and girls. From the other possible intervening factors I traced back the effect of the socio-educational milieu (crudely estimated by the school-education of the parents) and of the age of the child.

Age

Significant age differences are only found between neurobehavioural groups in the girls in the condition "with mother in the unfamiliar room" and in the boys in the Onetoy condition. In the novel room with mother girls showing a high amount of exploratory activity are younger than those behaving more passively ($p = .02$, Mann-Whitney U test, two-tailed). In the Onetoy condition younger boys are slightly overrepresented in the groups with low neurological scores (N=17, N=22) as compared to one of the groups with favourable neurological scores (N=17 versus N=12, $p < .04$; N=22 versus N=12, $p < .02$).

Socio-educational milieu

Only in the boys in the Blocks condition do groups differ significantly as to the school-education of the father and the mother. Both social background measures are higher for the group with high neurological scores, who play at a high level, than for the other group ($p < .007$ for school-education mother, and $p < .005$ for school-education father). Other differences do not reach significance, although trends are generally towards slightly higher school-training scores in children with higher neurological scores. This reflects the fact that neurological scores in this group have a slight relationship to socio-economic class.

8. DISCUSSION

8.1 The approach to the method

The study of children with "minimal brain dysfunction" is of primary importance for our insight into behavioural and learning problems. M.B.D. is one of the most frequently made "diagnoses" in children presenting such problems. However, there still exists great confusion as to the precise character, basis, and etiology of the behavioural disorders, traditionally included in the concept.

This holds particularly for the central question of this study: what is the significance of a non-optimal condition of the central nervous system for the child's adaptive behaviour in various environments (in his natural habitat)? To my knowledge, there is as yet no study in which results of standardized and comprehensive behavioural observations and independent neurological assessments have been related to each other.

A method of direct observation and quantitative analysis of free-field behaviour was applied which seemed to be most promising for the study of neurobehavioural relationships, but had not yet been used on a larger scale in previous human studies.

To make these investigations possible two restrictions were necessary,

a. Variance in possible determinants of behaviour other than the neurological condition had to be kept to a minimum. To that end the age range was kept as narrow as possible, while data were analysed for boys and girls separately. No special measures were taken to render the group homogeneous with respect to social background. By comparing children within a hospital sample, relatively homogeneous with respect to social background, such differences could be kept to a minimum.

b. These children were observed in a specially designed playing room which allowed for a strictly standardized observational procedure, instead of in their own natural environments, in which all sorts of uncontrollable environmental changes and unpredictable observer effects may exist.

When this study started in 1965 no results from systematic observational studies of children in their natural habitat were available to help in structuring the observations. The only background material came from a series of observational studies by Hutt, Hutt and Ounsted on hyperkinetic epileptics (Ounsted, 1955; Hutt and Hutt, 1964), children with and without upper C.N.S. lesions (Hutt et al., 1965; Hutt, 1968), autistics (Hutt and Hutt, 1968) and normal preschool children (Hutt, 1970). Some of their most interesting results will be related to ours in the course of this discussion. However, these studies were of little help in guiding the analysis of this material. Data processing was easier in their studies than in mine, due to fewer subjects, fewer behavioural categories, and fewer observational environments. They did not attempt to investigate relationships between behavioural categories in detail.

Problems in my study were also quite different from those generally met in ethological studies where so-called "natural" units of the behavioural repertoire are defined, which occur successively in the behavioural stream (they "can be empirically determined by dividing up the temporal continuity of action just as the animals themselves do" (Van Hooff, 1971) although generally a number of arbitrary decisions have to be taken to guarantee that categories are mutually exclusive). Temporal connections are considered to indicate causal relationships and such studies generally aim at the clarification of underlying motivational systems. The types of sequence analysis methods, utilized in such studies, would be quite unsuitable for the analysis of simultaneously occurring elements of behaviour, such as required in this study.

I started the analysis with the investigation of the behavioural structure, because it did not seem fruitful to select isolated "key variables". Undoubtedly, a number of shortcomings can be spotted in the analysis. However, preconditions of statistical techniques are rarely met in behavioural data collected in free-field observations. It may be a challenge to the statistically oriented methodologist, to develop suitable tools for the analysis of such data.

8-2 Neurobehavioural relationships

These detailed analyses revealed differentiated relationships between neurological findings and free-field behaviour in this group of "clinically undisturbed" children. The results indicate that a non-optimal condition of the nervous system plays a role in the determination of differences in free-field behaviour. Associations between neurological findings and behaviour have been found in all six observational conditions. At the same time however, the data show how complex relationships are; neurobehavioural associations are largely dependent on the situational context of the behaviour; they are partly different in boys and girls, while even in this relatively homogeneous group differences in socio-educational background and age may contribute to some extent to differences between groups.

Experimental studies in rats by Schwartz (1964) indicate how environmental and organismic factors may interact in behavioural development. Rats, with and without neonatal cortical lesions, were raised to early adulthood in environments that afforded either minimal or maximal opportunity for perceptual and motor experience. Behavioural testing in adulthood showed main effects of brain damage and quality of environment as well as interaction effects of these two variables on performances in a maze learning test. The negative effects of the neonatal lesions on adult behaviour were significantly offset by an enriched early environment. In humans interactions are far more complex than in lower animals. Eisenberg (1957) put forward the view that the sequelae of brain damage are determined by the alterations in the brain produced by the damage, the reorganization of personality in face of the deficit, and the influence of the social environment. In general it is extremely difficult to determine how these factors have been interacting, whenever a certain behavioural disorder becomes manifest. This is particularly true if the alterations in the brain are unknown, acquired in a life period in which the personality is not yet organized and in which the social environment has the profoundest influence on the behavioural organization.

8.3 Reactions to novelty

Different reactions to novelty were observed in children with low and high neurological scores. Especially in the girls low neurological scores are associated with a high amount of room exploration in the novel room with mother, while girls with high neurological scores show signs of discomfort and keep close to the mother. An exaggeration of exploratory activity was also observed by Corinne Hutt in severely brain damaged preschool children on first exposure to a novel object (Hutt, 1968). Vinogradova (1961) quoted by Stores (1973) reports an exaggeration and diminution of the orienting response in relation to brain damage in human, while Rosner (1970) concludes in a review of the pertinent research that "brain-injury may disrupt normal control over reactions to novel stimuli". Evidence comes mainly from experimental studies in animals, such as those by Kimble et al. (1967), who reports that hippocampal but not cortical lesions lead to an increase in exploratory activity in rats. Also in connection with lesions in the prefrontal cortex overreactivity to novel stimuli has been reported (Luria, 1973). Such lesions may lead to marked disinhibition of immediate responses to irrelevant stimuli, thus making the performance of complex behavioural programs impossible. In a discussion in the M.B.D. conference in New York (1973) several discussants suggested an analogy between frontal-lobe dysfunction and some aspects of the "M.B.D. syndrome" (Pontius, 1973).

Hutt and Hutt (1964) indicate that as a consequence of an exaggeration of inspective activity other, more creative, behaviours do not develop. Slotnick (1967) reports that female rats subjected to prior cingulate lesions did poorly in retrieving and nursing their young in a strange environment, not in an familiar one.

It seems to be far-fetched to relate findings in our relatively normal preschool children to those in animals with experimental brain lesions and in severely brain damaged children. However, there is growing evidence from animal studies and clinical observations in humans that severe brain lesions, acquired early in infancy, may result in only minor dysfunctions at later ages. It seems unjustified to conclude on the basis of these analogies that the high amount of exploration in the preschool girls with low neurological scores indicate brain damage. This would be the same sort of reversed reasoning with regard to the M.B.D. problem which has been so severely critisized previously. However, Benton's statement (1973) should also be kept in mind that "the mass of evidence points to the fact that cerebral lesions in children must either be quite extensive or have specific disorganizing functional properties in order to produce important behavioural abnormalities. It follows, I think, that if the behavioural deviations defining M.B.D. are to be ascribed to brain damage or brain dysfunction, than that damage or dysfunction can hardly be 'minimal' in character".

Girls with high neurological scores in our preschool group show more "inhibitory reactions" in the novel room, keeping close to the mother and looking around before further exploring the room.

Similar observations have been reported by Hutt et al. (1965) on the normal controls in their study. These children were observed to only actively explore or play, once they had "surveyed the environment". Their subsequent active investigation would be interrupted by brief periods of just looking around. Brain damaged children in their study did not show this "apprehensive reaction", but started actively moving around. Unfortunately, Hutt et al. do not report results for boys and girls separately.

Hutt et al. considered the behaviour in their brain damaged children as comparable to that in normal children of younger age, on the basis of their view that negative reactions to strangeness increase with age. In my study "explorers" among the girls are younger than "non-explorers". This may suggest an interaction effect between neurological condition and age in the determination of the amount of exploratory behaviour in girls. However, no relationship between exploration in the novel room and age is found in the boys. Additional information on reaction to strangeness in relation to age will be required. The assumption that children with signs of brain dysfunction behave like younger children seems not yet well supported.

In children with low neurological scores, after initial exploratory activity, exploration in subsequent observational conditions drops to a lower level than that seen in children with high scores. Children with an unfavourable neurological condition seem to need more environmental stimulation than controls to keep interested in the environment. Interestingly enough, in the Al 1 condition the boys with low neurological scores are still the high explorers, whereas the low scoring girls dropped already below the other group. Relative to their own sex group, boys and girls with low neurological scores react differently in that environment.

However, the trend in their behaviour over the three successive empty room conditions is similar, only the time course differs: both groups start with high exploration and end behaving passively. This result shows that comparing behaviour in isolated conditions may give quite insufficient information as to neurobehavioural relationships in boys and girls.

This rapid decrease in exploratory activity in children with unfavourable neurological scores is in contrast to the slow "habituation" in brain damaged children, reported by Hutt, Hutt and Ounsted (1965) and Hutt (1968). Hutt et al. attribute this phenomenon to a tendency to "short sampling" in brain damaged individuals.

The slow habituation found by the Hutt's in brain damaged children seems to be an aspect of the "invariability" which they typically find in their brain damaged group. Possibly, this phenomenon is directly linked to cognitive deficits in their severely brain damaged group, which makes these children incapable of modulating their behaviour in response to environmental changes. In my study satiation reactions are observed in the Al 1 and Al 2 conditions, indicating that a loss of interest in the environment is a prominent factor. Such a rapid loss of interest after an initial peak of activity is often reported by teachers of children with learning disorders. Sykes et al. (1973) describe this phenomenon in hyperactive children who, in an experimental situation, were unable to maintain attention over a prolonged period of time. These children are described as appearing to lack inhibitory control, showing more impulsive reactions towards novel stimuli. Luria (1973) mentions this as an inability to modulate the activity, frequently found in relation to damage to the prefrontal cortex. Close observation of behaviour in free-field settings may reveal such reaction tendencies in preschool children.

Up till now, no satisfactory explanation for the high initial exploratory activity has been given in terms of brain processes. Hutt refers to Berlyne (1960), who describes the function of exploratory activity as "maintaining a balance between internal factors and incoming stimulation". Hutt et al. suggest that any individual has an optimal level of stimulation ("arousal potential") which is considered as "a state of the reticular activating system". Novel, complex and uncertain stimuli increase internal arousal and the animal seeks to reduce it by specific inspective exploration". Also with too low level of stimulation, arousal may occur as cortical restraints upon the reticular system are released. This may give rise to diversive exploration, such as body-oriented or room-oriented activities which serve to vary sensory input.

Such an arousal model seems to be a physiological pseudo-explanation. Arousal is used in the sense of a "tendency to react" without independent evidence of the physiological mechanisms involved in these processes.

8-4 Play behaviour

Play behaviour shows interesting differences in relation to neurological scores. Girls with low scores play at low levels. Boys do the same, except in the Vartoys condition. This condition has been introduced to investigate problems in selective attention. The child is confronted with a large variety of toys, in contrast to the relatively homogeneous Block condition. However, the toys in the Vartoys condition with a preponderance of constructive material are especially attractive for boys. The attractiveness of toys seems to be of particular relevance for children with neurological dysfunction. Such children are described by their parents as easily distracted and bored, unless very attractive material is offered to them.

It is very likely that the Vartoys condition appeals especially to boys. This may explain the unexpected high play level of boys with an unfavourable neurological condition. This raises the general problem in studies of boys and girls in identical situations. The "objective" similarity may obscure the "subjective" difference for the two sexes. Girls with low neurological scores may function as good or even better than controls when observed in a for them more suitable situation.

The afore mentioned phenomenon that the low neurological boys perform better than their controls, finds substantial support from animal experiments. Johnson (1972) reports that rats with septum lesions learn avoidance tasks quicker than controls, whereas Musty (1969) reports that rats with hippocampal lesions press levers at a higher rate than controls in learning tasks. In these brain damaged animals there may simply occur a disinhibition, so that simple, isolated tasks can be performed quite well, whereas performances in complex tasks are disturbed. For children, however, another explanation must be considered.

The differences I find seem to be related to differences in motivation and the capacity for sustained attention, affecting the behavioural organization in non-stimulating situations. To reveal the exact background of these findings further, more specifically designed, studies are required.

Whatever the correct explanation may be, these results indicate at least that consequences of neurological non-optimality manifest themselves differently in different situations. The behavioural sequelae of an unfavourable neurological condition appears most clearly in situations with an aspect of "sensory deprivation", and of "uncertainty" and "strangeness". Strikingly enough in the first mentioned situations the boys fail and show relatively disorganized behaviour, while in the latter, girls show most behavioural deviations.

A striking feature in the study of Hutt, Hutt and Ounsted (1965) was the invariability of the duration and range of activities in the brain damaged group, whose behaviour was hardly affected by changes in the environmental structure. Also in hyperactive children in another study by the same authors such an invariability was observed.

An equally striking feature in my data is the large variability in neurobehavioural relationships, depending on the situational context in which the behaviour occurs. If, for instance, boys with low and high neurological scores had been observed only in the novel room with mother, hardly any difference in behaviour would have been spotted. In the condition for the first time alone in the empty room the boys with the low neurological scores are the "explorers". However, low scoring boys behave the most passively when they are for the second time alone in the empty room. In the Block condition the low scoring boys show the lowest level of play activity, in the Vartoys condition the highest, in the Onetoy condition again the lowest level of play activity. Only by careful description of context and behaviour can any meaningful data be obtained. Differences in neurobehavioural relationships not only relate to the features of that specific environment but also to the wider context in which behavioural observations are carried out.

Among children with favourable neurological scores quite different kinds of behaviour may occur. Two different patterns were found in play conditions: A pattern of "not being involved in play activity" and another "high level play" pattern. Undoubtedly a more differentiated picture would have been obtained when further differentiation in the analyses would have been possible, Because of these kinds of relationships, correlations between such variables and neurological categories can be expected to be low.

8-5 Differential effects of neurological dysfunctions

The contribution of neurological categories to the discrimination between groups is much more differentiated than suggested by the crude distinction between high and low scores. This manifests itself in two different ways,

a. different neurological conditions are important for the behaviour in boys and girls (Table 14).
b. different neurological conditions have different relationships to behaviour in different environments. The manner in which choreiform dyskinesia, in particular, affects the behavioural organization strongly depends on the situational context.

a) In preliminary analyses in boys a much stronger connection between neurological findings and behaviour was found than in girls. However, in the final profile analysis connections are about equally strong in both sexes. This is mainly due to the addition of the categories "maturation of functions" and "maturation of responses". These categories contribute strongly to the discrimination in the girls, but little in the boys, while on the other hand "choreiform movements" have an effect on behaviour in boys only. Although no conclusions about M.B.D. can be drawn from these data, one might speculate that Kinsbourne's (1973) view that "all indicators of M.B.D. represent the normal state of affairs in younger children" does not equally hold for boys and girls. In girls the dysmaturity aspect may be predominant, whereas in boys the aspect of neurological dysfunction may play a more prominent role in the genesis of the typical M.B.D. case.

b) There is great confusion about the significance of so-called "soft neurological signs". Many investigators plead for a more exact definition of such phenomena (Rutter et al., 1970; Touwen and Prechtl, 1970; Ingram, 1973). Ingram states "the fact remains that the use of the terms 'soft signs' and 'minimal brain damage' is diagnostic of soft thinking. These terms should be discarded. Pediatricians should describe what they find".

This view is strongly supported by my results, making use of detailed neurological data, particularly by the specific association between choreiform movements and free-field behaviour in boys. This neurological condition goes together with desorganization of the play activity in conditions with unattractive toys, but fails to show up in all other examined conditions. Its specificity is also indicated in our group by the lack of correlation between choreiform movements and other neurological conditions. Choreiform dyskinesia has to be considered as a dysfunction of the C.N.S. (Touwen and Prechtl, 1970) but not as a sign of developmental delay (highest frequency found is 12 per cent in boys at seven years of age (Stemmer, 1964)).

Much of the controversy around choreiform dyskinesia (Prechtl and Stemmer, 1962; Rutter et al., 1966; Wolff and Hurwitz, 1966; Nooteboom, 1967) can be explained by this specific connection to adaptive behaviour in boys, which differs from that of other neurological conditions.

8-6 Concluding remarks

Neurobehavioural relationships could be detected in various environments. There is not any one specific connection between "the neurological condition in general" and "the behaviour in general" but a variety of associations. Consistency of behaviour is remarkably low, as for instance has been illustrated by the finding that only one child out of 117 was in the group with the highest amount of gross body activity in all six observational conditions.

Numerous factors influence development of behaviour and may set limitations to the child's adaptational capacities. A non-optimal neurological condition is one of these many factors. Therefore, in a group of "clinically undisturbed" children the strength of neurobehavioural relationships should not be overestimated. In some instances neurobehavioural profiles can give a flattering impression of such associations, if not carefully interpreted.

Some restrictions must also be placed on the interpretation of the neurological findings. In the evaluation of minor signs of nervous dysfunction no structural correlates are available to validate a diagnosis of brain damage. Such signs are considered indicative of an unfavourable condition of the nervous system, primarily on the basis of empirical data showing that such signs relate to generally accepted "risk factors", or are more common in children with problem behaviour than in controls; on similarities between such minor dysfunctions and signs in children with unequivocal evidence of brain damage, and on results of experimental studies on early brain-lesions in animals.

Problems are compounded in children by the functional changes throughout development. Establishing age norms for the neurological repertoire of the child is a very time-consuming and difficult procedure. In preschool children only a few data on the distribution of single neurological signs have been reported up till now (Connolly and Stratton, 1968; Grant et al., 1973). For these sorts of reasons a concept of neurological optimality (Prechtl, 1968) was adopted for the categorization of neurological findings (Touwen, 1971). This concept proved most useful in this study. However, further research is needed to define more precise criteria of normal and abnormal in the developing nervous system.

There are interesting developments in thinking about M.B.D., triggered by,

a. animal experiments in which minor and frequently almost undetectable defects were found following serious brain lesions acquired in early infancy (Windle, 1968) and by,
b. many clinical observations (e.g. in children with intact cognitive functions after removal of large parts of the brain (Benton, 1973)).

The developing cerebrum seems to have an enormous capacity to compensate, the exact mechanisms of which are still largely unknown (Sperry, 1968). In a review on experimental studies in animals, Prechtl (1973) points out possible compensatory mechanisms, such as the development of new neural connections, and the activation of already existing ones. Functions are not taken over by parts of the brain which did not have such functions previously.

Originally the label "minimal brain damage" was replaced by "minimal brain dysfunction" because of a lack of direct evidence for structural defects. There is some evidence that the term "minimal" should be replaced by "severe" and "dysfunction" by "damage" in particular cases (Benton, 1973; Prechtl, 1973). However, there is a danger that a new stereotype, namely that all minor dysfunctions are an effect of severe brain damage acquired in early infancy, may replace the old one and retard progress in research as much as the original "minimal brain damage" stereotype has done.

Since the present investigation was intended as an exploratory study, children were observed in a large variety of environments so that differentiated relationships could be spotted. Many questions arising out of this study require further analyses, and a number of results have to be cross-validated. Relationships between free-field behaviour in laboratory settings and natural environments, and the long-term consequences of neurobehavioural findings at preschool age require further investigation. Specific experimental studies are required to determine the more precise character of behavioural dysfunctions in relation to brain-mechanisms.

In the course of this study data were collected on school and home behaviour, on children's reactions under time stress and when confronted with tasks of varying complexity, on their spatial-constructive and verbal abilities, etc. Data have also been collected on children's school adaptation at the age of eight and analyses are in progress and will be reported in due course.

A most important line of research concerns the rôle of the interaction of the child's organismic "make up" and the environment in the later emergence of behavioural problems. Pilot analyses have revealed slight differences in free-field behaviour at preschool age between children neonatally diagnosed as "apathetic" and "hyperexcitable" on the one hand and optimal controls on the other. Close follow-up studies in carefully selected groups of children, designed partly on the basis of findings at preschool age, will be essential in order to understand the etiology of associations found in this study. Some specific guidelines for the guidance of children with minor neurological handicaps are suggested by these data. They concern for instance the importance of an optimal variety of environmental stimulation for the behaviour of neurologically non-optimal boys. The quick loss of interest in the environment and the decrease in behavioural organization in mildly stressing situations in children with a non-optimal neurological condition may be of particular interest to educationalists.

Though these suggestions, based as they are on laboratory study, are not intrinsically new, nonetheless they are based on objective evidence of a type not easily acquired at this age. The more wide application of this technique of observation of the freely exploring child may provide the opportunity to objectively study adaptational strategies in children at risk, and thus provide information essential to their proper guidance with the aim of preventing more serious problems.

SUMMARY

The focus in this study is on relationships between neurological findings and free-field behaviour in preschool children. The study was triggered by the problem of learning and behaviour disorders in children, which are supposed to be related to a non-optimal condition of the nervous system and which are described in the literature under headings such as "minimal brain dysfunction (M.B.D.)" or "special learning disorders". There is much confusion and controversy as to the exact kinds of neurobehavioural relationships and their etiology. There is a dearth of experimental studies but a wealth of impressionistic descriptions.

This study differs in two important respects from previous studies in the M.B.D. area,

1. concerning the group studied: generally M.B.D. studies concern school-aged children in whom behavioural and/or learning problems have already developed. This did not apply to the preschool children included in this study.
2. concerning the method of direct observation and quantitative analyses of free-field behaviour that was applied: this method has not been used previously in relation to the M.B.D. problem nor on such a large scale in other human studies. In consequence in this study many problems related to data collection and processing had to be solved.

The general problem of the study is stated in <u>chapter 2</u> as follows: What are the relationships between neurological findings and "free-field" behaviour, directly observed in variously structured environments, in a group of preschool aged children with a variety of minor neurological dysfunctions but without serious neurological handicaps and not selected because of behavioural problems?

In the <u>introductory chapter</u> the wide interest in the M.B.D. problem is traced back to converging developments in education, psychology, and medical thinking during the last half century. Child centered didactical methods and the development of specific approaches for children with limitations in their learning abilities went parallel to a rapid development of refined psychodiagnostic tools and basic theoretical insights on

connections between somatic and mental aspects of the development. In neuropsychology the C.N.S. became considered as an integrated, differentiated system in which diffuse damage would lead to general deficits in the behavioural organization. Further, findings in relation to aphasia in adults and sequelae of brain damage in children together with the idea of a continuum of the degrees of damage led to the conception of a neurological background for adaptational problems in children.

Despite this widespread interest it is pointed out that progress in the study of M.B.D. was slow. This is attributed partly to differences in refinement and standardization of methods in the different disciplines. Many studies show fallacies and these are briefly indicated.

The method of free-field observation in stylized environments seems to be particularly suitable for the study of M.B.D.-types of behaviour. This method is applied in this study and its possibilities and limitations are discussed in chapter 3. The method allows for,

a. an objective and analytic study of complex behavioural phenomena,
b. the study of behaviour patterns which closely resemble those important for adaptation in "natural" environments,
c. the study in young children of behavioural aspects which are basically important in the child's future adaptation in formal and less formal situations (e.g. home, school).

With allowance for its limitations, which are related to restrictions in the method of registration, the choice of behavioural categories, the necessary reduction in the data, etc. it is suggested that the method of free-field observation may provide important information about the background of children's adaptational problems.

In chapter 4 the group, design, and measures used in the study are described. The study concerns 150 preschool children (age range 4;11 - 5;5 years) none of whom presented serious neurological disorders. Main criteria for selection were full-term delivery and completeness of obstetrical and neonatal neurological data. All children had a reassessment at preschool age. Apart from the neurological examination and the free-field observation, data were collected about the social background, the behaviour in home and school situations, and the psychological and medical history of the child. In addition, a number of experiments were carried our. In this report only a limited part of the material is discussed, namely that directly related to connections between neurological findings at the age of five and free-field behaviour.

To avoid the difficult discrimination between neurologically normal and abnormal, an optimality concept, devised by Prechtl, was applied. Behaviour was related to two sorts of neurological measures,

a. a general optimality score. On the basis of this "overall" score children were classified in three groups, with low, intermediate, and high neurological scores respectively. In a preliminary analysis, behaviour in these three groups was compared for boys and girls separately.
b. measures for six neurological functional categories, defined on the basis of clinical criteria and statistical evidence, and labelled as "sensorimotor", "posture", "coordination", "choreiform movements", "maturation of functions", and "maturation of responses". Free-field behaviour was studied in relation to these measures in the final analysis.

Observations took place in a specially designed playing room. Behaviour was video-recorded through a one-way screen and from a corner of the room and analysed from video recordings by two cooperating observers. Children were observed in six differently structured environments, always in the same sequence:

1. together with mother in the novel empty room (3 minutes)
2. alone in the empty room for the first time (3 minutes)
3. with blocks and a passive observer (10 minutes)
4. alone in the empty room for the second time (3 minutes)
5. alone with a variety of toys (15 minutes) and
6. alone with one "non-motivating" toy (5 minutes).

These environments were selected because they differed with respect to a number of aspects important for the structuring of the behaviour at preschool age: the novelty of the environment, the presence of a social figure, and the amount and variety of material.

Behaviour was described in terms of predefined categories, partly derived from systems by Hutt, Berkson and McGrew, and partly developed in pilot and preliminary analyses to this study. These categories allowed for a detailed description of the behaviour of the child in relation to the social environment (mother, observer), the physical environment (fixtures in the room, play material), and the own body. Aspects of the motor, visual, and verbal activity were scored. The procedures of registration, observation, scoring, and coding of behaviour were standardized as much as possible.

Having discussed a number of pilot studies, focussing on optimalizing of observational conditions and categorization of behaviour, preliminary studies are described in chapter 5 concerning the reliability of the application of behavioural categories in the observation, and the reliability of the coding procedure.

To estimate the reliability of the scoring procedure two analyses were carried out,
an interscorer reliability estimation (video recordings scored by two observers, independent of each other),
an estimation of the score-rescore agreement (video recordings scored by two cooperating observers on two occasions, six weeks apart).
Score-rescore agreement is in general slightly higher than interscorer-agreement, a difference which, it is suggested, may be explained by the possible communication between observers during the scoring procedure. In general it was found that measures are sufficiently high for a study in which groups of children are compared, most coefficients reaching values of .80 or higher. Reliability is particularly high in the categories concerning motor and play activity. The estimation of the intercoder reliability gives coefficients in the range of .80 to .98.

Prior to the investigation of neurobehavioural relationships, the structure of the behaviour was explored (chapter 6). A comprehensive analysis of the behaviour rather than a preselection of specific "key variables" was used.

The purpose of this analysis of the structure was:

a. to ascertain relationships between behavioural categories in order to avoid overinterpretation of differences on isolated elements of the behaviour, and
b. to reduce the data by combining categories in behaviour patterns on the basis of known relationships.

Behavioural categories used in the video analyses were included in "behaviour patterns" on the basis of statistical data and a number of other criteria, such as the environmental orientation of the behaviour, the comparability of the composition of patterns in different observational conditions, the relevance of the behaviour in relation to neurological findings, etc.

In the empty room conditions the following patterns were distinguished: room exploration, passive waiting, body-oriented activity, one-way screen reactions, close contact, verbal contact, and visual contact with mother. In the play conditions the following patterns were distinguished: low and high level play, exploratory play, no play activity, gross body activity, body-oriented behaviour, and room-oriented behaviour.

Relationships between behavioural categories within and across observational conditions are discussed. As might be expected, because of the large number of alternatives in the behaviour repertoire, correlations between separate behavioural categories are generally low. Higher correlations were found between a number of "behaviour patterns" when they occurred in the same observational condition. Across the six observational conditions relationships between such patterns are weak.

Neurobehavioural relationships were studied by means of a method of profile analysis. Results are given in chapter 7. Scores for behaviour patterns and for the six neurological categories were introduced in these analyses. They were carried out separately for boys and girls and for each of the observational conditions. Prior to this analysis, two preliminary studies were carried out:

a. one on sex differences in the behaviour, irrespective of neurological condition,
b. one on behavioural differences between groups with low, intermediate, and high neurological optimality scores.

The main results, reported in detail elsewhere, are the following:

a. In boys more exploratory activity and verbal behaviour was observed in the condition "together with mother in the novel room", while in girls more body-oriented behaviours were observed in all empty room conditions. Boys showed more gross body activity in all play conditions. Differences in the level of play activity between sexes are negligible. Some slight indications that the higher incidence of neurological dysfunctions in boys is one of the determinants of behavioural differences between sexes requires further analysis.
b. Neurological variables exerted a stronger effect on behaviour in boys

than in girls, and different observational conditions discriminated between neurological groups in boys and girls. In boys the condition "with one non-motivating toy", in girls the condition "together with mother in the empty room" seemed to be most sensitive.

In the final profile analysis groups of children were identified characterized by specific combinations of neurological and behavioural scores. The main results are the following:

Behaviour patterns associated with low neurological scores were similar in boys and girls in some observational conditions, different in others. Similar findings included high exploration in the novel room and low exploration when the environment had become familiar. Contrasting results were obtained when a variety of toys were available, where boys with low neurological scores played at a higher level than boys with high scores.

There were some sex differences found in the neurobehavioural associations, depending on the situational context.

In boys differences in"sensorimotor" and "postural" optimality scores were most closely related to differences in free-field behaviour, while "maturation of responses" had no effect. In girls "maturation of functions", "maturation of responses", and "sensorimotor" contributed most to the neurobehavioural discriminations, "choreiform movements" and "posture" least.

Choreiform dyskinesia only affected the behavioural organization in boys in conditions with non-attractive toys.

Differences in social background were only found in the Blocks condition between the two groups of boys. There were slight differences in age between some neurobehavioural groups in both sexes.

In chapter 8 the main results are discussed in the light of free-field observations in brain damaged children and experimental studies in animals. Relatively strong reactions to novelty, observed in neurologically non-optimal preschool girls are to some extent comparable with phenomena seen in unequivocally brain damaged children and in animals with lesions in hippocampus or pre-frontal areas.

The rapid decrease in exploration in preschool children with unfavourable neurological scores is in strong contrast to the slow "habituation" observed by Hutt, Hutt and Ounsted in severely brain damaged children. These differences may relate to motivational factors in our preschool group and cognitive deficits in the brain damaged children.

These findings of differences in neurobehavioural relationships found in different environments, are in sharp contrast to the invariability of the behaviour of children with brain defects, reported by the Hutt's and Ounsted.

General points made in the discussion concern,

- the necessity of specifying situational context and behaviour in reporting neurobehavioural relationships (there is a variety of associations between neurological categories and behaviour),
- the importance of comprehensive and differentiated neurological assessments: pooling "soft signs" implies loss of valuable information,
- the necessity of taking into account the fact that objectively similar environments may be differently perceived by different children,
- some changing opinions about the "structural basis" of M.B.D.-like behaviours,
- the controversies in the "choreiformity" literature, which are traced back to the specific connection of that neurological condition to adaptive behaviour in boys in non-stimulating situations.

The view is expressed that in girls the aspect of "dysmaturity", in boys that of "neurological dysfunction" may be most prominent in the typical M.B.D. child.

Finally, the relevance of the findings for the early detection and proper guidance of children at risk is briefly outlined. The observation and quantitative analysis of free-field behaviour is considered to be a promising method in the study of a variety of clinical and developmental problems.

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Appendix I

Optimality ranges for the items of the neurological optimality score at preschool age*

active power	moderately strong
resistance to passive movements	moderately strong resistance
range of movements	full range without overstretch
muscle consistency	moderate
claspknife phenomenon	absent
cog wheel phenomenon	absent
circumference of arms and legs	symmetrical
tendon reflexes of the legs	moderate
threshold of tendon reflexes of the legs	medium
tendon reflexes of the arms	moderate
threshold of the tendon reflexes of the arms	medium
abnormal skin reflex	evident contraction on both sides
plantar response	plantar flexion or no reaction
other skin reflexes of the leg on the toes	absent
glabella reflex	symmetrical brisk closing of the eyes
foot posture, sitting	symmetrical in median position
posture of the arms in forward extension	symmetrical without deviations from median or horizontal line
posture of the trunk, standing	symmetrical and straight
arm posture (standing)	symmetrical, hands median
leg posture (standing)	straight, symmetrical
foot posture (standing)	symmetrical arches median position
posture during walking	asymmetrical, body straight
ability to sit	possible without support
ability to stand	possible without support
walking	smooth and similar movements of trunk, legs and arms
following an object with eyes, head and trunk, sitting	balance without support of hands
response to push, sitting	balance without support of hands
response to push, standing	balance without change of foot positio
kicking	adequate touching of examined hand in three positions
rebound	5 cm
type of grasping of small object	pincer grasp
fingertip-nose test	adequate placing of the finger with eyes closed
Romberg test	standing still without mov. of feet
choreiform movements (distal, proximal)	absent
tremor	absent or slight high freq. tremor
choreathetosis	absent
facial musculature	symmetrical in rest and during mov.
pharyngeal arches	symmetrical in rest and during mov.
Chvosteks' response	absent
cornea reflex	brisk closing of the eyes
position of the eyes	centered
pursuit movements of the eyes	symmetrical, smooth
convergence	present and equal on both sides
optokinetic nystagmus	equal on both sides
directional nystagmus	grade 1 in 45° position of the eyes
visual fields	full range
pupillary reactions on light	directly and indirectly present
fundoscopy	well outlined contours of papilla, no edema

* As listed by Touwen (1971). Details about scoring in: Touwen, Prechtl: The Neurological Examination of the Child with Nervous Dysfunction (1970).

Appendix II

Functional categories of neurological items[1]

Sensorimotor

resistance to passive movements
tendon reflexes of the arms
tendon reflexes of the legs
abnormal skin reflex
threshold tendon reflexes of the arms
active power
skin reflexes of the leg on the toes
type of grasping
threshold tendon reflexes of the legs
position of the arms in forward extension
plantar response

Posture

posture of the feet, standing
walking
standing ability
posture of the legs, standing
posture of the feet, sitting

Coordination

Romberg
kicking
following object, sitting
response to push, standing
fingertip-nose test
rebound

Choreiformity

choreiformity in finger muscles
choreiformity in eye, tongue and face musculature
choreiformity in arm and trunk muscles

Maturation of functions

heel-toe gait
raising into sitting
walking on heels
walking on tiptoe
hopping
standing on one leg
diadochokinesis

Maturation of responses

plantar grasp
Mayer
Lery
Galant

[1] Details on assessment and evaluation in Touwen, Prechtl "The Neurological Examination of the Child with Minor Nervous Dysfunction", Heinemann, London, 1970.

Appendix III Technical note on video and audio equipment

Video equipment:

2 camera's, Philips EL 8010/02
camera 1, zoom-lens Angenieux-Zoom type 10 x 15B
F.15 - 150 mm
camera 2, wide angle lens: Canon C-16
33 mm 1:1.5
2 camera control units, Philips EL 8015/02
2 monitors, Philips EL 8100/03
1 Sync Pulse Generator, Philips EL 8250/01
1 video mixer, Philips EL 8255
this mixer gives the possibility to switch from camera 1 to camera 2 (and back) in a smooth way without loosing synchronisation; it is also possible to give a mixed picture of both camera's
1 video recorder, Sony OV 120 - UE
this recorder uses 2 inch wide videotape on with is 1 video track and 2 audio tracks
1 video monitor, Philips EL 8110/00/90 (large screen)

Audio equipment:

1 microphone, Sennheiser
this microphone is placed above the lightdiffuser in the middle of the room, not visible for the child
1 preamplifier, departmental design
this device amplifies the signals from the microphone to a suitable level for sound input of the video recorder
1 audio amplifier Seloso Milano
this amplifier is connected to a loudspeakerbox to mònitor the sounds to be recorded and reproduced
1 time marker departmental design
this time-marker gives soundbursts in the following pattern:
every 10 sec. a burst of 500 Hz (bursttime about 1 sec) /low tone/
every minute a burst of 1000 Hz (bursttime about 2 sec) /high tone/

Appendix IV

Standard introductions to each of the observational conditions

1. Introduction to the condition: "With mother in the novel empty room (Mo)[1]

The mother is required to sit on a stool on block a_4, and to stay there during the entire session. She is asked not to interfere with the behaviour of the child (by suggestions, prohibitions, presenting him food, etc.) and not to initiate contact with him. When the child initiates contact, the mother should react as neutrally as possible. Handbags and other objects are left outside of the room.

The following was said to the child: "I will look for some toys for you to play with. Please, wait here with your mother for a minute".

Comment: we chose this design because we wanted

a) to avoid the burden of additional material in the room, (such as magazines, handbags, etc.)

b) to have the mother available for the child when it needed contact.

We accepted the problem of some mothers feeling somewhat upset by passively sitting during a three minute observation.

2. Introduction to the condition "Experimental tasks"

After bringing material into the room the examiner asks the mother to go to the neurologist, who is in an adjacent room, for an interview. The examiner then says to the child: "Now we are going to do all sorts of things. Your mummy won't be far away and she will be back when we finish playing".

3. Introduction to the condition: "For the first time alone in the empty room (Al 1)

After having taken all the material out of the room, the examiner says: "Please, wait a minute. I will get some other things for you. I will be back in a minute".

4. Introduction to the condition: "With blocks and a passive observer" (Blocks)

After the examiner has put a box with blocks on square b_1 and c_1, the following introduction is given: "Now you may play with these blocks. Do what you like. In the meantime, I have to do some writing".

[1] In parentheses abbreviations used in the text.

(the observer sits on a stool on square d_6, making notes without paying attention to the child). When the child initiates contact, the observer reacts as neutrally as possible.

5. Introduction to the condition: "For the second time alone in the empty room" (Al2)

After removing the blocks the examiner says, "Please, wait a few minutes. I will get some other toys now. I'll bring them in in a minute".

6. Introduction to the condition: "Alone with a variety of toys" (Vartoys)

After having placed the toys in "standard positions" in the room the examiner says to the child: "These toys are for you to play with. I have to go to another room to do some work but I will be back in a few minutes" (the examiner leaves the room, gently closing the door. At the end of this session the examiner re-enters the room. After having required the child to stop playing, he removes all the toys except one, which had not been used by the child during the preceding session.

Comment: When the child had used all the toys, the one handled the least, was left in the room. If several toys had not been used, a particular toy was chosen according to a standard schema.

7. Introduction to the condition: "Alone with one "non-motivating" toy" (Onetoy)

Before leaving the room the examiner says: "I have to do a little tidying up but I'll leave one toy here. I'll be back in a few minutes".

Appendix V Categories applied in the observation of "free-field" behaviour from video-audio recordings

Behaviour scored in all conditions	Definitions	Operationalizations	Examples
1) Locomotion	Manner of changing position in space with reference to the floor (Hu)[1]	Number of "blocks" covered	
2) Locomotion pattern	Characteristically structured orientation of head, trunk and limbs during locomotion (Hu/Ka)	Number of times locomotion pattern is observed from a precoded list of locomotion patterns (App. VI)	Walking, hopping
3) Types of locomotion patterns		Number of <u>different</u> locomotion patterns in an observation	
4) Posture	Specific orientation of the head, trunk and limb-contours of the body, while the position in space with reference to the block pattern on the floor remains the same (Hu/Ka)	Number of times posture is observed from a precoded list of postural categories (App. VII)	Standing upright, lying
5) Types of postures		Number of <u>different</u> predefined postures during an observation	
6) Manipulation of fixtures	Active contact with hands, mouth or feet with any part of the environment, except its own body or clothing (Be) Touching, handling or moving fixtures with hands or feet (which fixtures are manipulated and in which way is specified) (Ka)	Number of times the child manipulates fixtures in the room (stool included)	Tapping the radiator twisting the doorsto
7) Manipulation of own body (clothes)	Movement of mouth or hands with respect to any part of the body (Be/Ka)	Number of times the child manipulates his own body or clothes	Scratching his face, fumbling in pocket, picking nose

1) Between parentheses the investigators are mentioned who developed (e.v. modified) a particular category. Hu: Hutt; Be: Berkson; Ka: Kalverboer.

Appendix V continued

Behaviour scored in all conditions	Definitions	Operationalizations	Examples
8) Gestures	Communicative movement patterns, which are no part of the movement patterns for verbalisation or vocalisation (Ka)	Number of times communicative movements as defined are observed	Pointing at an objec arm movements in re lation to verbalisat.
9) Additional movements	Movements of limbs, head or trunk, which are no part of the patterns of locomotion, body posture manipulation and/or communication (Ka)	Number of times additional movements are observed	Waving the arms, rocking
10) Visual fixation	Child looking at one particular aspect of the environment, unaccompanied by any other activity towards that aspect of the environment (Hu/Ka)	Number of times and duration in seconds that the child looks at an aspect of the environment for 1 second or longer	
11) Visual scanning	Child looking around, without focussing a specific aspect of the environment (Hu/Ka)	Number of times and duration in seconds that the child looks around for 1 second or longer	
12) Looking straight ahead	Looking in one particular direction, without active exploration or inspection of an aspect of the environment (Hu/Ka)	Number of times and duration in seconds that the child looks straight forward	
13) Verbal behaviour	All "verbal" sounds[2)] (Ka)	Number of 10" epochs, during which "verbal" sounds are observed	
14) Other sounds	All vocalizations which are not verbal (Ka)	Number of 10" epochs, during which "other sounds" are observed	To hum, to shout, to whistle, etc.
Behaviour concerning contact with mother			
15) Spatial contact with mother	Distance in space between child and mother (Ka)	Weighted scores for spatial contact (a "largest distance-score" and a "shortest distance-score") obtained according to the procedure described in App. XII	

2) Originally I distinguished between communicative and monological verbalizations; these two categories were lumped in the final analyses.

Behaviour concerning contact with mother	Definitions	Operationalizations	Examples
16) Visual contact with mother	Child looking in the direction of mother (Ka)	Number of 10 sec. epochs in which the child looks at the mother for 1 sec. or longer	
17) Tactile contact with mother	Touching the mother with hand, foot or mouth (Ka)	Number of 10 sec. epochs in which the child touches the mother	
18) Verbal contact with mother	Child communicating with the mother by verbalization or vocalization (Ka)	Number of 10 sec. epochs in which the child shows oral communication with the mother	
Behaviour related to the level of the play activity			
19) Play activity level I	Play activities which are not specific for the material handled and which have no observable constructive or symbolic character (Ka)	Duration in seconds of "level I activity"	-Turning box of blocks upside down -throwing with blocks -fumbling in small holes -tapping blocks against each other or tapping a block against the floor -rummageing among material without looking for something -purposeless scrambling in box of blocks 3)
20) Play activity level II	Play activities which are determined by external qualities of the material (such as similarity in form or size), and a number of predefined play activities which are directly related to obvious functions of the material (App. VIII) (Ka)	Duration in seconds of level II activity	Putting blocks in holes piling up blocks without really building
21) Play activity level IIE	Play activities with an experimenting or exploring character (as far as can be observed the function of these ac-	Duration in seconds of level IIE activity	-Opening andcclosing doors of cars (often repeatedly) -hoisting a platform in garage

3) Searching for toys (such as blocks), which are to be used in a particular play activity, is scored according to that play activity.

Behaviour related to the level of the play activity	Definitions	Operationalizations	Examples
	tivities is to inspect or explore the possibilities of the material) (Ka)		up and down by a handle without an object on it -turning a screw of a tanker off and on -turning around wheels of a car -comparing the size of blocks
22) Play activity level III	Constructive play activities, during which no different sorts of play materials are combined. Also phantasy play with one sort of material is included in this category. Furthermore activities are included in which different toys are used in "obvious" combinations [4] (Ka)	Duration in seconds of level III activity	-Building a tower from blocks -joining car and trailer together -moving around a car and making "car" sounds -drawing (if only scribbling it is scored level II) -dressing or undressing a doll An example of an "obvious" combination is "putting and turning a car on the platform up and down", as an isolated activity
23) Play activity level IV	Complicated constructive play activities in which different sorts of play-material are combined. Also included in this category: phantasy play with different sorts of material (Ka)	Duration in seconds of level IV activity	-Moving a car into a garage, tanking oil, parking it, etc., as a combined activity -Attaching a car to the crane and pulling it up -Putting a car into the garage by means of the platform and parking it -Making a building of blocks with obvious planning

[4] When a level III of IV play activity progresses in a stereotyped way, by continuous repetition of the activity, the score lowers to level II: e.g. when a car is put on the platform and turned up, the activity is scored level III: however, when the child goes on turning the car up and down on the platform, the score drops to level II. Such a change is also scored as a change in level of play activity cat. 26-, not as a change in play activity cat. 25.

Other behaviour related to the play-activity	Definitions	Operationalizations	Examples
24) "Tidying up" activities		Duration in seconds of "tidying up" activities	-Tidying away toys -Packing up blocks and closing the box -Putting material aside
25) Changes of play activity		Number of times that a predefined play activity is replaced by another predefined play activity (see for definitions the categories above)	
26) Changes in level of play activity		Number of times a play activity is replaced by a play activity of another level	
27) Longest play activity		Duration in seconds of the longest continuous play activity during the total observation period	
28) Changes in handling of play objects		Number of times that the child switches from one play object to another (this category is only applied in the situation with a variety of toys. The play objects are listed in App. IX	
29) Manipulation of different play objects		Number of <u>different</u> play objects manipulated during the observation session	
30) No play activity		Number of times or duration in seconds that the child is not occupied with the play material	

Appendix VI: Precoded list of locomotion patterns[1)]

Locomotion pattern	Definition
1) Walk	To move the body forward at a moderate pace, alternating legs and placing one foot firmly on the substrate before lifting the other (McGrew).
2) Walking on tiptoe	Feet are extended during walking, so that the body is raised and supported only on the toes (McGrew-Kalverboer).
3) Step	To move the leg forward once, placing it on to the substrate while shifting part of the body's weight on to it (McGrew).
4) March	To walk in a brisk, stereotyped manner with exaggerated movements in an even stride (McGrew).
5) Run	To move the body forward at a rapid pace, alternating legs during each stride with both feet off the ground instantaneously during each stride (McGrew).
6) Hop-loco	To move suddenly upward into the air by leg or foot extension, landing on one foot in a different location with horizontal motion (McGrew).
7) Jump-loco	To move suddenly upward into the air by leg and foot extension, landing on two feet in a different location with horizontal motion (McGrew).
8) Crawl	To move forward on hands and knees propelled by the limbs (McGrew).
9) "Swim"	To move the body backward, forward or in a circular direction, in constant, frictional contact with the substrate, propelled by the arms (Kalverboer).
10) Slide	To move the body in constant, frictional contact with the hips slightly flexed (McGrew-Kalverboer).
11) Skip	To move the body forward by alternating legs, placing one foot on the substrate and hopping slightly on it before shifting the weight to the other foot to repeat the same movement (McGrew).
12) Roll	Moving sideward in lying position with continuous rotation of the trunk (McGrew).

1) Locomotion patterns were selected which were most frequently observed in pilot studies.

Appendix VI continued

Locomotion pattern	Definition
13) Going on hands and feet	To move forward on hands and feet, propelled by the limbs (McGrew-Kalverboer).
14) Fall	The body suddenly and violently moves down from an upright position to a horizontal one, usually on to the ground. The landing is generally on the buttocks or on hands and knees (McGrew).
15) Other locomotion pattern	Each locomotion pattern, not included in the list, that can be unequivocally recognized as distinct from other locomotion patterns (Kalverboer).

Appendix VII: Precoded list of body postures[1)]

1) Standing	Upright with both feet supporting the body (McGrew).
2) Lying	A reclining posture with the main body axis horizontal to the ground (McGrew). This posture is differentiated in: a) supine: lying on back, torso 0-45^{o} angle to substrate (Berkson) b) prone: lying on belly, torso 0-45^{o} angle to substrate (Berkson).
3) Sitting	The body rests primarily on the buttocks. While seated the legs may be extended horizontally, partially flexed with only the feet on the ground, or dangled below. The neck is fully extended with the head upright (McGrew).
4) Kneeling	The body rests on the knees (one or both) and feet (both). Other limbs may or may not touch the substrate (McGrew-Kalverboer).
5) Bended down	The hips are flexed so that the trunk and head are in a lowered position. Only the feet are in contact with the substrate (McGrew-Kalverboer).
6) Squatting	Knees and hips are both flexed, only the feet are in contact with the substrate (McGrew).
7) All-fours	The body rests primarily upon the feet and the hands (Kalverboer).
8) Leaning	The body axis is approximately vertical. Balance is maintained by supporting the body against the wall, a person etc. (Kalverboer).
9) Half lying	Sideways reclined posture, with the main body axis approximately horizontal to the floor; usually leaning on elbow (McGrew-Kalverboer).
10) Half sitting	The body rests on the buttocks and on one of the elbows (Kalverboer).
11) Other posture	Each body posture, not included in this list, that is unequivocally recognized as distinct from other body postures (Kalverboer).

1) Body postures were selected which were most frequently observed in pilot studies.

Appendix VIII

Predefined play activities, to which a level II score is assigned

- Making a car go, without making car-noises
- Hoisting platform up and down by handle, without putting an object on it
- Opening and shutting car-door
- Joining together trailer and truck in a primitive way
- Picking block out of the box and replacing it again
- Connecting pieces of the construction material
- Screwing parts of the construction material together
- Turning screw of the tanker off and on

N.B.: To the activities, mentioned above, a level II score is assigned, when they occur in isolation. When they are part of a larger play activity, they are scored correspondingly.

Appendix IX

List of play objects in the condition: "Alone with a variety of toys"

1) Cradle with blankets and doll
2) Box with blocks of different shape and size
3) Garage
4) Paper and drawing pencils
5) Box with construction material
6) Two little cars
7) Truck with trailer (and blocks in the truck)
8) Crane

A score in the category " change in play object" is given, when the child switches from a defined play object to another defined play object. E.g. switching from truck to crane is scored in this category, switching from truck to trailer is not. In this connotation a play object may consist of a number of objects, usually handled in combination with each other.

Appendix X: Protocol sheet for the scoring of video-recorded behaviour in empty room conditions

Name : .... Condition: 0 with mother (1B) Case number: ....

Birth date : .... 0 alone, 1st time (IA_1) Observer : ....

Date of obs.: .... 0 alone, 2nd time (IA_2)

Age : .... Duration: .... min.

	10" epoch	locom.[1]	loc. pat.[2]	body post.[2]	addit. mov.	manip. self.	manip. envir.[3]	vis. fix.[3]	vis. scan.	vocal mon. com.	other sounds	gestures
1.	00											
2.	10											
3.	20											
4.	30											
5.	40											
6.	50											
7.	00											
8.	10											
9.	20											
10.	30											
11.	40											
12.	50											

Instruction to the observer:

1) indicate in code, which blocks are entered.

2) indicate in code, which locomotion patterns and body posture occur.

3) indicate in code, which fixtures and social figures are fixated or manipulated.

Appendix XI: Protocol sheet for the scoring of video-recorded behaviour in play conditions

Name : ....

Birth date : ....

Date of obs. : ....

Age : ....

Condition: 0 blocks + observer (IIC)

0 many toys (IIIA)

0 one toy (IVA)

Duration: .... min.

Case number: ....

Observer : ....

	10" epoch	locom[1]	loc. patt.[2]	body post.[2]	addit. mov.	manip. self	manip. envir.[3]	vis. fix.[3]	vis. scann.	vocal mon. c.	play act.[4]	play obj.[4]	level act.	inact.
1.	00													
2.	10													
3.	20													
4.	30													
5.	40													
6.	50													
7.	00													
8.	10													
9.	20													
10.	30													
11.	40													
12.	50													

Instruction to the observer:

1) indicate in code, which squares are entered.

2) indicate in code, which locomotion patterns and body-postures occur.

3) indicate in code, which fixtures and social figures are fixated or manipulated.

4) indicate in code, which play activities occur and which toys are handled.

Appendix XII

Schema for scoring child's spatial behaviour with reference to the mother

	a	b	c	d
1	0	0	0	0
2	1	1	1	0
3	2	2	1	0
4	3	2	1	0
5	2	2	1	0
6	1	1	1	0

During the three minute observation mother is sitting on a stool on block a_4. By numerically grading the blocks on the floor according to their distance from block a_4 as shown in the schema (where block a_4 itself scores 3 and distant blocks 0), spatial behaviour could be quantified by deriving scores for

a) the longest child-mother distance and

b) the shortest child-mother distance

This was done by noting, during each ten second epoch, the block furthest away from a_4 and that nearest to a_4 which the child entered and then summing respectively the 18 farthest and 18 nearest distance scores so obtained.

Appendix XIII Observational condition "with mother in novel empty room (Mo)

Behavioural categories		Correlations[a]													
Locomotion	1														
Body post./locom. patt.		+34													
Visual fixations (nr.)		+48	+28												
Manipulation of fixt.		+24	+25	+36											
Visual fixations (dur.)	2	+31	+18	+30	+33										
Mov. one-way screen		+15	+16	+14	+21	+38									
Looking straight ahead (dur.)	3	-21	-03	-41	-22	-57	-08								
Manip. of body (clothes)		-33	-18	-17	-14	-32	-15	+39							
Addit. movements (contin.)		-27	-22	-30	-21	-29	-13	+34	+48						
Visual scanning (dur.)		-40	-14	-23	-23	-34	-24	+22	+20	+17					
Tact. cont. child-mother	4	-29	-21	-29	-27	-29	-09	+26	+26	+10	+24				
Spat. cont. child-mother		-22	-25	-37	-33	-37	-20	+24	+19	+08	+20	+49			
Visual cont. child-mother	5	+19	+22	+30	+02	-20	-08	-32	-17	-23	-16	-28	-18		
Verbal cont. child-mother	6	+01	+07	+08	+12	+18	+03	-13	-29	-17	-14	-07	-19	+04	
Crying		-09	-02	-09	-10	-11	-08	+17	+21	-06	-02	+20	+06	-04	-04

a) a number of categories were excluded from the "overall" analysis for various reasons, such as experimental dependency, application in specific analyses, too low frequency of occurrance (see chapter 6-1).

Behaviour patterns:
1. room exploration
2. one-way screen reactions
3. passive waiting/body oriented act.
4. "close" contact
5. visual contact
6. verbal contact

Appendix XIV

Observational condition "first time alone in empty room" (Al 1)

Behavioural categories		Correlations[a]											
Locomotion	1												
Changes in body post./loc.patt.		+29											
Visual fixations (nr.)		+24	+29										
Manip. of fixtures		+14	+36	+11									
Visual fixations (dur.)	2	+16	+24	+11	+20								
Mov. towards one-way screen		-09	-06	-06	-12	+35							
Looking straight forw. (dur.)	3	-04	-14	-11	-17	-90	-33						
Addit. movements (discr.)		-16	-20	-15	-18	-52	-16	+44					
Visual scanning (dur.)		-27	-31	-05	-17	-82	-26	+49	+45				
Manip. of body/clothes	4	-34	-37	-03	-42	-12	+06	+06	-03	+15			
Addit. movements (contin.)		-20	-26	-15	-30	-37	-17	+27	+30	+20	+36		
Crying		-07	-07	+01	-11	+08	-11	-07	-09	-08	+20	+32	
Verbal behaviour		+14	+13	-02	-00	+06	+14	+03	-10	-17	-09	-10	-04

a) see note Appendix XIII

Behaviour patterns:
1. room exploration
2. one-way screen reactions
3. passive waiting
4. body-oriented activity

Appendix XV

Observational condition "second time alone in empty room" (Al 2)

Behavioural categories		Correlations[a)]											
Locomotion	1												
Changes in body post./loc.patt.		+39											
Visual fixations (nr.)		+44	+29										
Manip.of fixtures		+12	+14	+14									
Visual fixations (dur.)	2	+21	+03	+13	+21								
Mov.tow.one-way screen		-12	-13	-17	-16	+37							
Looking straight forw.(dur.)	3	-10	-03	-17	-19	-88	+35						
Addit.movements (discr.)		+11	+03	+05	-19	-41	-13	+37					
Visual scanning (dur.)		-25	+00	-03	-18	-59	-18	+18	+27				
Manip.of body/clothes	4	-29	-13	-09	-41	-20	-10	+20	-14	+12			
Addit.movements (contin.)		-14	-15	-01	-30	-18	-14	+19	+03	+11	+59		
Crying		+39	-06	-19	-01	-06	-06	+09	-08	+00	+23	+08	
Verbal behaviour		+23	+06	+08	-01	+05	+22	-01	-01	-07	-12	-21	-03

a) see note Appendix XIII

Behaviour patterns:
1. room exploration
2. one-way screen reactions
3. passive waiting
4. body-oriented activity

Appendix XVI

Observational condition "with blocks and passive observer" (Blocks)

Behavioural categories		Correlations[a]														
Locomotion	1															
Changes in body post./locom.patt.		+52														
Manipulation of fixtures	–	+24	+08													
Mov.tow.one-way screen		+44	–09	–06												
Glancing away from toys		+58	–14	+10	+62											
Visual fix.of observer		+02	+11	–00	–01	–05										
No play activity	2	+47	–11	+37	+39	+63	–00									
Manip.body/clothes (dur.)	3	+02	–25	+04	+19	+27	–06	+42								
Crying		–05	–12	+03	–02	–02	–05	+36	+27							
Addit.movements (contin.)		–07	–14	–05	+01	+03	+01	+32	+46	+44						
Addit.movements (discr.)	–	+05	–11	–06	–00	+10	–08	+04	+10	–02	+03					
Tidying up		–00	–01	+02	+07	+08	–04	+07	–04	–01	–02	+40				
Changes in play act.level	4	–14	+10	+05	–02	–15	+09	–07	+05	–13	–03	–01	+03			
Play activity level I		+11	+25	+07	–01	–10	+01	–03	–14	–07	–09	–09	+15	+33		
Play activity level II		+06	+26	+10	–15	–09	+06	–21	–20	–10	–04	–07	–03	+13	+19	
Play activity level III	5	–33	–19	–29	–11	–24	–03	–08	–01	–18	–12	+05	–16	–18	–47	–72

a) see note Appendix XIII

Behaviour patterns:
1. gross body activity
2. no play activity
3. body-oriented activity ("distressed")
4. low level play
5. high level play

Appendix XVII Observational condition "alone with a variety of toys (Vartoys)

Behavioural categories		Correlations[a]																	
Locomotion	1																		
Body post./locom. patt.		+78																	
Manip. of fixt. (dur.)	-	+02	-03																
Mov. tow. one-way screen		+09	-03	+21															
Looking straight forw.		+04	+11	+39	+24														
Manip. of body (clothes)		+03	+11	+21	+52	+37													
Crying		+09	-12	+37	+10	+37	+26												
Verbalization	2	+06	+05	+06	-04	-09	+02	+04											
Addit. movem. (cont.)		+03	+07	+16	+12	+19	+35	+12	+23										
Addit. movem. (discr.)		+92	+03	+26	+00	+01	+05	+01	+29	+56									
Glancing away from toys	-	+20	+04	+07	+06	+06	+17	+03	+33	+01	+11								
Changes of play act.	3	+24	+23	-11	-02	-11	+06	+01	+12	+08	-01	+36							
Changes in play act. level		+31	+22	-00	+14	+06	+19	+05	+06	+08	+04	+30	+32						
Play act. level I		+19	+03	+12	+13	+15	+15	+06	+12	+21	+16	+40	+21	+32					
Play act. level II	4	+15	+15	-13	+03	-18	-09	-10	+06	-14	+02	+05	+37	+17	+01				
Play act. level IIE		+06	+13	-11	-05	-11	-14	-03	-11	-12	-02	-03	+19	+14	+08	+29			
Play act. level III	5	-19	-09	-17	-19	-18	-16	-11	+03	-18	-14	-22	+32	-25	+38	-54	-23		
Longest play activity		-24	-19	-11	-17	-09	-10	-12	-03	-08	-11	-13	-18	-35	-16	-26	-17	+46	
No play activity (dur.)	6	+08	+02	+57	+36	+56	+58	+37	+07	+52	+28	+15	-14	+01	+23	-31	-18	-16	-10

a) see note appendix XIII

Behaviour patterns:
1. gross body activity
2. non-specific activity
3. low level play
4. exploratory play
5. high level play
6. no play activity

Appendix XVIII Observational condition "alone with one non-motivating toy" (Onetoy)

Behavioural categories		Correlations[a]														
Locomotion	1															
Body posture/locom. patt.		+59														
Manip. of fixtures (dur.)		+64	+40													
Mov. tow. one-way screen		+20	+25	+34												
Glancing away from toys	–	+28	+17	+33	+36											
No play activity (dur.)	2	+49	+32	+74	+31	+37										
Looking around	3	+09	+19	+33	-01	+25	+47									
Looking straight ahead		+15	-24	+32	-04	+28	+59	+59								
Manip. of body/clothes (dur.)		+29	+18	+56	+22	+30	+76	+48	+67							
Addit. movements (contin.)		+16	+05	+25	+06	+25	+44	+34	+38	+46						
Changes in play act. level	4	+06	+27	-06	+10	+13	-12	-07	-17	-11	-09					
Changes of play act.		-04	+27	-10	+05	-08	-20	-02	-14	-17	-07	+23				
Play act. level I		+16	+25	-05	+06	+08	-16	+08	-12	-12	-01	+31	+46			
Play act. level II	–	-10	-12	-25	-06	-14	-34	-18	-21	+27	+18	+16	+34	+09		
Play act. level III	5	-30	-21	-31	-14	-15	-37	-24	-22	-23	-16	+12	-01	-26	-21	
Longest play activity		-16	-03	-33	-15	-11	-43	-24	-29	-19	+01	+15	+01	+01	-33	+40

a) see note Appendix XIII

Behaviour patterns:
1. room-oriented behaviour
2. no play activity
3. passive waiting (body-oriented act.)
4. low level play
5. high level play

Appendix XIX

Behaviour patterns	Observ. cond.	Correlations a) among the behaviour patterns in the six observational conditions (N=117)																															
Room explorat.	Al 1																																
Room explorat.	Al 2	+35																															
Room explorat.	Mo	+29	+23																														
One-way screen	Al 1	+12	-03	+07																													
One-way screen	Al 2	-08	-02	+09	+29																												
One-way screen	Mo	+21	+11	+54	+18	+16																											
Verbal contact	Mo	-03	+12	+04	+13	-09	+04																										
Visual contact	Mo	-02	+08	+22	-06	+02	-19	-01																									
Gross body act.	Blocks	+11	+19	+30	+02	+11	+12	+10	+17																								
Gross body act.	Vartoys	+26	+26	+37	-05	-02	+15	+10	+08	+44																							
Low level play	Blocks	+06	+04	+17	-06	+10	+09	+07	+15	+20	+17																						
Low level play	Vartoys	-09	+03	+05	-19	-03	+05	-07	-02	+17	+22	+10																					
Exploratory play	Vartoys	+17	+19	+22	-14	-05	+17	+01	+11	+12	+37	+23	+27																				
Low level play	Onetoy	+11	+06	+06	+02	+13	+07	-04	-07	+04	+07	+25	+12	+19																			
Room orient. act.	Onetoy	+23	+08	+24	+01	-01	+16	+15	+08	+12	+23	+17	+09	+11	+11																		
Passive waiting	Onetoy	-01	-08	-02	-00	-05	-06	-10	+07	+07	+01	+11	+15	+08	-17	+31																	
No play act.	Blocks	-13	-01	-00	-08	-02	-16	+10	+09	+23	+10	-09	+25	-24	-05	+02	+11																
No play act.	Vartoys	-28	-32	-17	+13	-08	-17	+01	-05	-10	-06	-10	+26	-31	-28	-06	+24	+33															
No play act.	Onetoy	+06	-04	+08	+01	-03	+03	+12	+13	+12	+14	+12	+12	-05	-25	+62	+73	+14	+30														
"Tidying up" b)	Blocks	+03	-22	-08	+10	-10	+05	+02	-18	-05	+08	-03	+17	-13	-07	-02	+10	+06	+25	+10													
Body-orient. act.	Al 1	-48	-29	-13	-23	-02	-08	-18	-04	-16	-21	-11	+08	-24	-04	-16	+12	+06	+23	+05	+02												
Body-orient. act.	Al 2	-26	-29	-19	+02	-20	-07	-11	-16	-13	-19	-11	+11	-35	-09	-01	+17	+21	+34	+15	+15	+30											
Body-orient. act.	Blocks	-18	-20	-08	+17	+14	-10	+05	-18	-12	-13	-09	+09	-25	+02	-07	+16	+43	+39	+12	+07	+16	+24										
Non-specif. act.	Vartoys	-16	-16	-03	+25	+19	-03	+08	+02	-06	+05	+06	+27	-12	-06	+06	+07	+23	+38	+12	+34	-01	-02	+23									
Passive waiting	Mo	-13	-13	-47	-08	-01	-48	-19	-30	-10	-17	-11	+01	-14	-12	-13	+08	+06	+11	-01	+07	+16	+23	+14	-07								
Passive waiting	Al 1	-32	-08	-15	-78	-16	-11	-07	-07	-05	-01	-01	+16	+17	+04	-04	+09	+06	-12	-04	-01	+30	-00	-13	-13	+15							
Passive waiting	Al 2	+03	-19	-17	-11	-73	-15	-02	-01	-16	-01	-13	-05	+13	+01	-05	+05	-04	+08	-03	+16	-01	+08	-17	-03	+02	+19						
Close contact	Mo	-19	-22	-45	-06	-13	-31	-13	-25	-18	-08	-19	-08	-10	-01	-10	+10	+07	+23	+4	+16	+14	+21	+24	+05	+36	+20	+16					
High level play	Blocks	-01	-01	-13	+17	-03	-07	-03	-13	-35	-22	-75	-26	-12	-10	-12	-12	+31	+00	-11	-01	+09	-02	-05	-10	+02	-04	+15	+17				
High level play	Vartoys	-06	-09	-17	-06	+06	-09	-04	-08	-01	-21	-18	-36	-49	+10	-17	-21	-05	-19	-27	-03	+03	+16	-03	-14	+08	-03	-01	+02	+19			
High level play	Onetoy	-01	-09	-06	+06	-07	-05	-10	-03	-18	-05	-17	-14	-02	-10	-10	-37	-23	-19	+73	+07	+08	-08	-16	-06	+01	-08	+03	-01	+14	+25		
School train. parents c)		-11	-08	-08	+08	+08	-04	+03	+08	-14	-10	-06	-14	-00	-13	-18	+06	-06	+09	+05	+17	+03	+03	+10	-03	+06	-02	-01	+05	+12	-04	+08	
IQ child (Stanf. Binet)		-00	-13	-00	+09	+14	-05	+07	+01	-23	-16	-15	-27	-18	-10	-12	-17	-08	+03	-10	+01	+10	+08	+15	-10	+05	-09	-17	+04	+20	+17	+16	+34

a) Coefficient of .18 significant below 5%, of .23 below 1% level (two-tailed)
b) "Tidying up" is excluded from the overall-analysis, because of too low frequency of occurrance
c) Combination of maternal and paternal levels of school training

Appendix XX — Components of neurobehavioural profiles: differences between means a)b)

Ad Fig. 10 — With mother in the novel empty room (Mo)

	Boys			Girls		
	means		t-values	means		t-values
variables N	39	22	39–22	26	30	26–30
1. Sensorimotor	8.3	9.3	1.79	8.9	10.3	3.34
2. Maturation of functions	5.4	5.7	0.69	6.4	8.2	3.54
3. Maturation of responses	2.4	2.8	1.22	2.5	3.2	2.62
4. Choreiform movements	1.2	1.1	0.35	1.6	1.5	0.31
5. Coordination	3.8	4.2	1.24	4.0	4.6	2.47
6. Posture	4.2	4.7	1.86	4.5	4.2	0.68
7. Verbal contact	503.3	496.6	2.58	499.2	499.9	0.26
8. Visual contact	501.1	496.6	1.84	503.1	501.1	0.71
9. Close contact	493.2	511.9	4.73	491.6	505.3	3.28
10. Passive wait./body or. act.	487.6	514.8	4.52	486.3	512.9	4.45
11. Reactions one-way screen	508.8	491.1	4.98	505.1	491.5	3.71
12. Room exploration	521.6	477.3	7.64	512.5	485.8	4.22

Ad Fig. 11 — First time alone in the empty room (Al 1)

	Boys			Girls		
	means		t-values	means		t-values
variables N	28	33	28–33	20	36	20–36
1. Sensorimotor	7.6	9.5	4.10	8.7	10.2	3.41
2. Maturation of functions	5.2	5.7	0.94	5.6	8.3	5.48
3. Maturation of responses	2.0	2.9	3.26	2.2	3.5	4.34
4. Choreiform movements	0.8	1.5	2.54	1.6	1.5	0.31
5. Coordination	3.5	4.3	2.71	3.6	4.7	4.69
6. Posture	3.8	4.8	4.51	4.5	4.3	0.65
7. Passive waiting	490.0	510.8	3.81	518.3	487.9	4.93
8. Body-oriented activity	489.9	503.8	3.55	510.6	500.5	2.38
9. Reactions one-way screen	505.6	493.2	3.82	486.4	510.2	5.47
10. Room exploration	516.7	489.1	4.61	495.0	494.4	0.09

a) As a rough estimation of the significance of the differences between means t-values are preferred to p-values, because these are not random samples from two populations. One might consider t-values above 2 to be relevant.

b) Scores in the behaviour patterns (nr. 7 and lower) were obtained by summation of standard scores in the separate categories and adding 500 to the sum in order to avoid negative values.

Ad Fig. 12 second time alone in the empty room (Al 2)

	Boys			Girls		
	means		t-value	means		t-value
variables N	15	46	15-46	19	37	19-37
1. Sensorimotor	9.2	6.9	4.09	8.4	10.3	4.60
2. Matur. of functions	5.7	4.9	1.63	6.0	8.0	3.97
3. Matur. of responses	2.9	1.3	5.12	2.0	3.3	5.39
4. Choreiform mov.	1.2	1.1	0.31	1.4	1.7	0.89
5. Coordination	4.0	3.7	0.86	3.6	4.7	5.16
6. Posture	4.8	3.2	6.23	4.5	4.3	0.64
7. Passive waiting	493.8	525.9	6.08	513.6	492.3	3.92
8. Body orient. act.	495.4	497.3	0.40	511.7	502.9	1.65
9. React. one-way scr.	505.9	483.2	5.32	488.5	506.7	4.29
10. Room exploration	506.5	486.3	2.54	493.7	497.8	0.59

Ad Fig. 13 With blocks and a passive observer (Blocks)

	Boys			Girls					
	means		t-value	means			t-values		
variables N	36	25	36-25	20	8	28	20-8	20-28	8-28
1. Sensorimotor	8.2	9.3	2.02	8.3	10.6	10.4	3.00	4.94	0.71
2. Matur. of functions	5.2	5.9	1.65	6.0	7.8	8.2	2.33	4.13	0.51
3. Matur. of responses	2.3	2.9	1.89	2.2	3.5	3.2	3.02	3.65	0.93
4. Choreiform mov.	0.7	1.8	4.28	1.5	1.8	1.5	0.58	0.00	0.61
5. Coordination	3.8	4.1	0.94	3.5	4.9	4.8	4.20	6.78	0.62
6. Posture	4.2	4.7	1.92	4.4	4.9	4.2	1.50	0.59	1.49
7. High level play	494.1	509.6	7.42	500.2	497.0	503.5	0.89	1.56	2.42
8. Low level play	514.6	483.2	6.52	504.3	489.6	497.3	2.06	1.49	1.44
9. No play activity	499.8	496.8	2.12	497.8	514.9	497.2	3.40	0.67	4.27
10. Body orient. act.	496.5	496.1	0.17	499.9	536.8	495.2	3.30	1.61	4.53
11. Gross body act.	507.7	496.1	2.51	493.3	511.4	495.8	2.49	0.75	2.40

Appendix XX continued

Ad Fig. 14 with a variety of toys (Vartoys)

	Boys			Girls		
	means		t-value	means		t-value
variables N	25	36	25-36	26	30	26-30
1. Sensorimotor	7.3	9.6	4.99	8.6	10.6	5.37
2. Matur. of functions	5.1	5.8	1.64	6.2	8.3	4.20
3. Matur. of responses	1.8	3.1	4.62	2.5	3.2	2.62
4. Choreiform mov.	0.9	1.3	1.42	1.7	1.4	0.92
5. Coordination	3.4	4.3	3.05	4.0	4.6	2.58
6. Posture	3.8	4.8	4.20	3.9	4.8	3.51
7. High level play	499.3	492.8	2.57	500.8	516.2	3.07
8. Explorative play	508.7	506.0	0.50	501.0	480.2	4.52
9. Low level play	489.8	506.5	4.17	502.9	488.3	3.07
10. No play activity	496.2	501.8	2.50	498.9	503.0	1.19
11. Non specific act.	492.3	501.4	2.90	499.9	503.8	0.43
12. Gross body act.	498.6	507.8	2.13	495.5	491.1	1.31

Ad Fig. 15 with one non-motivating toy (Onetoy)

Boys

	means				t-values					
variables N	17	22	12	10	17-22	17-12	17-10	22-12	22-10	12-10
1. Sensorimotor	6.8	9.5	8.5	10.2	4.55	2.24	4.49	1.77	1.30	2.65
2. Matur. of functions	4.7	5.0	6.2	7.1	0.71	2.61	4.87	2.10	4.02	1.27
3. Matur. of responses	1.4	3.0	3.0	3.0	4.50	4.00	3.65	0.00	0.00	0.00
4. Choreiform mov.	.9	.6	1.8	2.1	1.16	2.02	3.33	3.51	6.23	0.61
5. Coordination	3.1	4.3	4.1	4.5	3.38	2.01	2.94	0.58	0.68	0.93
6. Posture	3.3	4.8	4.8	4.9	5.12	3.71	3.80	0.00	0.70	0.48
7. High level play	497.8	496.9	484.6	519.7	0.29	4.20	3.08	4.40	3.66	4.53
8. Low level play	507.9	514.0	487.5	482.2	0.96	2.80	3.78	3.78	4.70	0.77
9. No play activity	497.9	497.1	519.8	495.0	0.48	0.65	1.45	1.68	1.09	0.86
10. Passive waiting	492.9	492.1	552.2	489.3	0.16	5.05	0.71	5.46	0.45	4.17
11. Room oriented act.	499.7	502.6	556.3	481.4	0.37	3.72	2.03	4.04	2.72	4.17

Appendix XX continued

Ad Fig. 16 with one non-motivating toy (Onetoy)

Girls

	means						t-values[1]		
variables N	15	5	4	4	19	9	15–19	15–9	19–9
1. Sensorimotor	8.3	9.2	9.3	10.5	10.5	10.4	4.12	2.76	0.35
2. Matur. of functions	6.1	5.4	7.0	8.8	8.2	8.3	3.38	2.92	0.12
3. Mat. of responses	2.1	1.6	3.8	3.8	3.3	3.3	4.34	3.72	0.00
4. Choreiform mov.	1.5	2.0	1.0	.3	1.5	2.3	0.00	1.72	1.69
5. Coordination	3.5	4.8	4.5	4.3	4.6	4.8	3.72	3.39	0.90
6. Posture	4.6	3.6	1.5	5.0	4.8	4.6	1.05	0.00	0.97
7. High level play	502.5	492.4	508.8	497.5	515.8	486.3	2.35	2.53	5.83
8. Low level play	492.7	526.8	509.0	521.0	499.7	490.0	1.47	0.44	1.91
9. No play activity	496.3	498.0	495.3	497.8	494.8	516.2	0.87	6.96	1.12
10. Passive waiting	489.2	511.2	490.5	495.8	485.6	545.9	1.54	4.18	5.08
11. Room-oriented act.	486.7	490.8	492.0	528.5	482.7	519.0	0.55	2.36	3.60

1) Groups comprising 5 or less cases not included.

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Het onderzoek waarop dit proefschrift is gebaseerd berust op een vorm van samenwerking zoals die bestaat binnen een afdeling als de Ontwikkelingsneurologie. Vanuit verschillende disciplines werken hier onderzoekers aan één centraal thema: "de ontwikkeling van het zenuwstelsel". Enerzijds voelt ieder zich nauw bij het werk van de ander betrokken, anderzijds is er de ruimte eigen ideeën uit te werken en te verwezenlijken. In deze sfeer van "creatieve spanning" is dit onderzoek opgezet en uitgevoerd.

Professor Prechtl's visie op structuur en inhoud van wetenschappelijk werk geeft "coherentie" aan deze groep en leidt tot een gezamenlijke probleemgerichte orientatie. Ik hoop dat dit onderzoek aantoont hoe zijn principe van "crossing the borders" ook zijn medewerkers inspireert. In alle fasen is hij ten nauwste bij dit onderzoek betrokken geweest, richtingen aanduidend waar dit wenselijk en dreigende ontsporingen voorkomend waar dit nodig was.

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Professor Boeke werd voor de allerminst eenvoudige taak gesteld de uitwerking en verslaggeving van dit onderzoek, dat goeddeels buiten zijn direkte gezichtskring had plaats gevonden, kritisch te begeleiden. Hij is er in geslaagd vanuit zijn klinische en gedragswetenschappelijke orientatie een aantal waardevolle suggesties te geven die in dit proefschrift zijn verwerkt en het bepaald ten goede zijn gekomen.

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