PROBLEMS OF SENSORY INTEGRATION IN THE MENTALLY RETARDED CHILD AND THEIR IMPLICATIONS FOR THE PHYSIOTHERAPIST

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Affecting some 2.5-3.5% of the general population (Smith, 1971), mental retardation is an important national health, social and economic problem, with only four disabling conditions (cancer, arthritis, cardiac disease and mental illness) having higher incidence (Love, 1973). Of these conditions only mental retardation is prevalent in the early developmental period of life.

One of the definitions of mental retardation favoured today is that of the American Association for Mental Deficiency which states that it is

“subaverage general intellectual functioning which originates during the developmental period and is associated with impairment of adaptive behaviour” (Smith op. cit.; Beter & Cragin, 1972).

[In this definition, “subaverage” includes the lowest 16% of the distribution of intelligence quotient (I.Q.) and “developmental period” covers the years from birth to 16 years of age (Smith op. cit.).]

Recently, considerable interest has been shown in the normal developmental progress of children, resulting in an increasing awareness of the role of sensory experience and its importance in the later development of posture and motor abilities. However, although studies have been undertaken of the overt motor capabilities of children with intellectual handicap, little information is available regarding their sensory development and integration. For this reason, a project was commenced in the Department of Physiotherapy, University of Queensland, with the aim of studying the sensorimotor abilities of intellectually handicapped children (Chenoweth, 1976). It was hoped that by looking at the overall sensorimotor abilities and of sensory integration problems presented by the neurologically “mature” retardate, future study might be stimulated into the role of physiotherapy in an area which has been largely neglected or ignored.

The physiotherapist should be actively involved in both preventive and facilitatory aspects of the management of the retarded child so that fulfilment of potential may be achieved before the effects of deprived sensory input and impaired integration of that input are allowed to add to the problems already faced by the child.

SENSORY INTEGRATION

Sensory integration is the interaction and coordination of two or more functions in a manner which enhances the adaptiveness of the brain’s response. The resultant “perception” is a “developmental product in which the interpretation of sensation is modified either by a previous history of experience of the stimulus or by its association with other stimuli in the same or in different sensory modalities” (Birch and Belmont, 1965).

According to Hughlings Jackson (Bobath, 1972), the central nervous system is an organ of integration and reaction. It can only initiate and control movement in response to sensory input and, where impairment of that input exists, normal movement or normal postural adjustment cannot result. Cortical representation is of movements, not of individual muscles and a child learns not a movement, but a “sensation of movement” (Bobath op. cit.).

Thus the role of the sensory system is vital to normal motor functioning. One of


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the most basic demands of existence is the ability to interpret sensory stimuli and respond to them and, as Ayres (1972a) points out, an outstanding evolutionary feature of the nervous system is the almost one-sided development of additional sensory (as opposed to motor) neurons, thereby providing the opportunity for new and more complex adaptive responses.

Just as motor activity modifies skeletal growth, so sensorimotor activity modifies neural development in the growing child. Through the repetitive sensation of movement, he assimilates and learns by his experiences and it is by his motor interaction with his environment that the child integrates and cross matches the sensory information gained from his varying modalities. Use of a synapse increases the ease with which a connection is made and the interaction between the neurons varies as a function of that use (Ayres op. cit.). Therefore, repetitive experience is necessary for the full expression of inherent developmental tendencies.

Each developmental step is dependent upon a certain degree of maturation of the previous stage, with later complex learning being built upon initial learning in a hierarchical fashion (Belmont et al., 1966), and with the organisation and emission of an adaptive response being the catalyst of integration. Although the nervous system may be sufficiently mature, however, if a child is given insufficient sensory input or opportunity to practise, abnormality in perception and movement may be manifest, with the later dependent acquisition of skills being delayed or distorted (Illingworth, 1971).

In the early postnatal months, the tactile, proprioceptive and vestibular systems contribute the greatest percentage of input for the infant to attain and maintain a stable relationship to gravity. As he touches and becomes aware of both himself and surrounding objects, the development of a body image and the basis of form perception is begun. He cannot, however, investigate all objects in his environment in a motoric fashion and must therefore learn to investigate them "perceptually" (Kephart, 1964). The child learns to "explore" an object with his eye in the same manner with which he previously explored it with his hand, matching the previous tactile information with his present visual experience. As new associations are added to his repertoire of experiences, he develops greater potential for effectively solving problems.

This process of employing one type of sensory input to influence perception of input from another sensory modality is dependent on convergence and adequate communication between different parts of the brain. The greater the opportunity for interaction, the greater the adaptive capacity.

POOR SENSORY INTEGRATION IN THE MENTALLY RETARDED CHILD

Motor behaviour is a most sensitive index of the development and integrity of the central nervous system and at present is the one that can be most accurately measured. Efficient motor performance necessitates correct sensory input, the organisation and integration of this input, selection and performance of the appropriate response, and feedback to evaluate the effectiveness of the response. The terminal motor behaviour will be distorted if problems arise in any of these processes.

Evaluation of the intellectual capacity of a child must be based upon overt, adaptive behaviour, thought to be the forerunner of later cognitive behaviour (Ayres, 1972b; Knoblock and Pasamanick, 1974). When assessing a mentally retarded child however, it is difficult to determine the relative contributions to his poor performance of organic brain damage, his inability to comprehend what is required of him, and poor perception and sensorimotor integration. Thus measures of intelligence quotient may not measure cognitive and reasoning powers but may reflect the difficulty the child experiences in organising his sensory information into the required response.

Early learning is largely motoric. As a normal infant participates in his environment he can develop concepts of himself, the objects within reach and the relationship between himself and them. However, when an infant is given insufficient opportunity to learn and practise, and is deprived of normal tactile motor and manipulative experiences, the development of perception and skills must be delayed or distorted as a result. All too often, this becomes the lot of the retarded infant.
and, in some cases, may be the major factor in this retardation. He is apt to be over-protected by his parents and, paradoxically, to be unintentionally neglected as the parents often fail to understand that the child's lack of curiosity and interest in his surroundings is inherent in his condition and that he, in fact, needs much more sensory input than the normal inquisitive child who can actively participate in his own development. Because in his early life the child is often not handled as much as necessary by his parents to provide this source of proprioceptive, tactile and vestibular input, his postural reactions, balance and total body awareness may also be delayed.

Then as the retarded child grows and experiences repeated failure due to a poor basic knowledge and essential abilities, his behaviour becomes directed not towards the acquisition of new skills, but towards the avoidance of the unfamiliar, where he might fail again (Achenbach, 1974). His parents, having low expectations for their child, may reinforce this reticence as they fail to encourage him to attempt more mature and complex skills, allowing him to remain at a more immature developmental level than is necessary. That is, he is unable to fulfil his potential.

Brody (Cratty, 1970), has noted that infants who were handled often were consistently more attentive visually than those not handled as much, and visual attention is vital to the development of perception. An experiment conducted by Belmont et al. (op. cit.) dealing specifically with sensory integration has shown that when brain-damaged subjects had to use multimodal information for making judgement, they performed significantly more poorly. Their intersensory integration was found to be more distorted than their intra-sensory integration. This is the immature response found in normal infants of less than five months prior to the development of intersensory integration. Perhaps, therefore, sensory deprivation is not the only causative factor in the poor integration shown by the mentally retarded child, but the organic damage to connecting pathways may also play an important role in preventing the establishment of more mature responses.

A survey of the literature relating to mental retardation shows that a number of signs of neurodevelopmental disorder have been observed. These include such signs as:

1. Basic hypotonicity, especially in early childhood;
2. Hand-eye control slow to develop, especially when the infant is late in achieving midline hand grasping;
3. Poor quality motor performance characterized by clumsy and uncoordinated movement and poor fine manipulation;
4. A tendency to exhibit extreme response to stimuli (Stevens, 1964);
5. Persistence of primitive tonic reflex reactions only rarely (Hughes, 1971);
6. Finger agnosia being in direct proportion to measured intelligence (Black and Davis, 1966);
7. Repetitive rapid movement as shown by finger-tapping speed, directly proportional to measured intelligence (Black and Davis op. cit.);
8. Difficulty in focusing attention on a particular task or on a predominant stimulus, and poor concentration (Illingworth op. cit., Stevens op. cit.);
9. Delay in the development of postural reflexes and balance (Hughes op. cit.);
10. General hyperkinesia;
11. Expressive perseveration in action and speech;
12. Deficient body image (Illingworth op. cit.), distally more so than proximally (Clapp, 1972);
13. Difficulty in spatial appreciation and form discrimination;
14. Perceptual defects particularly an inability to compare and discriminate weights, colours, shape and time (Illingworth op. cit.; Kirkman, 1973).

The signs listed above highlight the sensorimotor manifestations of dysfunction which have been found in mentally retarded children by a number of different investigators. In order to evaluate the full implication of these manifestations, there appeared to be a need for a greater understanding of the sensorimotor development of retarded children.
The study

The project undertaken at the University of Queensland was aimed at determining whether chronological age or mental age was most indicative of sensorimotor development in physically competent mentally retarded children. For this purpose, a standardised neurodevelopmental assessment was carried out on a group of ten-year-old children with an I.Q. of 50-60. The results were compared with those obtained from assessing two groups of children with normal I.Q.'s—one aged 10 years, the other five years.

Only eighteen children with a chronological age of ten years and a mental age of five, who had no physical handicap, could be found in the Sub-normal Schools and Opportunity Schools in the city and suburbs of Brisbane. Twenty-seven ten-year-old and twenty-nine five-year-old children were randomly selected from Brisbane primary Schools and Kindergartens to be included in the study.

Table 1 presents a summary of the data collected and compares the percentage of each group in whom the test performance was inadequate. Examination of these figures shows that despite the similarity in chronological age between the mentally retarded and the normal ten-year-olds, the performance of the former group was inferior in every test.

### Table 1

<table>
<thead>
<tr>
<th>Test Item</th>
<th>Percentage Showing Inadequate Performance</th>
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<tbody>
<tr>
<td></td>
<td>Mentally Retarded Children</td>
</tr>
<tr>
<td></td>
<td>Age: 5 Years</td>
</tr>
<tr>
<td>1. Gross motor abilities</td>
<td></td>
</tr>
<tr>
<td>Level of activity</td>
<td>5.6</td>
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<tr>
<td>2. Significant neurological signs</td>
<td></td>
</tr>
<tr>
<td>Tone</td>
<td>41.2</td>
</tr>
<tr>
<td>Reflexes</td>
<td>52.9</td>
</tr>
<tr>
<td>Both tone and reflexes</td>
<td>29.4</td>
</tr>
<tr>
<td>3. Abnormal reflex patterns</td>
<td></td>
</tr>
<tr>
<td>T.L.R.</td>
<td>17.7</td>
</tr>
<tr>
<td>S.T.N.R.</td>
<td>5.9</td>
</tr>
<tr>
<td>A.T.N.R.</td>
<td>52.9</td>
</tr>
<tr>
<td>4. Postural and balance reactions</td>
<td></td>
</tr>
<tr>
<td>Body on body righting reactions</td>
<td>11.8</td>
</tr>
<tr>
<td>Equilibrium—kneeling</td>
<td>29.4</td>
</tr>
<tr>
<td>——sitting</td>
<td>61.1</td>
</tr>
<tr>
<td>Protective reaction</td>
<td>61.1</td>
</tr>
<tr>
<td>5. Vision</td>
<td></td>
</tr>
<tr>
<td>Eye follow</td>
<td>29.4</td>
</tr>
<tr>
<td>Fixation peripherally</td>
<td>23.5</td>
</tr>
<tr>
<td>Convergence</td>
<td>35.3</td>
</tr>
<tr>
<td>6. Tactile awareness and knowledge of body parts</td>
<td></td>
</tr>
<tr>
<td>Localization</td>
<td>5.9</td>
</tr>
<tr>
<td>Two-point discrimination</td>
<td>41.2</td>
</tr>
<tr>
<td>Finger agnosia</td>
<td>11.8</td>
</tr>
<tr>
<td>Astereognosis</td>
<td>22.2</td>
</tr>
<tr>
<td>Body parts (a) point to</td>
<td>66.7</td>
</tr>
<tr>
<td>(b) name</td>
<td>44.4</td>
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It can be seen however, that there were some similarities in performance between the mentally retarded ten-year-olds and the five-year-old children. This is particularly so in the response of the two groups to tests for tactile awareness and knowledge of body parts, the major difference lying in the difficulty experienced by the mentally retarded children in naming body parts, a task demanding intellectual reasoning and memory.

Other similarities between these two groups were demonstrated in tests for proprioception and balance where, although the mentally retarded children responded consistently poorly in all tests, the scores obtained by the five-year-old children in tests for finger proprioception, one-leg standing without vision and heel walking were equally poor.

Both the mentally retarded and the normal five-year-old groups found difficulty in responding correctly to verbal instructions, possibly reflecting deficiencies both in intellectual reasoning powers as well as in postural awareness. The mentally retarded children experienced a difficulty in copying perceived demonstrated positions which was not matched by the five-year-olds.

Although the visuo-motor perceptual abilities appear to be similar in the two groups of children, the overall performance of the mentally retarded group was poorer than that...
of the five-year-olds. A possible reason for this may lie not so much in a deficiency of visual perception but rather because of deficient intersensory integration, as expressed in the inability to translate a visual stimulus into the correct, precise motor activity.

It is evident from this study that not only are motor abilities correlated with mental age (motor performance being at present one of the most reliable indicators of intellectual development), but also that in areas of sensory appreciation and in tasks involving bimodal sensory integration, the performance of the intellectually handicapped child is more closely related to mental than to chronological age.

**Implications for the Physiotherapist**

Because mental retardation is not a discrete entity but is manifest in so many forms and degrees of severity, a discussion of the role of physiotherapy can only be presented in general terms. Each child must be assessed before a treatment plan is devised that will cater for his individual needs and problems. Suggestions given here will deal mainly with the problems that were found to be common in this study and are offered in the hope that those interested in this comparatively new and challenging field will be stimulated to further study and research.

Many of the problems observed in the intellectually handicapped child are similar to those found in infants who are developmentally delayed. However, when treatment and parental advice on handling is given during infancy, many of the secondary handicaps which may otherwise develop, may be prevented.

Early treatment in infancy must be based on the general developmental status of the infant, and the particular sensory and motor delays which are evident from a comprehensive assessment.

The provision of sensory experience must be in both a general interaction experiential form, as well as for the specific sensory input requiring particular attention.

Both infants and children need repetitive sensations of different “feels”, movements, sounds and visual experiences as well as an awareness of self body movement, leading to more meaningful contact with the environment. Like any child, they must “learn” by active motoric participation in their environment but unlike the normal inquisitive child, the developmentally retarded child often needs constant encouragement to participate actively and purposefully with his environment. A child, though craving for sensory stimuli, who has no normal outlet for his energy may resort to self-stimulating movements such as rolling his head from side to side in supine or rocking backwards and forwards in sitting (York-Moore, 1976). Such abnormal habits may be avoided if appropriate stimulation is given from early infancy.

Children less than five months developmentally need to be encouraged to respond meaningfully to sounds, to visually stimulating toys and to light touch on the hand, face and legs. From five to seven months, however, sensory integration should begin to appear allowing the child to reach out for and to turn towards a sound (Reynell, 1971) indicating the involvement of several sensory and motor modalities.

Although much can be achieved through general play and involvement with the infant or child, often very specific stimulation is necessary.

Tactile stimulation is a valuable tool when helping the developmentally delayed infant. Rubbing with different textures, for example, soft towel or material, stroking him both firmly and lightly with the hands, clapping and helping him touch his own body all help him learn to relate touch and position and begin to make him aware of his body parts. In the early months, the mouth is an important source of sensory information and the normal child will take hands, feet and toys to his mouth. Besides providing sensory stimulation, “mouthing” has also a desensitizing function against the primitive reaction to circumoral stimulation (O'Doherty, 1971). The retarded child, either because of total abnormalities or because of lack of initiative, may not use this source of information and so it is important when dealing with the very young child that he be stimulated around the mouth and that his supple body be flexed to allow exploration of the feet and hands.
Tactile stimulation of the older intellectually handicapped child also plays a major role in treatment. The stimulation itself serves to excite the reticular activating system, enhancing attention and learning potential. For this reason, it is useful to commence a treatment with general stimulation such as rubbing with a towel, or playing with water or sand to improve awareness of his own body which can then be further aided by repeatedly naming body parts touched—initially while the child watches and, later, while he is blindfolded. Specific use of tactile input when teaching representative drawings of figures and letters, may be instituted by the manipulation of letters cut out in wood or cardboard. This will often facilitate learning through the process of sensory integration. To further aid discriminatory touch, common objects known to the child may be placed in an opaque bag to be identified without the aid of vision.

As localization and interpretation of sound is very important, the child must be taught to listen and identify familiar sounds. Initially bells or rattles may be used to arrest his attention, to stimulate visual localization and encourage head turning. Hitting and grasping toys help him to associate his own movement with the production of sound, while the voices of people seen help him to remember familiar faces and also to associate voices with emotion and social interaction. Heard speech is vital for his own language development and a mother should be encouraged to talk simply to her child whenever possible. Vocalization and movement are very closely linked in the expression of emotion and these two modalities can be used to enhance each other, particularly in the development of more advanced levels. Sometimes music and rhythm may be useful in the development of expressive speech and controlled movement.

Vision plays a vital part in the development of both body space and form perception. For this reason, the development of visual attention and regard is very important and must be facilitated appropriately through the use of visual and ocular-motor reflexes.

Hand regard is facilitated by the supine position as this allows the freedom necessary to bring the hands to the midline. However, persistence of this position impedes the development of head control and other postural reactions. Although prone lying is an essential part of the daily routine of any infant for development of strong postural extension, suitable chest support in this position allows hand play to continue. Once independent sitting has been achieved, further eye-hand and manipulative abilities can develop more freely; but the “discovery” of hands from about four to five months reflects the beginnings of hand-eye coordination. This coordination of the eye and the hand which involves the integration of touch, proprioception and vision, proceeds rapidly through to nine months of age.

The role of the vestibular system in sensory integration has been emphasized by Ayres (op. cit.), who suggests that the stimulation provided by spinning serves to integrate sensations, which in turn facilitates learning. In a study of the effects of repetitive specific vestibular stimulation on the motor performance of children with Down’s Syndrome reported by Kantner et al. (1976), responses following stimulation by spinning included relaxation of increased extensor tonus with subsequent ability to learn to roll, a tranquillising effect on the infants during periods of active rotation and, in one case, the ability to hold the head up better in all positions with apparently an improved ability to follow objects more closely. During treatment of developmentally delayed infants, these reactions have also been observed in some children after spinning. The vestibular end organs are sensitive only to angular acceleration, which occurs at the beginning and stopping of spinning and any increase in the duration of spinning beyond 8-10 rotations does little to increase the stimulation of the vestibular system. Accordingly, frequent short bursts of spinning are more beneficial than one prolonged spin. Kantner et al. (op. cit.) argue that rocking the child over a beach ball or over a bolster gives a relatively low intensity stimulus to the vestibular end organs because of the absence of angular acceleration. However, once head control is established, this low intensity activity does aid in the facilitation of postural reactions, which were shown by this study to be performed poorly. However, more advanced methods of teaching postural reactions, bal-

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ance and equilibrium involving many sensory modalities would generally be introduced as the child progresses.

As progression through the stages of normal development occurs more slowly in the mentally retarded child, help and stimulation must be given to ensure some establishment of each stage before proceeding on to the next. For example, head control may be assisted on raising the infant from lying by rotating the body forward and to the side rather than just pulling the baby up to sitting. Rolling and sitting may also be assisted by facilitation.

Hughes (op. cit.) encourages full support of the baby on his feet from birth provided that correct weight-bearing alignment onto the heels is observed as she suggests that this builds up the supportive reflex very early and conditions the child to his own weight on the soles of the feet.

The position of side-sitting should be introduced at an early stage (York-Moore op. cit.) as this will enable the child to turn from sitting onto all fours and crawl. York-Moore also found that those children unfamiliar with side-sitting were slower to crawl and favoured bottom-shuffling rather than the hands and knees position. At a later stage, by careful positioning of toys at various levels, the child can be tempted into a standing position but no attempts to force the child to walk should be made if neither head nor body balance have been established. Fear of falling could lead to the development of a stiff and nervous gait and a delay in the achievement of independent walking. One of the skills in treating a retarded child lies in determining when he is ready to progress to the next stage of development and in not allowing him to continue to perform only those activities which he can achieve already.

As in the treatment of all developmentally handicapped children, when managing the older mentally retarded child, the principle should be followed that if a child performs an action poorly, the activity preceding this in a development is the one which must be practised (Holle, 1976).

The study reported here demonstrated that poor body awareness and poor position awareness were deficiencies shared by most retarded children (see Table 1). For this reason, activities which enhance body and position awareness need specific attention. The particular sensory area involved is that of proprioception which, together with integration of information from tactile and vestibular areas, provide the child with an awareness of position and movement. Early weight bearing, firm handling and bouncing activities should be encouraged as the approximation of the joints increases proprioceptive input and for this reason, a trampoline is useful equipment for the older child.

Good coordination is not inborn, but develops in conjunction with maturation of the central nervous system and is aided by the senses of touch and sight and most importantly, by the kinaesthetic sense and experience. When the nervous system is sufficiently developed to allow a particular movement, practice serves to enhance the ease with which the stimulation for that movement is transmitted and if the opportunity to practise is not given, further development and refinement of that movement will be retarded (Rosenbloom, 1971).

Experiences in learning about the three-dimensional nature of space must also be provided for the child. Thus, by repetitive sensations of his own body movements, the mentally retarded child is enabled to become aware of himself and of his relationships with his environment. It is on this basis that he builds his perception of space, time and form. For the older child, awareness of his own body must be encouraged by suitable activities, such as “mirror” games and “copy me” games. Language which should be used constantly during contact times is an important means of increasing the child’s body awareness. This may be reinforced by verbalizing the activities of washing, dressing and other functional activities. The study demonstrated that many retarded children have poor finger proprioception which means that the performance of fine motor work also requires considerable attention.

One area in which the ten-year-old retarded child performed as well as and sometimes better than the normal five-year-old in this study was that of form perception. This could be a result of the emphasis in schools today on perceptual tasks such as copying figures
and doing jigsaws. In caring for the retarded child, these activities are often commenced early, and the therapist may use these activities further by reinforcing the visual demands of the task with verbal and tactile cues.

Suitable programmes should be offered which will allow the integration of the modalities of body awareness, auditory and tactile perception into the total perception of space, time, laterality and direction. Adventure playgrounds challenge the child and allow him to experiment with what he can do with his body, at the same time encourage interaction with other children, enhancing social development which is also an essential part of the integration and interaction process.

The encouragement of the parents to participate actively in the programme of management is vital to the progress of their child and the physiotherapist must be concerned with guiding parents in the most appropriate methods of bringing all the required experiences within the range of their child. Because the time required for constant stimulation, care and management of each retarded child is beyond the scope of the physiotherapist, she must act in an advisory and teaching role to all those who constantly care for the child. This should involve showing parents, care workers or teachers how to provide the child with appropriate sensory stimuli, how to carefully position the child and to plan activities.

By encouragement and praise, the child must be given the opportunity to gain a vital awareness of himself and of his environment, so that he will be encouraged to develop his potential to its fullest capacity. If the emotional problems of frustration and dependency are minimised, he will be better able to cope with the world around him.

The community too has a part to play in reducing the effects of this enormous problem by providing support and understanding of the retarded child and his family so that they are more secure and hopeful of the future. However, unless the community is also well informed about the availability and expectations of therapeutic and education programmes, they cannot play their part and misunderstanding and mistrust will continue to prevent the total fulfilment of each child's potential within that community.

**Conclusion**

Because the associated problems experienced by the child who is mentally retarded may considerably affect his ultimate potential both as an individual and as a member of the community, methods of recognising and reducing these problems have important implications.

A study of sensory integrative problems in mentally retarded children revealed that they effectively reduced the overall performance levels of the child even though it was found that the sensory and motor abilities of the intellectually handicapped child were more closely related to mental than chronological age.

Although there may be several reasons for poor sensory and motor abilities it is important that the programme offered to each child should be based on his specific problems as revealed by individual assessment. Of equal importance is the need to stress preventive measures, since appropriate advice to parents can help to prevent the development of secondary problems in addition to improving overall developmental progress.

Because the problems in intellectually handicapped children may be manifested in many forms, the implications for physiotherapy suggested in this paper are offered as a guide only, as they relate particularly to the common problems shown in the group studied. Obviously, much more research needs to be undertaken in this field.

**References**


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