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ВЫПУСКНАЯ КВАЛИФИКАЦИОННАЯ РАБОТА

Comparative Analysis of Rehabilitation Techniques for Improving the Learning Ability in Preschool Children: A Clinical Case Study / Сравнительный анализ техник реабилитации по улучшению способности к обучению у дошкольников: клиническое исследование

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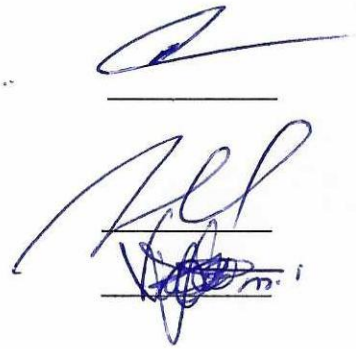

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CHAPTER 1: INTRODUCTION

1.1 Background of the Study

All humans, both young and old, possess the innate ability to learn. For a neurotypical adult learner (age 18 and above) with a relatively more developed brain, the skill and process, in itself, have become a practised daily routine for at least 18 years. On the other hand, due to their tender age and relative level of neurocognitive development, children's ability to successfully learn to appropriately change/adapt their behaviour to match the environment is a very fragile process.

Consequently, persistent hindrances such as low voluntary control, self-regulation, being easily fatigued as a result of lacking the ability to conserve energy, and seeing their peers being able to perform various activities which they cannot perform may negatively impact a child's learning ability. As a result, proffering clinical/scientific recommendations for overcoming these learning hindrances in children have necessitated conducting this study. More specifically, the goal of this clinical case study is investigating the use of the combination of replacement ontogenesis+dance (as neuropsychological rehabilitation techniques) in improving learning ability skills in preschool children.

1.2 Purpose of the study

The purpose of this study is to provide a qualitative and clinical perspective on developing children's learning ability through replacement ontogenesis method and dance – as neuropsychological rehabilitation techniques – in the following way:

Investigate the effectiveness and/or ineffectiveness of the combination of replacement ontogenesis technique and dance in improving the learning abilities of preschool children.

1.3 Significance of the study

1. This study is expected to provide a scientific perspective on the possible clinical outcomes of the combination of substitution ontogenesis rehabilitation technique and dance/movement therapy.
2. Positive outcomes of this study could reinforce the incorporation of dance/movement therapy into the educational extracurricular activities of preschool children in Russia, and in other parts of the world.
3. Positive outcomes of the use of dance/movement therapy could encourage the clinical use of dance by Child Neuropsychologists, and paediatricians in related fields.
4. This study is expected to spike further scientific interests in various ways of improving the learning ability of preschool children, current-day considerations in Child Clinical Neuropsychology, and also inter/multi-cultural differences in sequenced motor movements, rhythm perception, and rhythm reproduction.

Learning Ability

To begin with, what is learning? Learning is simply defined as the change in behaviour as a result of experience (Cronbach, 1965). The change in behaviour described here includes both overt and covert behaviours, and the cause of this overt/covert change in behaviour/experience encompasses any stimulus or several stimuli which the learner senses and perceives in the external world. However, a change in behaviour could be considered positive (an increment), or negative (a decrement). Since the focus of this study is in improving the learning ability of children, a more suitable definition is sought after.

According to Washburne (1936), learning is an increase in problem-solving ability through experience. In more details, a child is thought to have learnt if the child requires lesser time, energy, and thoughtfulness in completing a task; overtime. For example, in completing a single Schulte table task (**Appendix 1**), over three (3)

trials, learning is said to have occurred if it took a child 60 seconds, 45 seconds, and 30 seconds respectively to complete each trial. This reduced time, energy, and thoughtful input, subconsciously to the child, is interpreted as "fun" and an activity they would be willing to engage in another time in future (Read, Farlane, and Casey, 2002).

Yet, the previously illustrated example, apart from describing the "process" of learning, also introduces a new concept important for this study - the "volume" of learning. That is, if the child is presented with yet another task (like reciting a popular nursery rhyme) while performing the Schulte task (**Appendix 2**), "how much" of learning would occur? Learning ability, the volume and adaptiveness of learning, determines the future of possible learnable materials, behaviours, and information.

Scholarly, various diverging definitions of learning ability in children exist (Zukerman, 2016; Cain, Oakhill, and Elbro, 2003, etc). Nevertheless, a common factor considered in various definitions is the link between learning ability and academic activities. Fletcher, Lyon, Fuchs, and Barnes (2007) suggest that learning ability is the ability of a child to make (educational) progress while being provided high-quality academic instruction. Essential learning skills required in children for successful academic activities include reading skills, reading comprehension, reading fluency, written expression, mathematics calculation, mathematics problem solving, listening comprehension, and oral expression (Fletcher et al., 2007). According to the Diagnostic and Statistical Manual for the Diagnosis of Mental Disorders - 4th edition (DSM-IV), determining a child's learning ability (and subsequent diagnosis of learning disability) stems from focusing on particular areas of learning that is expected from a child from the basis of their intellectual skills, grade level (that is, class), and/or age (APA, 1994).

However, the importance of a child's learning ability is not only for academic activities. Learning ability skills are also necessary for communication (Shatz, and Gelman, 1973), making friends (Ladd, 1990), escaping danger (Padgett, Strickland, and Coles, 2006), and other skills required for daily functioning of the child.

Improving the learning abilities of children not only involves targeting the development of specific skills, but also executive control mechanisms which implement learning skills when needed (Derry and Murphy, 1986).

Replacement Ontogenesis

Amongst others, a few major executive control skills needed to be developed in preschool children include (a) self-regulation and forming the optimal functional status of brain parts, (b) specialisation and stabilisation of interhemispheric interactions, and finally (c) the ability to plan behaviour and analyse situations with a forecast for their resolution. These three factors [a,b,c] are the bedrock of the replacement ontogenesis method developed by Semenovich A.V. According to Semenovich (2015), the method:

"examines the fundamental neuropsychological patterns of psychological and pedagogical support of development processes. Replacing ontogenesis is presented as a basic technology for correction, habilitation and prevention; a scheme (algorithm) and specific psychotechnics that form the basis of neuropsychological support for children".

It is on the principles of the replacement ontogenesis method that one of the major treatments given to participants of this study was designed. Kolganova and Pivovarova (2023), through the manual: "Basic Neuropsychological Program for Child Development – **BNPCD** (age 3–12) by replacement ontogenesis method" provide a clinically and scientifically designed 24-lesson rehabilitation exercises for children with difficulties in motor activities, attention, speech, memory, forming spatial representations, regulating emotions, writing, reading, and in mathematics (more details on this available in Chapter 3: Methods).

Dance

The second treatment administered to children in order to improve their learning ability was dance. Dance is known to play important roles in human cultures, and the involvement of programmed/sequenced body parts (while dancing) makes it a growing interest in the cognitive sciences (Bläsing, Puttke, and Schack, 2010).

Dance/movement therapy uses movement to improve physical and emotional integration (Castro, 1992; Goodill, 2005; Parslow et al., 2008). Dance offers a unique opportunity for individuals with degenerative diseases, such as multiple sclerosis, to exercise control over personal space and recover a sense of control and ownership over body movements. Dance involves the culturally-mediated body, emotion, and mind, and may promote wellness by strengthening the immune system through muscular action and physiological mechanisms (Azevedo, 2002; Goodill, 2005; Hanna, 1995; Lopes & Carvalho, 1999). Data from trials have demonstrated that dance interventions improve cognitive function in the elderly with mild cognitive impairment (Lazarou et al., 2017).

Expert dancers show brain changes in the anterior cerebellar vermis and cerebellar lobules V and VI, which are key structures for entraining movement to external auditory timing cues (Brown et al., 2006). Expertise in dance is also associated with improved sensorimotor functions (Jin et al., 2019; Bläsing et al., 2012; Karpati et al., 2015) and proprioceptive body representation (Jola & Haggard, 2011).

Research has shown that dance movement therapy (DMT) is effective in treating health-related psychological problems (Salgado & de Paula Vasconcelos, 2010). A meta-analysis of 23 primary trials (N = 1078) found that DMT and dance significantly improved quality of life, body image, well-being, and clinical outcomes, including depression, anxiety, and interpersonal competence (Koch et al., 2014).

The cerebellum plays a crucial role in motor control, specifically in the precise timing and adaptation of movements (Manto et al., 2012; Therrien & Bastian, 2019; Bastian, 2006). It is involved in various motor tasks, including oculomotor movements (Thier & Markanday, 2019), grasping (Nowak et al., 2007), and voluntary limb movements (Ebner et al., 2011). The cerebellum's contribution to these tasks includes the control of precise, online adaptive, and predictive timing (Manto et al., 2012; Therrien & Bastian, 2019; Bastian, 2006).

Furthermore, the cerebellum is essential for sensorimotor synchronisation (SMS), which involves coordinating actions with temporally predictable, rhythmic events (Bares et al., 2019; Manto et al., 2012; Braitenberg et al., 1997; Damm et al., 2020; Doyon et al., 2003; Molinari et al., 2007). SMS is typically studied using finger tapping tasks to predict stimuli like metronomes or music sequences (Dalla Bella et al., 2017). The cerebellum is also involved in the perception of sequences (Molinari et al., 2008), which is necessary for SMS.

In addition, cerebellar circuitry is necessary for producing and adapting motor responses using error information from previous responses (Shadmehr et al., 2010). Given the cerebellum's role in motor and sensorimotor skills, dance is an attractive activity for individuals with cognitive dysfunctions. Dance involves full-body synchronisation to a musical beat in a non-verbal, communicative, and aesthetic context (Laland et al., 2016; Joufflineau et al., 2018). It engages various neuronal networks, including the premotor and parietal cortices, the supplementary motor area, the motor cortex, the basal ganglia, and the cerebellum (Cross et al., 2006; Bachrach et al., 2016; Brown et al., 2006; Cross et al., 2009).

1.4 Hypothesis:

Depending on personal characteristic(s) of a child, the administration of the treatments would cause an improvement in the overall subtest performance of the children at the end of the study.

CHAPTER 2: THEORETICAL FRAMEWORK

For the purpose of this work, theories focusing on the following would be used:

- Literature on diagnosed disorders in children
- The Luria's Approach to Neuropsychological Rehabilitation

2.1 Literature on Diagnosed Disorders

Cardiac Arrhythmia/Hypoxia (Jat, Lodha, and Kabra, 2011)

Cardiac arrhythmia is a condition characterised by a change from the normal heart rate and/or rhythm that is not physiologically justified (Antzelevitch and Burashnikov, 2011). It is a condition characterised by the disruption of the heart's normal rhythm (Fenton, Cherry, and Glass, 2008). Although they are common in children admitted to intensive care units, it is necessary for the condition to be treated as a life threatening emergency (Jat, Lodha, and Kabra, 2011; Khairy, Van Hare, Balaji, Berul, and colleagues, 2014; Sanatani, Cunningham, Khairy, Cohen, Hamilton, and colleagues, 2017). Several factors are required to evaluate rhythm disturbances in a child. These include the child's typical heart rate and rhythm, and the child's clinical condition, – especially hemodynamic status (Jat, Lodha, and Kabra, 2011).

According to Karpawich, Pettersen, Gupta, and Shah (2008), there are two differences when comparing arrhythmia in adults and in children. Firstly, abnormal cardiac heart rhythms occurring in children are commonly due to developmental alterations of the cardiac conduction tissue, genetically-inherited changes of myocardial cellular ion membrane properties and both pre- and post-surgical repair of associated structural congenital heart anatomical defects. Secondly, as opposed to

those in adults, abnormal rhythms occurring in the children can spontaneously disappear with progressive patient growth.

Arrhythmias in children can be classified according to their effect on central pulse in the following ways:

1.Fast pulse rate = tachyarrhythmia;

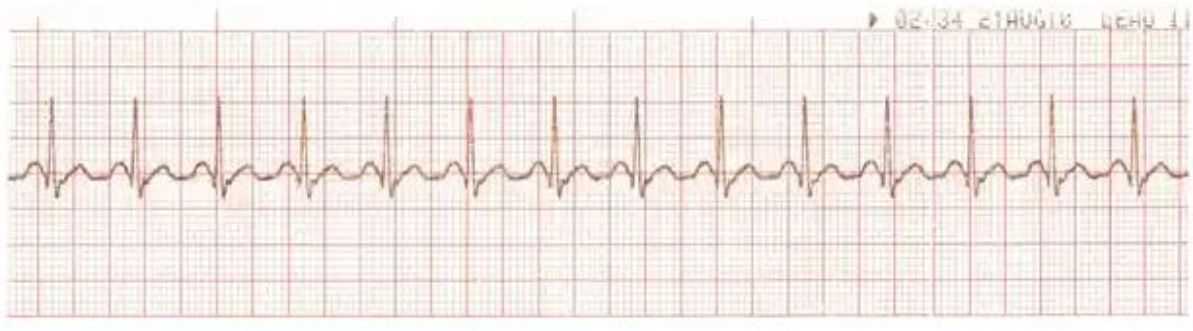
2.Slow pulse rate = bradyarrhythmia; and

3. Absent pulse = pulseless arrest (cardiac arrest).

Tachyarrhythmias

Tachyarrhythmias represents a variety of fast abnormal rhythms originating either in the atria or the ventricles of the heart. Tachycardia is defined as a heart rate that is fast compared with normal heart rate for the patient's age. However, more usually tachyarrhythmias are believed to arise from reentrant arrhythmias, in which the period of the oscillation is set by the time an excitation takes to travel in a circuitous path, rather than the period of oscillation of a pacemaker (Josephson, 2002).

Figure 2.1 **Electrocardiogram of a normal beating heart**



(Jat, Lodha, and Kabra, 2011)

Bradyarrhythmias

Bradycardia is defined as a heart rate that is slow compared with normal heart rates for a patient's age. Clinically significant bradycardia is defined as a heart rate less than normal for a patient's age associated with poor systemic perfusion. Bradyarrhythmias are the most common pre-arrest rhythm in children. They are often associated with conditions such as **hypoxia**, hypotension, and acidosis. Examples of bradyarrhythmias include: sinus bradycardia, sinus node arrest with atrial, junctional and idioventricular escape rhythms and AV block.

The heart rhythm is typically monitored by an electrocardiogram (ECG), which measures the voltage differences between points on the surface of the body (Gillete and Garson, 1999). Figure 2.1 shows the electrocardiogram of a normal beating heart. Table 2.1 shows the normal heart by age.

Table 2.1 **Normal heart rate by age**

Age	Heart rate (per minute)	Mean (per minute)
Newborn to 3 months	85-205	140
3 months to 2 years	100-190	130
2 years to 10 years	60-140	80
>10 years	60-100	75

(Jat, Lodha, and Kabra, 2011)

Only a small fraction (5%) of paediatric emergency hospital admissions are attributed to symptomatic arrhythmias (Strasburger, 1991). Primary care practitioners play a crucial role in diagnosing and treating childhood arrhythmias, which exhibit varying symptoms depending on age. Research has shown that paediatric arrhythmias often co-occur with underlying heart disease, and physical examinations may yield normal results despite significant arrhythmic disturbances (Bonow et al., 2011). Cognitive performance in children with arrhythmias has been

linked to basal respiratory sinus arrhythmia (RSA) and RSA regulation, with higher basal RSA predictive of better fluid intelligence (Staton et al., 2009).

Several studies have explored the relationship between arrhythmia and cognitive abilities, with inconclusive results (Hyde & Izard, 1997). A recent study examined cognitive and emotional functions in children and adolescents with atrioventricular reentry tachycardia (AVRT) and atrioventricular nodal reentry tachycardia (AVNRT), revealing cognitive deficits in nearly half of the patients, particularly those with earlier onset of arrhythmia (Maryniak et al., 2013). Another study investigated longitudinal functional and neuropsychological outcomes after paediatric out-of-hospital cardiac arrest (OHCA), finding that arrhythmia was the most common cause (33%) and that OHCA children exhibited worse sustained attention and processing speed scores (Hunfeld et al., 2021).

Atrial fibrillation, a common condition in older adults, has been linked to cognitive decline and morbidity (Hui et al., 2015). Research suggests that modulating effects of accepted treatments for atrial fibrillation on cognition warrant further investigation. Quality of life (QoL) studies in paediatric patients with cardiac arrhythmia are scarce, but one study found lower QoL assessments in children with supraventricular tachyarrhythmia (SVT) compared to healthy controls (Szafran et al., 2016).

Gao, Borlam, and Zhang (2015) investigated the relationship between cardiovascular reactivity and cognitive ability in middle childhood, specifically examining whether the findings of increased cardiovascular reactivity in relation to cognitive ability seen in infants, young adults, and the elderly can be extended to middle childhood. Findings of the study were consistent with existing literature in infants and older populations.

The study revealed the intricate relationship between cardiovascular function and cognitive development in middle childhood. By examining cardiovascular reactivity in relation to cognitive ability, this research contributes to our

understanding of the complex interplay between physiological and cognitive processes.

In another study, the quality of life (QoL) in paediatric patients with supraventricular tachyarrhythmia (SVT) was compared to healthy controls. The results show that SVT patients have lower QoL assessments in physical and psychological domains, but not in social and environmental domains. From a neuropsychological perspective, this study underscores the significance of considering the broader impact of supraventricular tachyarrhythmia (SVT) on paediatric patients' quality of life. The findings suggest that SVT affects not only physical well-being but also psychological functioning, which is critical for cognitive and emotional development. The study's results have implications for the development of holistic treatment approaches that address the interplay between physical and psychological health in paediatric patients with SVT. By acknowledging the neuropsychological consequences of SVT, healthcare providers can better support the comprehensive needs of these patients.

Three ways of treating arrhythmia have been identified. They include (a) doing nothing – especially when the condition is non-life threatening, (b) the use of certain drugs such as Digoxin (may cause nausea, vomiting, and diarrhoea), Adenosine (which can cause some chest pains), or Atropine (although it may cause difficulty swallowing) and finally (c) catheter ablation (McCammond, and Balaji, 2012; NHLBI, 2022).

Hypoxia

Hypoxia, or reduced oxygen availability, has been linked to adverse effects on neurocognitive development and function in children (Bass, 2004; Gozal, 2019). Chronic or intermittent hypoxia, such as that experienced by children with sleep-disordered breathing (SDB) or congenital heart disease (CHD), can lead to impairments in cognitive and academic performance (Gozal, 2019; Hogan et al., 2017).

Research has shown that hypoxia can affect various neurocognitive processes in children, including attention, memory, executive function, and processing speed (Gozal, 2019; Hogan et al., 2017). For example, a study by Bass (2004) found that children with SDB had significant impairments in attention and executive function compared to healthy controls. Similarly, Hogan et al. (2017) found that children with CHD had impairments in memory and processing speed.

The neurocognitive impacts of hypoxia in children are thought to be related to the effects of hypoxia on brain development and function. Hypoxia can lead to changes in brain structure and function, including reduced volume and activity in regions important for cognitive function (Gozal, 2019). Additionally, hypoxia can disrupt the normal development of neural connections and circuits, leading to long-term cognitive and behavioural impairments (Hogan et al., 2017).

In conclusion, hypoxia can have significant neurocognitive impacts on children, affecting various cognitive processes and leading to long-term impairments. Further research is needed to understand the specific mechanisms by which hypoxia affects brain development and function in children, and to develop effective interventions to mitigate these effects.

School Difficulties (Chess, 1968)

The theory of temperament and learning ability in school children, developed by Stella Chess (1968), provides a befitting theoretical framework to describe school difficulties. According to the theory, three major psychological factors influence a child's learning ability:

A. What?

B. Why?

C. How?

A. What?: This factor considers the suitability of tasks given to a child, its difficulty level, and if it matches the child's age. A discrepancy in the type of tasks given to a child in relation with the child's chronological age would definitely yield

negative results and school difficulties. If this task-child's age mismatch perseveres over a long period of time, this may cause the child to generally give-up on attempting this task, or other novel tasks. This "given-up" behaviour is similar to that expressed in "learned helplessness" (Maier and Seligman, 1967) which could be expressed in both adults and children. In addition, the "What" of learning also focuses on the child's cognitive capacity, ability to retain information, as well as the child's strengths and weaknesses in perceptual organisation.

B. Why?: This second factor, of particular importance to this study, is centred around the child's motivation, desire, and willingness to learn. If after personal assessment, the child perceives a task to be worth giving a try (that is, the task is within his/her maturity level), the child's proceding question would be: "do I really have to do this task?". "At this point and time, is it necessary for me to learn?". "What benefit will I gain if I engage in this task? The "Why" of learning could be regarded as the driving force/energy to which a child is willing or unwilling to learn, and the importance of this factor in a child's learning, growth, and development cannot be overemphasised.

C. How?: Finally, for the purpose of this study, the "How" factor perhaps marks the most important factor of a child's learning ability. This factor focuses on the child's style of behaviour as manifested in the classroom, and how he/she responds both to the individuals that make up his learning environment and to the tasks required of him/her.

This theory further categorises the temperaments into the following:

"1. Activity level: The motor component present in a given child's functioning, and the diurnal proportion of active and inactive periods.

2. Rhythmicity: The predictability of such functions as hunger, feeding pattern, elimination, and sleep-wake cycle.

3. Approach or withdrawal: The nature of the child's response to a new food, object, or person.

4. Adaptability: The speed and ease with which current behaviour can be modified in response to altered environmental structuring.

5. Intensity of reaction: The energy level of response, irrespective of its quality or direction.

6. Threshold of responsiveness: The intensity level of stimulation required to evoke a discernible response to sensory stimuli, environmental objects, and social contacts.

7. Quality of mood: The amount of pleasant, joyful, or friendly behaviour as contrasted with unpleasant, unfriendly behaviour, or crying.

8. Distractibility: The effectiveness of extraneous environmental stimuli in interfering with, or in altering the direction of, ongoing behaviour.

9. Attention span and persistence: These two categories are related. Attention span concerns the length of time a particular activity is pursued by the child. Persistence refers to the continuation of an activity in the face of obstacles to the maintenance of the activity" (Chess, 1968).

For a discussion on this theory, it is important to begin by clearly distinguishing temperament as used for the purpose of this study with the well-established concept of temperament (which relates to personality type). While both concepts, obviously, tend towards the ability to make adjustments to life, the author conceptualises the "temperament of learning ability" to be more flexible and adjustable; as opposed to temperament in personality.

The below table represents the relationship between Chess' nine temperaments, Luria's 16-fold subtests, and replacement ontogenesis method:

Table 2.3 ***Tabular representation of the link between replacement ontogenesis, Luria's subtests and Chess' temperament***

Replacement Ontogenesis Exercises	Related Luria's subtest	Chess' Temperaments
Breathing exercises	Rhythm reproduction, choice reaction	Rhymicity, intensity of reaction

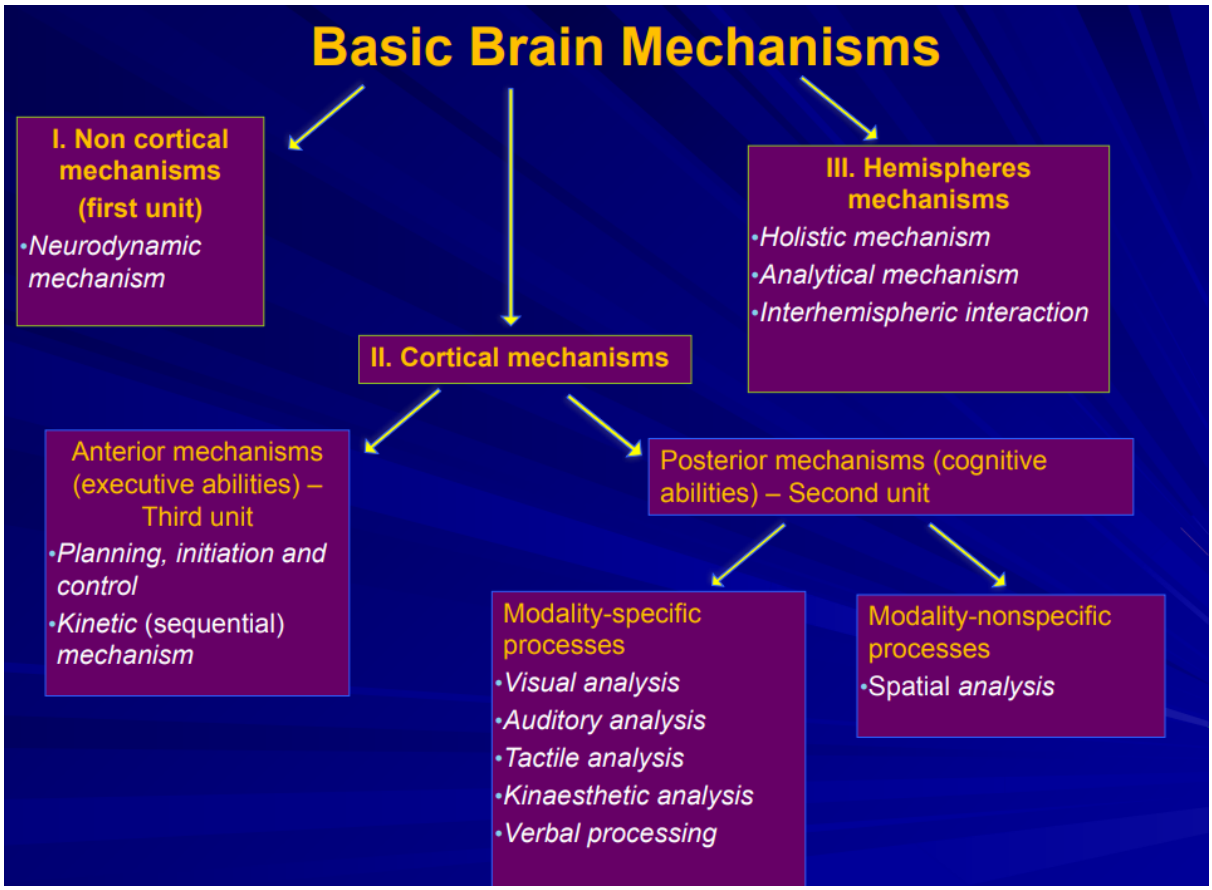
Stretching	Head’s test, imitating hand positions	Attention and persistence, approach or withdrawal
Relaxation	Choice reaction, word understanding	Threshold of responsiveness, quality of mood
Eye movement exercises	Manual motor sequences (kinetic), verbal memory	Adaptability
Basic exercises	Manual motor sequences	Activity level
Reciprocal coordination	Interhemispheric interaction, choice reaction, grammar understanding	Distractibility
Arm gymnastics	Manual motor sequences	Activity level

2.2. Luria's Approach to Neuropsychological Rehabilitation

As opposed to the conceptualisation of neuropsychological rehabilitation in the West - especially as prescribed in the Diagnostic and Statistical Manual for the Mental Disorders (5h edition) – DSM-V (APA, 2022) – Luria's neuropsychological approach views the brain as a dynamic, organised, and importantly a functional system. As a dynamic system, there is the presence of a wide range of flexible/possible changes, including developmental changes, which occur as a result of the age of an individual, or other factors. An organised system entails various motor and cognitive processes that do not occur haphazardly, but in an orderly and coordinated manner. Lastly, a functional system is characterised as having a defined/specific aim, is initiated/executed by interconnected components (or brain

units), and works in a dynamic manner. Figure 2 shows a schematic representation of the basic brain mechanisms according to the Luria's approach:

Figure 2 **Scheme showing Luria's Basic Brain Mechanisms**



A.R. Luria's approach to neuropsychological rehabilitation emphasises the concept of a neuropsychological syndrome, which considers the functional organisation of the brain and the behavioural system as a whole (Luria, 1970). This approach involves identifying the common underlying factor or cause of observed difficulties, rather than solely focusing on symptoms or diverse expressions of patient behaviour (Solovieva & Rojas, 2017).

Within the numerous interconnected dots and webbed activities of the brain's functional system, several dots makeup brain mechanisms. A specific brain mechanism which contributes to a respective component of the functional system is referred to as a neuropsychological factor. When several neuropsychological factors are combined, they provide a solid explanation on the neural basis of cognitive process(es) and behaviour(s).

Several scholars have given their opinions on Luria's approach. For example, Solovieva and Rojas (2017) reported that Luria's approach not only focused on the functional organisation of the brain, but also on the behavioural system in general. To them, it is very vital, when employing the Luria's approach, not to mistake a neuropsychological factor with symptoms. Symptoms, which often occur as mistakes made by a patient, could also encompass other "diverse expressions in the patients behaviour". The clinical application of the concept of neuropsychological syndrome means to consider the common reason (cause), or common base, of all the difficulties observed in each case.

Furthermore, several of Luria's colleagues and followers have also used his concept for developing different clinical pictures for adults and children (Simernitskaya, 1985; Xomskaya, 1987; Santana, 1999; Tsvetkova, 2001; Solovieva, Lázaro, and Quintanar, 2008; and Tsvetkova, 2004). From this approach, and upon which the focus of this study is built on, is the concept of substitution ontogenesis already explained (in Chapter 1: Introduction).

Korkman (1999) agreed to the use of Luria's approach specifically in the neuropsychological assessment of children. However, he further pointed out the difficulties in using a brain-behaviour model in children due to several factors to include brain abnormalities in children, comorbid disorders, and other factors. To overcome this difficulty, Luria's approach was adapted into a "Developmental Neuropsychological Assessment" - NEPSY, suitable for use with children (age 3-12). The NEPSY assessment is characterised by the integration of Luria's approach with contemporary child neuropsychological practices.

While the goal of this study is not aimed at another adaptation of Luria's approach, this study successfully links Luria's neuropsychological rehabilitation approach (especially his 16-fold subtests) with replacement ontogenesis, and dance/movement therapy (targeted specifically at developing rhythmic and kinetic skills). Refer to Table 2.1 for a tabular representation of Luria's subtests.

Neuropsychological Assessment of Children

Neuropsychological assessment of children requires consideration of age, developmental level, cognitive abilities, family and cultural background, and co-morbid difficulties (Middleton, 2003). A thorough assessment combines clinical interviewing, observations, and psychometric testing to identify the underlying causes of difficulties (Slepovich & Poliakova, 2012). Children's difficulties may present as memory and learning problems, absent-mindedness, forgetfulness, or struggles with verbal memory (Katona, 1988).

Observations during assessment may reveal repeated questions, difficulty with retention, and primacy or recency problems (Muñóz-Ledo, 2003). Qualitative examination of recall can identify strategies used to remember and learn (Pelayo et al., 2013). In child neuropsychology, establishing the level of maturation of subcortical or cortical functional relations is crucial (Santana, 1999). Separating cases with neurophysiological immaturity from cortical difficulties due to brain damage is essential (Tsvetkova, 2001).

Research has shown that neuropsychological rehabilitation programs based on Luria's approach can be effective in improving cognitive and behavioural functioning in children with brain damage or developmental disorders (Solovieva et al., 2008; Melnikova, 2015). Additionally, incorporating principles of neuroplasticity and cognitive reserve into rehabilitation programs can enhance their effectiveness (Horton, 2018).

Table 2.1 ***The 16-fold subtests within Luria's approach***

Subtests	**Brain Mechanism**	**Common mistakes**
Choice reaction	Planning, initiation and voluntary control	•Echopraxia (uncontrolled repeating the movements of the examiner) •Stereotype performance •Impulsivity •Slowness
Manual motor sequences (palm-fist-edge)	Kinetic (sequential) mechanism (Gross motor)	Kinetic (sequential) mechanism (Gross motor) Kinetic mistakes •Perseverations 1.Pathological 2.Single repeated movements •Elements are missing •Extra elements are added. •Performance is non-automated (elements are performed separately, with pauses between them). Spatial mistakes • Changing orientation Kinesthetic mistakes •Inaccurate posture

		Holistic mistake •Changing order
Drawing a fence	Kinetic (sequential) mechanism (fine motor)	•Pathological •Single repeated elements of fence Spatial mistakes •Not following the top edge Kinesthetic mistakes •Inaccurate fence Neurodynamic mistakes •Synkinesis
Interhemispheric interaction	Interhemispheric interaction in the movement	•Identity •Sequential execution Kinesthetic mistakes •Inaccurate posture Muscle tone •Inaccurate posture
Imitating hand positions	Kinesthetic analysis	•Inaccurate finger position •Searching for the correct finger position •Helping with another hand Mistake of voluntary control •Impulsivity

		Spatial mistake •Not correct fingers position in the space of hand
Visual perception		- Recognition of not coloured indistinct pictures Mistakes of perception • Difficulty with recognition of image (Tomato, Cap, Fire-pump) Mistakes of expressive language •Not correct naming: Bag - Handbag Balalaika – Guitar) Or using simple name: Clothes - Coat Saber - Knife •Description of the picture instead of naming Perseverative mistakes •Mushroom - Table lamp •Snake - Fire-pump •Telephone - Clock Mistake of voluntary control •Chaotic style of pointing out the pictures

		-Recognition of crossed-out pictures Mistakes of expressive language •Not correct naming: Bag - Handbag Balalaika – Guitar) Or using simple name: Clothes - Coat Saber - Knife •Description of the picture instead of naming Perseverative mistakes •Mushroom - Table lamp •Snake - Fire-pump •Telephone - Clock Mistake of voluntary control •Chaotic style of pointing out the pictures -Recognition of incomplete pictures Mistakes of perception •Difficulty with recognition of image (Comb, Jug) •Children 4-6 years of age (Pin, Teapot, Lightbulb, Bucket, Saber, Bender,

		Scale, Watering can) •Children 7 years of age and older can recognize all pictures Mistakes of holistic mechanism Mistakes of holistic mechanism •Fragmentary perception: Balalaika – Toothbrush Hammer - Brick Scissors – Spoon Anchor - Arrow) -Understanding the meaning of the story in the picture Mistake of voluntary control •Chaotic style of description Perseverative mistake •Looping on parts Analytical mechanism •Do not pay attention to details (snow ball, window) Holistic mechanism •A child cannot integrate details into a holistic story Mental retardation •Help from examiner does not help the child to

		understand the story
Visual memory for pictures	Visual memory	Memory mistakes •Omissions •Replacement with a picture that is close in meaning (Sheep instead of Goat, Goose instead of Swan, Bush instead of Tree) Mistakes of voluntary control •Lack of a positive dynamic in learning (plateau in performances) •Replacement with a picture that is far in meaning (Belt, Bottle) Kinetic mistakes •Perseverations (child shows the same picture in both groups) Neurodynamic mistake •Difficulty with reproducing the first set of 3 pictures
Visual memory for geometrical figures	Visual memory	Memory mistakes •Omissions •Incorrect geometrical figure

		Mistakes of voluntary control •Lack of a positive dynamic in learning (plateau in performances) Spatial mistakes •Mirror mistakes •Topological mistakes •Incorrect angles Right-hemisphere mistakes •Difficulty with reproducing the order of figures Left-handed •Inverse order of figures
Head's test	Spatial analysis	Spatial mistakes Mirror mistakes •Incorrect side •Incorrect orientation of palms •Topological mistakes Kinesthetic mistakes •Inaccurate posture Kinetic mistakes •Repetition of the previous position
Graphomotor subtest (mental rotation)	Spatial analysis	Spatial mistakes •Incorrect orientation •Mirror mistakes •Topological mistakes •Incorrect angles •Figure distortion

		Kinesthetic mistakes •Clumsy figures •Big figures mistakes •Synkinesis
Drawing a table	Spatial analysis (3D analysis) The ability to perceive and draw three-dimensional image	Spatial analysis (3D analysis) The ability to perceive and draw three-dimensional image Kinesthetic mistakes •Inaccurate (clumsy) table •Big-size table Neurodynamic mistakes •Synkinesis Kinetic mistakes •Repetition of the previously drawn table Mistakes of voluntary control •Lack of a positive dynamic in drawing (plateau in performances)
Rhythm reproduction	Auditory analysis	
	Verbal processing	Memory mistakes •Omissions •Replacement with a word

		which is close in meaning (COLD instead of FROST, MAN instead of GUEST) •Replacement with a word which has similar sound (RIS instead of RISK) Mistakes of phonemic analysis •Replacement with word which has similar sound (GUESS instead of GUEST) Mistakes of voluntary control •Lack of a positive dynamic in learning (plateau in performances) •Replacement with a word that is far in meaning Kinetic mistakes •Perseverations (child repeat the same word in both groups) 1 group - FROST, WINDOW, WEDGE 2 group - FROST, RISK, RAIN Neurodynamic mistake •Difficulty with reproducing the first set of 3 words Right-hemisphere mistakes

		•Difficulty with reproducing the order of words 1 group – WEDGE, FROST, WINDOW 2 group – RISK, FROST, RAIN
Phonemic analysis	Verbal processing (phonemic level)	
Words understanding	Verbal processing (word level)	
Grammar understanding	Verbal processing (sentence level)	

Table 2.2 ***Replacement Ontogenesis exercises and their specific target***

Exercises	Target
Breathing exercises	They soothe, develop self-control, improve the rhythm of the body, autonomic functions, and concentration.
Stretching	These exercises help to optimise and stabilise the muscle tone of the body.
Relaxation	Promotes relaxation, introspection, and the recreation of polymodal sensory images. It can be used both to regulate tone, improve self-control, and integrate the experience gained during the lesson.
Eye movement exercises	Exercises expand the field of vision, improve perception, and contribute to the formation of voluntary attention. Joint movements of the eyes, hands, tongue develop hand-eye coordination, interhemispheric interaction
Basic exercises	A complex of bodily-motor exercises aimed at developing basic motor skills (tonic and locomotor movements).
Reciprocal coordination	Exercises aimed at the formation of interhemispheric interaction, improving the effectiveness of self-control.
Arm gymnastics	Aimed at the development of fine motor

Exercises	Target
Breathing exercises	They soothe, develop self-control, improve the rhythm of the body, autonomic functions, and concentration.
Stretching	These exercises help to optimise and stabilise the muscle tone of the body.
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Eye movement exercises	Exercises expand the field of vision, improve perception, and contribute to the formation of voluntary attention. Joint movements of the eyes, hands, tongue develop hand-eye coordination, interhemispheric interaction
Basic exercises	A complex of bodily-motor exercises aimed at developing basic motor skills (tonic and locomotor movements).
	skills, speech, memory, and attention.

Table 2.3 ***BNPCD and relationship with Luria's 16-subtests***

Exercises	Related Luria's subtest
Breathing exercises	Rhythm reproduction, choice reaction
Stretching	Head's test, imitating hand positions
Relaxation	Choice reaction, word understanding
Eye movement exercises	Manual motor sequences (kinetic), verbal memory
Basic exercises	Manual motor sequences (kinesthetic, kinetic)
Reciprocal coordination	Interhemispheric interaction, choice reaction, grammar understanding
Arm gymnastics	Manual motor sequences

CHAPTER 3: METHODS

Design

A pretest-posttest within subject experimental group design was used for the study. In other words, the children belonged to the same treatment group, received the same treatments, and were tested before and after the administration of treatments. Due to a convenience sampling technique used and the scope of the study, there was no control (comparison) group.

Participants

Participants were two male children (outpatients) referred for neuropsychological assessment/rehabilitation at the Psychology Unit of Rehabilitation Clinic of Dr. Volova, Chkalova-Yekaterinburg, Russia. Participants were conveniently sampled, based on their availability. Parents provided verbal consent for the children to participate in the study.

Child 1 (referred to as **C1** henceforth)

Age: 12

Gender: Male

Anamnesis: Has cardiac arrhythmia. This prolonged cardiac arrhythmia has led to frequent hypoxia.

In more details, **C1** is from a family of 6 children, and is currently homeschooled. As at the period of conducting and completing this study, none of the older or younger children have been diagnosed with diseases of the nervous system. The reason for treatment was two episodes of sudden loss of skills (reading and writing) and deterioration of higher mental functions.

At the age of 10, the child, sitting at the table, lost consciousness. After a restoration of normal state of consciousness, it was discovered that the child had lost some of the skills acquired before this age, such as reading and writing, counting

and calculation skills. His attention indicators also worsened, signs of field behaviour appeared, and criticism of his behaviour and actions decreased.

After rehabilitation measures and the transition to homeschooling during a multidisciplinary medical examination, the lost skills were partially restored. However, after the child returned to school, he again had a regressive episode without loss of consciousness, followed by a deterioration in cognitive function and a repeated decline in reading, writing and arithmetics. In addition, the child has severe hyperplasticity of the joints, progressive postural disorders, and enlargement of internal organs. He is being seen by a neurologist, epileptologist, paediatrician, geneticist, and psychiatrist (specialists from Yekaterinburg and Moscow).

A preliminary diagnosis was made - the onset of a hereditary unspecified neurodegenerative disease (Niemann-Pick questionable). An extensive examination by a geneticist did not reveal the presence of genetic neurological and psychiatric diseases in the child. Due to changes in the EEG, the child was examined by epileptologists. The diagnosis of epilepsy is completely excluded, but the latest EEG showed an increase in pathological activity at night, which is associated with the course of an unspecified disease.

At the moment, Moscow doctors have come to the conclusion that the cause of the child's condition is an acute heart rhythm disorder leading to cerebral ischemia (autonomic dysfunction of the sinus node - migration of the pacemaker). Ekaterinburg specialists insist that the neurodegenerative disease is progressing, the examination is ongoing, and the child is not receiving specific or nonspecific drug treatment. Correctional work was carried out by two main specialists: a neuropsychologist and a speech therapist.

Child 2 (referred to as **C2** henceforth)

Age: 12

Gender: Male

Anamnesis: Child is without neurological or psychiatric diagnosis.

In more details, **C2** is the only child in a family of father and mother. He was brought to the clinic by his mother who gave complaints about motor clumsiness, school failure, and poor grades in the Russian language and mathematics. During initial interaction and assessment of **C2**, it was observed he had a decrease in his functional control, decrease in a large number of activities requiring switching, and problems in spatial perception. These observations led to particular attention being paid to his muscle-joint functioning.

Treatments

Two categories of treatments were administered to the study participants:

(a) Basic Neuropsychological Program for Child Development - **BNPCD** (age 5–12) by replacement ontogenesis method (Kolganova and Pivovarova, 2015), and

(b) treatment tasks (ball training, dance and guitar rhythm) specifically designed by the researcher, and pre-existing tasks (metronome task).

Basic Neuropsychological Program for Child Development Manual

This manual comprises twenty-four (24) lessons targeted at children with difficulties in motor activities, attention, speech, memory, forming spatial representations, regulating emotions, writing, reading, and in mathematics. Lessons are designed to be conveniently administered by parents, psychologists, teachers, and other professionals.

Each lesson is made of four (4) broad exercises covering respiratory exercises, eye-movement exercises, stretching, and a repertoire of motor exercises. All exercises, from Lesson 1-24, progress from simple to moderate to difficult levels. That is, Lesson 1-8 were simple basic exercises. Lesson 9-16 consisted of moderately more advanced exercises than Lesson 1-8. Finally, Lesson 17–24 consisted of the most demanding, tasking, and advanced exercises; compared to Lesson 1–16. The following illustrates four (4) broad exercises, a

Breathing exercise

The child is asked to lie on his back (with head facing up) on a clean mat laid on the floor. His right and left hands are placed at the sides of his body in such a way that both hands touch his body, and the palm of each hand rests on the mat. The researcher instructs the child that on hearing “вдох” (breath-in), he should breath-in in such a way that his stomach moves inwardly into his body. “Выдох” indicates the child should exhale (breathout) in such a way that his stomach protrudes outwardly. This is repeated 3-5 times (depending on the lesson from the manual).

During advanced levels, the child performed the breathing exercise with a pause after “breath-in”, and also after “breath-out”. In addition, rhythm was added to the breathing exercise, so that there are 1-5 counts (1,2,3,4,5) after “breath-in”, 1-3 counts after “pause”, 1–5 counts after “breath-out”, and finally 1–3 counts after “pause”. Also, verbal counting (1-5), while at advanced levels, was completely replaced with claps. This aided the child to maintain their own bodily rhythm.

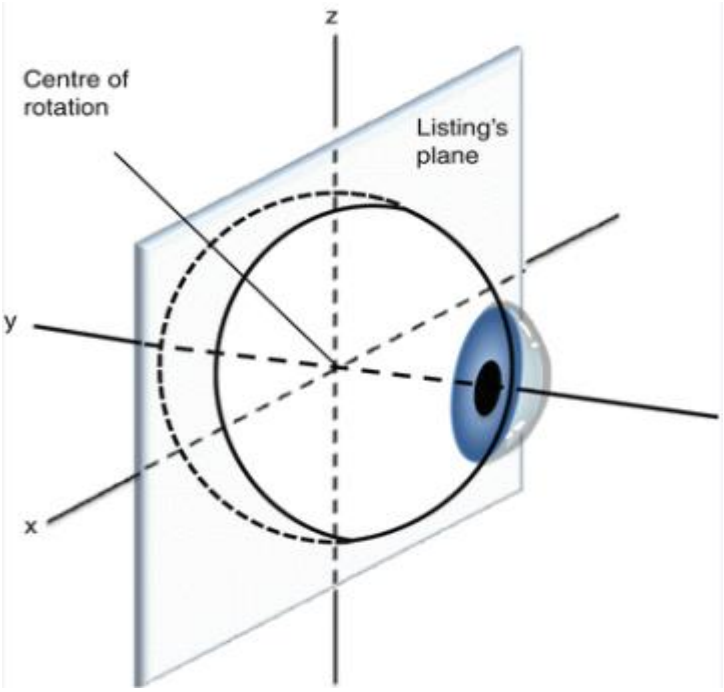
The major target of the breathing exercise is the ability to establish healthy rhythmicity with one’s body, regulate breathing/emotions, and the conservation of energy.

To track the recommended manner of the breathing exercise, the researcher placed his hand on the stomach of the child during breathing exercises.

Eye-movement exercise

The exercise here involved moving the eyes rightward, leftward, upward, and downward while looking at a red-coloured moving marker controlled by the researcher. Figure 3.1 illustrates a close resemblance to the eye movement procedure.

Figure 3.1 **Analogy of eye-movement during eye-movement exercise**



(Ento key, 2024)

The distance of the marker from the eyes was determined using the child's stretched hand length. The first stage was conducted using the distance of the child's fully stretched hand; so that the marker touches the tip of his middle finger. Second stage distance was to the elbow length of a stretched-out hand. The third and final stage was the distance between the child's eyes and the tip of his nose. To begin the exercise, the researcher held the marker (at the required distance) and moved it slowly to the right (in a straight line/plane), back to the centre, to the left, and back to the centre. The same procedure was carried-out while moving the marker upwards and downwards.

During advanced levels, the children administered the test to themselves. That is, they held the marker with their own hands and performed the exercise as already explained above. Also, the breathing exercise was merged with breathing exercise in such a way that while the eyes moved rightward, the child had to breath-in. The brief stop before the moving eyes begin to return to the central plane indicates pause. The period of the eyes finally moving back to the central plane meant breath-out.

The brief stop before the moving eyes begin to return to the central plane indicates another pause.

The major target of the eye-movement exercise is the improvement of oculo-motor skills which in turn positively influences reading ability, and the ability to easily scan the environment. In addition, the exercise also enhances voluntary control.

Stretching

Stretching exercises were predominantly exercises or tasks in which the child had to muster courage to overcome hindrances and stress. For example, the child is wrapped around his body with a flexible mat in such a way that only his head and lower legs stick out of the mat. The researcher asks the child to "wiggle" his body out of the mat (without the help of his hands which also have been wrapped).

The major target of the stretching exercise is improving self-induced motivation, and learning to overcome stressful/demanding situations in which there are only a few options for escape.

Repertoire of Motor Exercises

Exercises here are vast varieties of exercises which encourage motor movements; especially symmetrically and asymmetrically. For example, in an advanced level repertoire of motor exercises, the child is expected to move hands, legs, eyes, and tongue in specific manners.

The first stage is establishing symmetry between hand and leg movement. To do this, the child kneels on both legs (with knees touching the floor), and both hands with palms to the floor. Movement could be carried-out headward (that is, crawling forward), or sideways (to the left or right side of crawling position). In an advanced level left sideways movement type, the left hand simultaneously moves with the left leg (by verbally giving command of "1"), and the right hand simultaneously moves

with the right leg (by verbally giving command of “2”). Eye-movement could be either to the same direction of the moving hand, or opposite the direction of the moving hand. Tongue movement could be same direction of the moving eyes, or opposite the direction of the moving eyes. Total steps made could be upto eight (8) steps or more (depending on when the child reaches a natural obstacle in the room, like the room’s wall or door. After reaching the end of the left sideways movement direction, the same procedure is performed for a right sideways movement type. That is, the right hand and the left leg move simultaneously to the right, and so on.

The next step of this exercise is the asymmetrical movement where the left hand simultaneously moves with the right leg, and the right hand and left leg simultaneously move together. Here, eye-movement is usually to the direction of wherever the hand is moving towards, while tongue movement is usually the opposite direction of the moving eyes.

The major target of this exercise is interhemispheric brain interaction. In addition, a kinetic mechanism (through tongue movement) is established, as well as an oculo-motor mechanism (through eye-movement). A summation of all of the movements lead to a gross motor activity, and performing the exercise while being given common by the researcher establishes rhythmicity.

Dance Session

Initially, dance training was designed to be in two stages:

(a) a preliminary stage to establish basic understanding of the dance session, movements/steps, and overall rhythmicity, and

(b) an advanced stage with more designed movements of the hand, leg, tongue, and with the understanding of space where the exercise is being executed - that is, switches in forward/backward/zig-zag movements. Due to an observed sustained low motivation in the children during the preliminary stage of the dance, the advanced stage was cancelled and not executed.

Dance consisted of sequenced movements to a slowed down tempo version (playback back speed 0.5) of the YouTube Music song: “The Gym Beats Vol.4-NONSTOP-MEGAMIX” – refer to references for link to this music (YouTube App, 2024). Dance was specifically designed to develop rhythmic and kinetic skills of the children. In addition, the dance session also targeted interhemispheric brain interaction of the dancer by engaging different body parts moving symmetrically or asymmetrically.

The dance movements involved the Right Leg (**RL**), Left Leg (**LL),** Right Hand (**RH**), Left Hand (**LH**), and Tongue (**T**) movements in varying directions. Before dance begins, the dancer is expected to stand erect - in a Standby Position (**SBP**) - with both legs brought together, and Both Hands (**BH**) holding a ball at the core (centre) of the body (Figure 3.2).

In order to make the dance session easy for participants, there was only one dance step in every four beats of the music being played. This is explained as thus:

Musical beat: 1…2…3…4…5…6…7…8
Step: 1……..2……..

After participants mastered the steps and did not miss the rhythm (that is, were on beat), the steps increased to two (2) dance steps in four (4) beats. This is explained as thus:

Musical beat: 1…2…3…4…5…6…7…8
Step: 1……..2.....1……...2….

Ball training

Ball training primarily involved throwing and passing balls between the child and the researcher – on a rubber disc (while reciting a nursery rhyme or words beginning with a certain letter), without a rubber disc, or while the child was seated

(especially when the child complains of being tired). Without a rubber disc, the passing sequence was either anticlockwise or clockwise as follows:

1. The researcher throws the ball with his RH to the child to catch with his LH.

2. The child passess the ball to his RH, throws it back to the researcher to catch with his LH, and the researcher repeats the whole process (from step 1 above). The above (anticlockwise) two steps were also executed in a clockwise manner. Shape formed during ball passing in this throwing style is a rectangle (**Appendix 7**).

In an asymmetric manner, the researcher passes the ball using his LH to the child to catch with his LH. The child passes the ball to his RH, throws it at the researcher to catch with his RH, and the researcher repeats the whole process from the start. Shape formed during ball passing in this throwing style is an infinity sign or the number "8" **(Appendix 8)**.

Guitar rhythm

Guitar rhythm was carried out using a nylon guitar, at standard tuning (EADGBE), and either on the Key of **C** or **G.** Chord progression was **Amin-Emaj** (on the key of C), or **Emin-Dmaj** (on the key of G). The researcher first demonstrated the body movement sequence to the child (using verbal count -1,2,3,4, and without guitar rhythm), after which they both performed it slowly together. After this, the sequence was then performed with guitar rhythm at alternating tempos (slow to moderate to fast, or vice versa). Alternating tempos captured the attentiveness of the child.

Metronome task

Finally, the metronome task involved performing a palm-fist-clap hand movement – within a tight space (that is pencils), or within an open space (the entire table space in front of the child). In an advanced step, the child was asked to perform

the above task while performing mathematical calculations (like 10-5=?). This task is not novel, but readapted to suit specific needs of the child.

Neuropsychological tests

A complete Luria's neuropsychological battery was used in the assessment of the children. These 16-fold subtests assessed the children's choice reaction, rhythm reproduction, manual motor sequences, verbal memory, amongst others (refer to Table 3). The researcher ensured the professional treatment of all study participants, and paid great attention to their current emotional state while testing was carried-out. All testing was carried-out in the Psychology Office – which is moderately lit, quiet, and a conducive environment.

Drawings (for example, Complex Figure or fence) and writings were done using pencils with varying colours (depending on test), and on an A4 paper. Taps (while testing rhythm reproduction) were done on the wooden table of the office.

To enhance communication with the children (while speaking the Russian language), the researcher conducted testing which required lesser instructions (for example, rhythm reproduction, image copying and memorisation, etc), while his Clinical Supervisor (a licensed Psychologist) conducted tests which required extensive instructions (for example, test on telling the story from a picture).

All data generated through the assessment of the children are the sole property of the Clinic which the study was conducted. The researcher was only allowed access to photographed copies of these data.

Materials

Lesson manual, neuropsychology battery sheets (including images, pictures, drawings, etc), Schulte table - single and double (refer to Appendix), inflated small balls, inflated rubber balance disc, A4 papers, coloured pencils, Album for Brain Development: (a) Memory and Attention, and (b) Logic, Rhythm, Reading, and

Analysis (Natalia Talyzina), work-out mats, smartphone (for playing music and stopwatch), fully equipped physiotherapy gym, and other materials.

Procedure

Every lesson started first with capturing the attention of the child either through performing a double-Schulte test (Appendix 3), or any related exercise from the Album for Brain Development - Memory and Attention (Natalia Talyzina).

After successfully capturing the child's attention, a dance session followed.

Dance Procedure

At the command of the researcher, the dance sequence began (Figure 3.2). At Begin Position **BP** (on Count 1), the dancer is expected to move to the left side of their **SBP**; just by lifting only their **LL**, and raising **BH** above the head while holding a ball. At Count 2, **RL** is returned to **LL**, and **LH** holds the ball while **BH** is returned to **SBP** (Figure 3.1). Count 1 & 2 are repeated four (4) times, leading to a total of eight (8) steps to the left.

At the 8th step, dance movement changes to the right hand side.

When the dance sequence is to the left, the **RH** is expected to hold the ball while **BH** is being raised to meet above the head. The completion of SBP-BP-SBP is regarded as a complete dance sequence (DS). In total, there are four (4) DS to the left, and four (4) to the right.

Figure 3.2 **Standby Position (SBP)**

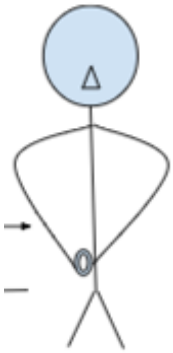
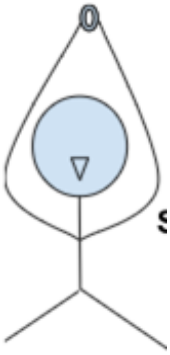


Figure 3.3 **Begin Position (BP)**



CHAPTER 4: RESULTS

The study was carried out from the end of January to mid-May, 2024. The correction program and the inclusion of oculomotor and breathing exercises in it were in all cases agreed upon with the epileptologists and neurologists observing the children.

At the end of the study, neuropsychological assessments had been carried-out before the start of the study (before Lesson 1), at the middle of the study (after Lesson 12), and at the end of the study (after Lesson 24).

Basic brain mechanisms harnessed during the study are as follows:

1. **I Functional block of the brain (neurodynamics):** qualitative assessment of the child's performance during the examination - using the Schulte test.

2. **III Functional block of the brain:**

A. Regulation and control: Qualitative assessment of the child's performance during the examination on choice reaction, and through Schulte test.

B. Kinetic (dynamic) component of movements and actions (kinetic mechanism).

C. Qualitative assessment of the child's work on dynamic praxis, and choice reaction.

3. **II functional block of the brain:**

A. Visual analysis:

- ➢ simple pictures (shape recognition)
- ➢ Identification of crossed out images
- ➢ Recognition of superimposed images (Poppelreiter figures)
- ➢ Chimeric images
- ➢ Story pictures
- ➢ Visual memory (memorising verbalised figures – 6 figures)
- ➢ Visual memory (memorising non-verbal images – 4 images)
- ➢ Visuo-spatial activity, spatial factor

- ➢ Table drawing
- ➢ Changelings
- ➢ Taylor drawing, Ostereith (+ hemispheric factors)
- ➢ Head's samples
- ➢ Praxis finger poses (+kinesthetics)

B. Auditory-speech analysis

- ➢ Auditory-verbal memory (cold frame wedge/guest, risk of rain)
- ➢ Auditory motor coordination (rhythms)
- ➢ Figure recognition (nominative function of speech)
- ➢ Study of understanding of close words (phonemic factor)
- ➢ Understanding logical-grammatical structures
- ➢ Interhemispheric factor
- ➢ Reciprocal coordination
- ➢ Figures by Taylor-Ostereith

All classes consisted of three blocks:

1. Neuropsychological support for children 5-12 years old (Kolganova Pivovarova).

2. Tasks (designed by the researcher) for the development of the kinetic component of movements and actions, and the development of rhythmic abilities. Activities included:

- ball training
- elements of dance training
- working out rhythms using a live instrument (guitar)
- tasks with a metronome

Tasks in this block were primarily at the development of the kinetic mechanism, the development of visual-motor and auditory-motor coordination, kinesthetic and spatial factors and interhemispheric interaction, as well as the development of the processes of regulation and control of activity.

3. Individual tasks and modifications of tasks from the second block, aimed at correcting deficits identified during the diagnosis of a particular child.

All children studied individually.

When compiling the program, the principle from simple to complex was used. Also, all proposed exercises and instructions gradually became more complex, and the degree of external organising assistance and support gradually decreased. Finally, the principle of the child's zone of proximal development was also taken into account.

Ball training

Ball training primarily involved throwing and passing balls between the child and the researcher - on a rubber disc (while reciting a nursery rhyme or words beginning with a certain letter), without a rubber disc, or while the child was seated (especially when the child complains of being tired). Without a rubber disc, the passing sequence was either anticlockwise or clockwise as follows:

3. The researcher throws the ball with his RH to the child to catch with his LH.

4. The child passess the ball to his RH, throws it back to the researcher to catch with his LH, and the researcher repeats the whole process (from step 1 above). The above (anticlockwise) two steps were also executed in a clockwise manner. Shape formed during ball passing in this throwing style is a rectangle (**Appendix 7**).

In an asymmetric manner, the researcher passes the ball using his LH to the child to catch with his LH. The child passes the ball to his RH, throws it at the researcher to catch with his RH, and the researcher repeats the whole process from the start. Shape formed during ball passing in this throwing style is an infinity sign or the number "8" **(Appendix 8)**.

Elements of dance

Initially, dance training was designed to be in two stages:

(a) a preliminary stage to establish basic understanding of the dance session, movements/steps, and overall rhythmicity, and

(b) an advanced stage with more designed movements of the hand, leg, tongue, and with the understanding of space where the exercise is being executed - that is, switches in forward/backward/zig-zag movements. Due to an observed sustained low motivation in the children during the preliminary stage of the dance, the advanced stage was cancelled and not executed.

Guitar rhythm

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Metronome task

Finally, the metronome task involved performing a palm-fist-clap hand movement – within a tight space (that is pencils), or within an open space (the entire table space in front of the child). In an advanced step, the child was asked to perform the above task while performing mathematical calculations (like 10-5=?). This task is not novel, but readapted to suit specific needs of the child.

Specific brain mechanisms targeted and observed during these sessions include:

➢ Non-cortical (neurodynamic) mechanism - assessment of the integrated performance of the child during tasks.

➢ Hemispheric mechanism – interhemispheric interaction while performing tasks which are symmetrical (for example, simultaneous movement of the right hand/leg during guitar rhythm or dance) and/or asymmetrical (metronome task, simultaneous movement of the right hand-left leg, or left hand-right leg during guitar rhythm or dance).

➢ Non-cortical mechanism – encompassing executive abilities (planning, initiation, and control of switches in ball throwing, metronome task, or body part during dance-guitar rhythm tasks; finger/tongue kinetics during ball training, guitar rhythm, or dance), and cognitive abilities (audio-visual analysis of the relationship between music/guitar rhythm and the corresponding body part to be moved, and spatial analysis of the appropriate direction to go during ball training and dance).

Final results

Child 1

Age: 12

Gender: Male

Anamnesis: Has cardiac arrhythmia. This prolonged cardiac arrhythmia has led to frequent hypoxia.

In more details, **C1** is from a family of 6 children, and is currently homeschooled. As at the period of conducting and completing this study, none of the older or younger children have been diagnosed with diseases of the nervous system. The reason for treatment was two episodes of sudden loss of skills (reading and writing) and deterioration of higher mental functions.

At the age of 10, the child, sitting at the table, lost consciousness. After a restoration of normal state of consciousness, it was discovered that the child had lost some of the skills acquired before this age, such as reading and writing, counting

and calculation skills. His attention indicators also worsened, signs of field behaviour appeared, and criticism of his behaviour and actions decreased.

After rehabilitation measures and the transition to homeschooling during a multidisciplinary medical examination, the lost skills were partially restored. However, after the child returned to school, he again had a regressive episode without loss of consciousness, followed by a deterioration in cognitive function and a repeated decline in reading, writing and arithmetics. In addition, the child has severe hyperplasticity of the joints, progressive postural disorders, and enlargement of internal organs. He is being seen by a neurologist, epileptologist, paediatrician, geneticist, and psychiatrist (specialists from Yekaterinburg and Moscow).

A preliminary diagnosis was made - the onset of a hereditary unspecified neurodegenerative disease (Niemann-Pick questionable). An extensive examination by a geneticist did not reveal the presence of genetic neurological and psychiatric diseases in the child. Due to changes in the EEG, the child was examined by epileptologists. The diagnosis of epilepsy is completely excluded, but the latest EEG showed an increase in pathological activity at night, which is associated with the course of an unspecified disease.

At the moment, Moscow doctors have come to the conclusion that the cause of the child's condition is an acute heart rhythm disorder leading to cerebral ischemia (autonomic dysfunction of the sinus node – migration of the pacemaker). Ekaterinburg specialists insist that the neurodegenerative disease is progressing, the examination is ongoing, and the child is not receiving specific or nonspecific drug treatment. Correctional work was carried out by two main specialists: a neuropsychologist and a speech therapist.

Correctional work was carried out by two main specialists: a neuropsychologist and a speech therapist. Obtained results are as follows:

Table 4.1 **Subtest assessment results (Child 1)**

Test	Primary diagnosis	Repeated diagnosis
Motivation to exercise	Unstable, low. Decreased due to impaired understanding of instructions	Sustainable. Diligently completes tasks.
Understanding instructions	Low, only simple, maximum two-step instructions	Full understanding of instructions
Neurodynamics (exhaustion).	High exhaustion, can work for 5-10 minutes, after which he complains of fatigue, lies down on the table, jumps off the chair, often changes position, needs rest	Passed a full diagnostic test (60 minutes) without interruptions. By the end of the lesson, he showed signs of exhaustion, manifested in decreased motivation and active interest in what was happening, excessive physical activity and frequent changes of posture.
Schulte	1 min 20 sec	49 sec
Fence Errors: Perseveration (repeating elements) Substitution (replacing sloping lines with vertical lines or vertical lines with sloping lines). Placements Breakaway Macro and micrography Spatial errors (line failure)	 No Yes 3 3 No Yes	 No Yes 1 1 No No

Dynamic Praxis -availability of joint implementation with a psychologist -availability of self-execution -expansion of the program -Perseveration -Violation of the order of elements -Spatial-kinesthetic errors	Available without errors Available - - + + (search and replace horizontal/vertical fist pose)	Available without errors Available - - - + (search for pose)
Choice reaction Type 1 Type 2	1 error with self-correction 3 errors with self-correction	No mistakes No mistakes
Simple pictures (out of 16) Recognized Correct nomination	15 14	16 16
Crossed out images (out of 6) Correct nomination	6 6	6 6
Overlay images (out of 16)	15	16
Unfinished images (out of 12) Correct nomination	9 7	10 10
Chimeric images	correct	correct
Visual memory Verbalizable figures (out of 6) Non-verbalizable figures (out of 4)	6 4	6 4
Table drawing Alone By memory Copied	Half Volume Volumetrically inaccurate Volumetrically accurate	Volumetrically inaccurate Volumetrically accurate Volumetrically accurate
Changelings Figure 1 Figure2 Figure 3	Correct on 1 try Wrong on 3 tries Wrong on 3 tries	Correct on 1 try Correct on 1 try Correct on 2 tries

Complex figure drawing Metric errors Structural-topological strategies Holistic Analytical Regulatory errors	 No Single Underutilised (slight decline) Fully used Yes	 No No Fully used Fully used Yes
Head's test (with and without re-encryption)	No mistakes	No mistakes
Imitating hand positions 5 poses right hand 5 poses left hand	 4 correct 4 correct Errors - search Spatial errors	 5 correct Search in 1 position 5 correct Search in 1 position
Body diagram	Formed, identification of body parts without errors	Formed, identification of body parts without errors
Right/left differentiation		
Auditory-verbal memory 1st call 1 group 2nd group 2nd call 1 group 2nd group 3rd call 1 group 2nd group Slowed-down call 1 group error 2nd group	 0 1 3 3 3 3 2 “Risk/list” 2	 3 3 3 3 3 3 2 “Klin/klen” 3

Auditory motor coordination Evaluation of rhythmic structures Executing rhythms according to the pattern	Failed 4 out of 8 are	No mistakes 5 out of 8 are correct
Reciprocal coordination	Available with glitches and errors, at a slow pace	Available at a slow pace
Reading and writing skills	At the time of diagnosis, writing was partially restored; he writes in block letters; when switching to capital letters, he finds it difficult to write connections. Reading skill is at a low level, at a very slow pace, only by syllables. Understanding the meaning of what you read is almost impossible.	The writing skill has not been fully restored and continues to experience difficulties in using capital letters. Reading is slow, syllable by syllable, understanding of what is read is fully accessible, can analyse the text read, highlight the main characters in it, the main plot.
Complaints/Assessment of child dynamics by teachers and parents	Reduced criticism towards one's condition. Experiences difficulty maintaining attention, low motivation to learn, and is distracted by various minor stimuli. Decay in reading and writing skills.	Parents note that the child has become much more collected, is able to concentrate and complete tasks to the end, academic performance has increased, and an understanding of the text read has appeared. There remains reduced criticism of one’s condition and difficulties in reading and writing, but both have become accessible.

Table 4.2 **Results for tasks on developing kinetic/rhythmic skills (Child 1)**

Task	Initial observation	Final observation
Dance	-Excessive slowness to process appropriate next dance step(s) to take. -Awkward erect standing position -High inability to keep to rhythm -Required constant hints on the dance sequence.	-Reduced slowness to process appropriate next dance step(s) to take. -Awkward erect standing position still exists. -Reduced inability to keep to rhythm. -Required lesser hints on the dance sequence
Ball training	-Awkward erect standing position. -Fanciful movements which appear unnecessary to achieve the current activity. -Required a few hints on the appropriate hand/direction to pass the ball.	-Sustained awkward erect standing position. -Sustained fanciful movements which appear unnecessary to achieve the current activity. -Required no hint(s).
Guitar rhythm	-High inability to keep to rhythm. -Excessive slowness to process appropriate next dance step(s) to take.	-Reduced inability to keep to rhythm. -Reduced slowness to process appropriate next dance step(s) to take.

	-Low performance in asymmetrical sequences compared to symmetrical sequences.	-Stable performance between asymmetrical sequences compared to symmetrical sequences.
Metronome task	-Required several hints -Several errors in keeping to rhythm -Occasionally forgot the switching task and executed it appropriately.	-Required fewer hints -Fewer errors in keeping to time -Improved understanding of the switching task and executed it appropriately.

Neuropsychological conclusion

1. **Initial primary deficits of the child:** neurodynamics, programming and control of activity, dynamic organisation of movements (switching) in fine motor skills, visuo-spatial recording of graphic images by 180 degrees, and in reading and writing skills.

2. **Strengths:** Good visual analysis, visual memory, and no pronounced decrease in auditory-verbal memory.

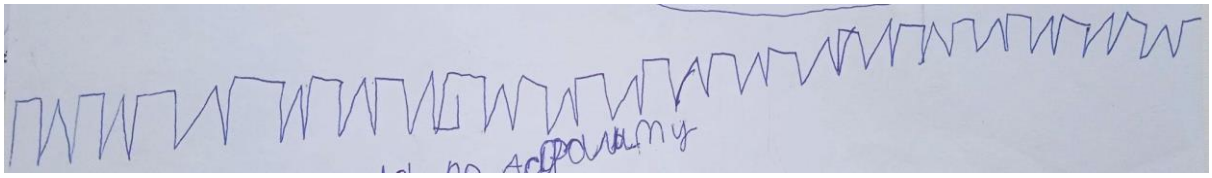
3. Several noticeable improvements in dynamics at the end of the study include:

- neurodynamic properties - increased motivation,
- regulatory functions - (a) programming and control of activities by reducing the number of impulsive errors, reducing the need for external organising assistance, and increasing the properties of attention, its stability and concentration; (b) a slight improvement in dynamic properties - greater ease of switching in writing, fine/gross motor skills, and speech.
- Visuo-spatial analysis and spatial representations.
- Improved reading skills evident by understanding the text being read.

- Reports indicating improvements in the child's behaviour, his emotional-volitional sphere, self-organisation abilities, and less mental exhaustion by doctors and parents.

Figure 4.1 **Pretest fence drawing for C1**

Figure 4.2 **Posttest fence drawing for C1**



Child 2

Age: 12

Gender: Male

Anamnesis: Child is without neurological or psychiatric diagnosis.

In more details, **C2** is the only child in a family of father and mother. He was brought to the clinic by his mother who gave complaints about motor clumsiness, school failure, and poor grades in the Russian language and mathematics. During initial interaction and assessment of C2, it was observed he had a decrease in his functional control, decrease in a large number of activities requiring switching, and problems in spatial perception. These observations led to particular attention being paid to his muscle-joint functioning.

Results

Control diagnostics were carried out immediately after the child was discharged from the hospital, where he underwent a gastroenterological examination for three weeks. The child demonstrated a deterioration in results compared to the interim diagnosis carried out during the mid-assessment (that is, after Lesson 12). Results are as follows:

Table 4.3 **Subtest assessment results (Child 2)**

Test	Primary diagnosis	Repeated diagnosis
Motivation to exercise	Stable, high	Sustained high
Understanding instructions	Available in full according to age	Available in full according to age
Neurodynamics (exhaustion)	There are no signs of severe exhaustion. The pace of mental activity is slightly reduced	There are no signs of severe exhaustion. The pace of mental activity is slightly reduced
Schulte	1 min 25 sec	51 sec
Fence Errors: Perseveration (repeating elements) Substitution (replacing sloping lines with vertical lines or vertical lines with sloping lines). Placements Breakaway Macro and micrography Spatial errors (line failure)	 No No 7 3 No No	 No No 0 1 No No
Dynamic Praxis		

-availability of joint implementation with a psychologist -availability of self-execution -expansion of the program -Perseveration -Violation of the order of elements -Spatial-kinesthetic errors	Available with kinesthetic and spatial errors Doesn't understand the program + + + +	Available with kinesthetic and spatial errors Available- 1 one error in left hand, no error in right hand +
Choice reaction Type 1 Type 2	 2 errors 2 errors	 0 errors 0 errors
Simple pictures (out of 16) Recognized Correct nomination	 15 15	 16 16
Crossed out images (out of 6) Correct nomination	6 4	6 6
Overlay images (out of 16)	13	15
Unfinished images (out of 12) Correct nomination	6 6	11 11
Chimeric images	correct	correct
Visual memory Verbalizable figures (out of 6)	 6	 6
Table drawing Alone By memory Copied	 Volumetrically inaccurate Volumetrically inaccurate Volumetrically inaccurate	 Volumetrically inaccurate Volumetrically accurate Volumetrically accurate
Changelings Figure 1 Figure2 Figure 3	 Didn't complete the task	 Correct after 3 attempts Incorrect on 1 try, did not correct the error Correct on 2 tries
Taylor, Rey-Osterrieth Figure		

Metric errors Structural-topological Strategies Holistic Analytical Regulatory mistakes	No Yes Fully used Fully used Yes No	Yes No Fully used Fully used Yes No
Head's test (with and without re-encryption)	With mistakes	No errors - mirrored With errors - with re-encryption (long search)
Imitating hand positions 5 poses (right hand) 5 poses (left hand)	 2 correct 3 correct Errors - search All poses are indistinct	 3 correct Search in 1 position 4 correct Search in 1 position All poses were indistinct
Body diagram	Formed, identification of body parts without errors	Formed, identification of body parts without errors
right/left differentiation	Differentiates poorly	Differentiates, but here are errors with self-correction
Auditory-verbal memory 1st call Group 1 2nd group 2nd call Group 2 2nd group 3rd call Group 1 Group 2 Slowed-down call Group 1	 0 1 2 3 2 2 0	 2 errors (called words from group 2) 0 3 2 3 3 3

Group 2	2	2
Auditory motor coordination Evaluation of rhythmic structures Executing rhythms according to the pattern	2 of 4 were correct 5 out of 8 were correct	3 out of 4 were correct 7 out of 8 were correct
Reciprocal coordination	Available with glitches and errors, at a slow pace, all movements are blurred	Available at a slow pace
Reading and writing skills	Reading by age, at a low pace. letter - with errors	Letter without errors
Complaints/Assessment of child dynamics by teachers and parents	Complaints about school failure, grades in Russian and mathematics for dictations and tests.	Mom notes the positive dynamics at school; he got 4 and 5 marks for tests and dictations. Finished the year without C grades.

Table 4.4 **Results for tasks on developing kinetic/rhythmic skills (Child 2)**

Task	Initial observation	Final observation
Dance	-Moderate slowness to process appropriate next dance step(s) to take. -Moderate inability to keep to rhythm -Required a few hints on the dance sequence.	-Reduced slowness to process appropriate next dance step(s) to take. -Reduced inability to keep to rhythm. -Required no hint on the dance sequence
Ball training	-Frequently protruded tongue while performing training. -Required a few hints on the appropriate hand/direction to pass the ball.	-Reduced protruded tongue while performing training. -Required no hint(s).

Guitar rhythm	-Moderate inability to keep to rhythm. -Slight slowness to process appropriate next dance step(s) to take. -Stable performance between asymmetrical/symmetrical sequences, with several mistakes. -Synkinesis is predominant.	-Significant reduction in the inability to keep to rhythm. -Little or no slowness to process appropriate next dance step(s) to take. -Stable performance between asymmetrical/symmetrical sequences, with a few mistakes. -Reduced, but still present synkinesis.
Metronome task	-Required a few hints. -Few errors in keeping to rhythm. -Synkinesis is predominant. -Understood the switching task and executed it appropriately.	-Required fewer hints -Near perfect ability to keep to time -Reduced, but still present synkinesis. -Sustained understanding of the switching task and executed it appropriately.

Neuropsychological conclusion

1. **Synkinesis:** The child had synkinesis (uses tongues simultaneously with almost any mental activity, or while under mental tension). Special efforts were made to eliminate them. By the end of the program, isolated synkinesis appeared due to fatigue.

2. **Deficits:** Spatial representations, visuo-spatial activity and spatial organisation of movements, kinesthetics, kinetics (switching in fine and gross motor skills), auditory-motor coordination, visual analysis, and school performance.

3. **Improvements:** Positive changes were observed in the dynamics – improvement in the kinetic component of movements, auditory coordination, visuo-spatial activity, spatial organisation of movements, visual analysis, and attention indicators. Also, school performance has improved. And finally, synkinesis has practically disappeared.

Figure 4.3 **Pretest Complex Figure drawing for C2**

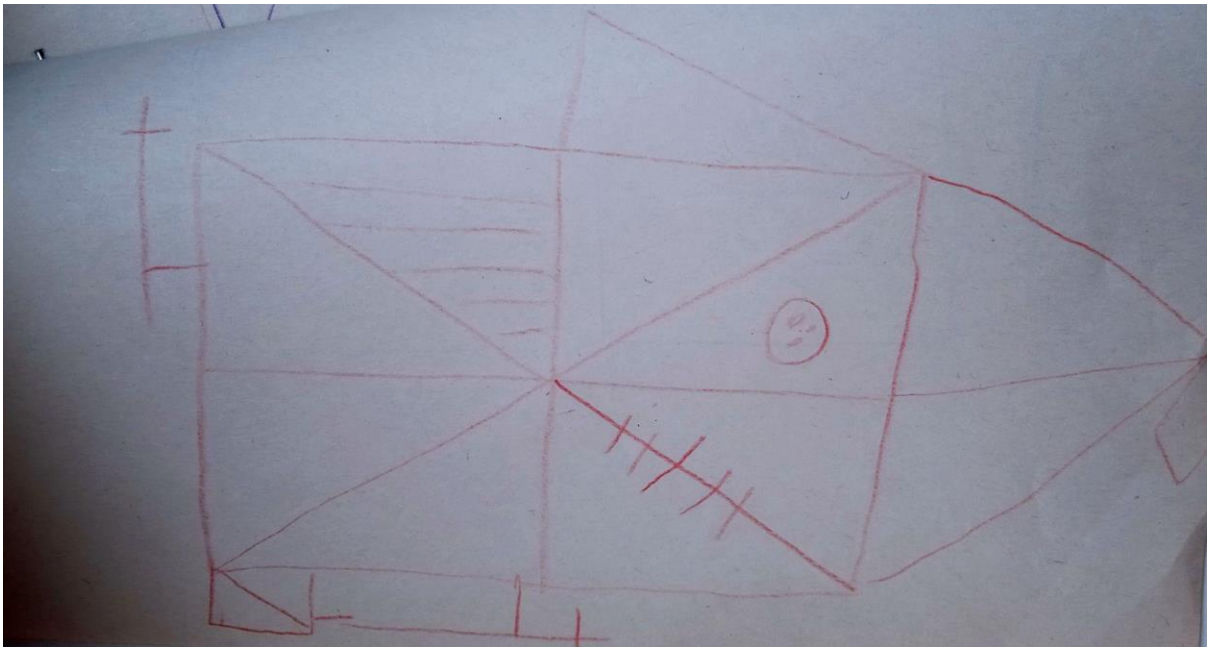
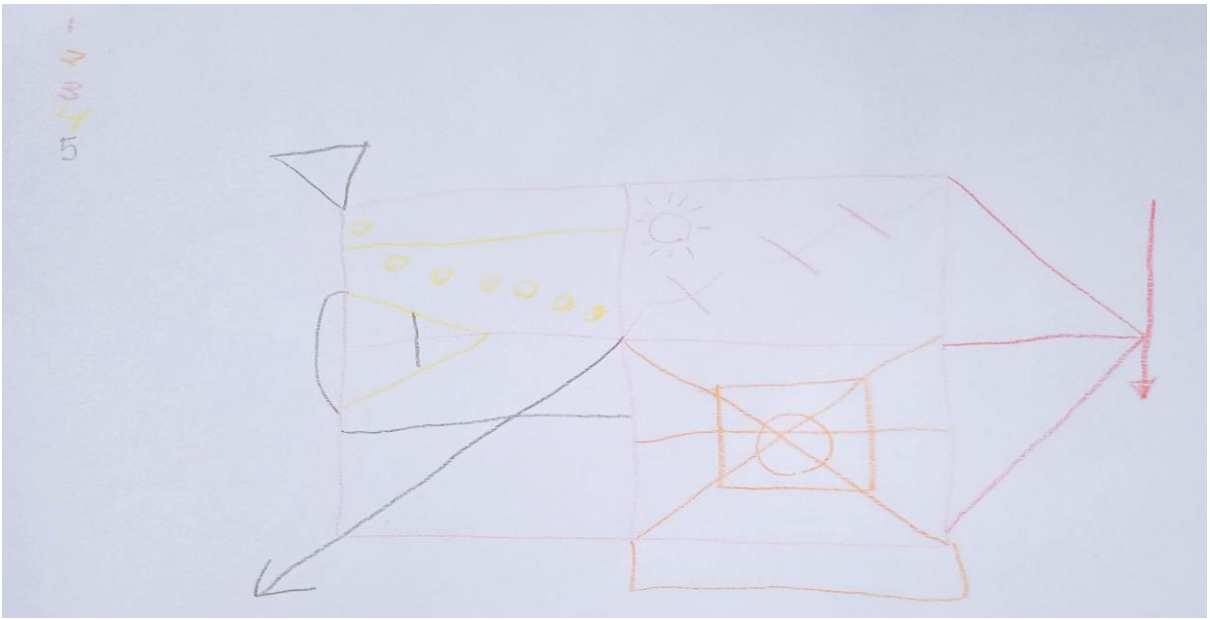


Figure 4.4 **Posttest Complex Figure drawing for C2**



The above mentioned qualitative assessments carried-out and results obtained lead to accepting the hypothesis.

CHAPTER 5: DISCUSSION/CONCLUSION

Results of the study show a slightly positive impact of the treatments administered to the children (BNPCD and dance), especially as evidenced in the reports provided by parents and teachers. Reported improvement in academic performance, grades, self-regulation in class, and attention are positive indices to improved learning ability, and overcoming school difficulties.

These results support previous (single) use of the replacement ontogenesis method in classroom teaching and educational reform (Stepanchenko, Partyko, Rybalko, Bobrovytska, Serdiuk, and colleagues, 2021; Piechka, Gonchar, Koval, Kusii, Lytvyn, and colleagues, 2022). Fadyeyev, and Fadyeyeva (2019) reported the use of the method in improving attention and overcoming learning difficulties. Interestingly, the replacement ontogenesis method has also been reported to be effective even in addressing conflict behaviour/bullying (Borisovna and Valeryanovna (2018).

Furthermore, existing literature has also shown the positive use of dance (as a neuropsychological rehabilitation technique) in children. For example, the use of dance has been shown to be highly beneficial for children with special needs (Borbáth, 2021), in overcoming intellectual disability and emotional/behavioural problems (Takahashi, An, Matsumura, Seki, Ogawa, and colleagues, 2023; Moula, Powell, Brocklehurst, and Karkou, 2022), and generally a great tool in child therapy (Weitz, 2017). Zilius (2010) provides extensive and inexhaustible benefits of dance in general.

However, it is important to note that the treatments administered and results obtained in this study may or may not be easily transferable for use with other children. Several factors such as the age, country of origin, previous exposure to music/dance, and even socio-economic background could influence the effectiveness of the treatments. For example, as Kolganova and Pivovarova (2015) stated in the 24-lesson manual used with the children, lessons prescribed in the manual are not appropriate for children with certain respiratory diseases (such as

asthma), and several other conditions. For the dance exercises, the researcher has personally noted socio-cultural differences that may exist in rhythm perception and reproduction. To this, a child's ability to first sense, process, and move to the rhythm of a song may be greatly influenced by the sociocultural background of that child, and the predominant genre of music of the child's culture.

In addition, while the field of (Child) Neuropsychology continues to expand, several limitations in neuropsychological testing and techniques have been identified. Reynolds, and Mason (2009) believe that only a few renowned observers such as Ward Halstead, A. R. Luria, Hans Teuber, Karl Pribram, Roger Sperry have made significant contributions to the field of neuropsychology through techniques, methods, and tests which they introduced. For example, Glozman (2007) stated that "Luria gained great insights into brain function with his rather informal, sometimes impromptu, bedside examination and discussions with soldiers with head injury".

At the same time, clinical and research practises in neuropsychology have been criticised by even neuropsychologists (for example, Ruff, 2003; Prigatano, 2003; Dodrill, 1997, 1999;) and professionals from related disciplines (for example, Coles, 1978; Reschly & Gresham, 1989). These researchers from related fields have specifically stated a lack of attention to research design principles in the field, and a failure to unite advances in psychometric methods of the past 25 years (Reynolds, and Mason, 2009).

Berrol (2000) strongly believes that Dance/Movement Therapy (D/MT), like other "process oriented forms", are difficult to be measured using traditional scientific methods (quantitative-experimental designs involving statistical analysis). This explains one of the major reasons why the researcher adopted a qualitative (rather than quantitative) assessment and analysis of the data obtained during the study.

For **C1,** overall performance showed good coordination of movements, but hyperplasticity of the joints and fanciful movements which did not go away during the program. Awkward erect standing position of the child is as a result of scoliosis - a condition characterised by a curved spine (**Appendix 8**). According to Janicki

and Alman (2007), several causes of scoliosis include congenital, neuromuscular, syndrome-related, idiopathic factors, and spinal curvature due to secondary reasons. Treatments vary depending on the type of scoliosis, but commonly include bracing and surgery. The scoliosis observed in the child, associated with a yet to be identified muscular pathology, and combined with pathology of the nervous system have intensified. This most likely may be as a result of the general progression of the child's disease.

Finally, synkinesis observed in **C2** could be assessed using a "Synkinesis Assessment Questionnaire" (Mehta and WernickRobinson, 2007). Amongst others, treatment for synkinesis could be pharmacological (Husseman and Mehta, 2008), surgical (Azizzadeh, Irvine, Diels, Slattery, Massry, and colleagues, 2019), or as is related to the field of this study, neuropsychological (Diels, 2022; Zavaliy, Ramazanov, Kalantarova, Rakhmanina, Kholmogorova, and colleagues, 2022).

5.1 Implications of the study

Findings of this study show positive potential clinical use of the combination of replacement ontogenesis and dance in improving the learning ability of children. Specifically, the methods have shown promise in overcoming school difficulties, and improving attention and self-regulation.

Nevertheless, the researcher acknowledges other available proven techniques for improving the learning abilities of children, including the supervised use of (a) Artificial Intelligence – AI (Jamet, Masson, Jacquet, Stilgenbauer, and Baratgin, 2018), (b) the development of metacognitive abilities which improve self-regulated learning (Dörr and Perels, 2019), and finally (c) listening to music (Foran, 2009).

5.2 Recommendations

1. The researcher calls on other professionals in the field of Child Clinical Neuropsychology to critically probe this work, and identify possible loopholes to which the goal of this study could be replicated.

2. The researcher also suggests that further research endeavours from this work should consider more participants, and be conducted longitudinally.

3. Finally, the researcher suggests that further research studies focused on the clinical benefits of dance should first determine the baseline multicultural differences in rhythm perception, reproduction, and music appreciation (in terms of genre of music to be danced to).

5.3 Limitations

1. A significant limitation of this study is in the small sample size of the participants; thereby, reducing the generalisability of the findings of the study.

2. Certain (extraneous) factors, which the researcher considers may have negatively influenced the performance of the children, were completely unavoidable. These included consecutive public holidays during the study period, and occasional absence of the children from lessons.

3. Although the duration of the study is appropriate for the scope of a master's thesis, the researcher believes a longitudinal study would have yielded different results than what was obtained.

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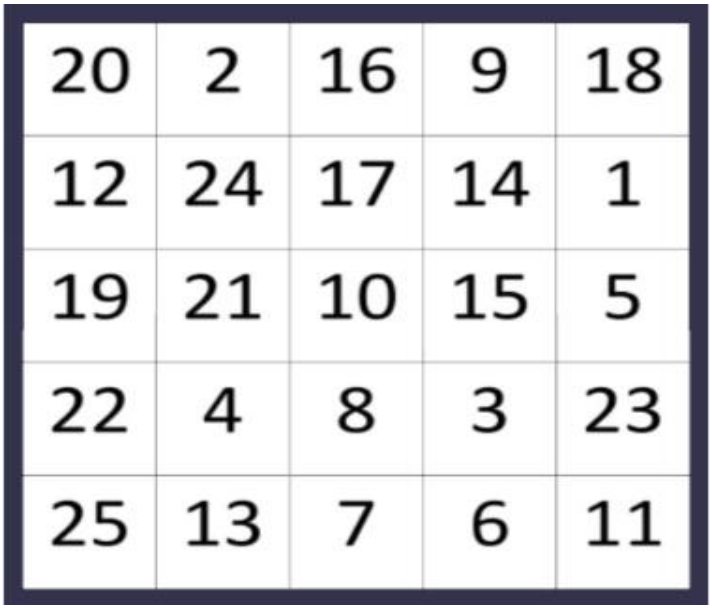
APPENDIX

Appendix 1 (Schulte test table; Type 1)

18	20	2	22	10
19	16	6	9	3
5	23	1	21	24
13	25	4	15	8
12	7	11	17	14

Single Schulte table (ResearchGate, 2024)

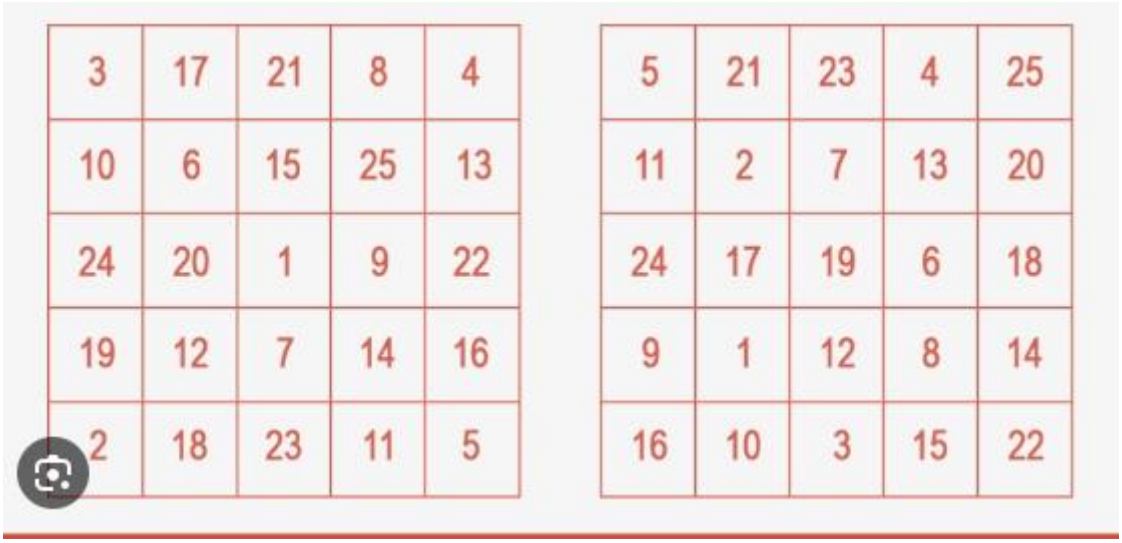
Appendix 2 (Schulte test table; Type 2)



20	2	16	9	18
12	24	17	14	1
19	21	10	15	5
22	4	8	3	23
25	13	7	6	11

schulte-table.com

Appendix 3 (Double Schulte test table)

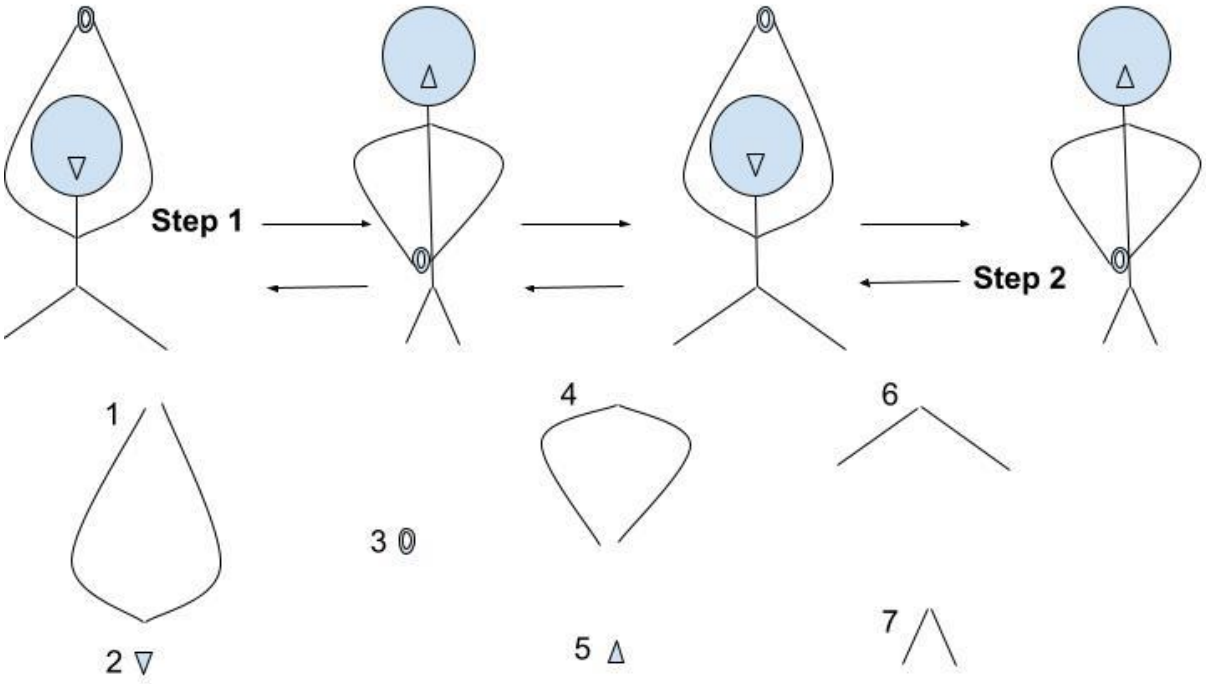


3	17	21	8	4
10	6	15	25	13
24	20	1	9	22
19	12	7	14	16
2	18	23	11	5

5	21	23	4	25
11	2	7	13	20
24	17	19	6	18
9	1	12	8	14
16	10	3	15	22

m.vk.com

Appendix 4 (Dance session pictorial representation)



Key 1= raised right and left hands (upwards, above head)

2= tongue (raised downwards)

3= ball

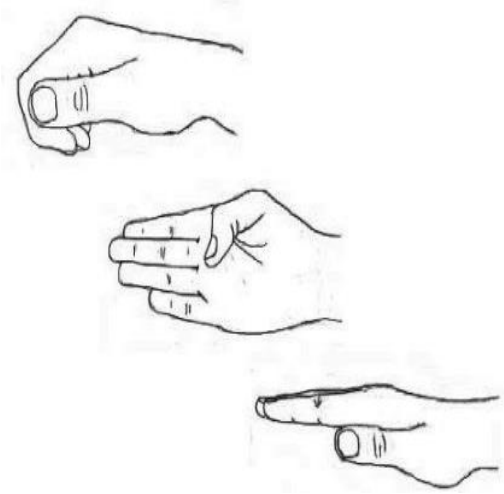
4= lowered right and left hands (downwards, below waist)

5= tongue (raised upwards)

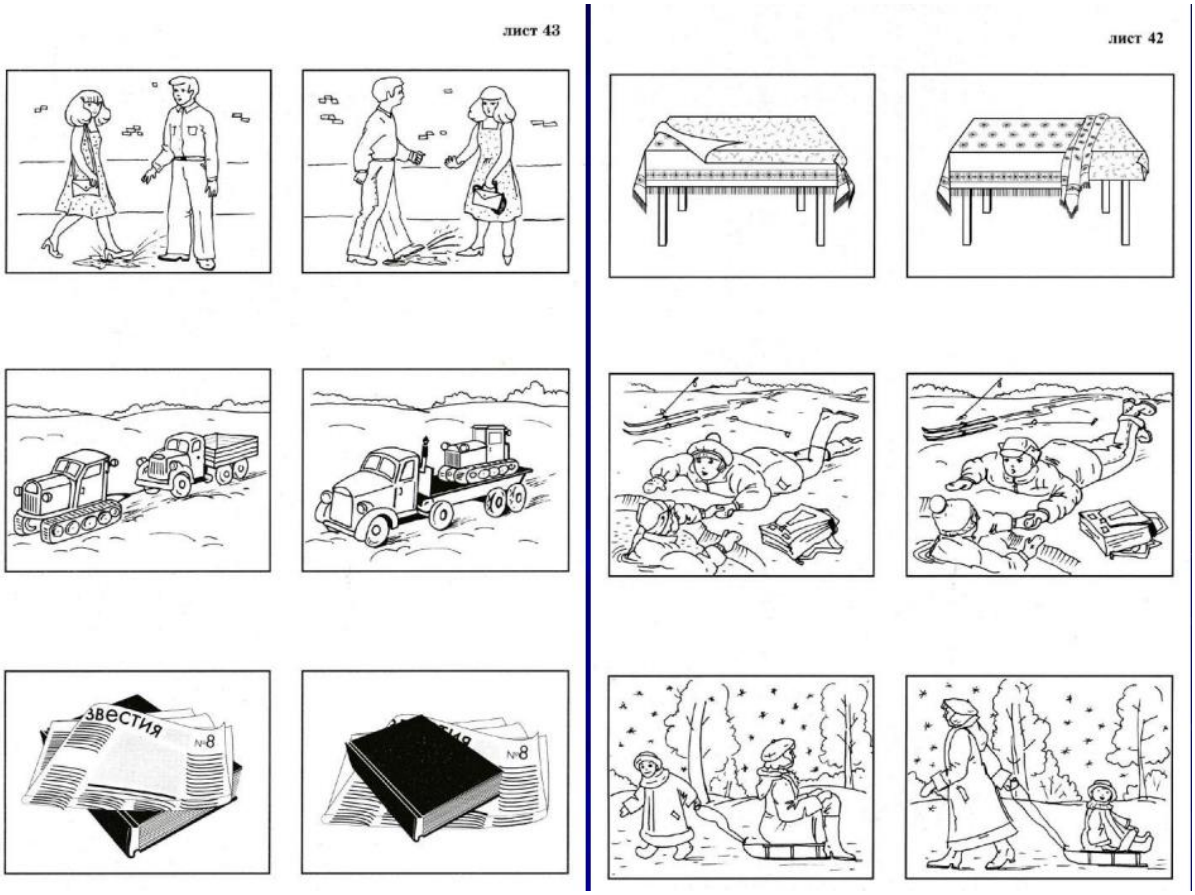
6= right and left legs spread apart

7= right and left legs brought together

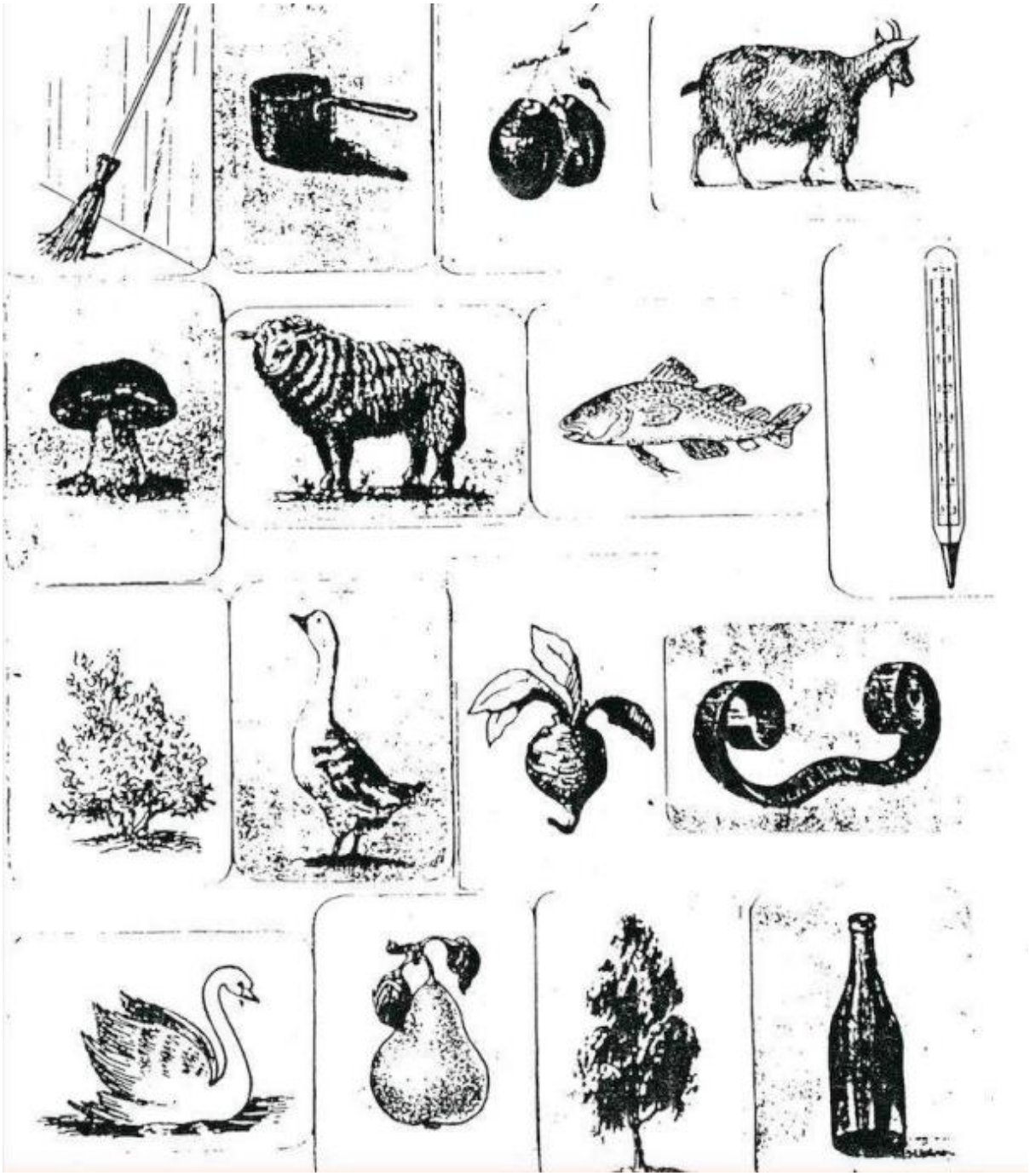
Appendix 5 (Palm-fist-edge image)



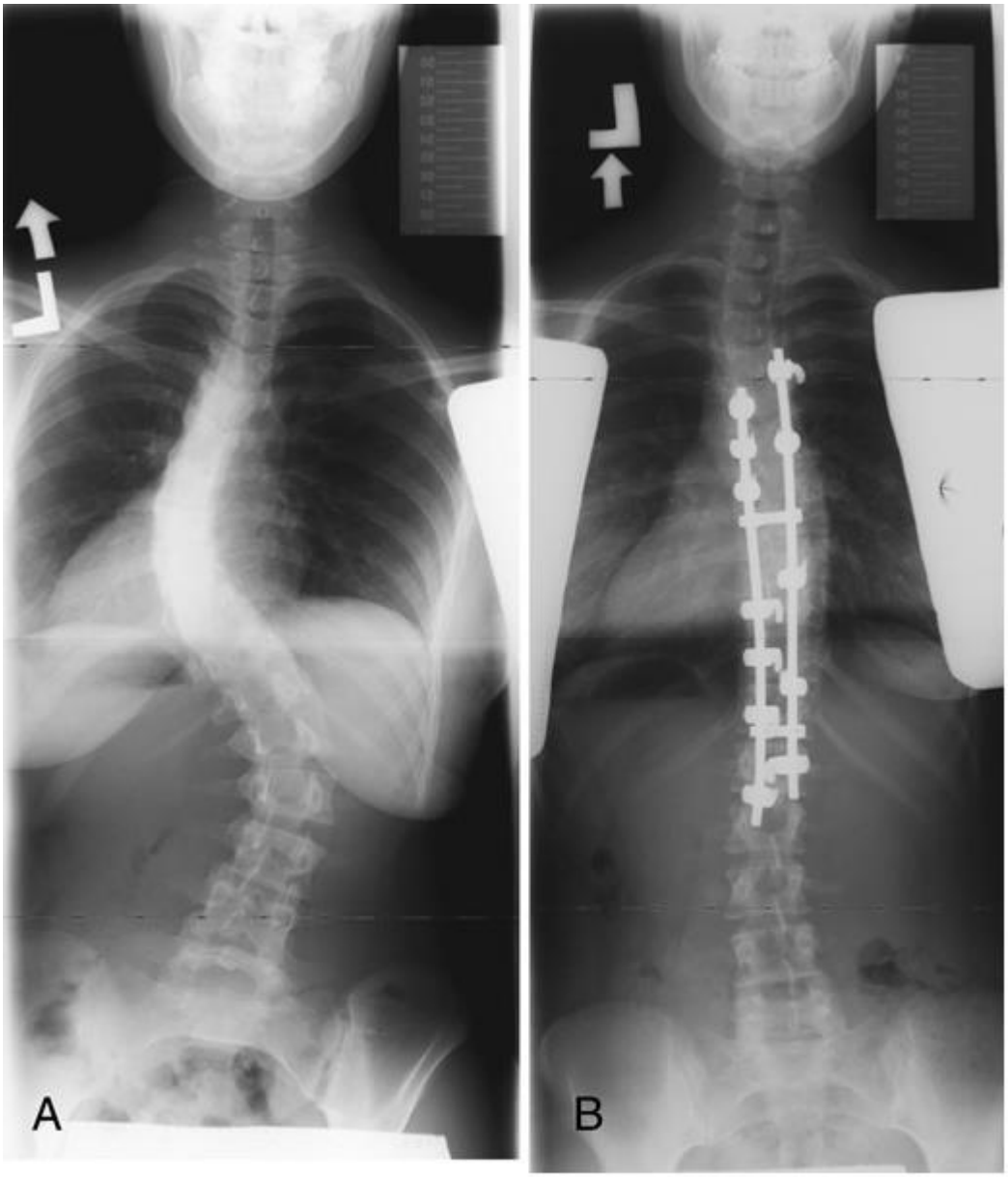
Appendix 6 Grammar Understanding Test



Appendix 7 Test of verbal memory



Appendix 8 Scoliosis image and a treatment type



A*Typical adolescent idiopathic scoliosis requiring correction and fusion;***B***Fused spine with screw construct*

Janicki and Alman (2007)