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A Study of Visual Perception in Individuals with Infantile Cerebral Palsy (ICP): Therapeutic Approaches and Strategies

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Abstract

This study aims to diagnose a significant cohort of children with neuromotor disabilities and to ascertain the impact of these disabilities on visual perception. It seeks to address this population's needs, investigate their condition's underlying causes, and propose diagnostic recommendations in speech-language pathology (orthophony) tailored to the various types and classifications of neuromotor disabilities. These classifications are based on the severity, degree, and diverse symptoms of the disability. The ultimate goals are to identify challenges in the cognitive abilities of affected children, provide support and information to their families, and elucidate preventative measures and therapeutic approaches for visual perception to alleviate their difficulties.The significance of this research lies in its potential benefit to speech-language pathologists dedicated to enhancing their services and its contribution as a scholarly addition to the body of scientific knowledge in studies and research concerning neuromotor disabilities.

Keywords: *Cognition, Visual Perception, Neuromotor Disability.*

Introduction

Neuromotor disability results from damage to the brain's motor cortex, occurring either in utero, during birth, or early childhood. This non-hereditary condition is often attributed to early developmental disruptions within the womb, leading to atrophy in both cerebral hemispheres. Other potential causes include perinatal hemorrhage or asphyxia. The extent of brain injury remains static, while the location and severity of the neurological impairment determine the specific type of neuromotor disability. Individuals with neuromotor disabilities commonly exhibit motor impairments accompanied by swallowing difficulties. However, the impact extends beyond these aspects, with associated symptoms that can impede speech-language pathology (orthophonic) intervention.

Some Algerian researchers in speech-language pathology, including Belkhiri (2004) and Bouakkaz (2006), have focused on individuals with neuromotor disabilities, adapting and applying assessment tools to identify their linguistic disorders. Notably, Dr. Bouakkaz (2006) adapted the ETL for children with neuromotor disabilities.

Barbot and Magic (1988) highlighted in their study that these children often experience cognitive challenges. Visual perception is a fundamental cognitive process crucial for learning and acquisition. It is considered an active and constructive cognitive process involved in processing visual information, representing an early stage of cognitive operations. Visual perception plays a vital role in learning, the ability to differentiate shapes based on color and size, and the interpretation and meaning-making of visual stimuli. It transforms raw visual input into a perception with a meaning and content distinct from its constituent elements, contributing to the child's cognitive framework. Impairment in this perceptual process inevitably leads to difficulties in visual perception. These difficulties are among the most prevalent cognitive disorders in children with infantile cerebral palsy (ICP).

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A study conducted by Khawla Fallah (2011) aimed to investigate the impact of neuromotor disability on visual perception. Tests were administered to three individuals aged 10 to 13 years, and the findings indicated a significant effect of neuromotor disability on visual perceptual processes. These studies motivated the present research to determine whether children with neuromotor disabilities exhibit deficits in visual perception. Consequently, the central research question is:

Do children with neuromotor disabilities experience difficulties in visual perception?

To address this question, the following hypothesis is proposed:

Children with neuromotor disabilities do indeed experience difficulties in visual perception.

Research Methodology

Conceptual Framework of the Study:

To ensure clarity and facilitate reader comprehension, this section defines the key concepts employed throughout this study:

✓ **Cognition:** Cognition is the process through which meaning is derived by transforming sensory impressions received from external stimuli into specific mental representations. This is largely an unconscious process, although its outcomes are conscious.

✓ **Visual Perception:** Visual perception is a critical cognitive function involved in the processing and interpretation of information. It is the process by which the meaning of visual information is determined.

✓ **Neuromotor Disability:** Neuromotor Disability (IMC) is an encompassing term for various disorders affecting movement, posture maintenance, and balance. These conditions result from brain damage occurring before, during, or within the first few years after birth. Depending on its location and severity, brain injury can cause a range of associated problems.

Definition of Neuromotor Disability:

The concept of neuromotor disability was first defined by Professor G. Tardieu in 1954. His work focused on a group of children with motor impairments due to neurological damage but with intact cognitive abilities, distinguishing them from children with encephalitis accompanied by intellectual disability (Le Métayer, 1999, p. 12).

In 1968, G. Tardieu proposed a broader definition of cerebral motor disability: "It is the result of a non-progressive lesion occurring before, during, or after birth, manifested by multifaceted paralysis that may, in some cases, affect the vocal organs and can be accompanied by sensory impairments and partial deficits in higher cognitive functions, excluding intellectual deficiency."

Cerebral motor disability signifies "children, adolescents, and adults with partial or total disabilities that impede the execution of voluntary movements for maintaining posture. This deficit results from a neurological injury occurring before, during, or after birth."

While the lesion itself is non-progressive, it impacts the neurological and psychological development during the early years of life. Motor disorders range from mild to severe, leading to a complete loss of independence in the most affected individuals. Neuromotor disability is congenital and not hereditary (Guidetti, 1999, p. 29).

Ultimately, based on the preceding definitions, neuromotor disability of neurological origin is linked to brain injury during the prenatal, perinatal, or postnatal stages. It manifests as a non-stable, non-progressive,

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non-hereditary motor disorder. Its effects include disturbances in posture and movement, often accompanied by higher-order processing impairments such as perceptual disorders, motor apraxia, and sensory disturbances. Critically, this neurological injury does not affect intellectual abilities (intelligence), allowing individuals with cerebral motor disabilities to attend mainstream educational settings.

This definition excludes children with intellectual disabilities and multiple disabilities. This condition is also referred to as Cerebral Palsy.

Etiology of Neuromotor Disability:

The multifaceted causes leading to neuromotor disabilities, which significantly impact a child's physical and neurological well-being and profoundly affect their lives and those of their parents, remain largely unknown to many. These causes can be categorized based on the period during which they exert their influence on the child:

1. *Pre-Conception Period:*

    - Early marriage, particularly for women, occurs before full maturation.
    - Consanguineous marriages, especially with a family history of genetic disorders.
    - Rh incompatibility.
    - Lack of birth spacing and childbearing by mothers over 40 years of age.
    - Pre-marital counseling and investigation of diseases within the extended family, not just the parents.
    - Maternal drug and alcohol consumption (Ahmed Saeed, 1999, p. 11).

2. *During Pregnancy:*

    - Acute maternal infections such as rubella, viral hepatitis, and syphilis.
    - Medications used by the mother, especially sedatives, antipyretics, and antispasmodics.
    - Exposure to X-rays.
    - Bleeding due to prolonged standing or falls.
    - Fetal malformations.
    - Preeclampsia.
    - Sexually transmitted infections (Ahmed Saeed, 1999, p. 13).

3. *During Childbirth:*

    - Difficult labor involving traction on the infant's head or arm, or the use of instruments like forceps.
    - Cyanosis (blue discoloration) of the newborn due to difficult delivery or umbilical cord entanglement around the neck.

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- Prematurity – premature birth (Ahmed Saeed, 1999, p. 13).

4. *The First Week of Life:*

- Kernicterus (nuclear jaundice) is due to blood type incompatibility between parents regarding A or B factors.
- Severe infectious diseases affecting the newborn.

5. *Infancy and Early Childhood:*

- Malnutrition.
- Poliomyelitis and motor system diseases like rheumatoid arthritis.
- Meningitis.
- Epileptic seizures.
- Certain infectious diseases, like measles.
- Brain injuries (Omar Abdel Salam, 2000, p. 46).

Types of Neuromotor Disability :

Neuromotor disability arises from damage or dysfunction in a group of cerebral cells or nerve tracts that control various muscles. The location and extent of this damage vary among individuals, resulting in diverse symptoms depending on the type, location, and severity of the lesion. Regardless of the specific symptoms and their intensity, they are classified under the single term "neuromotor disability."

Nevertheless, neuromotor disability has been categorized into several types based on:

- Accompanying symptoms.
- Affected limbs.
- Severity of the impairment.

Classification of Neuromotor Disability Based on Accompanying Symptoms:

Neuromotor disability can be divided into several types according to its associated symptoms:

1. Spasticity: Discovered by Dr. Little in London in 1861, this manifestation presents as a loss of balance and involuntary movements accompanied by muscle spasms in different locations depending on the site of the lesion. Muscle spasticity refers to stiffness and rigidity of the muscle in a contracted state due to increased muscle tone, resulting in slow and weak movements. This is the most common type of neuromotor disability, accounting for approximately 50-60% of cases, with the lesion typically located in the cerebral cortex. Furthermore, about 80% of these cases are attributed to premature birth (Al-Azzah, 2000, p. 56).

According to Metayer and Ganard (1979), this type results from damage to the pyramidal system, the system responsible for voluntary movement. This functional impairment is characterized by an exaggerated stretch reflex, indicating increased muscle tone and an overreactive muscle response to stimulation. The severity of muscle tone depends on the child's general condition and the level of stimulation they experience. Severe

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muscle tone can lead to muscle weakness due to the lack of function, culminating in the contraction of affected parts and resulting in deformities and rigid disorders such as scoliosis, pelvic deformities, and contractures of the knees and finger joints.

2. Athetosis: This disability stems from a lesion in the extrapyramidal system, particularly in the central gray nuclei responsible for monitoring and coordinating voluntary movements. It is characterized by the appearance of involuntary, spontaneous, irregular movements that disappear during sleep. Athetoid movements are more pronounced in the upper limbs compared to the lower limbs, typically involving extension of the fingers with abduction, and a tendency for the head to tilt backward. These movements are also associated with facial changes such as mouth opening, tongue protrusion, and uncontrolled movements leading to drooling. Consequently, there is an inability to control the muscles responsible for speech (resulting in limited, unclear, and incomprehensible speech) and difficulty in swallowing (Tison, 1997, p. 36)

3. Ataxia: This type arises from damage to the cerebellum, the part of the brain responsible for balance and motor and sensory coordination. It accounts for approximately 10% of cases. Children with this type of disability exhibit unsteady and uncoordinated movements, characterized by a reduced level of muscle tone accompanied by impaired balance (Al-Khafash Hanandeh, 2005, p. 7).

Children with ataxia often misjudge distances and depth perception due to irregular eye movements, leading to frequent falls. They may walk with their arms extended forward to maintain balance and demonstrate general instability and lack of postural control. Tremors are noticeably pronounced when the child attempts to perform a specific voluntary movement, such as writing or eating (Majed El-Sayed Obeid, 1999, p. 119).

4. Mixed Type: This classification applies when a child exhibits symptoms of the previously mentioned types. For instance, a child may experience symptoms of both spasticity and athetosis, or spasticity and ataxia, depending on the location of the brain lesion. In such cases, there may be increased muscle tone (spastic and rigid muscles) in one muscle group while another group exhibits decreased tone, leading to significant movement difficulties. This type is estimated to account for approximately 20% of neuromotor disability cases (Al-Khafash Hanandeh, 2005, p. 7).

Classification of Neuromotor Disability Based on Affected Limbs:

According to Suleiman (2001), the classification of neuromotor disability based on the affected limbs is as follows:

- **Monoplegia:** Paralysis of a single limb, most often affecting the hand compared to the leg.
- **Hemiplegia:** Involvement of the right or left side of the body, which can also affect the face. It is typically more severe in the upper limb (Fawzi, 2007, p. 27).
- **Diplegia:** Involvement of the entire body, with the lower limbs being more affected than the upper limbs.
- **Paraplegia:** A rare condition in children with IMC, affecting only the lower limbs.
- **Triplegia:** Involvement of three limbs of the body, most commonly both legs and one arm.
- **Tetraplegia:** Paralysis of all four limbs, both upper and lower (Djamal Al-Khatib, 2003, p. 53).

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Classification of Neuromotor Disability Based on Severity:

This classification depends on the severity or degree of the motor disability, which can fluctuate with physiotherapy and exercise and worsen with neglect. It is divided into:

1. **Mild Cases:** Children with mild cerebral palsy experience a problem that does not necessitate medical treatment. They can care for themselves without the aid of devices or assistive tools, can attend mainstream schools, and master skills and tasks performed by typically developing individuals.

2. **Moderate Cases:** In these instances, motor development is slow, but the affected individual can move with assistance from others or with assistive devices. They also possess the ability to control fine motor skills. Generally, these children experience mild intellectual impairments and speech and visual disturbances, as well as difficulty swallowing and drooling (El-Sayed Suleiman, 2001, pp. 30-31).

3. **Severe Cases:** Severe disability limits a child's ability for self-care, independent movement, and speech. Consequently, they require intensive, structured, and continuous therapy (Obeid, 1999, p. 120).

Therapeutic Approaches for Neuromotor Disability:

Neuromotor disability is considered a permanent condition that does not resolve spontaneously. However, treatment can involve medication to alleviate muscle spasticity and improve coordination, surgical procedures to facilitate physiotherapy and reduce motor deformities, as well as psychological, occupational, speech, and behavioral therapies. Early intervention significantly increases the child's chances of overcoming limitations and acquiring complex skills. Effective management necessitates a multidisciplinary team comprising a pediatrician, a psychologist to support the child's development, an orthopedist, a physiotherapist, an occupational therapist to teach daily living skills and strategies for school and work, and a speech-language pathologist (orthophonist) for diagnosing and treating communication problems. The following are some of the therapeutic approaches provided to children with neuromotor disabilities:

1. **Physiotherapy (La thérapie physique):** The primary aim of this therapy is to help the child interact with their environment and caregivers, while also providing support to the family. It assists the child in developing motor skills and educates parents or caregivers on necessary activities and exercises to help the child reach their maximum potential.

Physiotherapy ensures that the child engages in specific daily exercises aimed at reducing contractures and spasms, which helps mobilize their joints. This type of therapy includes muscle and knee exercises and assistance with standing, especially when the child is ready to explore their surroundings.

2. **Recreational Therapy:** This involves integrating the child into play activities, viewing occupational and physical therapy as forms of creative expression. Parents should identify creative ways to engage children with neuromotor disabilities, particularly those with limited ability to explore their environment. The goal is to develop the child's potential skills, especially psychomotor and auditory skills.

3. **Speech Therapy:** Many individuals with neuromotor disability (IMC) experience dyskinesia, which involves involuntary movement disorders affecting the face and pharynx, resulting in dysphasia, dysphagia, and dysarthria. Speech therapy serves as a means to improve swallowing and communication (Fahmy Ali Mohamed, 2008, pp. 258-260).

4. **Speech-Language Pathology (Orthophony):** A speech-language pathologist (orthophonist) focuses on the linguistic aspects and associated cognitive issues, such as visual perception, as well as language teaching methods for communication purposes. The orthophonist concentrates on the motor aspects directly related to language, speech, and voice. They also intervene in the cognitive aspects of language, primarily comprehension of all types, perception, visual perception, and memory.

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The inability to speak is a common problem in cases of neuromotor disability. Treatment depends on the underlying cause. If the cause is a lesion in the speech center of the cerebral cortex, the deficit may be irreversible. However, the family should focus on how to communicate with the child and understand their non-verbal expressions, such as facial expressions and gestures. If the problem lies in the muscles of the mouth and tongue, a speech-language pathologist can help train the child to speak (Abdullah Mohamed Al-Subai, 2004, p. 1).

5. **Occupational Therapy:** Occupational therapy differs from physiotherapy in its focus on the muscles the child needs for daily life, particularly the muscles of the hands (eating, drinking, writing, and drawing) and the muscles of the face and mouth (eating, drinking, and speaking). Through their expertise, occupational therapists assess the child's condition, identify the challenges they face, and then find the easiest way to perform the required tasks.

Key aspects of occupational therapy include:

- Assessing the child's condition to determine their abilities and difficulties.
- Focusing on the development of sensory-perceptual skills.
- Implementing programs to develop fine motor skills and visual-motor coordination.
- Training the child in self-care activities (eating, bathing, personal hygiene, dressing).
- Teaching the child how to use assistive devices and adaptive tools.
- Educating the family on implementing suggestions and exercises the child needs (Abdullah Mohamed Al-Subai, ibid., p. 3).

Definition of Visual Perception:

The topic of visual perception holds significant importance for specialists in various fields of study, particularly those interested in cognitive psychology. Numerous definitions have been proposed, including the following:

➢ Landry and Norman define it as "a modification of sensory impressions from external stimuli to interpret and understand them" (Adnan Youssef Al-Atoum, 2004, p. 39).

➢ Bagot (1996) defines visual perception as "the interaction with the external world and the recognition of objects within it, including their extension and presence in a specific location, to determine their characteristics by matching and comparing them with each other for naming and classifying them" (Bagot, J. D., 1996, p. 173).

➢ Fathi Al-Zayyat (1998) defines visual perception as "the process of interpreting and explaining visual stimuli, assigning meanings and significations, and transforming the stimulus from its raw form into a Gestalt. It plays a crucial role in school learning, especially reading" (Fathi Moustafa Al-Zayyat, 1998, p. 340).

➢ Fouad Bahi El-Sayed states that "the impression of visual images on the retina, the sensation of shape, color, and size, and the appreciation of their meanings constitute visual perception."

➢ Fikri Al-Atr defines visual perception as "the ability to organize and interpret sensory stimuli in light of past experience through the organism's direct visual response characteristic of environmental features. This response leads to the organism's extraction of information that enables it to know the immediate world and defines its relationship with it. Visual perception is a positive process dependent on

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the visual system's capture of information, and it is a selective process. Through visual tracking of information, what the organism can extract becomes a part or aspect of what is available."

➢ El-Sayed Abdel-Hamid defines visual perception as "attributing significance, meaning, interpretation, or explanation to a visual sensory stimulus" (Khadija Benfeliss, 2009, pp. 113-114).

Based on the preceding definitions, visual perception is "the process of organizing and interpreting visual stimuli into a meaningful form or pattern based on the perception of certain visual attributes that distinguish them from others, such as shape, size, color, direction, and depth."

Components of Visual Perception:

Visual perception comprises several skills, including:

1. **Matching:** This involves the individual's ability to analyze the components of the perceptual field and arrive at a correct judgment of what this field encompasses or includes. The ability to reorganize the perceived environmental field in a different configuration to arrive at the same field but in a different form and arrangement is also a necessary skill for perception.

2. **Perceptual Constancy:** This refers to the stability of the perceived visual object and its inherent nature in terms of shape, size, color, depth, area, or number, regardless of variations in the spatial relationships between its components or the viewing distance (Khadija Ben Feliss, 2009, p. 113).

3. **Visual Discrimination:** This concept refers to the ability to recognize the distinguishing and differentiating boundaries of a shape from other shapes in terms of color, pattern, and size. For example, a child distinguishing between similar letters, drawings, and pictures. A study by Leaner (1997) demonstrated that children who can discern differences between letters before entering school are more prepared to learn to read than others. A child with visual discrimination difficulties cannot perceive the difference between two or more visual stimuli.

It is important to note that there is a difference between the visual perception of objects and the visual perception of words. When objects are perceived visually, their perception is not affected by the reflection of their position in space. However, the visual perception of letters and words changes with variations in their spatial orientation.

4. **Visual-Motor Coordination:** Abdel-Raqeeb Al-Bahri (1990) defines visual-motor coordination as "the inability to achieve proper coordination between the eye and the hand, and the integration between eye and body movement to perform multiple activities" (Mohamed Awad Salem, 2003, p. 83).

5. **Figure-Ground Discrimination:** This concept refers to the inability or weakness in focusing on selecting the required stimuli from a group of stimuli when they occur simultaneously. It is a problem related to selective attention and the speed of perception. A child who has difficulty with visual figure-ground discrimination cannot distinguish between a specific shape and the background on which it is located.

Physiological Anatomy of Visual Perception:

Studies on neural activity have shown that visual information, after leaving the eyes, ascends through successive stages of a neural system that processes data within the visual pathway. At the beginning of this pathway, the external image travels from the retina towards two small structures deep within the brain called the lateral geniculate nuclei. Visual stimulation arriving from one eye or the other, but not both simultaneously, can activate individual neurons in the lateral geniculate nuclei. These neurons respond to any change in brightness or color within a specific region of the visual field, known as the receptive field, which varies from one neuron to another (De La Cour, 1998, pp. 37-38).

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Subsequently, visual information travels from the lateral geniculate nuclei to the primary visual cortex (V1) located at the back of the head in the occipital lobe. It is important to note that the behavior of neurons in area V2 differs from that in the lateral geniculate nuclei, as either eye can typically activate this cortex. However, these neurons are also sensitive to specific features such as the direction of movement of a stimulus within their receptive field.

Visual information is then transmitted from area V1 to more than twenty other distinct cortical areas. Some information originating from area V1 can be traced as it passes through two areas known as V2 and V4 before terminating in regions called the inferior temporal cortex (CTI Cortex Temporal Inferior). Other signals pass from area V1 through areas V2 and V3 and an area belonging to (MT/V5) before finally reaching the occipital lobe (Houdé, 1998, pp. 25-26).

Results

Table 1: Cerebral Cortical Areas and Their Functional Specialization in Visual Perception

Cerebral Cortical Area	Functional Specialization
V1	Receives signals from the lateral geniculate nucleus and transmits them to V2.
V2	Receives and classifies signals based on their nature (direction of motion, shape, color) and transmits them to specialized areas according to their specific function.
V3	Perception of form.
V4	Perception of form and color.
V5	Perception of motion.

Source: Ounais, I., 2017/2018, p. 61.

Approaches and Strategies for Addressing Visual Perceptual Disorders:

1. Approaches to Enhance Visual Perception:

a. **Enhancing Visual Scanning Skills:** This aims to encourage the child to observe and to develop the ability to move their head in all directions to examine their surroundings. Some children may encounter difficulties in maintaining balance and controlling head movements (Awadh et al., 2003, pp. 87-88).

b. **Enhancing Visual Comparison Skills:** This skill requires the child to identify similarities between different sets of stimuli and then categorize them. Through this, the child learns to classify objects based on their perceptual understanding of certain concepts.

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c. **Enhancing Visual Memory and Attention Skills:** This approach aims to develop visual attention skills and refresh the child's memory through visual stimuli. The task of visual memory and attention relies on recalling the location and distinctive characteristics of objects, such as names, faces, objects in their environment, letters, and words. Furthermore, visual discrimination, the individual's ability to distinguish similarities and differences in their surroundings, is manifested through the following skills:

- The child distinguishes and writes the difference between similar letters.
- The child associates an image with a word and the parts of the word that represent it.
- The child selects the letters that form a word from a set of letters.

1. Strategies for Addressing Visual Perceptual Disorders:

The task or skill analysis method is employed in training visual perception activities. This method comprises four stages:

- Goal Identification: Defining the overall objective to determine the sub-skills that need to be learned.
- Assessment of Child's Abilities: Evaluating the child's performance in executing the sub-skills.
- Identification of Cognitive-Motor Procedures: Determining the necessary cognitive and motor procedures to successfully complete the task.
- Writing Educational Objectives and Selecting Therapeutic Procedures: Formulating learning objectives and choosing treatment procedures that integrate the goals and procedures of this method.

Correspondingly, researchers have developed various methods and strategies for treating visual perceptual disorders and training children in visual skills, particularly visual-motor coordination.

Conclusion:

This study has attempted to shed light on a crucial topic: the investigation of visual perception in children with neuromotor disabilities. Visual perception is the primary process through which objects are represented with their specific meanings. However, research in this area remains insufficient given the needs of this population for assistance and support. Furthermore, children with neuromotor disabilities require essential educational interventions, as neuromotor disability is a chronic and multi-symptomatic developmental impairment resulting from brain damage before, during, and after birth. Despite its multiple causes, the most common is oxygen deprivation to the child's brain. The symptoms of the disability vary depending on the location and severity of the brain damage. Various theoretical studies indicate that neuromotor disability affects visual perception in affected individuals. Therefore, prediction and prevention through speech-language pathology intervention are necessary, involving the intensification of diagnostic tools and the development of new techniques aimed at enhancing the cognitive process of visual perception and improving the communicative and linguistic processes of individuals with neuromotor disabilities.

This has led us to propose a set of suggestions that we deem beneficial for these children:

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- Focusing on the often-marginalized population of individuals with special needs in our society, who also suffer from societal pressure in addition to the psychological distress resulting from their specific disability.

- Carefully considering the future of children with disabilities from an academic and social perspective.

- Raising public awareness about appropriate ways of interacting with this population through various media outlets.

- Ensuring that this population is taught by specialists in special education, which will be beneficial and advantageous for them.

- The necessity of holding coordination and communication meetings between affected children, educators, psychologists, and speech-language pathologists to monitor the children's progress.

- Developing a specific therapeutic protocol for children with neuromotor disabilities.

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