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The Neurological Examination of the Full Term Newborn Infant

SECOND EDITION

A Manual for Clinical Use from the
Department of Developmental Neurology, University of Groningen

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Preface to Second Edition

Heinz Prechtl has taught us a great deal and from many points of view. He emphasised the need to watch the baby—observation—as well as to do tests—our 'examination'. His concept of 'optimality' grows in importance and value the more one becomes involved in the subject, and it has wide applicability. These carefully evaluated standardised techniques of tests for the neurological examination of the newborn were first published twelve years ago, a long time in the history of neonatology and of paediatric neurology. Prechtl and Beintema gave us a fine tool and it is evidence of its quality that after twelve years it needs relatively little change. But the new edition is improved and will be even more useful.

Careful neurological examination of the newborn will be the only way in which a number of unanswered problems can be solved. For example, a difficult labour is not evidence of injury to the baby's brain, nor is a normal labour proof that the brain is unharmed. The history tells of a risk, but only the neurological examination can tell the state of the brain's functioning. Why is it that, whilst for the first ten days of life we can detect dysfunction of the nervous system, once these early days of life are past, the windows through which we look into the nervous system often close and the brain functions normally and yet, after several months, dysfunction appears again? And why is the newly reappeared dysfunction different—why does the neonatal hemi-syndrome reappear as general developmental delay suggesting mental handicap and not as hemiplegia?

The value of making a detailed assessment of central nervous system function in *all* newborn infants needs to be established, but there is no doubt about the value of the techniques described here.

This is an important book. We were glad to publish the first edition twelve years ago, and so we are to publish this new and revised edition. Heinz Prechtl deserves the thanks of the paediatric world.

Ronald Mac Keith

Preface to First Edition

Three places in Europe are outstanding for neurological studies of the newborn infant — Paris, Leipzig and Groningen. Three years ago we published a manual translated from the French, setting out the methods used in Paris by André-Thomas and Mme. Saint-Anne Dargassies[1]. This was the first English text book on the subject. This year had seen the publication of an American translation of Albrecht Peiper's monumental 'Cerebral Function in Infancy and Childhood'[2]. We now publish a new book by Heinz Prechtl in which he clearly sets out in detail his neurological examination of the newborn.

During the last three years the interest in, and the amount of work being done on, the behaviour and responses of the newborn have increased enormously. Many have visited, and many more have wished to visit, Groningen where Heinz Prechtl has been doing detailed studies on the newborn, combined with follow-up studies of the children as they grow up. There are good reasons why obstetricians, paediatricians, neurologists and infant welfare doctors want to keep in touch with the methods being evolved for neurological study of the newborn. The examinations during the first ten days of life can reveal abnormal signs. This valuable evidence of how the infant's brain has been affected by pregnancy and the birth process often disappears by the end of the second week. But while we have known that some children who have suffered perinatal injury to the brain appear to recover completely and lastingly, we have, since Little's day, been well aware that such perinatal damage may be followed later by cerebral palsy, mental subnormality, or (as Prechtl himself has shown[3]) behaviour disorder.

If we are to identify the exact nature of the perinatal injuries which are liable to be followed, after a few months of apparently normal progress, by appearance of motor or mental disorder, we need to know good ways of conducting the neurological examination of the newborn. With these we can try to identify the causes of such disorders, recognise them early, treat them well and take steps to prevent complications developing.

We are glad to be able to publish Dr. Heinz Prechtl's manual of the Neurological Examination of the Newborn Infant.

Ronald Mac Keith, 1964

1. André-Thomas, Chesni, Y., Saint-Anne Dargassies S. (1960) The Neurological Examination of the London: Medical Advisory Committee/National Spastics Society.
2. Peiper A. (1963) Cerebral Function in Infancy and Childhood. New York: Consultants Bureau.
3. Prechtl H. (1962) 'The long term value of the neurological examination of the newborn infant.' *In* Child Neurology and Cerebral Palsy. London: Medical Advisory Committee/National Spastics Society.

Foreword

The publication of a new and revised version of our manual offers a welcome opportunity to bring the text up to date, to eliminate a small number of errors and inaccuracies, and to make some modifications. Even more welcome is the chance to say something of the theoretical concepts and strategies on which the examination technique is based. This is the more important since a number of misunderstandings have occurred in the daily routine application of our technique, and they have occurred because the concepts on which our method is based have not been understood.

All attempts to select, for whatever reason, only certain parts of our examination technique will lead to insufficient results and may bring the neurological examination of newborn infants into discredit. If the complexity of the nervous system were understood, nobody would adhere to the absurd idea that there are 'the three' or 'the seven' important reflexes which will give a reliable answer about the condition of the nervous system.

Another error, which unfortunately may be found in various places, is the attempt to select items from other examination techniques based on completely different concepts, for example from those of André-Thomas and Saint-Anne Dargassies and from our own, or from the assessment scale designed by Brazelton (1973). Such a collection of unrelated items is therefore not a true over-all examination of the condition of the nervous system. The reason why such selections of items and methods are bound to fail will be substantiated in the Introduction, where our strategy will be described in detail.

Both mistakes are serious, especially because early assessment is now more and more considered to be useful and important. Infants with suspected brain damage must receive a careful and detailed examination in order not to overlook those with impairment of the nervous system, or, on the other hand, not to worry parents unnecessarily by making erroneous statements about healthy infants.

For the cases in which detailed examination is not indicated or not possible we have designed a screening test. This test takes only a few minutes and cannot lead to a neurological diagnosis. The items involved are those which discriminate best in a large study between obstetrical optimal and obstetrical at-risk groups of infants. The screening is not based on clinical impressions nor on an arbitrary selection of items. Since it is also standardised, the screening test can help to select those infants who need an extensive examination. For the same reason, it is therefore superior to eclectic neurological examination techniques and is also without their ambition.

Since the first edition of this manual was published, the literature on the neurology of the newborn has increased considerably. My former co-worker Beintema

has published a monograph (Beintema 1968) and has given all the details of the developmental course of the various items of the examination during the first nine days of life. He has also shown the reliability of a single examination. Those interested in the details of the developmental course will find the exact data in Beintema's monograph.

Another advance since the first edition is the better understanding of the way in which the neurological tests depend on the behavioural state of the infant.

The introduction of the concept of 'optimality' made it possible to identify obstetrical risk factors in a new dimension. Furthermore, the neurological findings can now be evaluated in a quantitative way as an optimality score, in addition to giving the qualitative recognition of pathological signs and of neurological syndromes as we have described them in this manual. This quantitative dimension is especially helpful when symptoms cannot be grouped into a meaningful syndrome, although they indicate impairment of the integrity of the nervous system.

During the last few years, polygraphic recordings of newborn infants with impairment of the nervous system have led to a better understanding of the behavioural state cycles and their disorders. Abnormal behavioural state cycles in themselves have become a neurological sign and have therefore acquired diagnostic significance.

The increasing interest in the neurology of the newborn over the last few years has produced many studies, but unfortunately these are scattered over many scientific journals. As far as possible they have been taken into account in preparing this second edition.

It is hoped that this new edition will help many to become acquainted with the difficult but rewarding techniques of examining the nervous system of the young infant. The detailed description, together with practice and experience, should help to obtain reliable results in routine clinical use.

Finally, I should like to thank Dr. Bert Touwen, who looked through the manuscript in its final stages and made many useful suggestions.

Groningen, 1977 *Heinz F. R. Prechtl*

Introduction

Why a Neurological Examination of Newborn Infants?

There are several reasons for examining particular newborns neurologically in the early days of their lives. First of all, if there is suspicion of an injury of the nervous system a neurological examination must be made in order to clarify its condition. Symptoms which arouse suspicion of damage to the brain include depression of the nervous system with poor sucking, poor tone and abnormal posture, abnormal spontaneous movements and marked asymmetries and neonatal seizures. In addition, there are babies who must be examined because their history is complicated by conditions which are known to carry the risk of damage to the nervous system. All so-called 'at risk' infants, whether pre-term or full-term, of mothers with diabetes or toxaemia, and those infants who may have had birth trauma due to instrumental delivery or perinatal asphyxia should receive a neurological examination.

The important aim of such an examination is the documentation of the condition of the nervous system of the neonate. The neurological diagnosis arrived at has an immediate therapeutic consequence in few cases, but this is no reason to declare that the examination is clinically irrelevant or unimportant. On the contrary, for the selection of those patients who need special attention and follow-up care it is crucial. It is absurd to consider that recording the fetal heart rate, perinatal blood pH values of the newborn and the Apgar score are a sufficient evaluation of the functional condition of the nervous system of the newborn.

An abnormal or pathological finding in the newborn period cannot justify making any prediction about the individual's neurological condition several months or years later. During the past few years it has been found that there is an individually different compensatory capacity in the young nervous system which is influenced by the environmental conditions in which the infant grows up and which determines the long-term prognosis of the neonatal neurological findings. Abnormal neonatal findings, however, are a strict indication to follow those infants at short intervals so as to make an early diagnosis of persistent abnormalities and to begin therapy.

Whilst those infants whose symptoms disappear should be discharged from the follow-up, the neurological examination is of especial value for those infants whose abnormal signs, present in the first days or weeks, may disappear, but are followed months or even years later by the appearance of abnormal neurological signs or behavioural problems. The earlier documentation of abnormal signs will then be of value. This 'silent period' and the facts listed above give sufficient reason for certain infants receiving a comprehensive neurological assessment in the newborn period.

Who are the Infants at Risk?

The neurological examination of the young infant is not an easy task. The examiner must be familiar with the early developmental stages of the nervous system, he must have technical skill, and he must have sufficient time at his disposal. The investment incurred in training people is considerable. It is therefore of the utmost importance to consider in detail the fundamentals and strategies which are employed.

It is in practice impossible to examine all newborn infants, although this might be an ideal condition, and therefore great care has been taken in identifying those infants at risk of neurological problems. Starting from the premise that the same factors which increase the risk for mortality also increase the risk (if the baby survives) for permanent brain damage, we can use the results of mortality studies to identify conditions which may cause neurological morbidity.

Neuropathologists can collect direct evidence of brain damage, but the abnormal clinical signs and behaviour of newborns are only indirect indications of brain dysfunction. A comprehensive and precise neurological examination can help, but only if it is possible to show that particular neurological signs and syndromes do correlate with the history and with the follow-up findings. However, the problem is complicated, for pre- and perinatal complications are ill-defined entities. There are many signs which occur individually or in combination and indicate risks for the fetus or newborn. It is often said that obstetrical complications are multifactorially structured, which means nothing else than that the different symptoms fall together in clusters which are relatively separate from each other.

Another problem is the strict definition of obstetrical factors and measurements. Obstetrical complications such as pre-eclamptic toxaemia, fetal distress and asphyxia are by no means exactly-defined entities, and there is little agreement about the levels of maternal blood pressure, fetal heart rate and pH values which clearly indicate risks. There is no sharp division between normal and pathological, as borderline values are influenced by many factors. This was why we abandoned the usual concept of abnormality and looked instead for the presence of favourable (optimal) conditions (Prechtl 1968).

The Optimality Concept

It is doubtless easier to obtain agreement about the optimal course of pregnancy and delivery than it is to obtain agreement about obstetrical complications—with the exception of severe and evident pathological conditions. With this in mind we have designed a list of criteria which indicate optimal measurements of observed phenomena. These criteria include the age of the mother at the baby's birth, the number of previous deliveries, maternal blood pressure, fetal heart rate, condition of the placenta and the duration of the apnoea before the onset of the first breath. A point is given for any criterion of optimality. The resulting 'optimality score' describes the favourability or unfavourability of the course of pregnancy and delivery. One must not forget, however, that optimality is not synonymous with normality. The borderlines of optimality are much narrower than those of normality and, by the same token, not everything which is non-optimal is therefore abnormal or pathological. Whilst non-optimal conditions may fall within the normal limits, they can also

indicate severe pathology. By applying the optimality score one escapes the uncertainty of the dividing line between normal and abnormal. Furthermore, there is one other advantage in that one avoids the difficulty of counting up all obstetrical complications to give a risk factor, for the different complications have different weights which indicate different degrees of risk to the infant. In order to obtain this weighting, one must know the risks for the occurrence of brain dysfunction. There is no way out of this circular reasoning. On the other hand, weightings are unconnected with the optimality concept because there is no gradation of the optimal, and it has been shown that the optimality system has a self-weighting property. It is crucial to adhere to the definitions of optimal conditions. A non-optimal condition indicates only the absence of an optimal condition. It is wrong to identify non-optimality with the traditional complications (Kittner and Lipsitt 1976) because the specific advantages of the optimality concept are then lost. Such erroneous 'non-optimal conditions' would again need weighting.

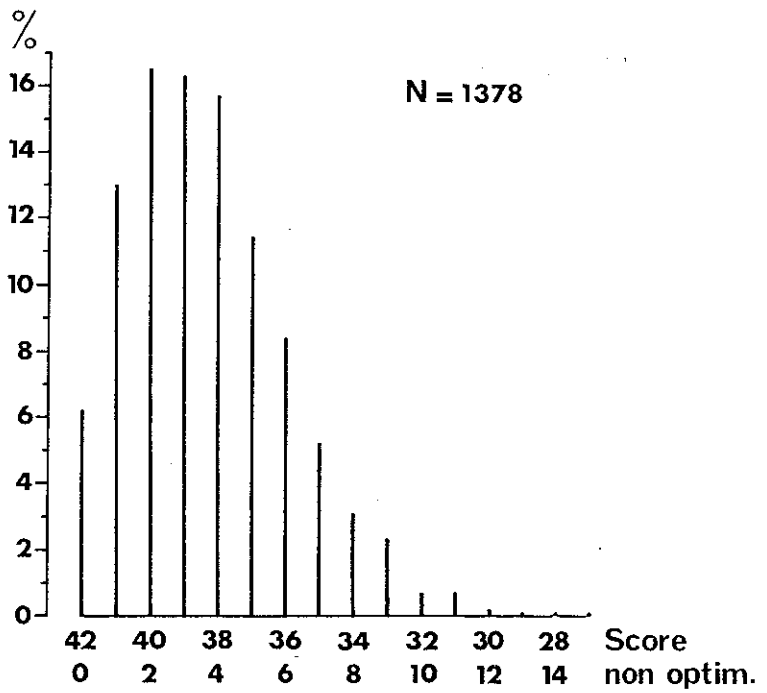


Fig. 1. Distribution of obstetric optimality scores of 1378 babies born at the University Hospital, Groningen. Since 42 criteria for optimality of the history were selected, 42 is the highest possible score.

The method used is simple and routine. The lists of data can be filled in from the files by a nurse, midwife or doctor. The final result is a number, the sum of all optimal conditions, which is used as an indicator of the degree of risk to the nervous

system. We have applied this method in a large study on 1378 newborns of 38 weeks or more gestation and with birthweights above 2800g. Since 42 criteria were selected, all infants who were within the limits of the optimal criteria received a score of 42. The distribution of the scores is given in Figure 1. As this pre-selected population came from a University Hospital the distribution is not representative of the geographical area. The mode of the curve lies at 40 optimal conditions. The lowest score found was 27.

One cannot give a meaningful answer to the question, 'What risk does a particular obstetrical complication imply for the nervous system of the infant?' until we have analysed many other non-optimal conditions which accompany that particular complication. If one sees danger only in those conditions which are under study then the risk is exaggerated, because damage to the nervous system will usually occur only if these particular complications occur together with other factors which are often not controlled. In the light of this knowledge, many published studies will need to be revised. Returning to our own analysis, this problem can be solved if the single risk factors are studied within their distribution with other non-optimal factors. The results obtained are not only more reliable but also more meaningful. Finally, this method of identifying babies at risk facilitates the selection of those babies who need special attention and follow-up.

The extent to which newborns who have been assigned to the at-risk category by means of the optimality concept can be put under surveillance will depend on the number of expert personnel and facilities available in any given area. This aspect of the optimality concept provides considerably more flexibility than the traditional at-risk registers. In practice, flexibility means that the cut-off point can be adapted to the local facilities. Infants below the designated cut-off point always have a higher probability of nervous dysfunction.

The strategy of the neurological examination

The nervous system is the most complex organ of the human organism. It receives information from within, generates information and receives information from the outside. This information can be carried to other parts of the body at varying distances, and it can be compared, transformed and stored. These properties of the nervous system make possible internal homeostasis, co-ordination of different subsystems, adaptation of the organism to the environment and memory and social communication, to name just a few of the most important functions.

It is not surprising that the examination of such a system is difficult. There are many methods available, and they range from measurements of bioelectric and biochemical values to the observation of complex behaviour, spontaneous or elicited. From the mosaic of the different aspects one can try to compose a picture. The way this picture will look will depend on the theoretical concept of the nervous system one holds.

The idea of morphological topology has dominated neurology for a long time. Particular functions are related to particular structures of the nervous system, *e.g.* respiration to the respiration centre, sucking to the sucking centre, the tendon reflex

to the afferent/efferent spinal reflex arc, and consciousness to the reticular formation. These are the essential structures and their damage will inevitably lead to the loss of the function. Many other elements of the nervous system are also involved during normal functioning. Moreover, the examples mentioned are exceptions rather than the rule, for they are only observed when the normal complex functioning is subjected to artificial abstraction and when one is content to study caricatures of biological functions. Yet the method does have its merits in cases of diagnosis of circumscribed lesions, tumors, local haemorrhage, peripheral nerve lesions or lesions of the spinal cord.

This purely morphologically-oriented method will fail if the defect is not circumscribed but is a change in the information processing system due to biochemical disturbances, changes in the properties of the membranes or a developmental defect in the neural circuitry. In such cases the application of system theory is more helpful because it deals with functional complexes and studies systematically the related mechanisms and structures. Thus the complexity of the biological phenomena is preserved and the result of the analysis gives a comprehensive picture of the desired details. The classification into spinal reflexes, brain stem reflexes, hypothalamic regulatory mechanisms and cortical or cerebellar activity is then superfluous.

A principal problem in developmental neurology is the dynamic changes of the nervous system during development. A strict distinction must be made between the morphological and functional changes due to the normal developmental process and those due to damage and to compensation for such injuries. A neurological examination must not aim to assess both the maturity and the integrity of the nervous system. Since these two aspects are dependent on each other, two independent assessment methods must be used in order to avoid circular reasoning.

What is the Aim of a Neurological Examination?

This question is less trivial than it seems at first glance. If a method of detecting local lesions is needed, the examination will follow the topography of the nervous system and the examiner will examine first the cranial nerves, then the spinal reflexes, then the long fibre systems and the extrapyramidal motor patterns. This strategy may lead to a diagnosis of the localised lesion or it might not show any deviations from the norm or it might be impossible to interpret abnormal findings. Pre- and perinatal damage to the nervous system often belongs to the last group, especially in the newborn infant. It is evident that another method should be chosen.

The present neurological examination is designed to obtain the maximum amount of information about the complex neural functions in the minimum time and with no risk to the patient. The sequence of decisions necessary for the design of such a technique are illustrated in Figure 2 (p. 6).

If we start with a list of all the functions of the nervous system which can be assessed then we can select from this list those tests which represent the developmental stages for which the assessment technique is designed. All tests must be age-specific and, in our case, must be related to the repertory of the newborn around term. Of course this still leaves us with too many tests, and the next step therefore is

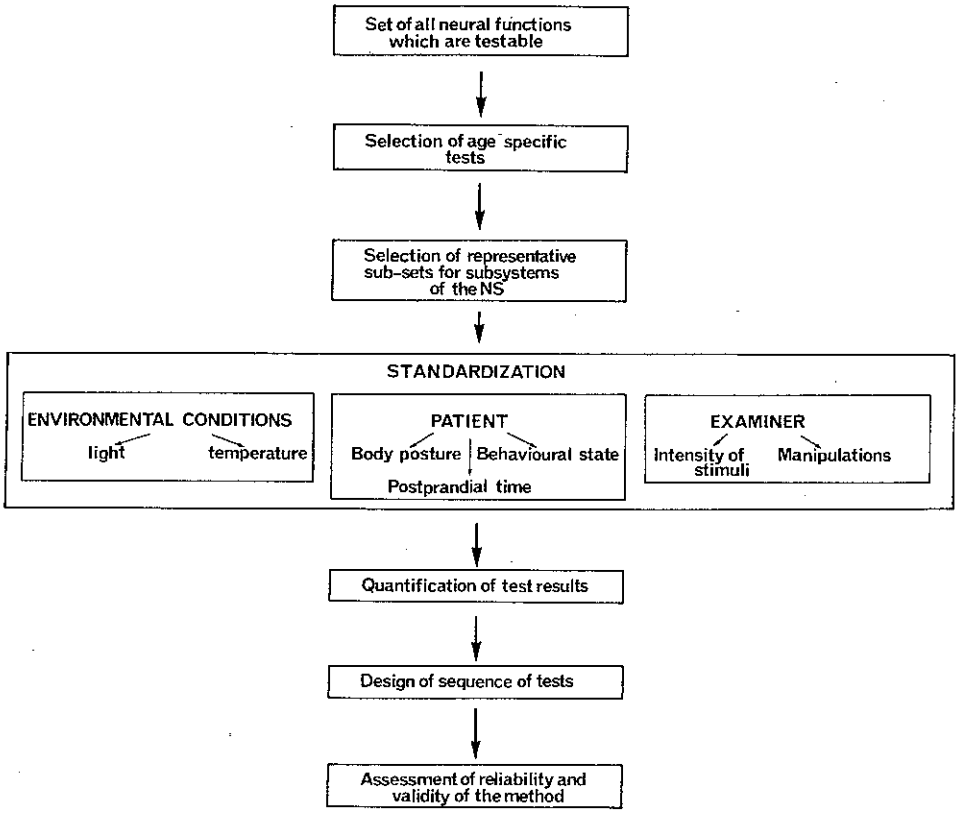


Fig. 2. Flow diagram indicating all decision steps for the design of the neurological examination technique.

to select the tests which represent the functional subsystems of the nervous system. One must choose very carefully in order to obtain a comprehensive and well-balanced (but not too large) selection of all the important subsystems. Nevertheless, the time given to the examination cannot be reduced below a certain minimum without a serious loss of information.

An important refinement of the examination technique is obtained when, in addition to the Yes/No recording of the presence or absence of a particular response (*e.g.* the Moro) the qualitative description of the intensity of the response on a

semi-quantitative scale is used. But a prerequisite of any quantification of results is a strict standardisation of the examination technique with respect to:
a. the stimulus intensity;
b. the manipulations of the examiner; and
c. the body posture of the patient.
Environmental conditions such as room temperature, lighting and the examination table must also be standardised.

Behavioural States

All these attempts would be of limited value if one of the most crucial variables—the behavioural state—was not also controlled. The neural mechanisms of young infants have been considered to be especially inconsistent: responses occur at one moment but not at another. This variability was for a long time a reason for doubting whether a neurological examination of young infants was useful at all. The break-through came with the discovery that most infantile neuromechanisms are dependent on the behavioural state, by which we refer to a relatively stable condition such as quiet sleep, REM sleep, quiet wakefulness, active wakefulness or crying. The intensity of many responses is determined by the behavioural state in which it is examined, and it is therefore meaningful to quantify the neurological findings only when the state-dependency is known. This problem has now been solved. The optimum behavioural state for each test item is that one in which a response of medium intensity is consistently found. Since the behavioural state depends on the time since the last feed, one should conduct the examination preferably two to three hours later.

It is self-evident that the sequence of the test items will be governed by the state-dependency of the responses. Since one cannot always wait until the infant is in the optimal behavioural state for a particular reflex or response, the examination sequence is designed to give the maximum probability that all tests are carried out in the correct behavioural state. Several responses, however, have an influence on the behavioural state, and so all those responses which do not influence the behavioural state should be examined first, and, likewise, all the items which elicit crying in the infant should be tested at the end of the examination. The sequence of tests in relation to the various behavioural states is the most essential aspect of any adequate neurological examination technique.

Lastly, in order to limit any unnecessary manipulation of the infant, all the tests which can be carried out in one particular position (*e.g.* when the baby is prone, supine or upright) will be grouped together.

This sequence of groups of tests gives an optimal strategy for the design of an examination technique. It must then be tested to find whether the technique is reliable, can be carried out with high inter-observer agreement by different examiners, and also has a high test-retest reliability. The test of validity will be a consistent relation between the neurological findings and the history and follow-up data.

The examination technique described in this book is based on all these considerations. It has been shown to be valid for infants of 38 to 42 weeks gestational

age and for pre-term babies once they have reached this age. The pre-term infants may have a lower resistance to passive movements.

Since the behavioural state and many responses are not stable until after the first two days of birth, a full neurological examination should be postponed until later unless there are urgent reasons for it being done earlier.

infants

the first
til later

General Considerations

One of the main problems which make neurological assessment of the newborn baby difficult is the standardisation of the examination procedures. This includes standardisation of (1) the external conditions, (2) the internal state of the baby, and (3) the handling of the infant which is inevitable throughout the test.

The External Conditions

(a) *Physical*

The baby should be examined in a warm environment of about 27-30°C (80°-85°F) in order to avoid stimulation as a result of heat production or of heat loss respectively. Radiated heat should probably be avoided, as in our experience this makes the temperature difficult to control. A small room with a high temperature is favourable. The light should be bright enough for examination but not so bright as to irritate the baby. The examination table should have a soft surface in order to avoid rolling movements of the baby. The advantage of a feather mattress is that a dip can easily be made in it to maintain the child's head in an optimal (midline) position during the examination.

(b) *The Observers*

There has been much discussion as to whether the mother should or should not be present during the neurological examination of the infant. In our view, she should not be present for the full examination. The close attention which is given the baby and the necessity of repeating some of the tests several times may distress her unduly and cause her unreal fears about her infant's health. She should, of course, understand why the child is being tested and realise its importance and significance. The screening test can usually be carried out in the presence of the mother, providing the examiner takes care to explain to her what he is doing and reassure her that responses such as the Moro response are entirely normal.

The examiner will try to standardise his own clothing and behaviour. In different clinics there will be different regulations about feeding, the degree of sterilisation and so on, and he will necessarily conform with local custom. The examiner cannot expect to gain useful results until he has had some practice in the techniques involved. None of these require elaborate study, but they do require a certain amount of experience. On the other hand, the screening test described on page 63 should be picked up very rapidly, although the examiner who is carrying out the screening test should be familiar with the more detailed method.

The Internal State of the Baby

During the first 10 days of life the neurological responses are markedly

influenced by physiological fluctuations in the newborn infant. During the first and second days there may be rapid and large fluctuations in behaviour states, from deep sleep to full activity. A routine examination should not be carried out before the third day unless otherwise indicated. Flexor activity may dominate in the legs and arms. There may be a persisting influence of drugs given to the mother during labour. During subsequent days other factors may have an effect on the results of the neurological examination. Physiological jaundice tends to make certain neurological items rather more difficult to elicit. Mild dehydration may depress or excite the baby. It is not yet possible to make precise statements about the effects of many other conditions, but one should be aware that pathological conditions not primarily in the central nervous system itself (*e.g.* a cardiac lesion or a urinary infection) may profoundly affect the results of the neurological examination.

The Technique of Handling the Baby

In order to get reliable and consistent results, the technique of the examination must be standardised. This will ensure not only a higher consistency by the same observer (test-retest reliability) but also a good agreement between different observers (inter-scorer reliability). By the strict use of the operational definition of each test, subjective elements can largely be eliminated in the description and interpretation (scoring) of results. For each test the technique of handling the baby and conducting the test is described in detail.

In addition, as the baby's behaviour is related to the *state* he is in and some responses may be present in one state but not in another, certain observations are repeated from time to time during the examination and it is therefore essential to keep to the sequence described.

The Significance of Behavioural States

It is important to carry out the various observations and tests only when the baby is in the appropriate behavioural state. Only then can the necessary standardisation of the procedure be met. Throughout the book the optimal states are indicated for each item. They are chosen because normal infants show a medium activity or a medium response intensity. In most items, deviant findings can then be seen as an increase or decrease. In addition, states which are contra-indicated are given. If the baby is not in the adequate state it should be either aroused or pacified. Sucking should not be used for pacification because of the marked influence it can have on most of the items in the examination. Mild rocking or cuddling is always preferable if the baby is upset. If this is not effective, the examination should be terminated and repeated when the baby is in a more adequate state.

The Optimal Findings per Item

To help the examiner in the interpretation of the results for each item, the optimal finding is given. 'Optimal' means the best response obtainable, and is printed in bold letters for each item. If desired, an optimality score giving a general impression of the integrity of the nervous system can be obtained at the end of an examination. This is only complementary to a clinical diagnosis, but is especially helpful in cases where deviant findings do not form a picture which is clear enough to allow a diagnosis to be made (see pp. 59-61).

The Pattern of the Examination

The examination is in two parts. First, the *observation* period, when the infant is lying undisturbed in the crib or the incubator, and second, the *examination* period, when the infant is undressed and placed on an examination table. The optimal time for examination is about two to three hours after the last feed, as at this time the baby is most likely to stay awake throughout the examination. An inquiry should be made to see whether the behaviour and the amount of food taken at the last feed were in any way unusual. The examination is not begun if the infant remains in profound sleep when the blankets are removed, or if he is continuously crying.

A specimen examination form is provided on the back flap of this book. On the top half of the first page of this form certain essential data obtained prior to the examination are inserted. The Summary following should be filled in only when the examination is completed. It summarises the essential findings of the examination and details of any subsequent investigations that are necessary. It allows the physician to scan his cases rapidly and to pick out those of particular interest. From page 3 onwards the form is scored and is not a simple normal/abnormal record. It must therefore be filled in while the examination proceeds. For every group of tests there is a space provided for recording the state of the infant at that time and this should always be filled in.

Essential Data

Various essential items of information are recorded at the top of the form. One must know when the baby was last fed, how he is being fed, what drugs have been administered to either the baby or the mother, and any special investigations, such as an estimation of serum bilirubin level, which may have been carried out. The frequency of defecation and any vomiting are recorded, as well as the infant's temperature. Hyperthermic babies are often irritable and restless.

There is also space for any information which a nurse in charge of the child may wish to report to the doctor. Such remarks as 'he is a difficult feeder' or 'he seems very drowsy' can alert the examiner, although they must be interpreted with care.

The Observation Period

State

The state of the infant is assessed while he is still lying in the crib with the blanket covering him. There are six possible scores of the state, which are recorded now and re-recorded throughout the examination.

State 1. Eyes closed, regular respiration, no movements.
State 2. Eyes closed, irregular respiration, no gross movements.
State 3. Eyes open, no gross movements.
State 4. Eyes open, gross movements, no crying.
State 5. Eyes open or closed, crying.
State 6. Other state — describe (*e.g.* coma).

In state 1, spontaneous 'startles' may appear. In states 2 and 3, small, isolated movements of eyes, face and hands may occur, but in state 2 gross movements lasting several seconds are possible, although the eyes are kept closed. In state 4, these movements occur primarily in the extremities. After the initial state has been assessed the blanket is removed and the state is then reassessed and subsequently checked at various stages of the procedure. Boxes for recording the state are on the right-hand side of the form and should be filled in from time to time.

Resting Posture

The blanket is removed and a preliminary sketch is made of the resting position of the head, trunk and upper limbs. In making this observation it is important to be aware of the effects of swaddling. In our unit the blanket is placed lightly on top of the child who is laid alternately on one side and then the other after alternate feeds. Local practice of the nursing staff should be ascertained and noted. In some units it is the practice to swaddle the baby quite tightly and it is impossible then to know what the spontaneous posture of the arms and legs would be (Figs. 3 and 4).

Recording Apart from the sketch, the initial position is recorded (*i.e.* left side, right side, supine, *etc.*).

Significance Opisthotonos may be observed at this stage, or other abnormal postures such as undue rotation of the head or undue rotation and extension of an arm.

Spontaneous Motor Activity

Spontaneous movements may vary considerably, depending on the behavioural state. Indicate, for the legs and arms separately, whether the types of movements observed are predominantly in a wide range (*i.e.* of high amplitude), whether the movements are with the limbs predominantly in flexion or extension postures and whether they are alternating movements.

Fig. 3 (*above*) and **4** (*right*). Resting postures. Both babies are in either state 1 or 2.

Recording The intensity of movement is graded:

—	absent
+	weak
++	**strong**
+++	very strong

Obviously, such recording has a subjective element to it and can only be based on the wide experience of the observer.

Athetoid Postures and Movements

Athetoid postures and movements are those in which some of the fingers are fully flexed while others are simultaneously extended, as well as simultaneous flexion of the elbow and rotation of the upper limb, or extension at the elbow with rotation of the wrist. Athetoid movements are slow changes from one athetoid posture to another. (See Fig. 17 on page 25.)

Recording
- — absent
- + occasional athetoid postures
- ++ **occasional athetoid movements of the arms, forearms, hands and fingers**
- +++ continual athetoid movements

Developmental Course In prematures, continuous athetoid movements are seen quite often. In the full-term infants the continuous movements may be replaced by athetoid postures which change from time to time. Athetoid postures in full-term infants occur throughout the whole neonatal period.

Significance In apathetic infants athetoid movements are rare. They may be exaggerated in infants after perinatal anoxia.

Tremor

If a tremor occurs, the frequency and its amplitude should be noted. Usually only the arms are involved, but in severe cases the legs and the whole body may show trembling movements.

Recording Record *incidence, frequency* and *amplitude* separately.

Incidence This is recorded **absent** (—), rare (+) or marked (++).

Frequency Less than 6 times per second is considered as low frequency and about 6 times per second and more as high frequency.

Amplitude Less than about 3cm is noted as low amplitude and 3cm and more as high amplitude.

Record in all instances if absent (—).

Significance During the first one or two days high-frequency, low-amplitude tremor is regularly found in normal full-term infants, even when they are not crying. From about the fourth day on, however, the occurrence of tremor is suspicious except during or after vigorous crying. Tremors occur in all infants who are crying vigorously. This type of tremor is usually of high frequency and low amplitude. It is also regularly seen in pre-term infants around 40 weeks conceptional age, even without crying. A sustained low-frequency, high-amplitude tremor is often associated with low threshold for tendon reflexes and easily elicitable Moro responses, and sometimes with hypermotility and increased resistance to passive movements. Neurophysiologically, these trembling movements are a clonus (Schulte 1965).

Other Movements

Marked overshooting of spontaneous movements, tonic or clonic convulsions, or rhythmical twitchings of the face may be present and should be recorded.

Skin

Colour of the skin, whether normal, pale, plethoric, jaundiced, cyanosed, should be recorded.

Respiration

Frequency and regularity should be recorded.

Examination in the Supine Position I

The baby is lifted from the cot and placed in a supine position on the examination table.

Skull

Describe any differences from the normal, such as cephalhaematoma, caput succedaneum or asymmetries of the skull.

The Fontanelles should be palpated, and their size and tension noted. Altered tension, bulging or any concavity are abnormal.

The Sutures are palpated and their separation and overlap noted. The circumference of the skull is measured in cms.

Face

We describe five standard facial expressions, which are bland, alert, fussing, crying (Figs. 5, 6, 7 and 8) and frowning. We believe that constant frowning is not a normal expression in the newborn period. Note the shape of the palpebral fissure, the nasolabial fold (especially asymmetries), the mouth (especially asymmetries) and also look for oedema (especially around the eyes).

Recording Describe the expression and describe any abnormality of palpebral fissure, nasolabial fold, mouth and the presence of oedema. Record: symmetrical-asymmetrical; oedema, present or absent.

Significance Observation of the expression may lead one to detect facial palsies, and it is worth noting that sometimes these are more readily observed with one expression than another. Any malformations of the lips, nose, jaws or ears should be recorded. Their presence may alert one to the possibility of neurological anomalies.

Chvostek's Reflex

State Optimal 3 and 4, exclude states 1, 2 and 5.

Position Not important.

Procedure Tap sharply with forefinger over the parotid gland (Fig. 9).

Response A twitch of the facial muscles on the stimulated side.

Recording

—	**absent**
+	weak
++	strong

Significance It may or may not be positive in infants with tetany, in hypoglycaemic infants or in infants of diabetic mothers. The value of this sign is still doubtful.

Developmental Course This reflex is normally absent.

Fig. 5. Bland.

Fig. 6. Alert.

Fig. 7. Fussing.

Fig. 8. Crying.

Fig. 9. Chvostek's reflex (no positive response).

Lip Reflex

State Optimal 2 or 3, exclude 5.

Position Supine.

Procedure Tap the upper or lower lip sharply. Do not tap at the corner of the mouth.

Response Protrusion of the lips by a contraction of the orbicularis oris muscle. The threshold of the response will be lower in state 2 than in state 3. Crying and sucking interfere with the response (Figs. 10*a* and *b*).

Recording
- — absent
- \+ short and weak
- ++ **good, sustained response**

Significance In normal, sleepy babies a light touch can elicit the response. In apathetic babies, however, quite a strong stimulus or repeated stimulation may have to be used before a response occurs.

Jaw Jerk (Masseter) Reflex

State Optimal 3 and 4, exclude all other states.

Position The best position is supine, hands folded over the chest in the median plane.

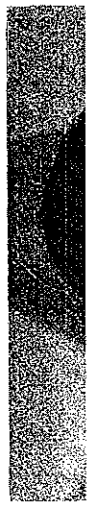
Procedure Place the index finger of one hand on the chin well below the lip and deliver a short, sharp tap to it with the tip of the other forefinger (Fig. 11).

Response A quick contraction of the masseteric muscles lifts the chin. This response can be felt (with the finger in the procedure mentioned above) far better than it can be seen.

Recording
- — absent
- \+ **present**
- ++ exaggerated, usually with clonus

Significance In brain-stem lesions or damage of the fifth cranial nerve the response is absent or weak.

Developmental Course Present in the first ten days, but weaker during the first two days.



Glabella Reflex

State Can be elicited in any state except state 5.

Position Hold the head firmly.

Procedure Tap sharply on the glabella (Fig. 12).

Response There is a tight closure of the eyes of short duration.

Recording
- — absent
- \+ weak response, just discernible
- ++ **good response**
- +++ sustained closure for more than one second

Significance In facial paresis, an asymmetrical response is found. Apathetic babies often show a weak response with a long latent period before the response. A low threshold (a strong response to a light tap) can be found in hyperexcitable infants, and this easily becomes a general startle response.

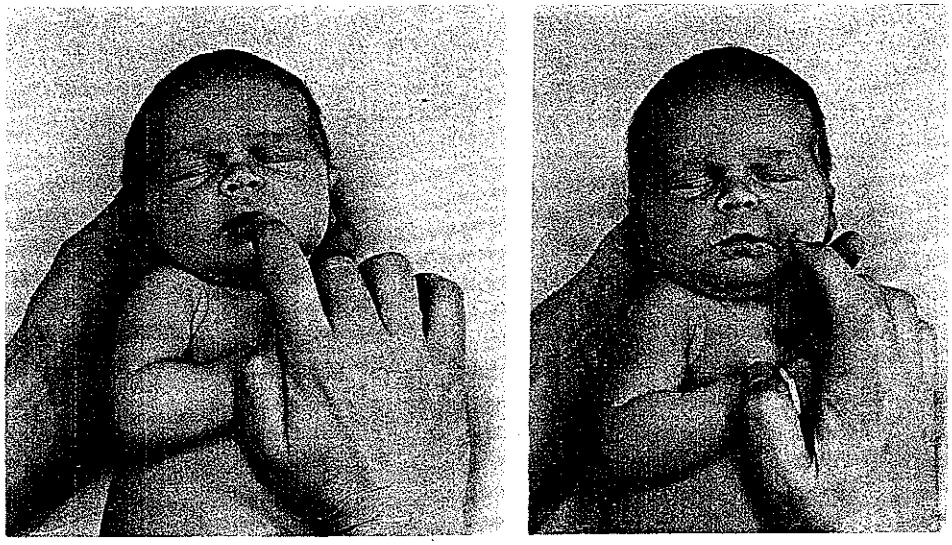


Fig. 10. Lip reflex: (*a, left*) elicitation and (*b, right*) response.

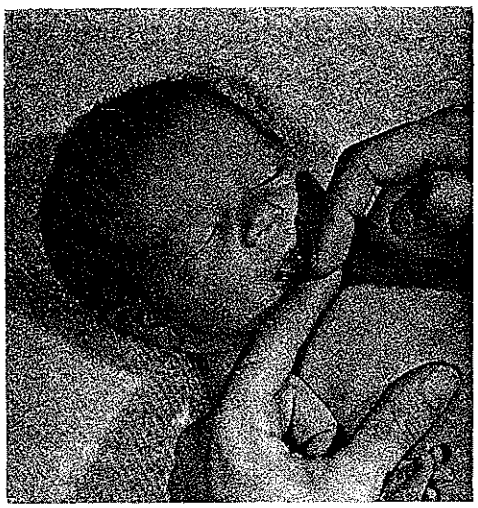


Fig. 11. Elicitation of the jaw jerk.

Fig. 12. Glabella reflex.

Examination in the Supine Position II

The baby now should be undressed by the examiner. Much may be learnt about his strength and change of state while this is being done. The baby is then once more laid in a supine position on the table, with the head centered in the midline. Again the state is assessed and recorded as each group of tests is done.

Posture

In normal infants the posture is symmetrical, the limbs semi-flexed and the lower limbs in slight abduction at the hips (Fig. 13). Pathological deviations from this normal posture are:

(1) Limbs lying flat on the surface (frog posture).
(2) Opisthotonic posture, the head retroflexed and the lower limbs extended (Fig. 14).
(3) The head turned constantly towards one side and an asymmetrical posture (Fig. 15).
(4) Strong flexion of upper and lower limbs.
(5) Both hands constantly held in front of the mouth.
(6) Strong asymmetry in the posture of the limbs. One arm and/or leg is endo- or exo-rotated (Fig. 15).

Recording Normal, otherwise describe.

Note After breech presentation with extended legs, the lower extremities are usually kept fully extended. After feet-first breech presentations there is a predominant flexor posture of both legs. These postures can be seen during the whole neonatal period. After face presentation, the head is more or less retro-flexed, the posture simulating opisthotonus, but this condition is of no pathological significance.

Spontaneous Motor Activity

State Only state 4 is adequate.

Position Symmetrical, supine.

Recordings The normal spontaneous motor activity (type) is alternating in upper and lower limbs (Fig. 16*a, b, c*). The type of movement is recorded as flexor, extensor or normal range. The *speed* should be recorded as:

\+ slow (like a slow-motion picture)
\++ **medium**
\+++ high

and the symmetry of the movements should be noted (record + or —).

The *intensity* (strength) is recorded as:

\+ low
\++ **medium**
\+++ very intensive

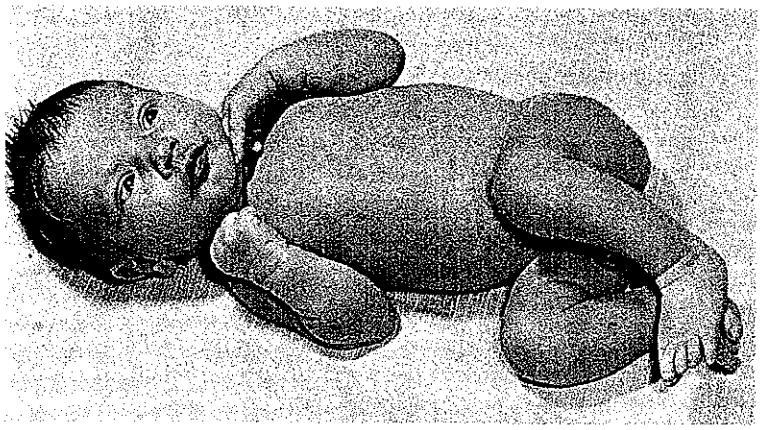


Fig. 13. Resting posture.

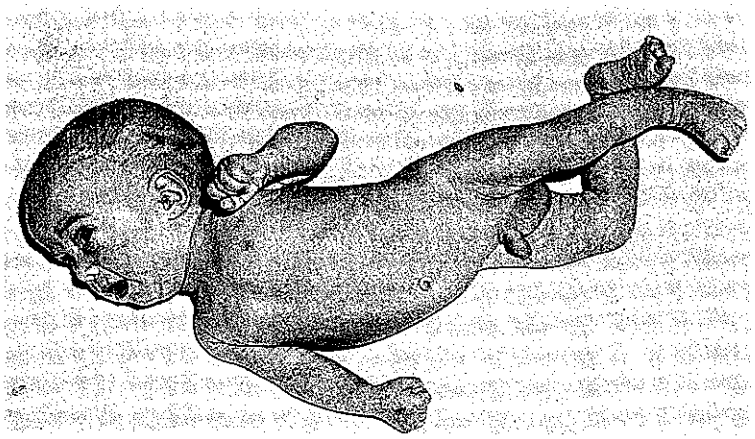


Fig. 14. Opisthotonic posture in a 14-day-old baby with hydrocephalus.

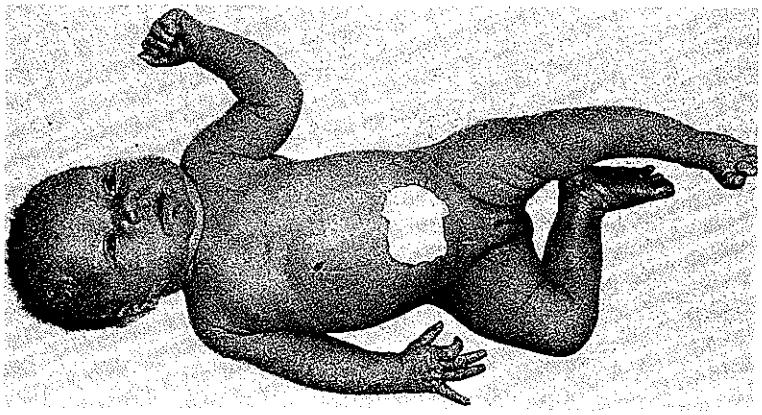


Fig. 15. Asymmetrical posture: paresis of right upper and lower limbs.

The average *amount* of movement in one time period of about 3 minutes is recorded as:

\+ low, a few isolated movements
\+\+ **medium, continual movements**
\+\+\+ high, a great deal of movement

Athetoid movements, tremors or other abnormal movements may be observed at this stage of the examination: they are recorded and described in the same way as under the observation period (p. 14).

Respiration

State 3 and 4 only.
Position Supine.
Recording Record the type, which is normally costo-abdominal. Also note whether accessory respiratory muscles are involved or whether there is any retraction of the head with respiration.

Skin

State and *Position* not important. Avoid crying.
Procedure Observe the colour, and assess the condition (elasticity) of the skin by raising a fold of skin on the abdomen or thigh between thumb and index finger, and releasing it, and noting the way in which the skin snaps back.
Response and Recording The colour is noted and recorded as in the previous section (page 15). In normal circumstances the skin, when raised and released, will immediately take up its former contour. In certain abnormal conditions, such as dehydration, the skin will remain as a fold. Record also the temperature and any perspiration. Note any abnormalities such as vascular or pigmented naevi and café-au-lait spots, which may also go hand-in-hand with neurological abnormalities.
Significance These tests are really estimates of the state of hydration of the baby which, as indicated, may alert one to other abnormal neurological findings.

Skin Reflexes

Abdominal Reflex

State 2 or 3, exclude all states in which the abdominal muscles are contracted.
Position Supine.
Procedure Scratch with a pin from the side towards the centre of the abdomen. Do this in the four quadrants of the abdominal wall (Fig. 18, p. 25). A positive response can be expected only if the abdominal muscles are fully relaxed. Observe habituation after about three responses, elicited every few seconds.
Response Quick contraction of the abdominal musculature in the stimulated area.
Recording — absent
\+ just discernible response
\+\+ **good positive response**
Significance Watch for asymmetry on the two sides. A total absence of these reflexes probably has no pathological meaning.

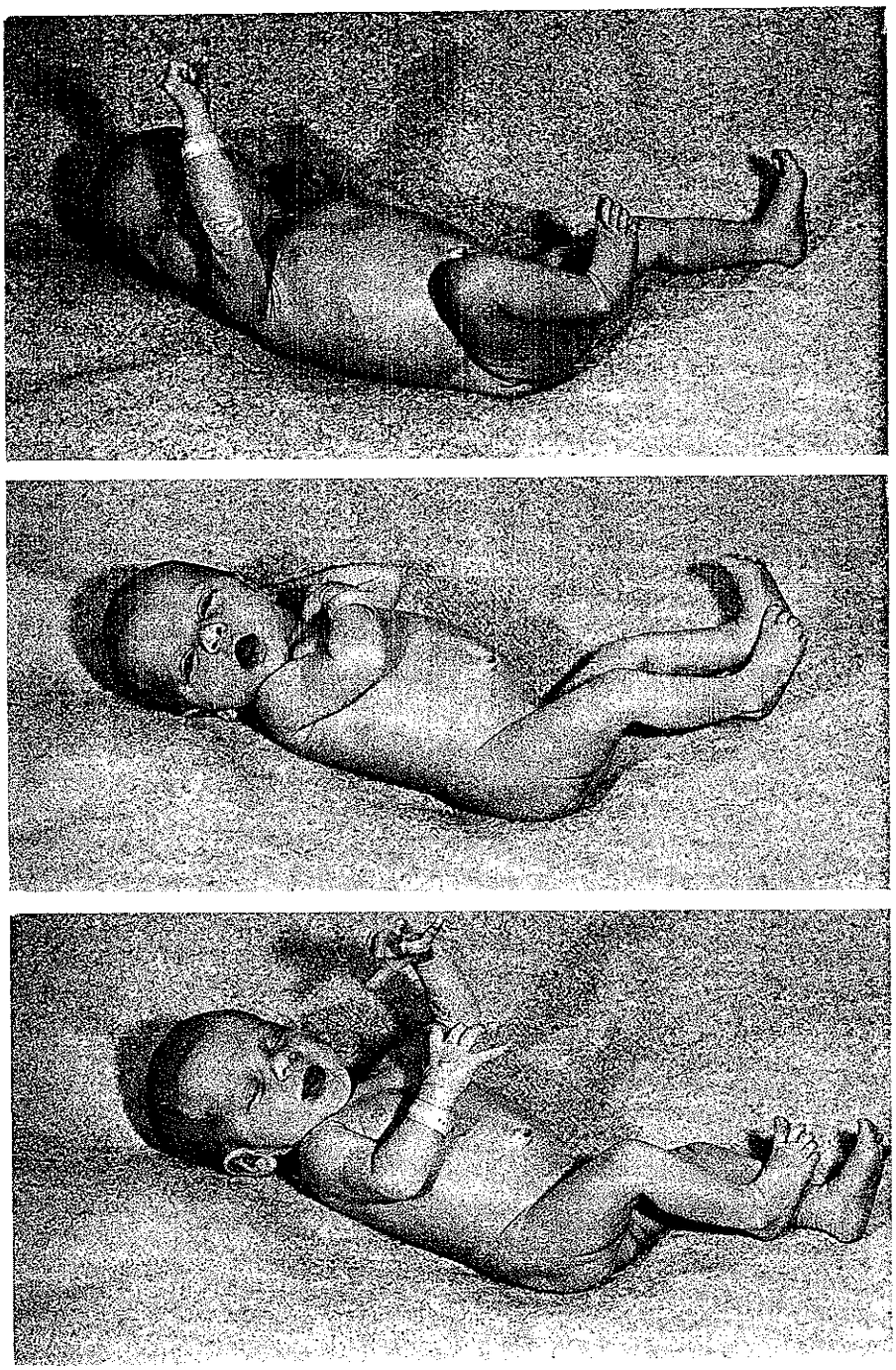


Fig. 16*a, b, c.* Spontaneous motor activity.

Developmental Course They are practically always present during the first ten days of life, but may be weaker during the first two days.

Cremaster Reflex
State Not important.
Position Supine.
Procedure Scratch the skin gently on the medial part of the thigh with a pin.
Response The testis on the stimulated side is pulled up, or the response may take place on both sides.
Recording — absent
\+ present, but weak
\+\+ **good positive response**
Significance Absent in spinal cord lesions at segments L1 and L2.
Developmental Course If the testes are descended and no oedema of the scrotum is present, the response is always obtainable in the first ten days of life, but may be weaker in the first two days.

Anal Reflex
State Not important, but the lower limbs must be relaxed.
Position Supine, lower limbs straightened and extended vertically (Fig. 19*a*).
Procedure Scratch the peri-anal skin with a pin.
Response Contraction of the external anal sphincter (Fig. 19*b*).
Recording — absent
\+ weak response, just discernible
\+\+ **good positive response**
Significance An absent reflex may be associated with damage to the sacral cord at S4 and S5.
Developmental Course Always present during the first ten days of life.

Fig. 17 (*left*). Athetoid movements.
Fig. 18 (*right*). The method of eliciting the abdominal reflex (in left lower quadrant).

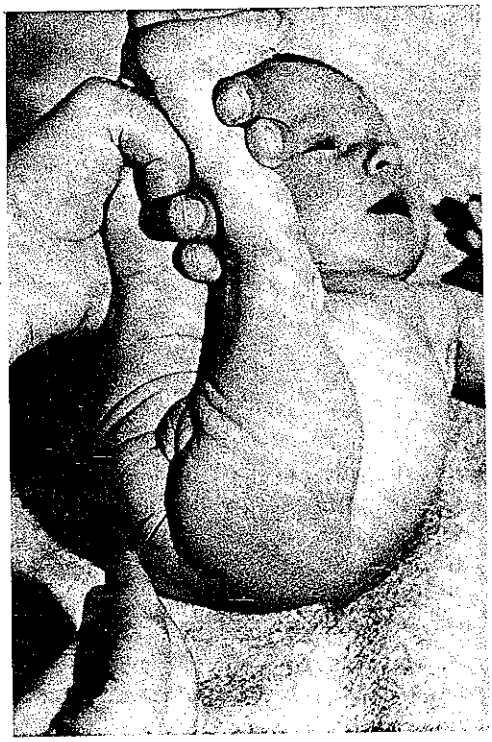


Fig. 19. The anal response: (*a, left*) before stimulation and (*b, right*) the elicited response.

The Eyes

Observation of the Eyes

State All states when the eyes are open.

Procedure Observe whether the eyes are central or whether there is a constant strabismus, or whether the eyes deviate in either direction or tend to point downwards (the 'setting-sun' sign), or whether either eye fails to move in a particular direction.

Recording Note whether the eyes are centred or deviated to left or right. Normal newborns show conjugated eye movements, at least from time to time, and occasionally strabismus (Figs. 20 *a, b, c*). Record whether slow or rapid eye movements occur.

Significance Constant strabismus is abnormal, as is any indication of abducens paresis. The 'setting-sun' sign may be found transitorily in babies without any other indication of dysfunction (see Fig. 21).

Nystagmus Nystagmus should be absent. Even short bouts of nystagmus are seen more often in at-risk infants. Sustained nystagmus after slight movements of the head is pathological.

Recording	—	**absent**
	+	inconstant nystagmus
	++	sustained nystagmus

Pupils

Observe the shape—round, oval or irregular; the size—normal, constricted or dilated. Note whether the two pupils are equal in size (record yes or no). Describe any unusual size.

Reaction of Pupils to Light

It is not necessary to use a direct light in order to see whether the pupils react to light. Indeed, a bright light should be avoided as this will cause a blink. A test can easily be carried out by shading one eye with the hand for a moment or two and then withdrawing it, and by keeping a light source at a distance. (It should be remembered that the pupillary responses of infants are not as strong as those of adults.)

Recording	—	absent
	+	just discernible
	++	**good response**

Significance Asymmetry in the pupil or poor response to light suggest neurological dysfunction (such as Horner's syndrome). In comatose states the response is weak or absent.

Fig. 20

Optic

State

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Signif

(*a*)

(*b*)

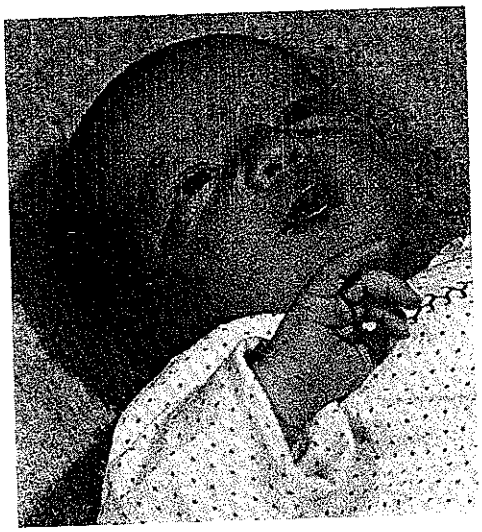


Fig. 20*a, b, (above) c.* Spontaneous eye movements.

Fig. 21. 'Setting-sun' sign.

Optical Blink Reflex

State 3 or 4, exclude 1, 2 and 5.
Position Not important.
Procedure Shine a bright light suddenly at the eyes.
Response Quick closure of the eyelids. There is sometimes a slight dorsal flexion of the head.

Recording
— absent
\+ weak blink
\+\+ **full response which can be repeated, but habituates after several trials**

Significance This response will be absent in some infants with impaired light perception.

Acoustic Blink Reflex

State 3 or 4, exclude 1, 2 and 5.

Position Supine.

Procedure Clap the hands about 30 cm from the infant's head. Be careful to avoid producing an air stream passing the face.

Response Quick closure of the eyelids.

Recording
- — absent
- \+ weak blink which cannot be obtained again by repeating the clap
- ++ **strong blink which can be reproduced with a stimulus interval of about 2 secs, habituating after several trials**

Significance It may be absent in infants with impaired auditory system, but can be absent in normal babies after it has been elicited only two or three times, as there is a rapid habituation to the stimulus.

Developmental Course Often very difficult to elicit in the first two or three days of life, but is certainly present afterwards in infants with normal hearing.

Corneal Reflex

State Whenever the eyes are open. Sometimes the infant should be brought into sitting position to open the eyes (vestibulo-palpebral reflex).

Position Supine.

Procedure Touch the cornea lightly with a piece of cotton-wool. Be careful not to touch the eyelids or the lashes.

Response The stimulated eye closes (Fig. 22).

Recording
- — absent
- \+ **present**

Significance Absent in lesions of the fifth cranial nerve.

Supine Suspension

Sometimes it is necessary to lift the infant's head and shoulders simultaneously in order to induce the eyes to open (vestibulo-palpebral reflex).

State 3 or 4.

Procedure Hold the baby suspended in the supine position with the head higher than the legs, and the arms hanging freely. One hand supports the baby's buttocks and the other hand is behind the back. Do not support the shoulders. Wait until the baby has been quietened (Fig. 23).

Recording Observe the posture and watch carefully for asymmetries. Make a sketch and record whether the upper and lower limbs are flexed or extended.

Significance A paresis of a limb will result in an asymmetrical posture. In general depression of the CNS the limbs will hang floppily down.

Doll's-eye Test

State Optimal 3 or 4, exclude 1, 2 and 5.

Position Supine suspension.

Procedure Turn the head slowly to the right and left and watch the position of the eyes (Fig. 24 *a, b*). Keep the head in the extreme position for several seconds.

Response The eyes do not normally move with the head.

Recording — absent (*i.e.* the eyes do move with the head)
\+ **present**

Significance Asymmetry in abducens paresis.

Developmental Course Always present during the first ten days of life. Disappears as fixation develops.

Fig. 22. Corneal reflex.

Fig. 23. Posture of the baby in supine position.

Fig. 24. The doll's-eye test. Rotation of the head in (*a, left*) clockwise direction and (*b, right*) in anti-clockwise direction.

Asymmetrical Tonic Neck Reflex

State 2 or 3, exclude 1 and 5.

Position Supine, with the baby back on the examination table.

Procedure Turn the face slowly to the right side and hold it in the extreme position with the jaw over the right shoulder. Repeat turning face towards the left shoulder.

Response The jaw ('face') arm and leg extend; the 'occipital' arm flexes at the elbow. The responses of the lower limbs are more constant than those of the upper limbs.

Recording Record separately for the turning of the face to the right and to the left side:

— **absent**
\+ sustained response

Significance The response may be *absent or present* in the newborn. A constantly present, well-marked tonic neck reflex may be a sign of neurological dysfunction, although this is still not certain.

Developmental Course It is seen more regularly at the age of two or three months.

Power and Passive Movements

Resistance against Passive Movements, Power of Active Movements and Range of Movement

State Optimal 3 and 4.

Position Place the baby on the examination table, with the head in the midline.

Procedure In this examination one assesses the resistance to passive movements,* the power of active movements,** and the range of movements of the joints (which is related to the degree to which the ligaments and muscles can be stretched).

In order to examine the resistance against passive movements and the active power of the muscles, one moves both the upper and lower limbs rhythmically and simultaneously through their full range of movements. Avoid any jerky or too rapid movements. Assess the resistance to passive movements when the baby is making no active movements at all. Assess active power when active movements of the baby interfere with the passive movements which the examiner is trying to make. If during the handling the infant changes from the optimal state, it may be necessary to pick him up and pacify him in order to get him back into state 3 or 4. However, note that rocking or sucking interfere with the state of the motor system; therefore, there should be a time interval between pacification and re-examination. The range of movements of the joint is tested by seeing whether the joint can be moved beyond the usual limit in any particular direction.

(*Note:* No undue force should be used in carrying out any of these tests. Under no circumstances should the infant be made to cry!)

Recording Resistance against passive movements, active power, and the range of movements of the joints are recorded for the neck, trunk, shoulders, elbows, wrists, hips, knees and ankles, using the following notation:

Resistance against passive movements

—	complete lack of resistance (floppy)
+	barely discernible resistance
++	**moderate resistance**
+++	strong resistance
++++	extremely strong resistance

* It will be noted that throughout this section, and indeed throughout the book, the use of the words 'tone' and 'tonus' has been avoided. We believe that so much confusion has arisen from the use of these terms that it seems better to discard them altogether. Nevertheless, the description 'hypertonia' or 'hypotonia' of newborn babies is so useful in practice that we have found it impossible to avoid using these words. Briefly, by 'hypertonic' baby we refer to one who is, in general, 'stiff' and who has marked resistance to passive movements, whereas the 'hypotonic' baby is the reverse.

** It has been stated that it is impossible to assess the active power of the baby. We believe that it is possible to make a very reasonable estimate of the active power by resisting the movements which the baby makes spontaneously. The rough scale which we have suggested is an estimate of the active power and in practice it proves very reasonable, as has been confirmed by high inter-scorer reliability for different observers.

Active power — no active movements
\+ active movements present but unable to withstand slight resistance
\+\+ **active movements with ability to overcome moderate resistance**
\+\+\+ powerful movements which are difficult to restrain

The exact definition of these grades again is obviously subjective, but they are useful for repeated observation by the same observer who will have a clear clinical impression in his own mind. In our experience there is usually reasonable correlation between different but practised examiners.

The Range of Movements (Figs. 25 to 32)

This is recorded only if the range of movements is abnormal. In practice the range of movement is seldom less than normal, except extension of the hip which is scored separately. It is not clinically practical to make an accurate estimate of the number of degrees of overstretch by which the range of movement is increased. The scoring is, therefore, 0 (optimal), + or ++. The normal range of movements for the different joints is as follows:

The neck Bend the head forwards and backwards about a horizontal coronal axis; retro- and anteflexion movements through 110°. Rotational movement about a vertical axis, turning face from side to side, 150°. Bending of head to side about a sagittal axis, with nose pointing forwards all the time, 90° (Fig. 25*a, b, c*).

The trunk The extreme positions for movements of the trunk are shown in Fig. 26*a, b, c, d.*

The shoulder The limitation of abduction of the arm at the shoulder is shown in Fig. 27*a* and is about 120° from the trunk. The arm will rotate through 260°/270° (Figs. 27*a, b, c*). Other possible movements at the shoulder are not considered.

The elbow The forearm moves through about 170° at the elbow.

The wrist Flexion and extension of the hand is through about 200° (flexion 110°, extension 90°) (Fig. 28).

The hips Move in flexion and extension through about 160°/170°. Extension (retroflexion) at the hip is limited to about 10° from the vertical axis when the pelvis is not tilted. The thigh flexed at the hip can be abducted to an angle of about 80° with the mid-plane, *i.e.* an angle of about 160° between the thighs, flexed and abducted (Fig. 29*a, b, c*).

The knees The knees should not hyperextend (Fig. 30) and the legs should fully flex onto the thighs. The full range is through 170°.

The ankle Figure 31*a* and *b* shows the maximum degrees of flexion and extension of the foot at the ankle, which moves through a range of about 130°.

Significance Barely discernible (+) resistance to passive movements is often found at some stage in the neonatal period and may not in itself reflect any neurological impairment, unless it is constantly present over the whole neonatal period. Cases with increased bilirubin levels or mild dehydration, and most pre-term infants, may have a lower resistance to passive movements. The presence of increased resistance is much more likely to be abnormal. If there are marked variations in resistance from time to time, while the child is apparently in the same state, this may also reflect neurological

dysfunction. Asymmetry is of great significance. Note also marked differences between arms and legs, especially if the legs show less resistance than the arms.

Bilateral weakness of active power may suggest a general muscle disorder or a general depression of the nervous system. Unilateral or partial weakness may indicate focal neurological lesions.

Marked increase in the range of movements of joints often correlates with a low resistance to passive movements; it may sometimes occur without associated changes and reflects some laxity of the ligaments. At the hip joint, limitation of retroflexion is usually found after breech presentation with extended legs (Fig. 32). Congenital subluxation, which causes a limitation of abduction, may be noted here.

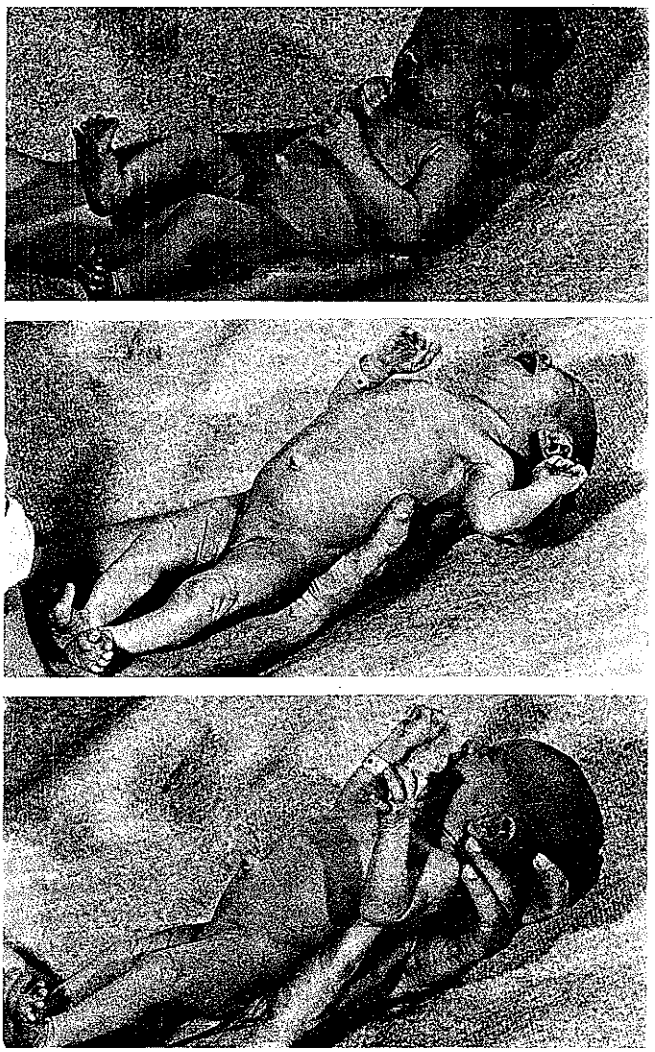
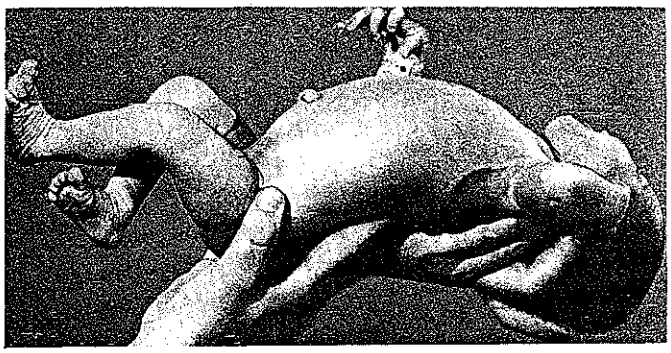
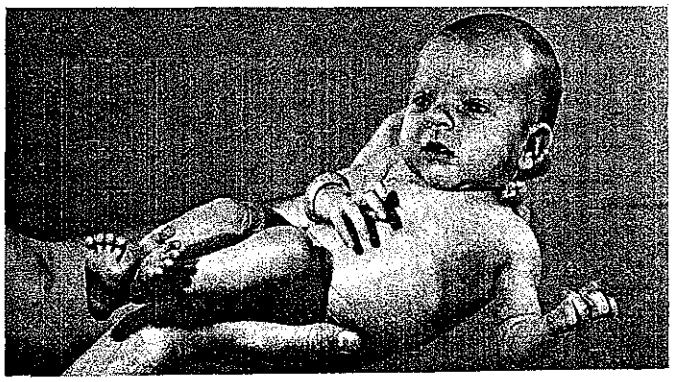
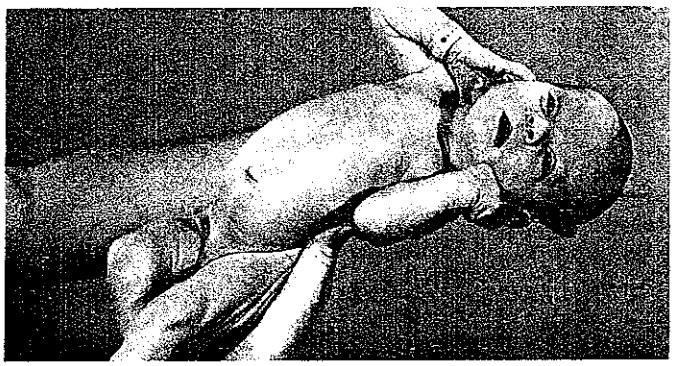


Fig. 25. Resistance to passive movements of the neck: (*a, top*) anteflexion, (*b, middle*) retroflexion and (*c, bottom*) turning.







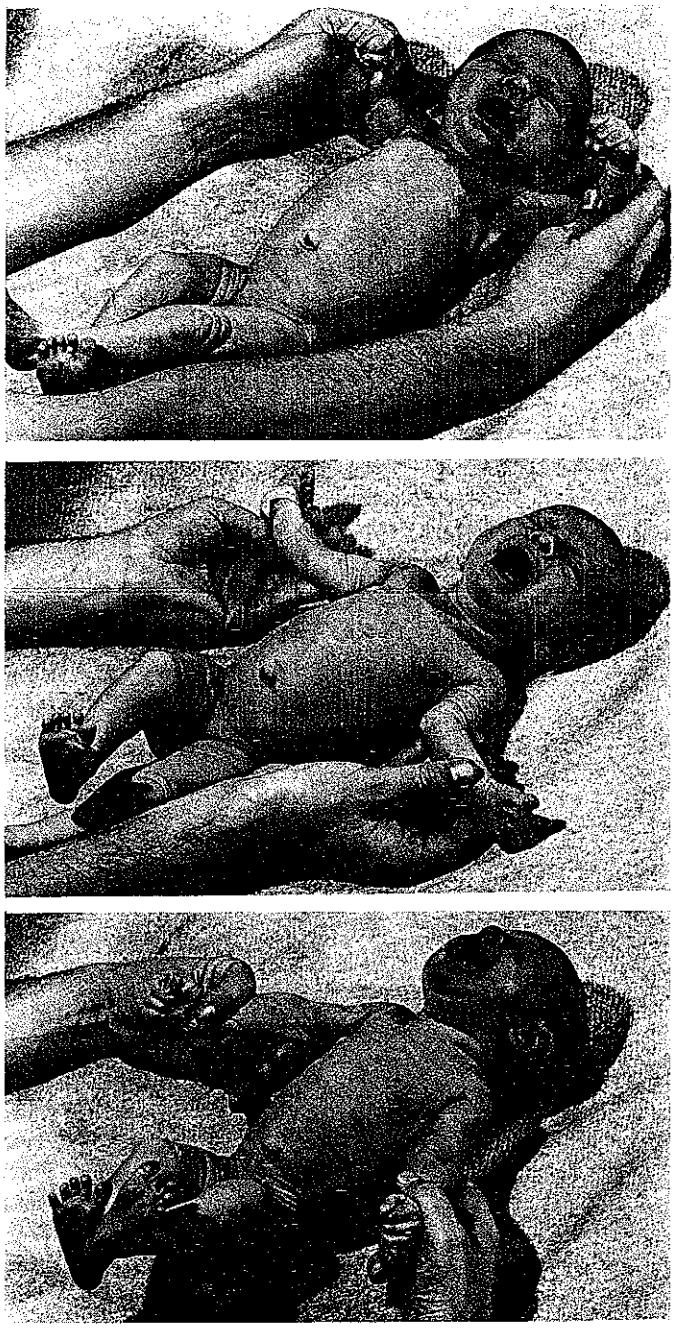


Fig. 26*a, b, c, d* (*facing page*). Resistance to passive movements of the trunk.
Fig. 27*a, b, c* (*above*). Resistance to passive movements of the shoulders and elbows.

Fig. 28. Range of movements of the hands.

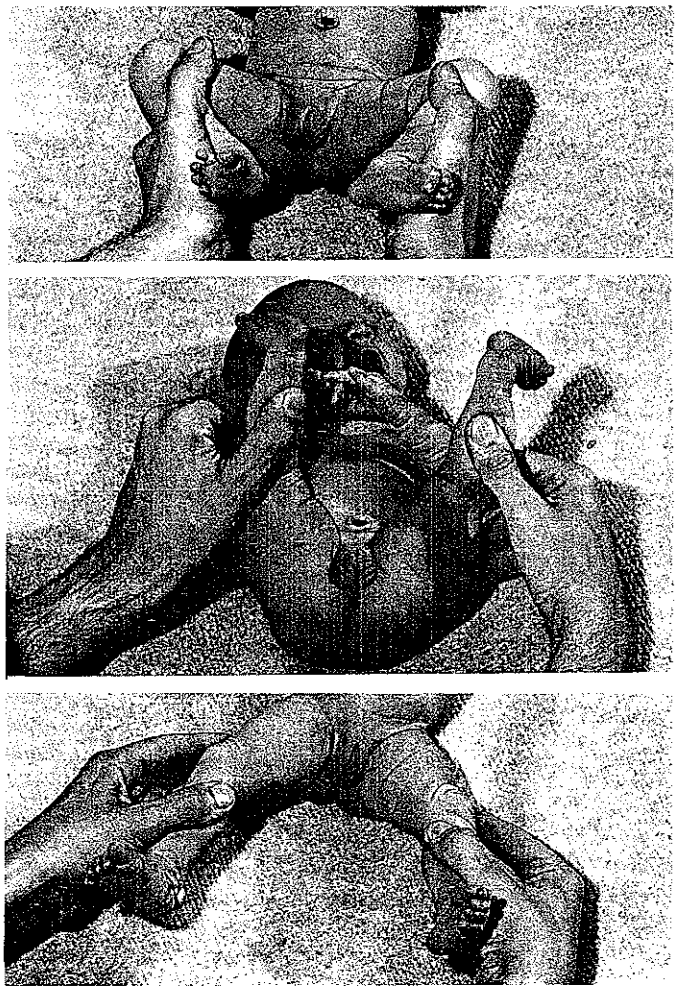


Fig. 29. Range of movements of the hips. (*a, top*) External rotation and abduction of the hips with bent knees. (*b, middle*) Flexion of the hips. Note that the knees are nearly straight. (*c, bottom*) Abduction of the hips with straight legs.

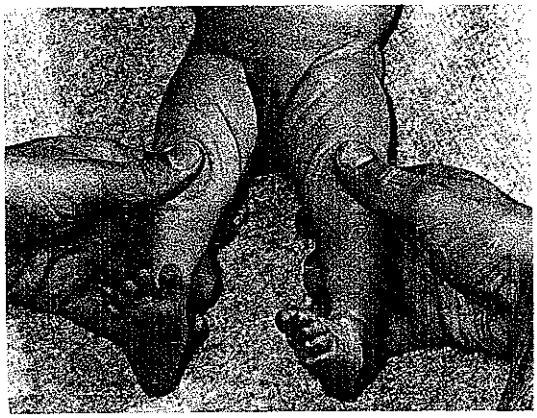


Fig. 30. Range of movements of the knees—extension.

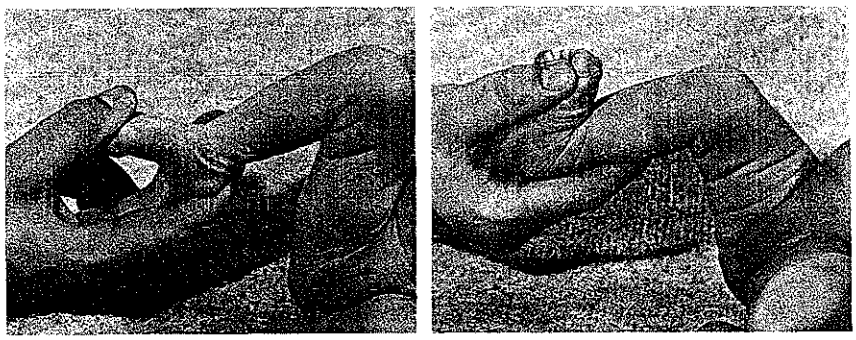


Fig. 31. Range of movements of the ankle joint: (*a, left*) extension and (*b, right*) flexion.

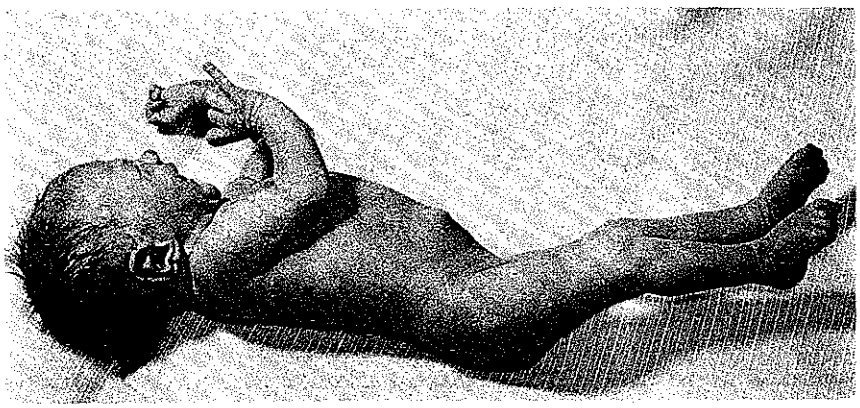


Fig. 32. Limitation of retroflexion of the hip. Note that this is not necessarily pathological but is found after breech presentation with extended legs.

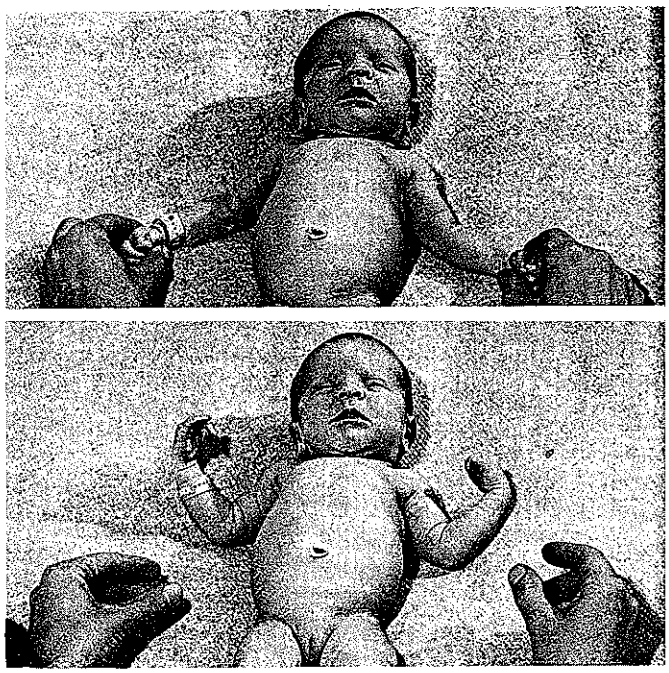


Fig. 33*a*, *b*. Recoil of the forearms at the elbows.

Recoil of the Forearm at the Elbow

State Optimal 4.

Position Symmetrical supine, exclude asymmetrical positions.

Procedure Both forearms are simultaneously passively extended at the elbow and then released (Fig. 33*a* and *b*).

Response Brisk flexion at both elbows, usually symmetrical.

Recording
- — absent
- \+ weak recoil (up to 45°)
- ++ **marked, quick flexion in both arms**
- +++ rapid and forceful flexion

Consistent asymmetry should be recorded.

Significance In hypotonic and apathetic babies this response may not occur. Asymmetry occurs in hemisyndromes or paresis of one arm.

Developmental Course The response is stronger in the first two days of life when flexion postures predominate. It is present throughout the neonatal period.

Muscular Consistency

State and *Position* not important.

Procedure Palpate trunk, arm and leg muscles when relaxed.

Recording Note any deviation from normal.

Significance Deviations from the normal are softness in congenital muscular disease or hard, stony consistency in severely hypertonic children.

Reflexes and Responses

Biceps Reflex

State Optimal 3, exclude 1, 2 and 5.

Position Supine, with the arms semi-flexed, symmetrical with the head centred.

Procedure Place the index finger of one hand on the tendon of the biceps muscle in the elbow area, tap with the other index finger. The examiner's ring finger rests on the infant's wrist and presses gently to stretch the biceps a little (Fig. 34).

Response A short contraction of the biceps muscle can be observed and also felt.

Recording

—	absent
+	just discernible response
++	**good contraction**
+++	very exaggerated contraction going on to clonus

Significance Look for absence or exaggerated reflexes or differences in intensity on the two sides. Absent in depressed infants or in cases of congenital muscular disease.

Developmental Course In the first two days of life it is brisker than in later days.

Knee Jerk

State Optimal 3, exclude 1, 2 and 5.

Position Supine, the head should be in midline.

Procedure Support the lower limbs with one hand under both knees, lift a little and wait until both lower limbs are relaxed. With index finger of the other hand tap the tendon below the patella (Fig. 35).

Response Quick extension of the knee caused by contraction of the quadriceps muscle. There may be a quick adduction of the other lower limb.

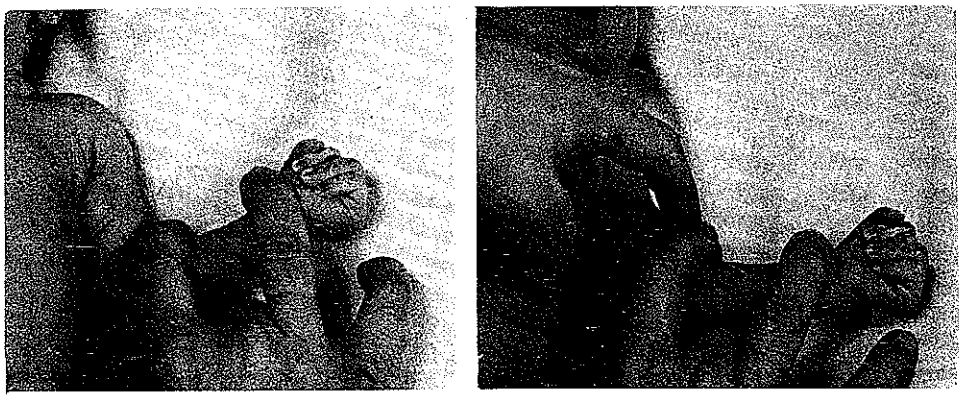


Fig. 34. Elicitation of the biceps reflex.

Recording — absent
\+ just discernible response
\+\+ **good contraction**
\+\+\+ exaggerated response, with at least a few beats of clonus

Significance Watch for asymmetries. In depressed infants or in muscular disease the reflex is absent or difficult to obtain. Exaggeration may be found in hyperexcitable infants. Clonus is normally found during state 1.

Developmental Course This reflex is more pronounced during the first two days or so of life than later.

Ankle Clonus

State Optimal 3 and 4.

Position Supine, the legs slightly flexed.

Procedure Press both thumbs with a rapid abrupt movement against the distal part of the soles of the feet. This produces a quick dorsiflexion of the feet (Fig. 36).

Recording — **absent**
\+ present (2 to 3 beats)
\+\+ prolonged clonus

If present, record the average number of beats for which it is sustained by eliciting the response two or three times.

Significance If ankle clonus is sustained it is evidence of neurological impairment.

Palmar Grasp

State Optimal 3 and 4, exclude 1, 2 and 5.

Position Supine, strictly symmetrical, the head in the midline and the arms semiflexed.

Procedure Put fingers (usually the index finger) from the ulnar side into the hands and gently press the palmar surface. *Never touch the dorsal side of the hands.* Ensure the head stays in the midline (Fig. 37).

Response Flexion of all fingers around the examiner's finger.

Recording — absent
\+ short, weak flexion
\+\+ **strong and sustained for several seconds**
\+\+\+ sustained grasp with the tips of the infant's fingers going white

Significance Watch for difference of intensity between the two sides. Sucking movements facilitate grasping. If grasping is absent or weak, try the facilitating influence of simultaneous sucking. If there is no effect, the reason for the absent palmar grasp is probably peripheral and not central. Asymmetries occur in Erb's and in Klumpke's paresis. The response is weak or absent in depressed babies.

Developmental Course It may be less intense during the first and second days.

Plantar Grasp

State Not important if the infant is awake.

Position Supine.

Procedure The examiner presses his thumbs against the balls of the infant's feet.

Response Plantar flexion of all toes (Fig. 38).

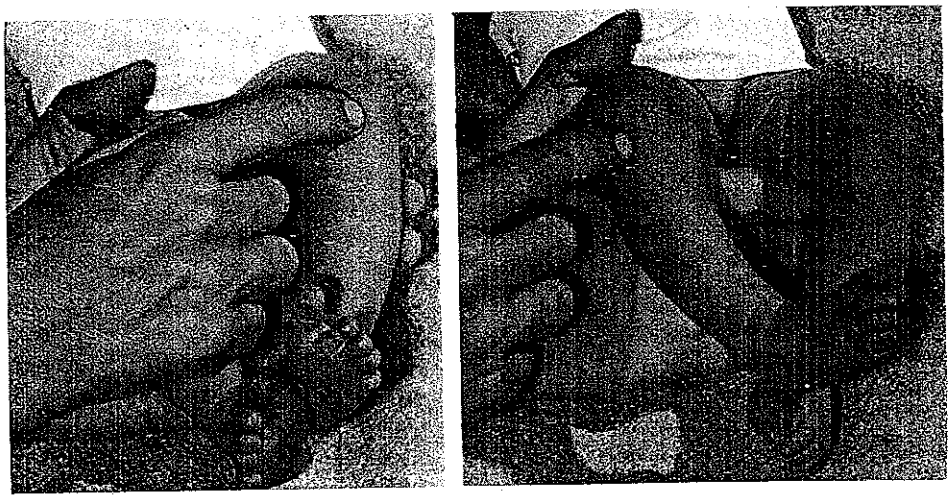


Fig. 35. Elicitation of the knee jerk.

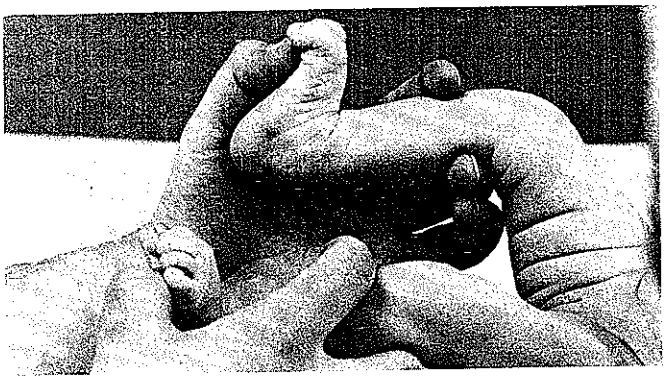


Fig. 36. Elicitation of ankle clonus.

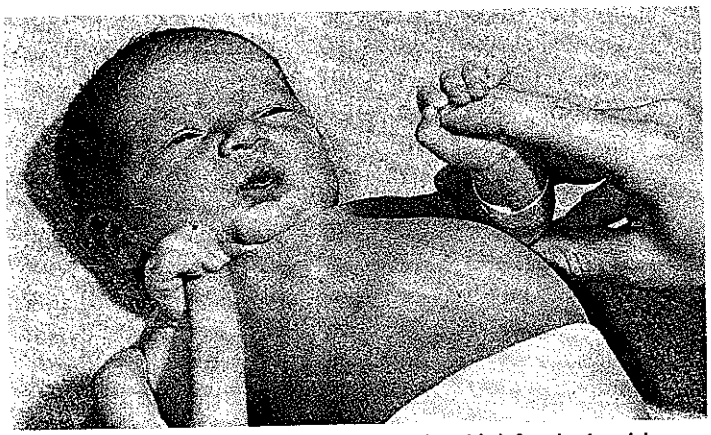


Fig. 37. Testing for the palmar grasp. Note that this infant is also giving a good example of the palmomental reflex.

Recording — absent
\+ weak and unsustained response
\+\+ **good sustained response**
\+\+\+ very strong, prolonged response

Significance Absent in defects of the lower spinal cord. Look for asymmetries.

Developmental Course May be less intense during first and second days of life.

Babinski Reflex

State Not important.

Position Supine, legs semi-flexed.

Procedure Scratch the sole of the foot with a thumb nail on the lateral side, starting *from the toes towards the heel.* Be sure that stimulation is a scratch and not merely pressure, otherwise a plantar flexion may be elicited.

Response Dorsal flexion of the big toe and spreading of the smaller toes (Fig. 39).

Recording — absent
\+ weak, dorsal flexion and some spreading of the toes
\+\+ **good dorsal flexion with marked spreading of the toes**

Significance Look for asymmetries. This response is very constant and, despite the difficulties described in obtaining it in the past, it can be elicited. Absent in defects of the lower spinal cord and in severely apathetic infants.

Developmental Course No change in intensity during the first ten days of life.

Magnet Response

State Optimal 4, exclude 1, 2 and 5.

Position Supine, with the lower limbs semi-flexed and symmetrical. Head in midline.

Procedure Light pressure to the soles of the feet. The hands of the examiner should continue to maintain light contact with the feet while the lower limbs extend; avoid heavy pressure (Fig. 40*a*).

Response Extension of the lower limbs (Fig. 40*b*).

Recording — absent
\+ weak, incomplete extension
\+\+ **sustained extension**
\+\+\+ rapid and long sustained extension

Significance Look for asymmetries. Absent in cases of damage to or malformation of the spinal cord and weak in cases of breech presentation without extended legs, but exaggerated in breech cases with extended legs. It is weak in the sciatic nerve stretch syndrome.

Developmental Course It may be absent or more difficult to elicit during the first two days of life, since flexion patterns of the lower limbs predominate.

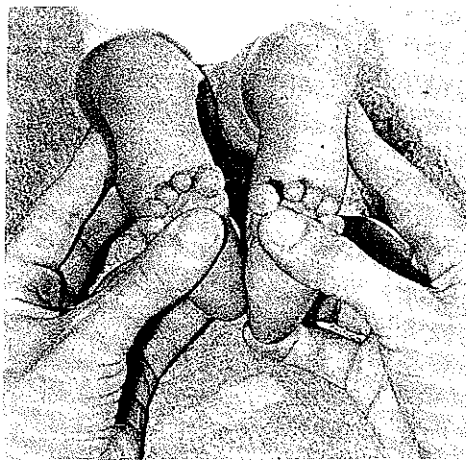


Fig. 38. Plantar grasp.

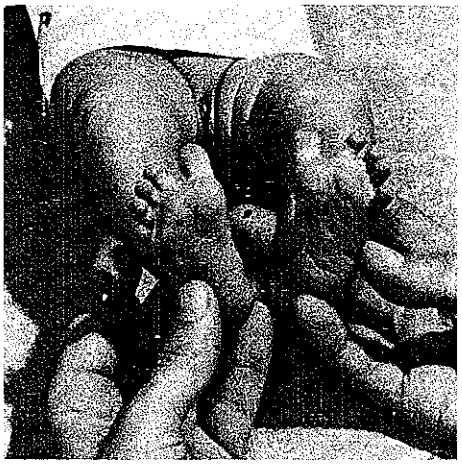


Fig. 39. Babinski reflex.

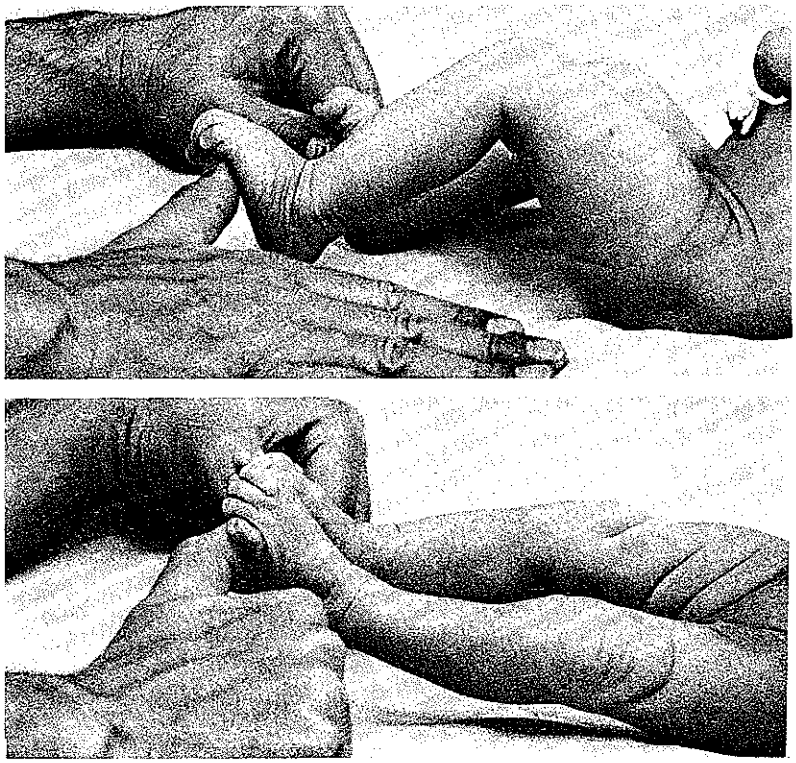


Fig. 40. The magnet response: (*a, top*) stimulation and (*b, bottom*) response.

Withdrawal Reflex

State Optimal 3, exclude 4 and 5 when the infant is very active.

Position Supine, lower limbs relaxed in semi-flexed posture.

Procedure Gently scratch the soles of each foot in turn with a fingernail or pin.

Response Simultaneous flexion of hip, knee and foot (Fig. 41), often followed by the unstimulated leg.

Recording
- — absent
- \+ weak flexion
- ++ **strong flexion**
- +++ very vigorous flexion and alternating flexion and extension

Significance Watch for asymmetries. Absent in spina bifida and damage to the spinal cord. Weak in the sciatic nerve stretch syndrome. It is absent or weak after breech presentation with extended legs and may even be reversed to an extensor response.

Developmental Course Constantly present during the first ten days of life.

Rooting Response

State Optimal 3, 4 and 5, exclude 1 and 2.

Position Supine, with the head symmetrical in the midline and the hands above the chest.

Procedure With a finger tickle the perioral skin at the corners of the mouth, the upper lip and the lower lip in turn. The examiner holds the baby's hands against the baby's chest with the other hand because the infant's arm position influences the rooting response.

Response After stimulation of the corners of the mouth, there is directed head turning towards the stimulated side. With stimulation of the upper lip there is opening of the mouth and retroflexion of the head. Following stimulation of the lower lip, the mouth opens and the jaw drops. In all instances the infant tries to suck the stimulating finger (Fig. 42).

Recording
- — absent
- \+ only a weak turn towards the stimulated side
- ++ **full turn towards the stimulated side and grasp with the lips**
- +++ very vigorous turning with overshooting and grasping

Significance Absent in depressed infants, particularly those depressed by barbiturates. Turning away from the stimulated side will occur in satiated babies. There is a high correlation with the level of alertness. Look for asymmetries of the response and check these by tickling both corners of the mouth simultaneously. In asymmetrical response the head will nearly always turn to one side.

Developmental Course Always present during the neonatal period, but less vigorous during the first two days.

Sucking Response

State 3 and 4, exclude 1 and 2.

Position Supine.

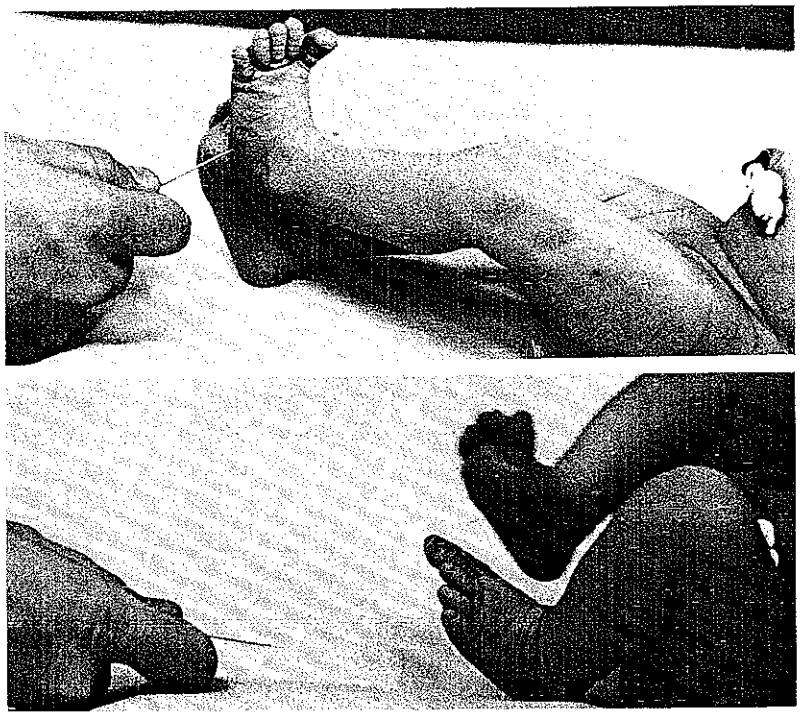
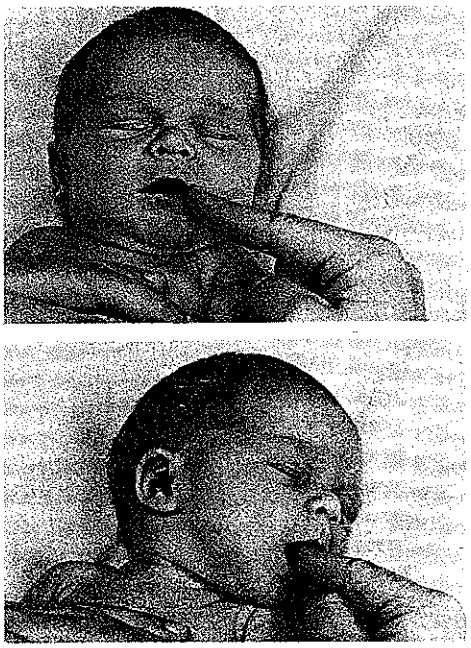


Fig. 41. The withdrawal reflex: (*top*) stimulation and (*bottom*) response.



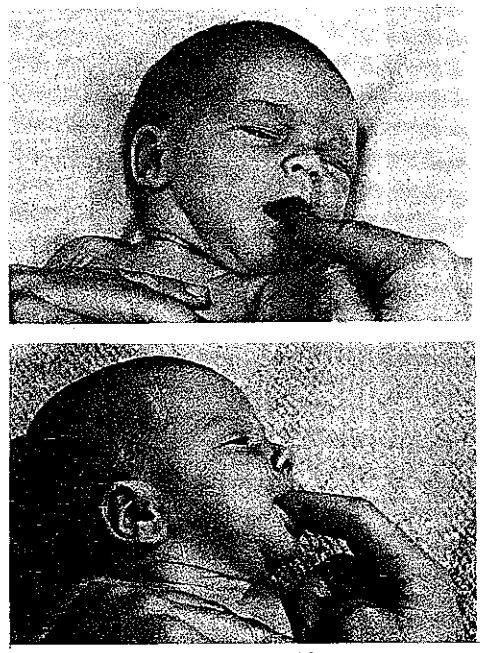


Fig. 42. The rooting reflex: (*top left*) stimulation, (*top right*) head turning and (*above, left*) grasping with the mouth.

Fig. 43. Testing sucking

Procedure Put the index finger about 3 or 4cm into the mouth (Fig. 43).
Response Rhythmical sucking movements will be felt.
Recording The following components should be noted separately.

1) Stripping action of the tongue forcing upwards and back
2) The rate
3) Suction (negative pressure)
4) Grouping of the sucks

First and third component
— absent
\+ low or barely discernible function
\+ + **intermediate range of function, adequate and sufficient performance**
\+ + + exaggerated performance

For the rate give the number of sucks per 10 seconds. Record — absent, + up to 8 sucks/10 secs, + + 9 to 12 sucks/10 secs, + + + more than 12 sucks/10 secs.
For recording the grouping of sucks
— absent
\+ **groups present**
\+ + bouts of 15 to 30 sucks with no grouping

Significance Poor sucking (weak, slow and with short periods) is found in apathetic babies, in whom it may even be absent. Barbiturates depress sucking, and the baby may be thus affected if he is being breast-fed and the mother is receiving any of these drugs.
Developmental Course Sucking is often less intensive and less regular during the first three to four days. If possible, not only the sucking reflex should be tested but also a feed should be watched.

Traction Test
State Optimal 4, exclude 1, 2 and 5 if there is sustained crying.
Position Start with the baby in the symmetrical supine position (Fig. 44*a*).
Procedure Grasp the infant's hands at the wrists and pull him slowly up to a sitting position (Fig. 44*b, c*). If necessary, support the head.
Response The response consists of a resistance to extension of the arms at the elbow when the body is pulled to a sitting position. The head is actively lifted.
Recording
— the arms extend fully at the elbow with no resistance, head lag is present
\+ **the arms remain moderately flexed at the elbow throughout the procedure, head actively lifted**
\+ + there is strong resistance to extension and semi-flexion is maintained and head follows actively

Significance Resistance to traction will be absent in hypotonic infants. It will be asymmetrical in plexus paresis. There will be strong flexion of the elbows in hypertonic infants.
Developmental Course May be stronger during the first two days when flexion patterns dominate.

Control of Head Movements during the Sitting Posture

Position Sitting posture.

Response The degree to which the head is maintained in the upright position is observed here (Fig. 44*c*).

Recording

— head hangs passively down

\+ head returns to the upright position, momentarily at least, once or twice

\+\+ **head remains in the upright position for at least 3 seconds, although oscillating slightly**

\+\+\+ head is maintained constantly in the upright position with only very minor oscillations

Significance The head control is a joint function of the strength of the neck muscles and the activity of the labyrinth. The labyrinthine component alone can be evaluated

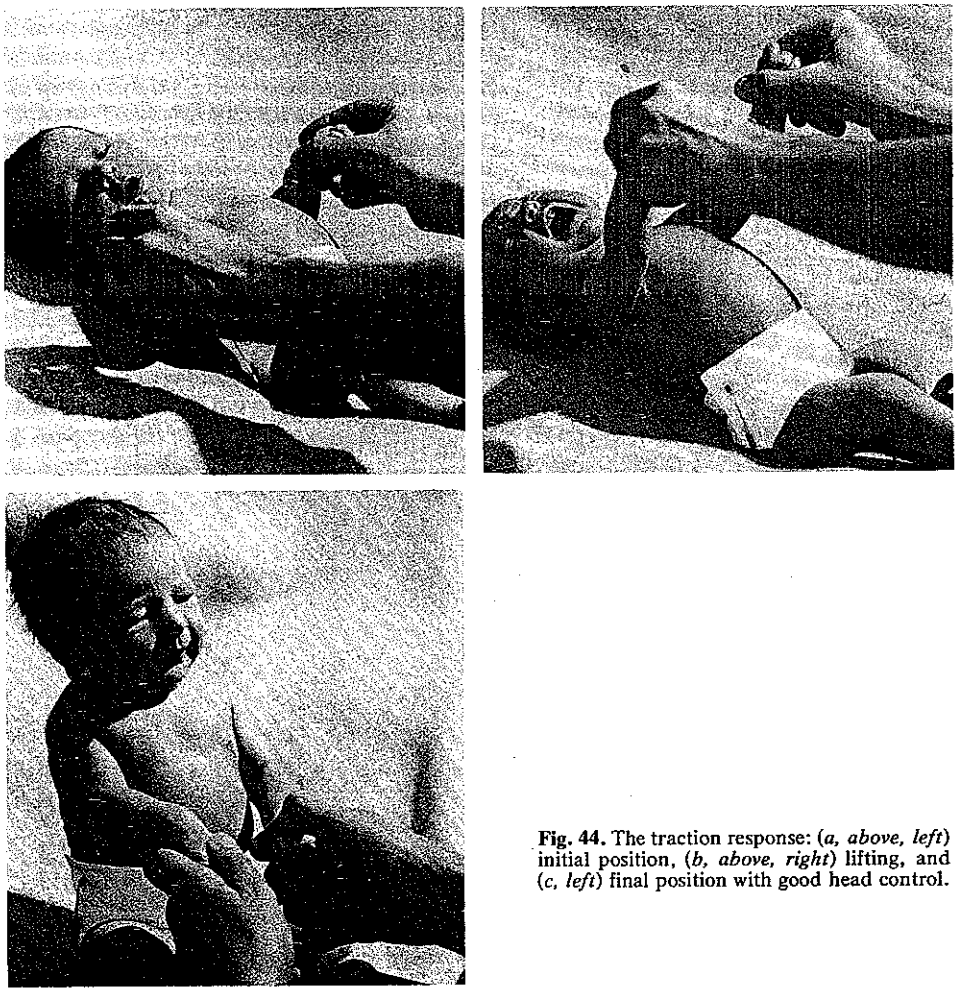


Fig. 44. The traction response: (*a, above, left*) initial position, (*b, above, right*) lifting, and (*c, left*) final position with good head control.

by checking its effects on the eye movements. Neck muscles can be evaluated in the relevant portions of the examinations of the neck muscles. This response is weak or absent in hypotonic infants and in apathetic infants. It is exaggerated in hypertonic infants.

Developmental course During the first two or three days the head control is weak, after that it is usually present ++.

The Moro Response (Head Drop)

State Optimal 3 and 4, exclude 1 and 2.

Position Symmetrical, arms in front of or beside the chest. Head in the midline (Fig. 45*a*).

Procedure The head is held in the hand and the body is supported by the lower arm of the examiner. The examiner's other hand supports the infant's back and buttocks. The head is then dropped a few cm with a sudden rapid but not too forceful movement of the hand. The head should be dropped back only at a moment when the neck muscles are relaxed and the head itself is in the midline position. Do not tilt the body. The test should be carried out at least three times in order to observe all the components fully.

Response A complete Moro consists of an abduction of the upper limbs at the shoulders, extension of the forearms at the elbows, extension of the fingers (Fig. 45*b*). Subsequently there is an adduction of the arms at the shoulders and a flexion of the forearms at the elbows.

Recording Separately for abduction at shoulder, extension at elbow and adduction of the upper limbs and flexion at elbow.

1) Abduction at the shoulder
   - — absent
   - \+ only anteflexion at the shoulder
   - ++ **to about 45° from the trunk**
   - +++ to 90° from the trunk

2) Extension at the elbow
   - — absent
   - \+ to 90°
   - ++ **to about 135°**
   - +++ full extension of the elbow to 180°

3) Adduction at the shoulder
   - — absent
   - \+ half the range of the abduction
   - ++ **full adduction through the range of abduction**
   - +++ across the midline

4) Flexion at the elbow
   - — absent
   - \+ weak, just discernible
   - ++ **fully developed movement**

The *threshold* for the Moro response should be marked as low (easily elicitable), medium, or high (after 5 or more trials elicitable only with strong stimuli). If a clonus is present during the response, note the frequency and amplitude as described above under spontaneous movements (page 14).

If the head drop has no effect, try the effect of eliciting response with the technique (dropping) described below.

Significance Look for asymmetry, which is present in Erb's paresis and clavicular fractures. An absent or constantly weak Moro indicates serious disturbances of the central nervous system.

Moro Response (to a 'Drop' of the Baby)

If a head drop is contra-indicated for one reason or another, one can elicit the Moro response by the following technique, which is less disturbing to the child.

State Optimal 3 and 4, but no states excluded.

Position Baby is suspended horizontally as above.

Procedure The examiner lowers his hands rapidly about 10 to 20 cm and brings them to an abrupt halt. There is no flexion of the neck.

Response, Recording, Significance All as described under the head drop method.

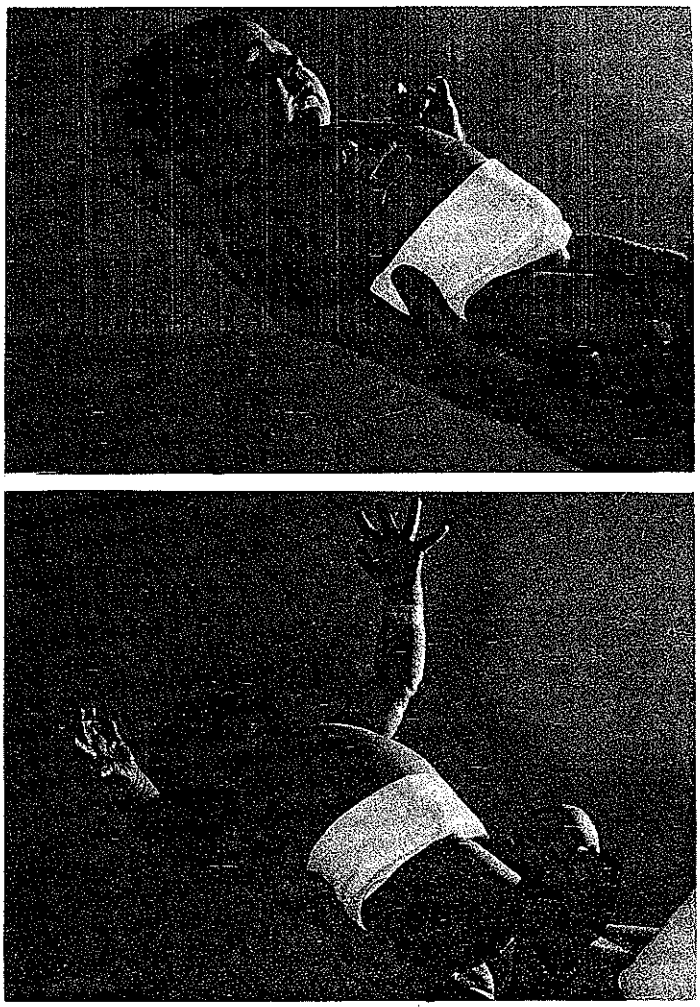


Fig. 45. The Moro response: (*a, top*) position and (*b, bottom*) response.

The Infant in the Prone Position

Turn the baby over onto his stomach.

Inspection and Palpation of the Vertebral Column

Palpate, with the first and second fingers, the dorsal spines of the vertebral column and inspect the skin which covers them. One can feel abnormalities of the vertebra by palpation. Record as absent (—) or describe the abnormality.

Spontaneous Movements of the Head

State 4 and 5 only.

Position Prone.

Response The head may be lifted off the table for some seconds. It may be turned to the right or to the left to take up a new posture (Fig. 46*a, b, c*). It may be moved rhythmically from side to side.

Recording Record the response of lifting the head, whether it is straight up or to the right or the left.

— absent
\+ a short lift once or twice
\++ **lifting sustained for a few seconds**
\+++ a lift of some centimetres sustained for at least 10 seconds

Record separately for rhythmical turning.

Significance Sustained (+++) is found in hypertonic babies or in opisthotonos. Floppy and apathetic babies do not show any head lift.

Developmental Course The baby's ability to lift the head is weaker in the first 2 or 3 days of life.

Spontaneous Crawling and Bauer's Response

Crawling can be observed spontaneously and with reinforcement (Bauer's response).

State Optimal 4 and 5, exclude 1, 2 and 3.

Position Prone.

Procedure Watch for half a minute. If the infant does not crawl spontaneously, then the examiner gives a reinforcing stimulus by pressing his thumb gently on the soles of the feet. See whether this increases the crawling and actually causes movement of the baby (Fig. 47).

Response Crawling.

Recording
— absent
\+ weak intention to crawl
\++ **co-ordinated crawling**
\+++ locomotion for at least 30 cm occurring within one minute

Record separately for spontaneous and reinforced crawling.

Significance Crawling is absent or weak in depressed infants and in muscle weakness.

Developmental Course This is not easy to obtain during the first two or three days of life.

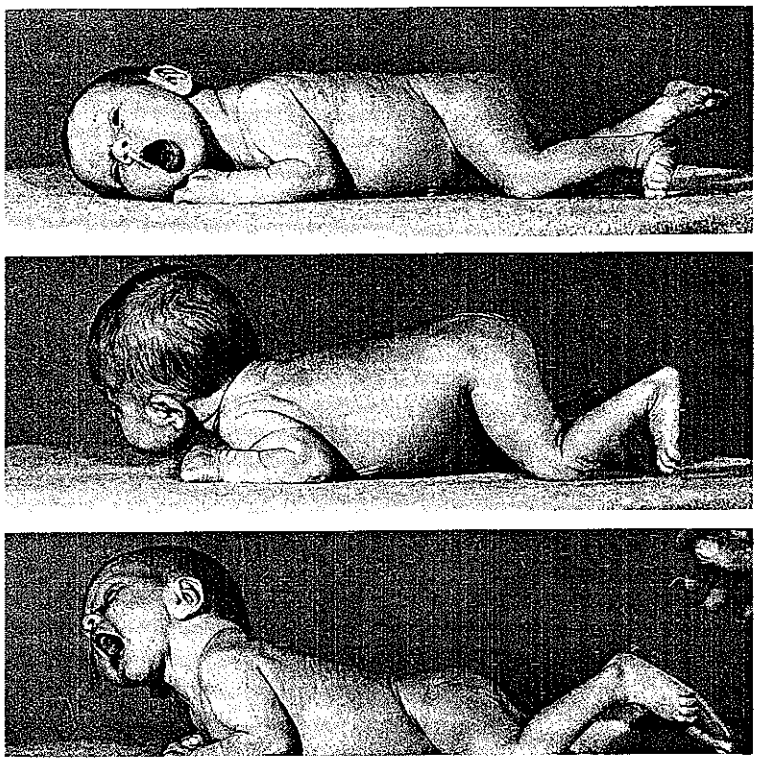


Fig. 46. Spontaneous crawling (*a* and *b*) and head lift (*c*) in the prone position.

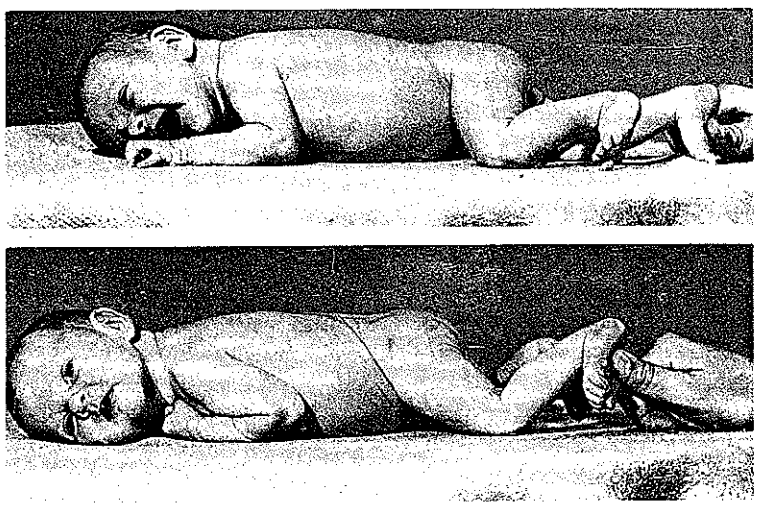


Fig. 47*a, b.* Crawling with stimulation (Bauer's response).

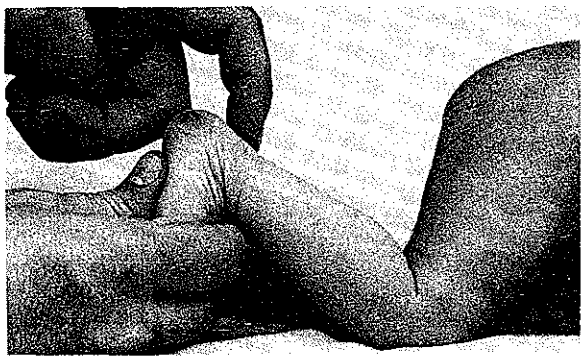


Fig. 48. Elicitation of the ankle jerk.

The Ankle Jerk

State Not important, as long as the baby is not too active.

Position Prone.

Procedure Take hold of the foot with one hand, flex the knee a little (Fig. 48) and tap the Achilles tendon with forefinger of the other hand or with a small hammer.

Response Plantar flexion of the foot at the ankle. It is sometimes easier to feel this than to see it.

Recording
- — absent
- \+ **present**
- ++ brisk with clonus

Significance Look for any asymmetry, but absence should not be considered as pathological.

Developmental Course The ankle-jerk may be brisker during the first few days of life.

Incurvation of the Trunk (Galant's Response)

State Optimal 3, 4 and 5, exclude 1 and 2.

Position Symmetrical, prone.

Procedure Scratch *slowly* with a pin along a paravertebral line about 3cm from the midline down from the shoulder to the buttocks (Fig. 49*a*).

Response The trunk curves with the concavity on the stimulated side (Fig. 49*b*).

Recording
- — absent
- \+ weak, short incurvation movement
- ++ **good, fully developed incurvation of the whole vertebral column**
- +++ very exaggerated response to even a weak stimulus

Significance Since one scratches the paravertebral region from the top to the bottom, one tests every skin segment of the trunk. There will be an absent response below the level of a transverse lesion of the cord. Notice any asymmetry between the two sides. Differences should be equivalent to asymmetries seen in the testing of the abdominal reflexes.

Developmental Course The response is often weak or absent in the first few days and this is not indicative of any abnormality. In most cases it becomes easier to obtain this response by about five to six days.

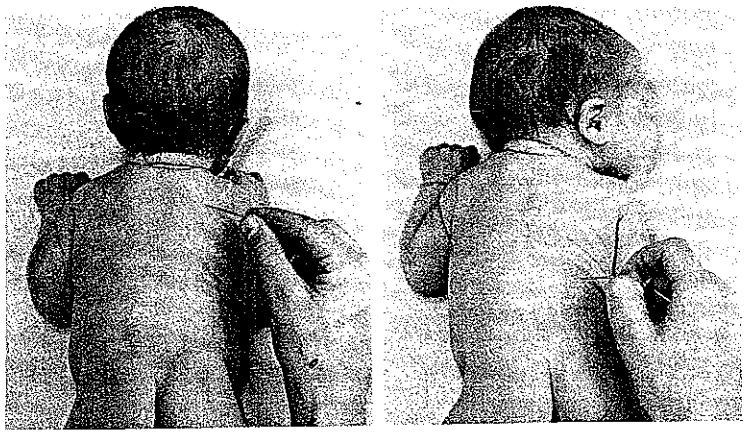


Fig. 49. Incurvation of the trunk (Galant's response): (*a, left*) stimulation and (*b, right*) response.

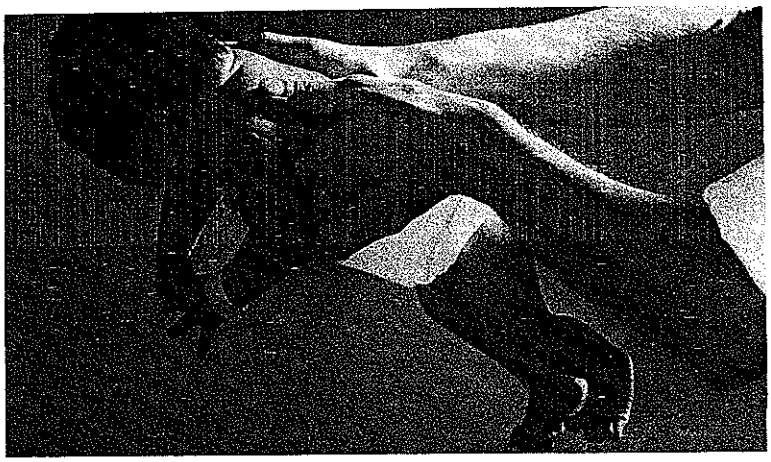


Fig. 50. Posture in prone suspension.

Posture of the Head and Limbs in Prone Suspension

State Optimal 4 and 5, exclude 1 and 2.

Position Suspended in prone position.

Procedure The infant is held in the air with the examiner's hands around the chest, the limbs hanging free.

Response The infant will show some anti-gravity posture (Fig. 50).

Recording Make a sketch.

— flaccid hanging down

\+ head hanging but some flexion of the extremities

\++ **some head lifting and semi-flexion of the limbs**

\+++ sustained head lifting and extension of the lower limbs

Significance Absent or weak in hypotonic babies, but there is a very pronounced response in hypertonic babies and in cases of opisthotonos.

Developmental Course Babies tend to be less active during the first two days of life.

The Baby Upright

Placing Response
State Optimal 4, exclude 1, 2 and 3.
Position Hold the baby with both hands under the arms and around the chest. Support the back of the head with the thumbs and the jaw with the index fingers.
Procedure Lift the baby so that the dorsal part of the foot is lightly touching a protruding edge, such as a table top (Fig. 51*a*). Make certain that the foot is not pushed into plantar flexion, which elicits a proprioceptive placing response.
Response The foot is lifted by simultaneous flexion of the knee and hip and placed on the table (Fig. 51*b*).
Recording Record separately for the left and right foot.
— absent
\+ **present**
Significance Not known at present. Absent in paresis of the lower limbs and in apathetic infants.
Developmental Course Not so pronounced in the first four days of life.

Stepping Movements
State 4 or 5.
Position Hold the baby as for the placing response.
Procedure Keep the baby upright and allow the soles of the feet to touch the surface of the table. Move the baby forward to accompany any stepping.
Response Alternating stepping movements with both legs (Fig. 52).
Recording
— absent
\+ shows intention to move with one or two steps
\+\+ **good response with more than three steps**
Significance Absent in infants born by breech presentation who either extend or flex the legs. It may also be absent in depressed infants.
Developmental Course Less easily elicited during the first two or three days of life.

Rotation Test
State Optimal 3, 4 and 5, exclude 1 and 2.
Position Upright suspension.
Procedure Hold the baby with the examiner's hands under the infant's arms, so that the examiner and the baby face each other. Spin round slowly about 90° so that the baby turns with the examiner. Do this first in one direction and then in the other.
Response Carry out the test first with the baby's head unrestrained and then with the head held firmly by the examiner's forefinger and thumb. When the head is free it will

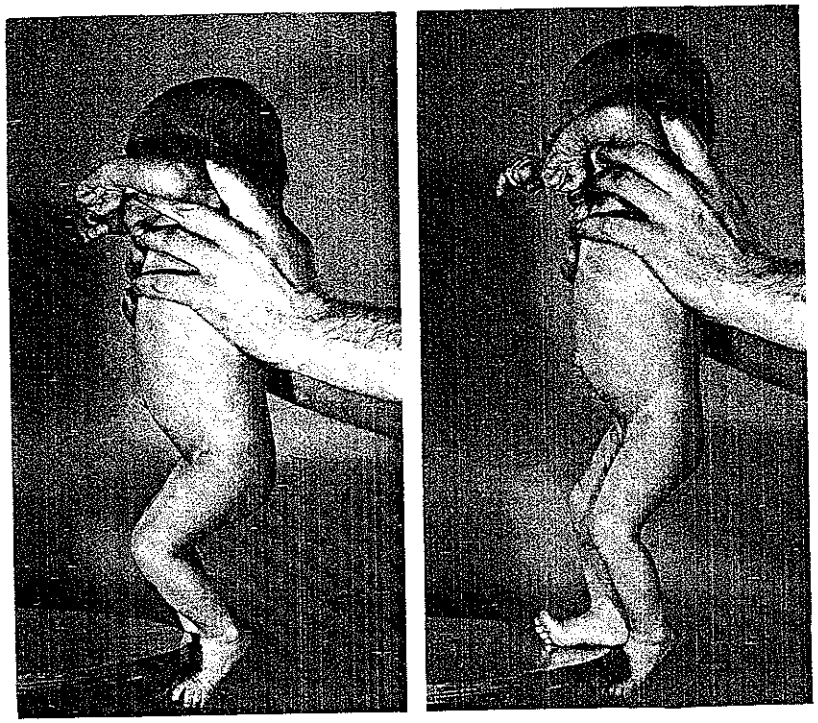


Fig. 51. The placing response: (*a, left*) procedure and (*b, right*) response.

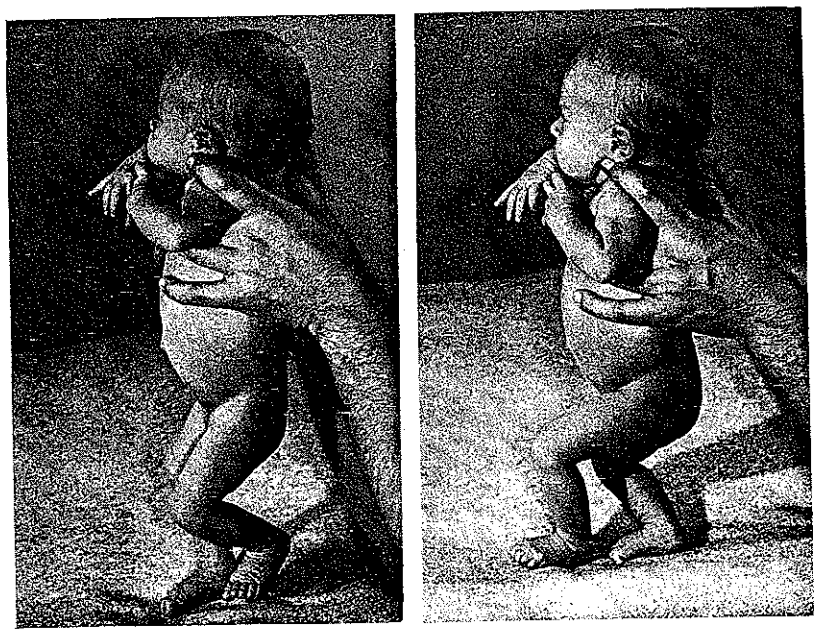


Fig. 52. Stepping movements.

turn towards the direction in which the baby is being turned, and when the head is held the eyes will turn towards the turning direction (Fig. 53).

Recording — absent
\+ weak response, just discernible
\+ + **good response**

Record separately for the test with the head free and the head held firmly.

Significance This is a vestibular reflex. It will be absent in any case where vestibular function is disturbed. There will also be an abnormal response in eye-muscle paresis.

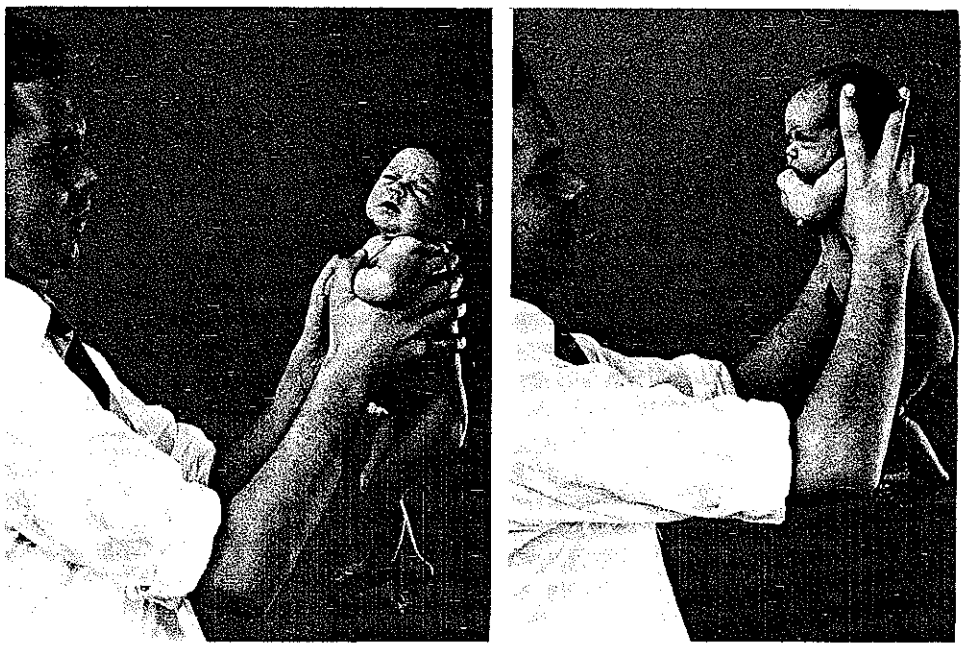


Fig. 53. Testing vestibular response: (*a, left*) with the head free and (*b, right*) with the head fixed.

Examination in Supine Position III

Spontaneous Motor Activity

Replace the baby in the supine position on the examination table, with the head in the midline. Record the state and the type, intensity, symmetry, speed, amount of spontaneous motor activity, and athetoid movements, as on pages 20 and 21.

Significance It is well worthwhile re-assessing the spontaneous motor activity at the end of the examination. Babies who were initially apathetic or drowsy may show quite different behaviour after the handling they have undergone during the examination. If they do not, this is a sign of marked depression of the nervous system. On the other hand, if they were very active at the beginning of the examination they may be less active at the end, as a result of fatigue. Babies without signs of neurological abnormalities will be scored here as: 'alternating movements' with intensity, symmetrical activity (++) and speed (++) as well as the amount of movement (++). Athetoid movements or posture should also be recorded. Tremor is recorded as on page 14. If the baby has been in state 5 for some time, a high-frequency, low-amplitude tremor is now quite usual.

Moro Response

If the Moro response was not found in the previous attempts to elicit it (by either method), or if the conditions of the baby made it undesirable to carry out the head drop, one can try to elicit the Moro at this stage by Moro's original method.

State Easy to elicit in 1, 2 and 3, exclude 4 and 5. Contra-indicated in very active states.

Position Supine symmetrical.

Procedure The examiner raises both hands on either side of the baby and strikes the surface on which the baby is lying about 15cm from the baby's head (Fig. 54*a*). The disadvantage of this procedure is that one cannot control the symmetrical posture of the head during the test. The baby usually rolls to one side, leading, normally, to an asymmetrical response (Fig. 54*b*).

Response, Recording, Significance, Tremor Same as in the head drop test (page 48).

Crying

State Optimal state 3 or 4, exclude 5.

Position Not important.

Procedure Pinch the baby on the arm or leg and make him cry (pain cry).

Recording Describe whether the cry is high pitched or not, or whether there is grunting. Record intensity as low, medium or high. Record duration (of each cry): short (less than one second), medium (one to two seconds), long (more than two seconds for each cry).

Significance There is a strong suspicion that babies with different types of neurological abnormality cry in a different way from normal babies (*e.g.* Wasz-Höckert *et al.* 1968). High-pitched cries and weak cries are almost certainly abnormal, as well as whining, rather sheep-like cries and grunting.

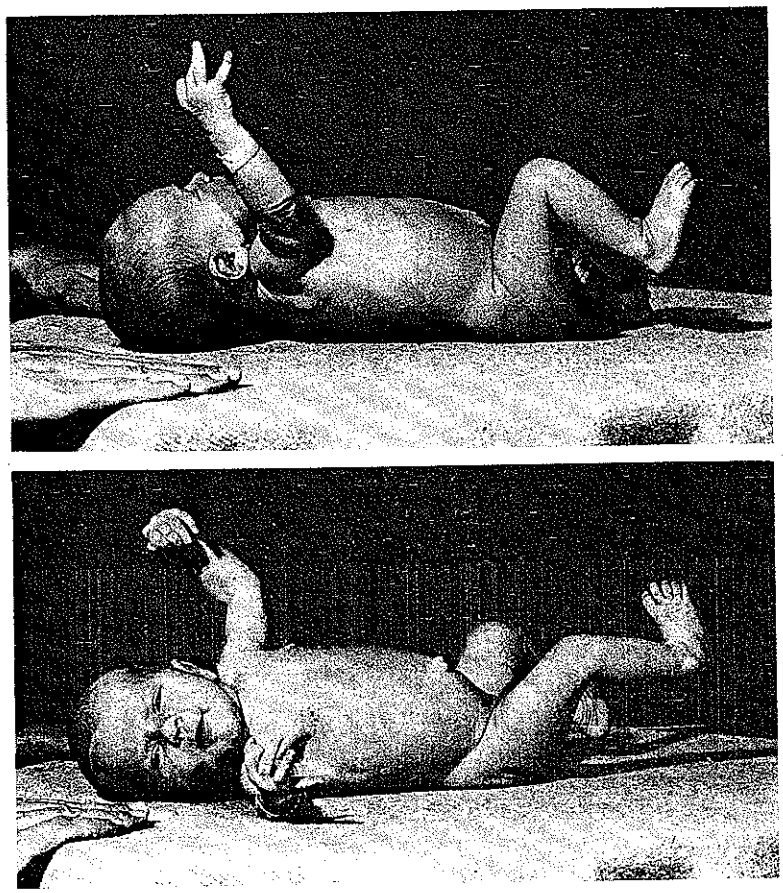


Fig. 54*a*, *b*. The Moro responses produced with the infant in the supine position.

Summary and Appraisal

At the end of the examination the clinician will wish to try and make some conclusive statement about the condition of the baby and, if possible, make a diagnosis. As the tests have been carried out in a sequence which is in no way logical in terms of anatomy or topography of the nervous system, but in a sequence aimed at least disturbance to the state of the baby, re-assessment must now be made.

The first and second pages of the form give a summary of the results. In the rest of the form one avoids, as far as possible, describing the response in terms of subjective impressions or making any judgements about whether the baby is normal or has some pathological lesion. This means that later on it is possible to reassess the preliminary neurological examination in the light of later knowledge. This will also make it easier for different observers to compare their data.

A brief account now follows of the Summary section of the form.

Posture

With the head centered in the midline, the posture of the limbs should be approximately symmetrical, with the arms and legs semiflexed. Abnormal postures are opisthotonos, frog posture, marked asymmetries, predominant extension of arms and/or legs in hypotonia or marked flexion in hypertonia, and constant and forced turning of the head to one side when it is released.

Motility

The various items recorded should be averaged. If ++ is the average, motility can be recorded as 'normal'. If the motility in states 4 and 5 was only +, the baby can be recorded as 'hypokinetic' and if it was +++ it is 'hyperkinetic'. In a few newborns the motility changes within a minute from + to +++ and vice versa, although the baby seems to stay awake throughout. Where the baby was in state 3 during the observation of spontaneous motor activity but was moving normally during other tests, the motility should be described as 'normal'.

Pathological Movements

These should be described, if they occur. Examples are rapid, overshooting movements, tremors (clonus) and convulsions.

Motor System (Abnormal Tonus)

Resistance to passive movements should be ++ for each joint tested if the child is normal. There should, therefore, be a total score of 16 pluses. If the resistance is generally increased to +++ and ++++ or decreased to + or —, hypertonia or hypotonia respectively should be recorded. However, there might be a hypotonia of

one or more joints as a sign of a local lesion, as in a peripheral nerve lesion or in a spinal cord injury. There may also be a marked difference between arms and legs.

Responses

Give an average of the intensity of all responses which were tested. Note which responses were absent.

Threshold Responses

Give an impression of the ease with which the responses were elicited. *Low threshold:* responses easily elicited on first or second trial, even with a low intensity of stimulation. *Medium:* responses occurred regularly when several attempts were made to elicit them. *High:* the stimuli had to be strong and repeated in order to elicit the responses.

Tendon Reflexes

Note the threshold separately as low, medium or high.

Moro Response

The Moro, in view of its significance, is recorded separately. Threshold is recorded as low, medium or high.

State

Note the state throughout the examination. For example, record state 2 in the observation period to state 5 at the end of the examination. Record how the infant's state changes on stimulation, and how easy it is to pacify or upset the baby.

Crying

A high-pitched cry is very likely to be significant. The type, intensity and duration of the cry should be recorded.

Hemisyndrome

Any asymmetry found in motility, motor system, posture and responses is recorded. At least 3 items must be found asymmetrical to be called a hemisyndrome. From the combination of the items it is sometimes possible (though not always) to get a hint of where the lesion is.

Syndromes of Abnormal Reactivity

It is often not possible to conclude from the presence of a few isolated neurological signs whether there is brain damage or not, but when a comprehensive examination has been carried out, testing a broad spectrum of functions, symptoms may group themselves into distinct combinations as clear syndromes. They indicate a more complex aspect of the condition of the nervous system, especially its reactivity. The following syndromes have been found:

Hyperexcitable: Low-frequency, high-amplitude tremor, high or medium intensity of tendon reflexes and Moro with low threshold. There may also be hyper-

kinesis with increased resistance to passive movement, prolonged crying, and an instability of states.

Apathetic: Low intensity and high threshold for responses, many responses absent, hypokinesis and decreased resistance to passive movements present. The baby is difficult to arouse. The nervous function is generally depressed and hemisyndrome is often present afterwards.

Comatose: Characterised by slow or abnormal respiration, absent or weak arousal to various stimuli, including pain and vestibular stimulation.

Record whether the examination was completed or not and give the reason if it was not. It may have been, for example, that the baby was continuously in state 5 and so the examination was abandoned, or it may have been that the examiner was unable to finish the test because of lack of time.

Diagnosis

We do not want to discuss neurological symptomatology here, but we would like to stress that one should try and discover the causal factors of any signs one has discovered during the examination. Neurological signs present in the neonate may be due not to a primary disturbance of the nervous system but to disturbances of the 'milieu interne' (electrolytes, body temperature, blood glucose level, *etc.*). As soon as these deviations disappear, then the neurological symptoms wane also. Only those symptoms and syndromes which directly indicate damage to the nervous system have a high prognostic value. This will in any case involve additional examinations, such as transillumination of the head, examination of the fundus oculi, lumbar or ventricular puncture, skull X-ray, polygraphic EEG, air studies and arteriography or CT scan. Space is therefore required for recording the results of any of these tests which are necessary. Since these are techniques well established in paediatrics, they will not be described here.

Optimal and Non-optimal Findings

It will not always be possible to reach a qualitative diagnosis as described in the previous section. In border-line cases especially, when the examiner is not sure whether the infant should be categorised as normal or deviant, the application of the optimality concept may be of great clinical help. Instead of a vague statement about the condition of the nervous system, a more objective recording can be made by knowing the number of non-optimal findings and the items involved.

Even if the presence of a clinical syndrome can be identified, it may add to the description of the nervous system to know which other items are not within the optimal range.

Although the optimality concept is not restricted to research projects, it has turned out to be particularly fruitful in clinical research when infants have to be grouped into classes with different optimality scores. The specification of the degree of neurological optimality within the broad category of 'clinically normal' infants is an important refinement in deriving appropriate control groups.

The Neurological Examination for Quick Screening

For the purpose of screening, a short version of the neurological examination is designed. A limited number of tests are selected which give the highest chance of detecting abnormalities. It should be stressed, however, that this screening test cannot replace a full neurological examination. If a suspicion of neurological abnormality arises, a detailed examination must be carried out.

The screening test gives only rough qualitative data. Posture, observation of the eyes, spontaneous motor activity, resistance to passive movements, the traction test, sucking and the Moro response are all recorded. This makes it possible to detect local signs such as paresis or mild hemisyndromes, as well as such abnormalities as increased nervous excitability and abnormalities of the motor system which have not been marked enough to alarm the doctor, parents or nursing staff during the daily routine.

The examination should be carried out two to three hours after a feed. The baby has to be undressed and laid on an examination table.

Although the time spent on the examination need not be more than ten minutes, the available time should be divided proportionally into patient observation and the elicitation of the various tests. It should be stressed again that the examiner carrying out the screening test should be familiar with the detailed method.

See pp. 64-65 for scoring form.

Neurological Screening Examination of the Newborn Infant

Name ..... *Date of Birth* ..... *Age* .....

Case Number ..... *Date of Examination* .....

Time after last feeding .....

Sex .....

---

state**

State at beginning of the examination: **1,2,3,4,5.**

Posture (head centered in the midline):
upper limb: semi-flexed, flexed, extended*.
lower limb: semi-flexed, flexed, extended.
approximately symmetrical: yes, no.
opisthotonos: no, yes. Frog posture: no, yes.
constant head-turning towards one side: no, yes.

Eyes centered: yes, no.
constant deviation: no, yes.
constant strabismus: no, yes.

state

Spontaneous motor activity (head centered in the midline):
alternating movements in arms and legs: yes, no.
symmetrical on both sides: yes, no.
movements show normal intensity and speed: yes, no.
tremor: no, yes.
overshooting, rapid movements: no, yes.
rhythmical jerks: no, yes.
convulsions: no, yes.

* delete throughout where inappropriate
**record the state throughout the examination

state

Resistance to passive movements (head centered in the midline):

neck: normal, low, high.

trunk: normal, low, high.

arms: normal, low, high, symmetrical: yes, no.

legs: normal, low, high, symmetrical: yes, no.

state

Traction test:

resistance in arms: normal, low, high.

head control: sustained for 3-10 secs, less than 3 secs, more than 10 secs.

sucking (on the finger of the examiner): present and strong, weak, absent.

state

Moro response (head drop):

symmetrical response with abduction and extension; present or absent

absent flexion and adduction only: no, yes.

asymmetrical: no, yes.

with tremor: no, slight, marked.

Result: normal, suspect.

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