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The Development of Vision, Hearing and Communication in Babies and Young Children

It is generally agreed that the younger the age at which children with physical, mental or emotional disabilities are identified, fully assessed and effectively treated, the more hopeful the outlook for recovery or rehabilitation.

Formerly, unless a child's abnormality was immediately apparent, early recognition of a handicapping condition depended almost entirely upon the parents' uneasy suspicion that their child was not developing in the same way as other children of his age and upon their willingness to seek medical opinion. Only occasionally did it depend upon their doctor's ability to be on the look-out for, and to recognize early signs of, deviant development. There is no doubt that, in the training of medical students and postgraduates, too little attention has hitherto been paid to developmental pædiatrics, in proportion to the attention devoted to hospital and laboratory-based pædiatrics. Recently, however, with the falling infant mortality and child morbidity rates and the rising interest and participation of family doctors in social medicine, child welfare clinics and the school health service, the demand for further knowledge concerning normal and abnormal developmental processes has become insistent.

In discussing the problems involved, it is advisable first to define terminology.

Developmental pædiatrics is concerned with the growth and development in structure and function (from fœtal viability to full growth) of normal and abnormal children, for three purposes: (1) to ensure optimum physical and mental health of all children in the community; (2) to ensure early diagnosis, full assessment and effective treatment of handicapped children; (3) to discover the causation and prevention of handicapping conditions.

For the purposes of this paper, I am distinguishing between handicapped children, whose disabilities are inherent, and disadvantaged children whose disabilities originate in their unfavourable environment. Thus a handicapped child is one who suffers from continuing disability of body, intellect or personality, which is likely to interfere with his normal growth and development or capacity to learn. Growth and development are not identical, although they are closely interwoven and usually proceed simultaneously and harmoniously. Growth is increase in size, development is increase in complexity. Growth can be measured with some degree of accuracy, but many aspects of development, especially those related to function, at present defeat analysis, so that we can only come to helpful conclusions, particularly concerning sensory, cognitive and affective development, by accurate history taking, careful observation and patient follow up.

Infants at Risk

Whatever disagreement there may be concerning the form and efficiency of risk registers, the fact that certain infants are at greater risk of developing a handicap than others has never been in doubt (Sheridan 1962). These infants may be grouped according to whether they have suffered from adverse family history, prenatal hazards, perinatal dangers, or postnatal mishaps, and those who show developmental danger signals.

Developmental danger signals may be divided into two main categories: first, the mother's suspicions that her child is not seeing, hearing, moving his limbs or taking notice like other children of his age; second, the examining doctor's findings of delayed motor development, lack of normal visual alertness, inattention to sounds, lack of interest in people or playthings, delayed acquisition of vocalization or speech, abnormal behaviour of any sort.

In consideration of these danger signals it cannot be emphasized too strongly that the mother's suspicion, however incompletely defined or seemingly far-fetched, must always be treated with the greatest respect because she is usually right; and that it is never safe to rely upon a single medical examination of vision, hearing, vocalization or social response.

STYCAR[1] Testing Procedures

My own investigations were begun more than thirty years ago and still continue (Sheridan 1944, 1945, 1948). Following three and a half years of residential posts in pædiatric teaching hospitals where I was exceedingly well taught according to the conventions of the time, I obtained a public health post in rural Cheshire and very quickly discovered the limitations of my previous training and experience. I was totally unable to answer the questions put to me by mothers, teachers and health visitors. Most particularly I became aware of my profound ignorance regarding mental retardation, visual and auditory disabilities, neurological disorders, personality problems in young children and the specific learning difficul-

[1]Screening Tests for Young Children and Retardates

ties of school-age children, who, since there was no school psychological service outside London, were then usually brought to the unfortunate school medical officer to give whatever empirical advice he could.

Having made some terrifying errors of diagnosis, notably deeming mentally defective a child with partial sight and another with high-tone deafness, I decided I must find some means of routine testing of the visual and auditory competence of 5-year-old school entrants. In my ignorance I thought that suitable testing material must exist somewhere and I made a study of the principal child development scales available, notably those of Gesell, Stutsman, Doll, Buhler and, later, Catell, only to discover that they disagreed among themselves and that, since they had been designed by psychologists for other purposes, they did not provide the sort of pædiatric information I needed regarding the development of vision, hearing, language and social relationships. I had already begun to realize that there is a world of difference between seeing and looking, hearing and listening, speech and language. It became clear that I must devise my own testing procedures.

The summary of results to date has already been published (Sheridan 1960*b*); I am still working on suitable tests for babies under 6 months. It needs to be explained that although my first tests were evolved for ordinary 5-year-old school entrants, most of my tests for children under 5 years have been worked out in reverse order from the scales of the child psychologists. The usual procedure involves establishing 'norms' of performance under standardized conditions for each age group in the ordinary unselected child population, and then comparing the performance of selected groups, such as superior or handicapped children, in terms of a mathematical quotient of the 'norm'. Handicapped children are, however, frequently lacking in the sensory equipment or everyday experience which is essential to comprehend the examiner's intentions, though they may be able to obey his instructions when these are interpreted for them in terms they can understand. For ~~my~~ purpose, therefore, it was necessary first to discover materials and procedures which were applicable to handicapped children and then take these back to normal children, not only to find out the corresponding mental-age levels being 'tapped', but also to learn the nature and variations of normal and abnormal modes of response. From the pædiatric point of view, to observe how the child responds to a testing procedure is as important as to know whether or not he can respond to an expected level. Nevertheless, even though it is appropriate to record results of the STYCAR tests descriptively rather than in terms of quotients, it is essential that recommended standards of materials, distances and methods of application, &c., should be observed or the tests will cease to provide reliable information.

In the clinical situation, vision and hearing tests are usually applied in conjunction with tests for motor and other abilities, suitable for that particular child's age and stage of development (Sheridan 1960*b*, 1968, 1969). In order, however, to demonstrate their developmental sequences, they are described here in serial form, beginning at six months.

It is more comprehensible, in describing the vision series, to begin with the tests designed for 5–6-year-olds and to show how those for the younger children and babies evolved from them; but the hearing and language series will be described in the natural order of progression from babies to school entrants.

STYCAR Vision Tests

When I began my investigations the only available vision tests for illiterate children were the E test, Landolt's broken ring test and graduated picture charts, and I gave all these an extensive trial. The instructions for the Landolt's rings proved too difficult. The pictures were usually highly stylized representations of not very familiar objects, and usually so crowded, especially in the lower lines, that many children found them bewildering. The E test, which at first sight appeared promising (and which is still recommended by many ophthalmologists who can never have attempted personally to screen large numbers of 5-year-olds in ordinary school conditions) proved to be unreliable. Diagonal positions cannot usually be copied at this age, leaving only the four cardinal positions. Of these, up and down are only rarely mistaken but right and left are frequently confused; when the child copies the E in reverse, the examiner does not know whether the child is not understanding the test, is not seeing it, is mirror-writing, is bored and not playing, or whether, when he does copy it correctly, he is just guessing. Resolving these possibilities is very time-consuming, and even then does not give information regarding the child's ability to distinguish different shapes, which I also wished to know.

Letter Tests

Having discussed my problem with many infant teachers, I eventually evolved a chart containing the ten or twelve script letters children first learn, with not more than three letters on any line. I took this to an ophthalmologist colleague, Gertrude Pugmire, who helped me to measure my letters as accurately as possible to standard

Snellen block capitals. This chart proved an immediate success, but in using it continually I discovered that when the children could not name or sound the letter, in their eagerness to succeed, they would draw it in the air, or mime it – blowing kisses for X, opening imaginary umbrellas for U. It became obvious that the script letters could be discarded in favour of accurately measured Snellen letters which could similarly be drawn or matched with wooden letters or from a printed key card. In the meantime, I had discovered that the letters first recognized were not always those the teacher considered 'easy'. At the time I thought that 'difficult' letters like V and X were recognized because they were familiar shapes on street placards, and only later realized that these letters were favoured because they were founded on verticals, horizontals, circles, squares and triangles, all of which can be copied by 5- or 6-year-olds and matched at much younger ages. The two versions of this chart have been in use for over thirty years. Using it, Gertrude Pugmire and I were able to show that 97% of 5-year-olds were readily testable at school entrance, and that normal vision at this age is R6/6, L6/6 (i.e. full adult vision). Later, when I wished to test younger children using the same techniques, I discovered that it was necessary to mount the letters on single cards, and that these children, owing to their limited ability to maintain attention in time and space, were unable to keep in rapport with an examiner at 20 feet (6 m) and therefore needed to be addressed from 10 feet (3 m) (Sheridan 1960*a*). Without expecting much result, I tried using smaller letters and was astonished to find that children from 2½ years could see and match letters of 3/3 with each eye separately, giving an equivalent of R6/6, L6/6, i.e. full adult vision. The youngest I have so far tested in this way was 2¼ years. It is probable, however, that full vision is present from a much earlier age.

Recognition of Snellen letters involves not only seeing the letter as a small black mark on white ground (the 'minimum observable') but also distinguishing its pattern, i.e. the thickness of the strokes which form the 'limbs' of the letter (the 'minimum separable'). This needs to be remembered in comparing the size of other objects used in the miniature toy tests and the graded ball tests, which were evolved for children under 2½ years.

Miniature toy test: This necessitates matching seven common toys of very small size (chair, doll, car, plane, spoon, knife and fork) at 10 feet (3 m). It is difficult to correlate these toys with Snellen letters, but the experts consulted consider that discrimination of the prongs of the smaller fork at 10 feet demands visual acuity of at least 6/6. Two-year-old children greatly enjoy this test. (The youngest child I have successfully tested was 19 months.)

Graded balls test: For the past four years I have been working on tests suitable for children under 2½ years, which do not require spoken or mimed instruction and which can be applied and recorded in some standardized fashion. Eventually ten graded white plastic balls were decided upon, ranging in diameter from 2½ – ⅛ in. (6·25–0·3 cm). These are presented in two ways, rolling and fixed.

The rolling balls test is given at 10 feet (3 m) by rolling a ball slowly along the floor over a smooth dark carpet, horizontally across the child's line of vision while observing whether his eyes follow its complete movement. If he is sufficiently ambulant he is requested to 'get it and give it to Mummy'. It is necessary to change frequently the side from which the ball is thrown and to vary the speed and length of roll, in order to prevent intelligent anticipation, especially after 12 months.

The fixed balls are mounted on black sticks and presented at 10 feet (3 m) from behind a screen, through which the examiner observes the child's eye movements as each mounted ball is presented above, below and to either side of the screen, against a black background (Fig 1).

Both tests are always given or attempted, beginning with the rolling balls, since it is easier for young children to watch the movement of small objects than to fixate still objects of similar size, and the primary aim of the pædiatrician is to make sure that the child possesses useful vision. This difficulty in fixation does not appear to be a question of visual acuity but of visual attention.

It is possible to relate the diameter of the balls to Snellen letters in terms of the 'minimal observable' and indeed of the 'minimal separable', but I prefer straightforward recording in descriptive terms, since so many other factors must be taken into account. For instance, owing to dazzle effect it is more difficult to distinguish a black dot on a white background than a white dot of similar size on a dark background.

These tests have proved very useful for children from about 6–7 months to 2½ years of age. I am still wrestling with the numerous problems of clinic testing for children under 6 months.

Hearing Tests

Once the necessary experience has been acquired it is comparatively easy to demonstrate the presence of normal hearing in children from 6 months onwards (Sheridan 1958). When the child does not respond in the expected manner to suit-

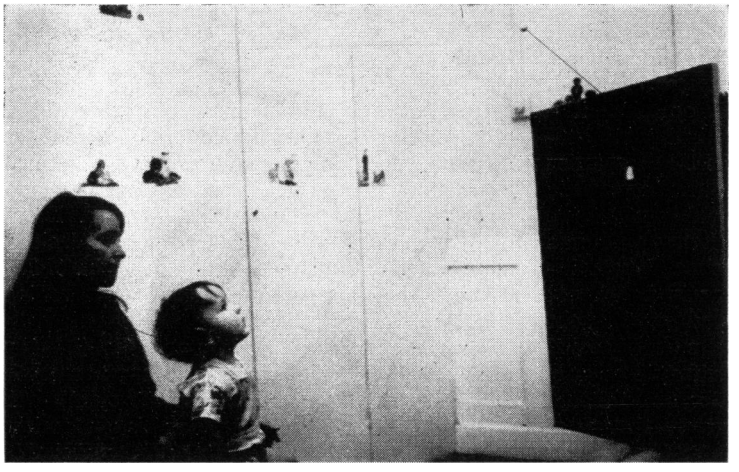

Fig 1 *Normal vision: 14-month-old child; visual fixation at 5 feet (test then repeated at 10 feet)*

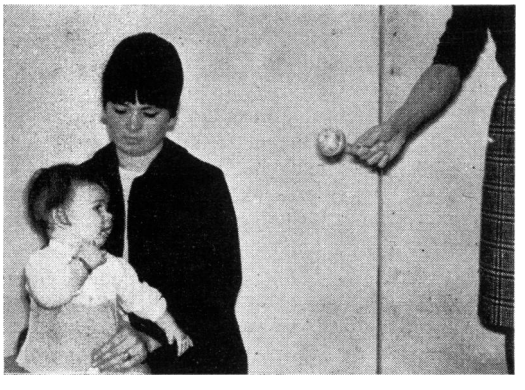

Fig 2 *Normal hearing: 6-month-old child; response to minimal movement of rattle at ear level. (From Sheridan 1968)*

able sounds presented from each side, but outside the child's peripheral visual field, the doctor should be immediately on the alert for a hearing defect. In the ordinary clinical situation a baby of 6 months will turn promptly towards the origin of any quiet sound which is meaningful to him, or which is so novel as to provoke his curiosity (Fig 2). He is usually not yet able to localize more precisely the source of testing sounds applied above and below his ear level, although by 8 or 9 months he will immediately visually localize a sound-making instrument applied from any direction within 3–6 feet (1–2 m), provided it is not situated in mid-line over his head or behind his back. Thirty years ago, Gesell and Buhler used crude instruments such as bells, clackers, whistles and squeakers. Twenty years ago the Ewings designed finer infant tests which form the basis of those still in use, employing toy drums, high- and low-pitched rattles, the tinkle of spoons in cups, tiny bells, rustling tissue paper and human voice. When I came to use these and similar tests myself in ordinary clinics, I found it necessary to standardize them for time and distance and to stress particularly their fallibility with regard to high-tone deafness, and the importance of noting reaction to the highest-pitched consonant sounds in speech. Nowadays we can reinforce these homely tests with small portable transistor audiometers, but these, too, have limitations, so that any child known to be at risk should be carefully followed up until he shows by talking intelligibly that he appreciates the entire speech range including the highest-pitched consonants. From 6 months onwards, the quality and quantity of the child's spontaneous vocalizations give valuable information concerning his ability to listen to and understand the speech of others.

STYCAR Hearing Tests

It is impossible to describe in detail this series of hearing tests which were originally designed to assess the auditory competence of handicapped children, but later were found to have considerable usefulness when standardized for normal children up to 7 years. They consist of two toy tests, five picture vocabulary tests for recognition of words delivered at 10 feet (3 m), four word lists and two sentence lists for repetition at 10 feet (3 m) without lipreading, and three 'cube tests' employing small coloured wooden blocks to be moved at a given signal, such as a high-pitched consonant delivered at 10 feet (3 m) outside the child's range of vision.

In conjunction with observation of the child's spontaneous vocalizations and spoken language, these tests give reliable information concerning a child's everyday auditory competence. In any

case of doubt, they should always be supported by expert pure-tone audiometry, particularly to exclude high-tone impairment. The pure-tone audiogram alone without such clinical assessment is not sufficient, since it cannot tell us what use that particular child is able to make of the amount of hearing he possesses.

STYCAR Language Tests

During the past four years, I have also attempted to discover how a young child acquires the use of language symbols so that, when confronted with a non-speaking child of 2–4 years, I might find out whether he possesses any code of symbols, verbal, graphic, mimed or other, by which he is capable of representing his concepts of past, present, future; or whether he is still in the pre-linguistic stage of communication and capable only of crude gestures and formless vocalizations indicating needs and emotions tied to the 'here and now' (Sheridan 1964*a*, *b*).

This work is still in progress but two tests have proved valuable, the 'common objects' test and the 'miniature toy' test.

Common objects test: This was founded on the observation that by the age of 12 months most normal children show by their manipulative play with ordinary objects, such as cups, spoons, hair-brushes, and familiar toys, such as dolls, rattles and wheeled toys, that they have observed the world around them with understanding, and that they comprehend the function of these objects in relation to themselves some time before they recognize their names. The common objects, however, must be of natural size, and the toys reasonably large for the child to demonstrate 'definition by use'. Otherwise they are just grasped and thrown about. This definition of function, e.g. hair brushing, feeding from cup, &c., is always applied first to his own person, only some weeks later to other persons and later still 'externalized' to dolls, by which time true make-believe (or symbolic) play is usually appearing. In my view, these early fragmentary 'definition by use' activities indicate that the foundation of 'inner language', i.e. a registry of classified memories which later become compressed into memories-in-code has been laid down.

Miniature toy test: About the age of 18–20 months the normal child begins to appreciate that miniature toys are representations of real-life objects, i.e. symbols, which can be detached from and manipulated apart from himself. After much consideration, I selected a set of twenty miniature toys, including baby dolls, domestic animals, household furniture, crockery, cutlery and transport. The child is first presented with the toys one by one without any instruction other than a friendly 'look at this'. Normally he responds by immediately moving and grouping them meaningfully (Fig 3); if he can talk, by spontaneously naming them and describing what they do; and if he can understand spoken language, by responding to questions and instructions. In a short space of time, the experienced examiner can thus gain an enormous amount of information concerning the child's general understanding of the world around him and of spoken language, his vocabulary, articulation, use of pronouns, and prepositions, &c. He can also observe the child's interpersonal communications with his mother and others and his ability to remember and obey two or more instructions, as well as his hand-eye co-ordination, vision, hearing and motor behaviour. I am still trying to find some way of 'streamlining' the application and recording of this test. The rather lengthy reporting it now demands, while exceedingly helpful for future reference, is time-consuming.

Fig 3 *Language: deaf non-speaking 23-month-old child; meaningful assembly of miniature toys*

Conclusion

The study of developmental pædiatrics offers endless opportunities, not only in early diagnosis, effective management of handicapped children and helpful guidance to their parents, but also for basic research of the kind that has engaged my own lifelong attention. As Cullinan recently pointed out (1968), the family doctor has a special interest and indeed an inescapable responsibility in this field, not only because he is uniquely situated to follow up his own infants at risk, but also because it is to him that the worried parents first turn for sympathetic understanding, reassurance and advice. We need many more doctors

willing to undertake this work. At present too few of us are carrying too heavy a load. Postgraduate training has a way of coming into existence when the demand becomes insistent enough.

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Developmental Pædiatrics in General Practice

Gone are the days when children were regarded as miniature adults. It is now accepted that, before maturity is reached, each child will pass through many stages and phases of development, and that the behaviour patterns which these phases produce will follow each other in an orderly sequence.

However fashionable it may be to describe the family doctor as the doctor of first contact and of continuing care, it must be admitted that this is, in fact, what he really is; and when these two phrases – first contact and continuing care – are used in connexion with children, they surely describe developmental pædiatrics in a nutshell, and indicate the role which the family doctor could play in this field.

I believe that the family doctor is ideally placed to practise this new branch of preventive and diagnostic medicine, although it is true that this may apply more to the family doctoring of the future when sociology, community and family medicine will play an ever-increasing part. However, the change from the classical, passive role of the doctor, i.e. waiting for the patient to present himself and his symptoms, to the more active role which preventive medicine demands – selling ideas to the patient – will have to be made in any case, and once this is recognized, the doctor is part of the way to accepting the function of developmental assessments.

A well-known American educator, Francis Parker, was once asked how soon a child's education should begin, and on hearing that the child in question was 5 years old he replied 'My goodness, don't stand there, wasting time, hurry home for you have already lost the best five years'. I would like to go further than that and suggest that developmental pædiatrics really begins in the antenatal clinic where much can be suggested to a mother about the possible effects of the new baby, both on herself and on older children. The importance of good antenatal care in the prevention of toxæmia and prematurity is well known to us all. And who is better placed to do this than the family doctor who is giving his continuing care to the family during all the different phases of their lives?

This is illustrated by a mother who had taken both her own and her baby's discharge from the hospital where the baby had been born only 24 hours previously. The baby had not been expected for another four weeks and was small. During an angry exchange with the nursing staff when she had insisted upon taking her discharge, she had been told that she was taking home a premature baby, and the hospital had asked me to try to persuade her to return. By the time of my arrival, the child mother (for she was an unmarried mother of 18) was in a highly agitated state. She was frightened to find herself alone with this tiny baby, and probably already regretting her early departure from hospital.

It was quite easy to demonstrate by a variety of tests that this was no premature baby but one small for dates, for example, by the Scarf sign which showed that the baby's hand would not reach beyond the acromion process, whereas, had the baby been premature, it would have reached well past it. Both the patient and the doctor gained confidence from the handling and testing of the baby, and the reassurance which I was able to give her was based upon sound clinical observations, and not merely upon cheerful optimism. Moreover, this encounter at what was for her a critical time sealed a bond between mother and doctor which is one of the rewards of true family doctoring. It has also made her one of the most faithful attenders at our development clinic.