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ORIGINAL ARTICLE

The Effect of RCA Software on Psychomotor Education of Children Diagnosed with Autism Spectrum Disorder

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Ethical Statement
Ethical approval was obtained for this research from the Scientific Research Ethics Committee of Çanakkale Onsekiz Mart University Graduate Education Institute (Date: 26.10.2023, 13/42).

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Conflict of Interest
This research was presented at the 1st Interdisciplinary Special Education Congress held at Istanbul Aydın University between 6-8 December 2024.

ABSTRACT

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition that emerges in the early years of life and is characterized by deficits in social communication and interaction, verbal and non-verbal communication difficulties, and restricted, repetitive patterns of behavior. Due to these differences, various developmental skill areas are adversely affected in individuals with ASD. The aim of this study is to examine the effectiveness of the exercises included in the RCA Software in enhancing the psychomotor skills of children with autism in a more effective, enjoyable, and rapid manner, and to observe the impact of these exercises on other developmental domains. Within the scope of the study, exercises focused on muscle tone, coordination, rhythm, breathing, and impulse control have been implemented, and both the relevance of these exercises to their intended purposes and their effectiveness in supporting other developmental areas have been evaluated. The study involved two children, aged seven and eight, diagnosed with moderate ASD. As a result of the intervention, meaningful improvements have been observed in several developmental areas. In both children, the most notable improvement has been seen in the area of fine motor skills, while the least progress has been observed in speech comprehension and independent living skills. Additionally, varying degrees of improvement have been recorded in gross motor skills, speech, social behaviors, and perception.

Keywords: Autism Spectrum Disorder, RCA Software, psychomotor, development

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INTRODUCTION

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder that manifests from the early years of life through symptoms such as deficits in social communication and social interaction, verbal and non-verbal problems, and restricted and repetitive behaviors. Due to these neurodevelopmental differences, many skill areas are affected. One of these skills, psychomotor skills, is defined as "purposeful, coordinated motor movements." Coordination of psychomotor movement is of significant importance in an individual's daily life.

In this study, the RCA (Reeducation of Children with Autism) Software, an Erasmus+ project titled *Developing New Software for Psychomotor Reeducation of Children with Autism*, has been used to improve psychomotor skills and observe their effects in various domains. The RCA Software aims to help children with autism overcome or reduce specific difficulties in one or more sensorimotor and psychomotor behavior areas, as well as to support learning and development. Additionally, no previous research has been found in the literature using the RCA Software, which contributes to the originality of this study.

In this research, the observation method—one of the qualitative data collection tools—was used. After the installation of the software, exercises were implemented with the help of a researcher in a controlled environment where stimuli were regulated for the child. The study was planned to last for one year.

Although the cause of autism is unknown, it has increased over the years, and currently, it is known that 1 in 54 children is diagnosed with autism. For this reason, all kinds of practices, methods, and techniques that can support the development of children with autism should be tried, and their effects measured. The RCA Software is up to date and focuses on various areas to support the development of psychomotor skills in children with autism. Measuring, developing, improving, or disseminating the effectiveness of the exercises used within educational institutions is part of the broader impact of this research.

In the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), Autism Spectrum Disorder (ASD) is defined as a developmental difference characterized by deficits in social communication and interaction, as well as restricted and repetitive behaviors. Although it is not explicitly stated in the DSM-5 definition, it is known that children on the autism spectrum exhibit limitations in psychomotor skills compared to typically developing individuals, with approximately 73% showing such difficulties (Berkeley, Zittel, Pitney, & Nichols, 2001). Psychomotor skills can be defined as purposeful and coordinated motor movements (Newell, 2010: 285).

When examining studies that focus on the psychomotor skills of children with autism, early research indicates that their gait differs from that of typically developing individuals. In another study, researchers examined home videos of autistic children during infancy and found differences in movements such as rolling from a supine to prone position, sitting, crawling, and walking compared to typically developing peers. More recent studies have concluded that children with autism exhibit limitations in both gross and fine motor skills (Su & Taşkıran, 2022). Difficulties in tasks involving object use, issues with static and dynamic balance, and coordination problems are among the gross motor skill challenges faced by children with autism. Additionally, these children often require more time when using gross motor skills, processing incoming information, and initiating movement.

Fine motor skills are defined as the ability to coordinate hand muscles. Due to various reasons, children with autism may delay using their hands or fail to explore them properly, leading to underdeveloped hand muscles and weak motor

maturity (Yanardağ & Huri, 2021). Some studies suggest that difficulties in motor skills are linked to developmental differences in social skills (Zachor, Ilanit & Itzchak, 2010). However, psychomotor development affects more than just social growth; it also impacts cognitive, language, and daily living skills and contributes to an individual's socialization, thereby supporting improved quality of life (Uzun, 2019). Therefore, it is essential to support the psychomotor skills of children on the autism spectrum from an early age.

Various exercises, methods, and techniques have been used to support the development of psychomotor skills. A review of the literature reveals the following findings: Çelik and Buğday (2022) presented a study highlighting the importance of participation in physical activities for children with autism. Their findings emphasized that motor activity contributes to psychosocial improvement in autistic children (reducing stress and anxiety, increasing social participation, self-confidence, and achievement levels), improves motor functions, enhances muscle tone control, and yields positive physical outcomes. Savahil (2016) worked for two months with autistic children on activities like stringing beads, making pasta necklaces, and painting with cotton swabs. As a result, improvements were observed in hand and foot coordination as well as movement reactions. Kavlak (2019) found that after the implementation of developed exercises, children's motor skills were strengthened, and improvements were noted in balance, flexibility, running, fine motor skills, and explosive strength in the upper extremities. It is well known that among the specific characteristics of children with ASD are difficulties with eye contact and stereotypical behaviors. Studies have confirmed that the use and continuity of psychomotor rehabilitation exercises are significant in promoting eye contact and reducing repetitive behaviors (Uzun, 2019).

In line with this, the software we used—RCA Software—includes psychomotor rehabilitation exercises and aims to help children with autism overcome or alleviate specific difficulties in one or more sensorimotor and psychomotor behavior areas. The goal is to contribute to learning and development. The aim of the psychomotor skills training is to provide children with easy, enjoyable, cheerful, and motivating ways to enhance their abilities. The exercises included in the categories are selected based on the child's level. The student begins the training by choosing a male or female character. The program includes a sensor that detects the child's psychomotor movements and provides feedback based on the appropriateness of the movement. There are exercises in 12 different domains (Developing New Software For Psychomotor Reeducation of Children With Autism, Access Date: 01.11.2022, https://rca-software.org/).

The exercises include:

1. Recognizing body parts
2. Exploring the movement space
3. Identifying the objective space
4. Lateral exercises
5. Fine motor skill exercises
6. Understanding the presence of people around
7. Muscle tone exercises
8. Coordination exercises
9. Rhythm exercises
10. Impulse control exercises
11. Time perception assessment
12. Breathing exercises

In this research, coordination, rhythm, breathing, impulse control, and muscle tone exercises were implemented. RCA Software is based on the foundations of perceptual-motor processes and components. Perceptual-motor activities hold an important place in motor development because they directly influence children's future perception-based learning and therefore need to be strengthened (Goodway et al., 2019).

Table 1. Sensory, Perceptual, and Motor Issues and the Intervention Process in Autism Spectrum Disorder (Yanardağ & Huri, 2021)

Psychomotor Reeducation Processes	Components
Body Awareness	• Awareness of body parts • Understanding the functional capabilities of each body part • Comprehension of how body parts move in a coordinated and purposeful manner
Spatial Awareness	• Subjective localization • Objective localization • General localization
Directional Awareness	• Laterality • Directionality
Time perception Awareness	• Synchronization • Sequencing • Rhythm

Body Awareness: Body awareness refers to a child's ability to accurately distinguish between different parts of their body. It enables the child to effectively plan and utilize space and time. By the age of four, space-body orientation is typically completed, and children are considered to have attained body awareness (Albu et al., 2006).

Spatial Awareness: Spatial awareness is closely related to body awareness. A child first perceives their own body and the amount of space it occupies; then, through movement, they learn to express their body effectively in relation to the environment. There are two factors involved in spatial awareness: subjective and objective localization. Subjective localization is defined as one's own internal perception, whereas objective localization refers to areas beyond the child's personal space. Spatial awareness is a critical factor for children's adaptation to school and the surrounding environment (Albu et al., 2006).

Directional Awareness: Directional awareness involves a child's ability to attribute dimensionality to objects in their environment. It encompasses awareness of the body's dimensions, such as laterality, position, and direction. Directionality refers to assigning dimensionality to external objects in space. Directional awareness is considered a prerequisite skill that should be developed before a child begins formal schooling (Elena et al., 2014; Goodway et al., 2019).

Temporal Awareness: Temporal awareness involves the development and internalization of a sense of timing. It is connected to spatial awareness; the development of spatial awareness supports the emergence of temporal awareness. This process is rhythm-based and is achieved through the synchronized interaction of motor and emotional systems. Temporal awareness is essential for children's ability to learn efficiently, as well as for planning and executing tasks (Albu et al., 2006).

The fact that psychomotor development is also interconnected with other skill domains clearly highlights its importance in the education of children with autism. For this reason, it is necessary to examine, research, and modify software,

applications, methods, or techniques that support motor development in greater depth. The RCA Software includes psychomotor rehabilitation exercises. These psychomotor exercises are implemented to address irregularities within the system and aim to strengthen the connections between movements and functions of the central nervous system in performing cognitive tasks (Yanardağ & Huri, 2021). Additionally, due to the lack of existing literature on the use and outcomes of this software, its investigation was deemed necessary.

The Project aims to examine the contribution level of the muscle tone, coordination, impulse control, rhythm, and breathing exercises—which are embedded in the RCA Software and based on the principles and components of psychomotor reeducation—to the development and maintenance of sensorimotor skills in children with autism.

The study aimed to answer the following research questions:

- What changes occurred in the muscle tension of the autistic child following the muscle tone exercises included in the software?
- Do the coordination exercises within the software affect the child's control and strength of motor movements?
- What is the contribution of rhythm exercises in the software to the child's ability to perceive regular intervals and perform timing tasks?
- To what extent do the impulse control exercises in the software support the child's ability to respond appropriately to a given situation or stimulus?
- How do the breathing exercises impact the child's attention to and engagement with their environment?

The project was completed within one year. Initially, students who required training in the skill areas targeted by the software were identified. The software was then integrated into the educational programs of selected children with ASD. Subsequently, the data collected were analyzed to determine whether the results aligned with the software's intended goals and outcomes, and the findings were documented in a final report.

METHOD

Research Design

The study we conducted is based on the foundations of interpreting and questioning observed situations or behaviors. Guba and Lincoln (1994) defined qualitative research as a method that aims to understand the form and meaning of the problem being investigated within its natural setting through interpretative and inquisitive inquiry. Therefore, the qualitative research method has been employed in this study. The research, which lasted one year, included students diagnosed with moderate-level Autism Spectrum Disorder as part of the sample group.

Another reason for selecting the qualitative research model is its suitability for being conducted with smaller groups compared to quantitative research. This allows for a more in-depth examination of the sample group and enables the study to be carried out in a more feasible manner in terms of time and cost (Baltacı, 2019).

For this research, ethical approval was obtained from the Scientific Research Ethics Committee of Çanakkale Onsekiz Mart University, Graduate School of Education (Date: 26.10.2023, Decision No: 13/42).

Setting and Participants

In the study, two students aged between 7 and 14, who reside in the province of Çanakkale, have been diagnosed with moderate Autism Spectrum Disorder, and are currently receiving education at a rehabilitation center, have been selected as participants. Among the sampling methods, the critical case sampling technique has been used.

Critical case analyses are frequently utilized in the evaluation of various educational programs—particularly those that are newly implemented. The key assumption in this method is: "If a specific sample group exhibits certain reactions or outcomes in response to a given situation or intervention, it is likely that other groups may exhibit similar responses" (Baltacı, 2018)

Instruments

The study was conducted in the student's classroom, within a structured and stimulus-free environment. The objective was to observe and deeply analyze the student's responses within this setting (Baltacı, 2019). For this reason, the observation method was deemed appropriate among data collection tools. Among the advantages of the observation method are: the ability to capture nonverbal behaviors, the reduced artificiality of observations conducted in a natural setting compared to other methods, and the absence of strict time constraints. However, the method also has certain disadvantages, such as the potential influence of the observer, time consumption, and challenges in control and quantification (Büyüköztürk et al., 2013). To mitigate these limitations, the observer/practitioner maintained objectivity during the recording and reporting of observations, made minimal and non-disruptive interventions to preserve the natural flow of behavior, and took necessary actions to manage time effectively while maintaining control over the student's responses.

The **Munich Functional Developmental Diagnosis (MFDD)** has been used in this study as one of the tools to assess the psychomotor development of the student. The MFDD has been specifically developed to evaluate the developmental progress of children with developmental challenges and to tailor appropriate support strategies based on their individual needs. It is a standardized scale designed to assess psychomotor development in infants and young children. By utilizing standardized physical development tables, the MFDD helps in identifying developmental delays or deficits. In this study, the MFDD was employed to evaluate the psychomotor development of the child.

Procedure

The data collection process of the study has been carried out systematically in accordance with the defined work packages. First, the selection of students in the study group has been completed, and both the students and their parents have been informed about the process. In order to determine the participants' initial levels, MFDD assessments have been conducted, ethical approval, and parental consent forms have been obtained. Following the completion of this stage, the implementation of exercises has begun. Starting from the third month, muscle tone exercises have been introduced, and the children's development has been observed. These exercises have been conducted over eight class hours per month, with a target for each child to repeat the exercises at a rate of at least three-quarters, which has been largely achieved. From the fourth month, coordination exercises have been implemented, following a structured program aimed at developing the children's motor skills. These exercises also took place for eight class hours per month, and the children's participation rates have been monitored. By the fifth month, impulse control exercises have

been introduced, focusing on improving the children's self-regulation skills. During this stage, the exercises have been conducted over six class hours per month, and at least three-quarters participation has been ensured. In the sixth month, rhythm exercises have been initiated to support children's rhythm perception and motor planning abilities. These exercises have been carried out over eight class hours, during which most of the children have reached the targeted level of repetition. From the seventh month, the focus has shifted to breathing exercises, aimed at improving the children's breath control and speech skills. These exercises have been implemented over six class hours per month, and children have been supported to repeat the exercises at a rate of at least three-quarters. Beginning of the eighth month, a general evaluation process has been launched using the MFDD tool. The effects of the exercises have been analyzed, and results have been reported based on the collected data. Finally, in the eleventh month, a project workshop has been organized to present and share the findings. During the workshop, the impact and applicability of the study have been discussed, along with suggestions for future research. Thus, the data collection process of the study was completed, and the findings have been compiled into a scientific report.

Data Analysis

In this study, descriptive analysis, one of the qualitative data analysis methods, was employed. According to Yıldırım and Şimşek (2003), in descriptive analysis, it is essential that research findings are both summarized and interpreted by the researcher. In our study, data obtained through the observation method were summarized at the end of the research and interpreted based on the findings, forming the basis of the research report. Before presenting the research report, it is important to mention the process of developing codes, categories, and hypotheses aligned with emerging themes. One of the most critical criteria of scientific research is the credibility of its results. The most commonly used criteria to ensure credibility are validity and reliability. Validity is typically divided into internal and external validity. One of the key strategies to ensure internal validity is prolonged engagement (Başkale, 2016). According to this method, spending a certain amount of time in the same environment with participants before beginning the study is essential for managing researcher bias. Additionally, establishing a friendly relationship helps foster trust and allows for more accurate responses (Başkale, 2016).

In our study, the participants were individuals diagnosed with Autism Spectrum Disorder (ASD). As previously noted, individuals on the autism spectrum commonly experience difficulties with socialization. Therefore, engaging with participants and spending time with them prior to the study not only put the researcher at ease but also has helped the participants feel safe and supported the development of a sense of trust.

Another method used to enhance validity is expert review (Creswell, 2013). For expert review, it is ideal to involve a researcher or colleague who is well-versed in research methods and can provide constructive feedback on both strengths and weaknesses of the study. The expert should be able to examine all aspects of the research and offer detailed insights (Holloway & Wheeler, 1996; Streubert & Carpenter, 2011). In this study, feedback and guidance have been obtained from special education teachers working in rehabilitation centers and from Dr. Nergis Ramo Akgün, who served as a consultant.

To ensure external validity, it is necessary to provide a detailed description of the participants and the research setting (Başkale, 2016). Accordingly, it can be stated that the study was conducted with two students diagnosed with the same level of Autism Spectrum Disorder, who required additional support in specific areas. Prior to the intervention, preliminary observation sessions have been held to assess the students' current status. Once the data has been

recorded, the specified exercises have been introduced.

The implementation process proceeded as follows: First, the student has been placed in an individual education classroom, and then environmental stimuli have been minimized. Adjustments have been made to lighting, noise, and temperature, and no non-educational materials have been present in the classroom. The student's physical and psychological state has been checked before starting the exercises. After ensuring the student has been in the proper position, the researcher has given the necessary instructions and has invited the student to begin the exercises. The exercises have been completed within predefined time frames. Observations during the sessions have been video recorded with parental consent.

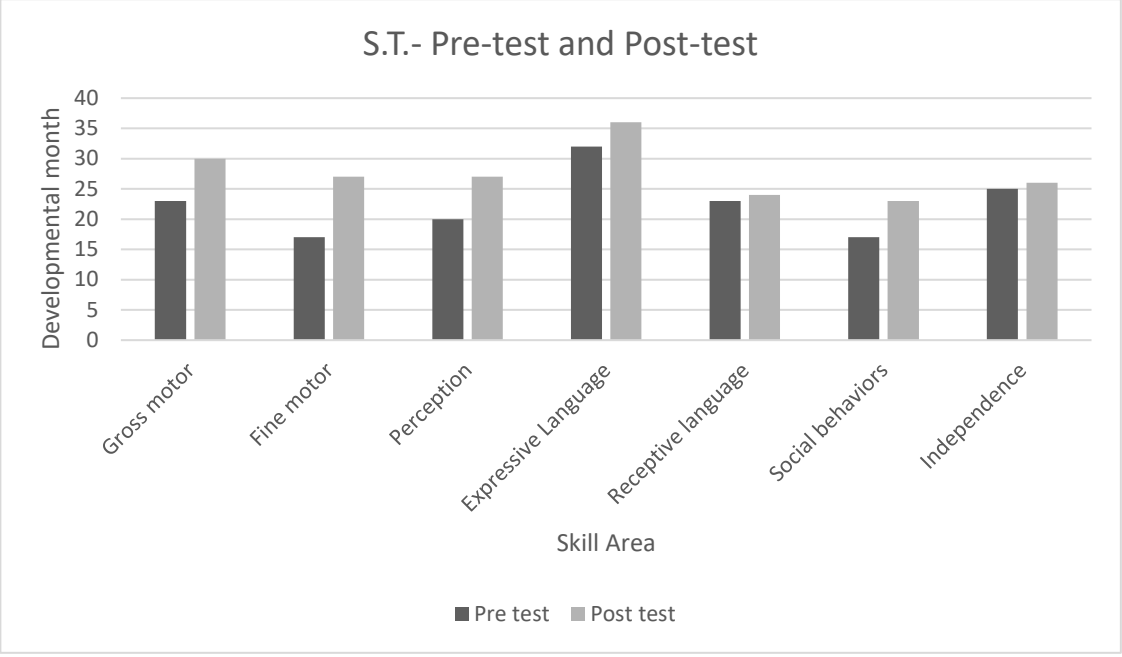
RESULTS AND DISCUSSION

As a result of the study, significant differences were observed in both students. When examining the findings, the most notable improvements were seen in gross and fine motor skills. In addition, varying degrees of development were also observed in the categories of perception, speech, speech comprehension, social behaviors, and independence.

Table 2. Results for S.T

Functional skill areas	Pre test	Post test
• Gross motor	23	30
• Fine motor	17	27
• Perception	20	27
• Expressive language	32	36
• Receptive language	23	24
• Social behaviors	17	23
• Independence	25	26

The data in Table 2 present the pre-test and post-test results of the student named S.T. Upon examination, the following developmental progress has been observed: seven months of improvement in the gross motor domain, ten months in fine motor skills, seven months in perception, four months in speech skills, one month in speech comprehension, six months in social behavior acquisition, and one month in independent living skills. The area in which the student showed the greatest improvement was fine motor skills, while the least improvement was observed in the domain of independent living skills.



Gross Motor Skills

Before beginning the intervention, the student named S.T. had completed developmental milestones up to the 20th month. Therefore, the final assessment began from the 20th month onward. As a result of the intervention, S.T. demonstrated the following abilities:

- In line with the 21st month, walks three steps on stairs with child-sized steps while holding onto both railings.
- In line with the 22nd month, kicks a ball from a stationary position.
- In line with the 23rd month, descends an indoor staircase with child-sized steps while holding on with one hand.
- In line with the 24th month, walks three steps on tiptoes without support.
- In line with the 26th month, stands on one foot while holding onto something with one hand.
- In line with the 27th month, walks five steps on tiptoes without holding onto anything.
- In line with the 28th month, jumps in place once, briefly, without falling.
- In line with the 30th month, when given the instruction *"Jump forward,"* the student jumped in place, but did not complete the developmental milestone of *"Jumps forward without falling,"* and the assessment was concluded at that point.

Fine Motor Skills

Before the intervention began, the student named S.T. had completed developmental milestones up to the 16th month. Therefore, the final assessments started from the 17th month onward. Accordingly, S.T. demonstrated the following abilities:

- In line with the 17th month, is able to place two rings onto a stacking pyramid.

- In line with the 20th month, can thread a bead onto a string.
- In line with the 21st month, can draw curved lines in two directions.
- In line with the 22nd month, can place two matchsticks into a matchbox.
- In line with the 25th month, can draw a straight spiral.
- In line with the 27th month, can open the lid of a bottle (closed and filled with candies) and take out two candies.
- At the 28th-month milestone, when given the instruction *"Open the lid of the toy box,"* the student did not open the lid, and the assessment was concluded at this stage.

Perception – Comprehension and Logical Reasoning

Before the intervention, S.T. had completed developmental milestones up to the 19th month. Therefore, the final assessments began from the 20th month. Accordingly, S.T. demonstrated the following abilities:

- In line with the 20th month, can remove an object from a bottle.
- In line with the 22nd month, places a matchstick into an open matchbox.
- In line with the 23rd month, nests three cups inside one another.
- In line with the 24th month, can take a pencil out of a pencil case and unwrap a chocolate.
- In line with the 25th month, nests a large and small circle inside each other.
- In line with the 27th month, nests a square, triangle, and one large circle inside one another.
- At the 28th-month milestone, was unable to sequence five cubes by size, and therefore the assessment was concluded.

Speech – Expressive Language

Before starting the intervention, the student named S.T. had completed developmental milestones up to the 31st month. Therefore, the final assessment began from the 32nd month. As a result of the intervention, S.T. demonstrated the following abilities:

- In line with the 32nd month, forms sentences with three words.
- In line with the 33rd month, names all objects in a set of 12 test images.
- In line with the 34th month, uses the pronoun "I".
- Was unable to complete the milestone for the 36th month, which is "Uses four-word sentences in child-directed speech", and the assessment was therefore concluded.

Speech Comprehension

Before the intervention, S.T. had completed developmental milestones up to the 22nd month. Thus, the final assessment began from the 23rd month. Following the intervention, S.T. demonstrated the following:

- In line with the 23rd month, correctly identifies or points to four out of eight test images.
- Was unable to complete the 24th-month milestone, "Points to or identifies three parts of the body", and the assessment was concluded at this stage.

Social Behavior

Prior to the intervention, S.T. had completed developmental milestones up to the 16th month. Therefore, the final assessment began from the 17th month. As a result of the intervention, S.T. demonstrated the following abilities:

- In line with the 17th month, helps sort or gather toys.
- In line with the 19th month, approaches with a picture book to gain attention and attempts to express a desire.
- In line with the 20th month, carries out simple household tasks.
- In line with the 21st month, enjoys being around familiar people.
- In line with the 23rd month, independently throws away trash into the bin.
- Was unable to achieve the 24th-month milestone, "Wants to play with children of the same age", and the assessment was concluded.

Independence

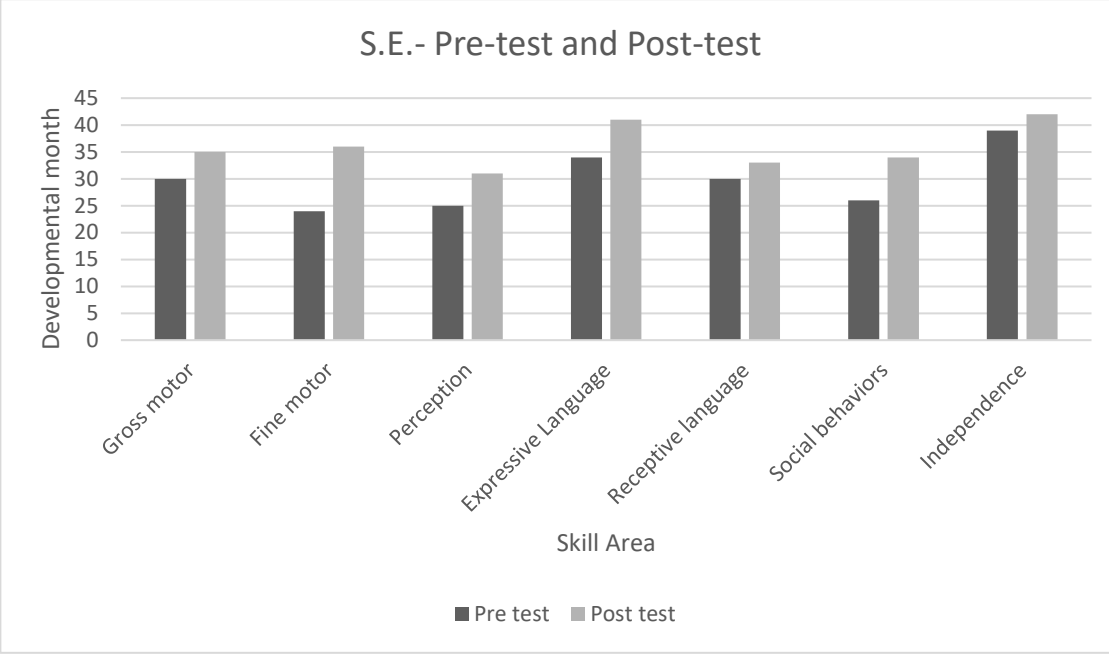
Before the intervention, S.T. had completed developmental milestones up to the 24th month. Therefore, final assessments began from the 25th month. As a result of the intervention, S.T. demonstrated the following abilities:

- In line with the 25th month, wipes hands when they are dirty.
- In line with the 26th month, removes a jacket with unfastened buttons.
- Was unable to complete the 27th-month milestone, "Imitates an adult", and the assessment was concluded.

Table 3. Results for S.E

Functional skill areas	Pre test	Post test
• Gross motor	30	35
• Fine motor	24	36
• Perception	25	31
• Expressive language	34	41
• Receptive language	30	33
• Social behaviors	26	34
• Independence	39	42

The data in Table 3 present the pre-test and post-test results of the student named S.E. Upon examination, the following developmental progress was observed: 5 months of improvement in the gross motor domain, 12 months in fine motor skills, 6 months in perception, 7 months in speech skills, 3 months in speech comprehension, 8 months in social behavior acquisition, and 3 months in independent living skills. The area in which the student showed the greatest improvement was fine motor skills, while the least improvement was observed in the domains of speech comprehension and independent living skills.



Gross Motor Skills

Before beginning the intervention, the student named S.E. had completed developmental milestones up to the 30th month. Therefore, the final assessments began from the 30th month onward. Accordingly, S.E. demonstrated the following abilities:

- In line with the 30th month, can jump forward without falling.
- In line with the 31st month, can stand on one foot for two seconds without support.
- In line with the 32nd month, can climb two steps using adult-sized steps while holding on with one hand.
- In line with the 35th month, can jump over an obstacle without touching it.
- The milestone for the 36th month, *"Rides a tricycle,"* was not yet achieved, and the assessment was concluded at that point.

Fine Motor Skills

Before starting the intervention, S.E. had completed developmental milestones up to the 24th month. Therefore, the final assessments began from the 25th month. Accordingly, S.E. demonstrated the following abilities:

- In line with the 25th month, can draw a straight spiral.
- In line with the 27th month, can open the lid of a bottle (closed and filled with candies) and take out two candies.
- In line with the 28th month, can open the lid of a toy box.
- In line with the 30th month, can remove beads from a string.
- In line with the 31st month, can draw a multi-directional spiral.
- In line with the 32nd month, can twist a bottle cap open and closed.
- In line with the 34th month, can build a tower using eight cubes.

- In line with the 36th month, can perform cutting tasks using scissors.
- The milestone for the 37th month, "Tears paper sideways using both hands," was not achieved, and the assessment was concluded at this stage.

Perception

Before the intervention, the student named S.E. had completed developmental milestones up to the 20th month. Therefore, the final assessments began from the 20th month. As a result of the intervention, S.E. demonstrated the following abilities:

- In line with the 25th month, can nest a large and a small circle inside each other.
- In line with the 27th month, can nest a square, a triangle, and a large circle.
- In line with the 29th month, can place three out of four shapes into a box.
- In line with the 31st month, can sequence objects according to size.

Speech – Expressive Language

Before starting the intervention, S.E. had completed developmental milestones up to the 33rd month. Therefore, the final assessment began from the 34th month. As a result of the intervention, S.E. demonstrated the following abilities:

- In line with the 34th month, uses the pronoun "I".
- In line with the 36th month, forms four-word sentences in child-directed speech.
- In line with the 38th month, uses counting terms for more than one object.
- In line with the 39th month, uses correct forms of the words "to me" and "to you".
- Was unable to achieve the 41st-month milestone, "Names the objects in a test image using plural forms", and the assessment was concluded.

Speech Comprehension

Before beginning the intervention, S.E. had completed developmental milestones up to the 29th month. Therefore, final assessments began from the 30th month. As a result of the intervention, S.E. demonstrated the following abilities:

- In line with the 31st month, understands the concept of heavy and can point to a heavy object when asked.
- In line with the 32nd month, recognizes two types of movements in a picture.
- Was unable to complete the 33rd-month milestone, "Understands two of four given envelopes", and the assessment was concluded at this point.

Social Behaviors

Prior to the intervention, S.E. had completed developmental milestones up to the 25th month. Therefore, final assessments began from the 26th month. As a result of the intervention, S.E. demonstrated the following abilities:

- In line with the 26th month, spontaneously takes care of a doll or stuffed animal.
- In line with the 27th month, tries to comfort someone who is upset.
- In line with the 31st month, expresses needs verbally.
- In line with the 34th month, expresses desires using the pronoun "I".
- Was unable to achieve the 36th-month milestone, "Plays according to turn-taking rules in a game", and the assessment was concluded.

Independence

Before the intervention, S.E. had completed developmental milestones up to the 40th month. Therefore, the final assessments began from the 41st month. As a result of the intervention, S.E. demonstrated the following:

- In line with the 41st month, remains dry and clean throughout the day.
- In line with the 42nd month, puts on trousers independently.

This study aimed to examine the effects of psychomotor reeducation exercises implemented through the RCA Software on the sensorimotor and developmental skills of two students diagnosed with moderate Autism Spectrum Disorder (ASD). The findings indicate that both participants demonstrated meaningful improvements in multiple developmental domains, particularly in fine and gross motor skills, which were directly targeted by the intervention.

The most notable progress was observed in the fine motor domain, with S.T. showing a developmental gain of 10 months and S.E. achieving a gain of 12 months. These outcomes align with the literature suggesting that structured psychomotor exercises significantly contribute to fine motor coordination, hand strength, and object manipulation skills in children with ASD. Improvements in gross motor skills were also evident, with S.T. gaining 7 months and S.E. gaining 5 months. These gains suggest enhanced body coordination, balance, and motor planning, which are critical for both academic functioning and daily life activities. In addition to motor improvements, the study found gains in perceptual and cognitive domains, particularly in perception, comprehension, and logical reasoning. S.T. exhibited a 7-month gain, while S.E. improved by 6 months in this domain. These findings support previous research highlighting the interconnectedness of motor and cognitive development in children with neurodevelopmental disorders. The ability to manipulate objects, understand spatial relationships, and engage in sequencing tasks suggests enhanced perceptual-motor integration. Moderate progress was also noted in speech and language development. S.T. showed improvements of 4 months in expressive language and 1 month in comprehension, while S.E. improved by 7 months and 3 months, respectively. While these gains are more modest compared to motor domains, they are significant in light of the known challenges children with ASD face in verbal communication. Social behavior development was another area of growth, with S.T. demonstrating a 6-month gain and S.E. showing an 8-month gain. This may be attributed to increased self-regulation and task engagement fostered by structured routines and repetitive practice. Activities that required imitation, cooperation, or environmental awareness might have facilitated social responsiveness. The use of personalized, low-stimulus environments likely supported the development of attention and helped reduce anxiety, contributing to more adaptive social behavior. The least improvement was noted in independent living skills and speech comprehension, with both students showing only 1–3 months of developmental gain. These areas typically require extended and context-rich practice and may not be as responsive to short-term psychomotor-focused interventions. This outcome underscores the need for complementary interventions that address functional life skills and language comprehension through real-life simulations and broader contextual learning.

From a methodological standpoint, the use of descriptive analysis, structured observation, and long-term engagement enhanced the credibility and depth of the data. The integration of expert reviews and pre/post assessments further strengthened the validity of the results. The inclusion of two individual case studies allowed for detailed monitoring and the identification of specific areas of growth, aligning with the principles of critical case sampling.

CONCLUSION AND RECOMMENDATIONS

This study examined the effects of RCA Software, developed to support the psychomotor development of children diagnosed with Autism Spectrum Disorder (ASD). The intervention included exercises focused on muscle tone, coordination, rhythm, breathing, and impulse control, and the development of the two participating students was assessed using pre-test and post-test data. The findings indicate that both students demonstrated positive changes across multiple developmental domains, particularly in psychomotor skills. For both students, the most significant improvement was observed in the area of fine motor skills. This result is consistent with findings from similar studies in the literature (Savahil, 2016; Kavlak, 2019), which also emphasize that regular physical activity and targeted exercises lead to improvements in hand-eye coordination, grasping, and fine motor abilities in children with autism. Conversely, the least improvement was observed in the domains of speech comprehension and independent living skills. This suggests that the direct impact of psychomotor exercises on cognitive-linguistic development may be limited, although they may still play a supportive role indirectly. Furthermore, this finding implies that speech and language development requires longer-term support through diverse educational strategies (Yanardağ & Huri, 2021).

Another noteworthy result of the study was the observed development in social behaviors and perception. The regular implementation of the RCA-based exercises enhanced the children's ability to sustain attention, respond to environmental stimuli, and engage in social interactions. These findings are in line with those of Çelik and Buğday (2022), who reported that motor activities contribute to psychosocial improvement in individuals with autism. In addition, rhythm and breathing exercises appeared to support progress in motor planning and focus skills. These exercises are thought to contribute not only to psychomotor development but also to higher-level cognitive functions such as time perception and attention control. Goodway et al. (2019) explain this phenomenon in the context of the impact of perceptual-motor processes on learning.

In conclusion, RCA Software appears to be an innovative and effective tool in psychomotor education processes, offering varying degrees of positive contributions to the developmental areas of children with autism. It is believed that the impact of the software can be further enhanced through systematic use and the customization of exercises to meet individual needs. However, it is also important to recognize that additional and more robust support strategies are needed, particularly in the areas of language development and independent living skills.

Based on the findings of this study, a series of recommendations have been developed for both practitioners and researchers. First and foremost, it was determined that RCA Software led to notable improvements in the psychomotor skills of children diagnosed with Autism Spectrum Disorder (ASD). This finding highlights the need for the wider implementation of the software in special education settings. It is especially recommended for systematic use with children who demonstrate significant limitations in psychomotor development. In this context, the software should be utilized not only for therapeutic purposes but also as part of support education programs, which could enhance its overall effectiveness. The adaptability of the software to individual differences makes it suitable for integration into Individualized Education Plans (IEPs). Accordingly, special education teachers are encouraged to structure RCA Software activities in alignment with IEP goals, allowing students to experience a more targeted and effective learning process.

However, the findings also indicate limited progress in areas such as language development (especially speech comprehension) and independent living skills. This suggests that while psychomotor-based exercises may offer indirect

support, they are insufficient for fostering direct improvements in these domains. Thus, it is recommended to implement complementary intervention programs, such as communication-based therapies, play-based interventions, or activities that specifically target daily living skills, alongside RCA Software.

This study was conducted with a limited number of participants, and therefore carries certain limitations in terms of generalizability. Future research should include larger samples that represent different age groups, varying levels of ASD, and diverse socio-cultural contexts. Longitudinal studies are also needed to assess the sustainability of RCA Software's effects and to monitor how well skill gains transfer to everyday life situations. Additionally, the potential for using RCA Software in home environments, not just educational institutions, emphasizes the importance of family involvement. With the help of informational guides, training videos, and parental support materials, families can be empowered to use the software more effectively. This would ensure that learning continues beyond the classroom and is reinforced at home. Especially in the post-pandemic era, the role of digital tools in education has become increasingly important, making remote accessibility and usability of such software a crucial feature.

Furthermore, to increase the effectiveness of RCA Software, it is essential that teachers and therapists using the software are adequately trained. In this regard, it is recommended to organize in-service training for special education staff and online module tutorials specific to the software. Through such educator training programs, practitioners will gain deeper familiarity with both the content and pedagogical use of the software, which will in turn improve the accuracy and impact of its application. Finally, it is recommended that the current version of RCA Software be further developed. The integration of new exercise modules targeting language development, communication, attention, memory, emotional awareness, and social interaction would allow the software to evolve into a more comprehensive digital intervention tool aimed at multi-dimensional development. These advancements would support RCA Software in becoming not only a psychomotor development tool, but also a holistic educational and rehabilitative resource designed to foster the well-rounded development of individuals with ASD.

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REFERENCES

Amerikan Psikiyatri Birliği. (2014). *Ruhsal bozuklukların tanısal ve sayımsal el kitabı: DSM-5 tanı ölçütleri el kitabı* (E. Köroğlu, Çev.). Hekimler Yayın Birliği.

Baltacı, A. (2019). Nitel araştırma süreci: Nitel bir araştırma nasıl yapılır? *Ahi Evran Üniversitesi Sosyal Bilimler Dergisi*, *5*(2), 368–388. https://doi.org/10.31592/aeusbed.598299

Başkale, H. (2016). Nitel araştırmalarda geçerlik, güvenirlik ve örneklem büyüklüğünün belirlenmesi. *Dokuz Eylül Üniversitesi Hemşirelik Fakültesi Elektronik Dergisi*, *9*(1), 23–28.

Berkeley, S. L., Zittel, L. L., Pitney, L. V., & Nichols, S. E. (2001). Locomotor and object control skills of children diagnosed with autism. *Adapted Physical Activity Quarterly*, *18*(4), 405–416.

Büyüköztürk, Ş., Akgün, Ö. E., Karadeniz, Ş., Demirel, F., & Kılıç, E. (2013). *Bilimsel araştırma yöntemleri* (17. bs.). Pegem Akademi.

Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed methods approaches* (2nd ed.). Sage Publications.

Çelik, O. T., & Buğday, B. (2022). Otizmli çocuklarda fiziksel aktivite. *Anatolian Journal of Health Research*, *3*(1), 30–32. https://doi.org/10.29228/anatolijhr.55619

Dönmez, M. U. (2019). Otizmli bireylerde fiziksel aktivite uygulamalarının bazı fizyolojik ve psikolojik parametreleri üzerine etkisi: Alanyazın derlemesi. *Academic Studies on Natural and Health Sciences*, *4*(1), 607–615.

Elena, S., Georgeta, N., Cecila, G., & Lupu, E. (2014). Perceptual-motor development of children in elementary school. *Procedia - Social and Behavioral Sciences*, *114*, 632–636. https://doi.org/10.1016/j.sbspro.2013.12.759

Goodway, J. D., Ozmun, J. C., & Gallahue, D. L. (2019). *Understanding motor development: Infants, children, adolescents, adults* (8th ed.). Jones & Bartlett Learning.

Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 105–117). Sage Publications.

Holloway, I., & Wheeler, S. (1996). *Qualitative research for nurses*. Blackwell Science.

Kavlak, B. (2019). *Otizmli çocuklara uygulanan düzenli fiziksel aktivite programının bazı motorik özelliklere etkisi* [Yüksek lisans tezi, Kocaeli Üniversitesi Sağlık Bilimleri Enstitüsü].

Newell, K. M. (2020). What are fundamental motor skills and what is fundamental about them? *Journal of Motor Learning and Development*, *8*(2), 280–314.

Özdemir, M. (2010). Nitel veri analizi: Sosyal bilimlerde yöntembilim sorunsalı üzerine bir çalışma. *Eskişehir Osmangazi Üniversitesi Sosyal Bilimler Dergisi*, *11*(1), 323–343.

Savahil, Ö. (2016). *5–10 yaş arası otizmli çocuklarda ince motor becerilerinin reaksiyon zamanı ve hareket hızına etkisinin incelenmesi* [Yüksek lisans tezi, İstanbul Gelişim Üniversitesi Sağlık Bilimleri Enstitüsü].

Şimşek, A. (Ed.). (t.y.). *Sosyal bilimlerde araştırma yöntemleri*. Anadolu Üniversitesi Açıköğretim Fakültesi Yayını. ss. 162–183.

Vilensky, J. A., Damasio, A. R., & Maurer, R. G. (1981). Gait disturbances in patients with autistic behavior: A preliminary study. *Archives of Neurology*, *38*(10), 646–649.

Yanardağ, M., & Huri, M. (2021). *Otizm spektrum bozukluğunda duyu-algı-motor sorunlar ve müdahale süreci*. Sakarya

Üniversitesi Yayınları.

Yıldırım, A., & Şimşek, H. (2003). *Sosyal bilimlerde nitel araştırma yöntemleri* (3. bs.). Seçkin Yayıncılık.

Zachor, D. A., Ilanit, T., & Itzchak, E. B. (2010). Autism severity and motor abilities correlates of imitation situations in children with autism spectrum disorders. *Research in Autism Spectrum Disorders*, *4*(3), 438–443.