http:// ijp.mums.ac.ir
Original Article (Pages: 18112-18122)

The Relationship between Motor Skills and Language Performance in Mentally Retarded Children

Ehsan Hemmati [1], Fateme Taaki [2], * Alireza Aghaz [3], Roya Mokhtari Fard [4], Ahmadreza Darabi [5], Maryam Safary [6], Maryam Issadokht [7], Alireza Alidad[8], Abdulghafoor GereyNurani[8], Hossein Abbasi[9], Mohammad Taghi Joghataei [10]

[1] Student Research Committee, School of Advanced Technologies in Medicine, Iran University of Medical Sciences, Tehran, Iran.

[2] MSc Student in Mental Health, Student Research Committee, School of Behavioural Sciences and Mental Health (Tehran Institute of Psychiatry), Iran University of Medical Sciences, Tehran, Iran.

[3] Department of Speech Therapy, School of Rehabilitation Sciences, Isfahan University of Medical Sciences, Isfahan, Iran.

[4] Psychology of Exceptional Children, School of Educational Sciences, Islamic Azad University of Isfahan (Khorasgan), Isfahan, Iran.

[5] Department of Occupational Therapy, School of Rehabilitation Sciences, Shiraz University of Medical Sciences, Shiraz, Iran.

[6] MSc Student in Clinical Psychology, Medical School, Islamic Azad University of Najafabad, Najafabad, Isfahan, Iran.

[7] Primary Education, School of Literature and Human Science, Islamic Azad University of Najafabad, Najafabad, Isfahan, Iran.

[8] Department of Speech and Language Pathology, School of Rehabilitation Sciences, Iran University of Medical Sciences, Tehran, Iran.

[9] Department of Speech Therapy, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran

[10] Division of Neuroscience, Cellular and Molecular Research Center, School of Advanced Technologies in Medicine, Iran University of Medical Sciences, Tehran, Iran.

Abstract

Background: The aim of this study was to investigate the relationship between motor skills and language skills in mentally retarded children. The secondary purpose of this study was to expand the evidence based on previous studies by examining the possible relationships between motor, cognitive and linguistic developmental domains that were performed in mentally retarded children with different IQs.

Methods: The present study was descriptive and correlational. 39 children with mental retardation, including 21 girls and 18 boys, participated in the study. After obtaining the parents' written consent, the Children's Communication Checklist-Persian (CCC-Persian) and the Intelligibility in Context Scale (ICS) were completed. Then, an occupational therapist carefully evaluated the gross and fine motor skills of all of these children by the Lincoln-Oseretsky Test. The psychologist then evaluated the rational age and nonverbal IQ of these children by the Goodenough test.

Results: There was a positive and significant correlation between the language and the fine motor skills, as well as, the score of the CCC-Persian and fine motor ($P < 0.05$). In addition, there was a positive and significant relationship between the score of the Goodenough test with the speech, syntax, social interactions, the CCC-Persian, and the ICS scores ($P < 0.05$).

Conclusion: It is expected that improving motor skills increases language and speech skills in mentally retarded children and vice versa. Therefore, paying attention to movement therapy and art therapy has an effective role in strengthening speech and language skills in these children.

Key Words: Art therapy, Children, Language, Mental Retardation, Motor Skills, Movement therapy, Speech.

* Please cite this article as: Hemmati E, Taaki F, Aghaz A, Mokhtari Fard R, Darabi A, Safary M, Issadokht M, Joghataei MT. The Relationship between Motor Skills and Language Performance in Mentally Retarded Children. Int J Pediatr 2023; 11 (08):18112-18122. DOI: **10.22038/ijp.2023.70906.5211**

Corresponding Author:

Alireza Aghaz, Department of Speech Therapy, School of Rehabilitation Sciences, Isfahan University of Medical Sciences, Isfahan, Iran. Email: a.aghaz@rehab.mui.ac.ir

Received date: Feb.24,2023; Accepted date: Aug.08,2023

1- INTRODUCTION

The early years of a child's life are an incredible time for growth and learning. During the normal development of an infant, the emergence of motor milestones is an essential part of the process (1, 2). However, children are capable of acquiring new motor skills, which makes it important for them to develop motor skills. In infants, the development of motor skills creates new opportunities for learning (3, 4). Being able to move around and interact with their surroundings helps kids learn more, and ultimately alters their sensory systems (4). These changes lead to improvements in language and cognition which, in turn, will affect children's curiosity and understanding of their living environment (1, 5). Theory of cognitive embodiment suggests that language and cognition are considered as a cognitive subset that occurs in mutual relations between the individual's body and the physical and social environment (6). There is neurophysiological and neurocognitive evidence from a developing organism that is consistent with this view. Neuroimaging techniques have identified important areas involved in motor, cognitive and language functions; including the cerebellum, the lateral prefrontal area, and the connective structures (basal ganglia) that are simultaneously activated during motor and cognitive tasks. This confirms the mutual relationship between these two areas (7, 8). Broca's area, a region of the brain associated with language functions, also exhibits activity during motor tasks such as planning, observing, understanding and imitating movements (9); and the activity of motor areas has been, additionally, observed during language tasks.

Behavioral studies have demonstrated the correlation between motor and linguistic development, as well as between motor growth in infancy and alterations in language. Recent research has revealed associations between these two areas (10) and cognition (11). Several studies have been conducted on normal children showing that there is a relationship between motor performance and cognition (12-14) as well as motor performance and language (15-18). Numerous studies conducted on both healthy and unhealthy adults have demonstrated a strong relationship between motor functioning and language and cognitive capacities. Although the focus of investigations varied, the findings were similar.

Although the development of motor, cognitive, and language functions may also involve several basic processes in both healthy and unhealthy populations, the correlation between the developments of these areas in abnormal children seems to be stronger than that in normal children (19-21). This stronger correlation shown between developmental domains in abnormal children reflects abnormal connections between neurocognitive processes (22). In fact, it is argued that the connection between new and complex movements and cognitive processes can be found in natural and unnatural samples due to the existence of common neural infrastructures and neural integration in general; however, the relationship between simple motors and cognitive processes has only been seen in clinical samples, which exist due to neurodevelopmental weakness. Consequently, it is recommended to compare these relationships in normal and abnormal populations (such as children with low/high intelligence or with different motor skills) to check the correlation strength (23).

Despite the ongoing debate regarding the relationship between motor skills, and language and cognitive abilities, numerous studies have suggested that certain cognitive aptitudes are linked exclusively to gross motor activities (e.g., throwing or

jumping), not to fine motor activities (e.g., threading beads and painting) (12, 13). Studies have shown conflicting results in regards to the consequences (24, 25). A recent study has indicated that little evidence supports the existence of a relationship between motor and cognitive domains in normal children aged 4-16 years (23). There is more evidence to investigate precise connections: the results of cross-sectional studies have proven that there are connections between certain aspects of motor skills and cognition. Specifically, it has been pointed out that fine motor skills have the strongest relationship with high-level cognitive functions (23). However, these findings are not yet clear for younger children or children with intellectual disabilities. Also, in the field of language skills, the question ought to be answered whether there are specific connections between different motor skills (for example, fine and gross) and various language functions (comprehension and expressive language skills) or not (26).

The existence of a clear connection between developmental motor skills, and developmental language and cognitive skills is supported in previous studies; and there are reports regarding the existence of disorders and delays in motor and linguistic skills of children with intellectual and developmental disabilities (27- 30). However, few studies have been conducted in the field of communication between developmental domains in specific clinical groups. Hassanati et al. compared motor skills of 5-year-old children with their phonological and phonological production disorders. They selected 32 children with phonological and phonological production disorders and evaluated their linguistic and motor skills. They determined that children with production disorders exhibited poorer motor skills, likely related to the phonological production disorders (31). Hartman et al. investigated the relationship between gross motor skills and mental planning (of high-level cognitive skills) in 61 school-age children with borderline intelligence and 36 children with mild intellectual incapacity. They found a significant relationship between the two components (32). In the same line, Wuang et al. reported a strong correlation between gross motor skills and total IQ in 7-8-year-old children with mild mental retardation (33). They additionally pointed out that in comparison to gross motor skills, fine motor skills had twice more impact on specific cognitive and linguistic functions such as processing speed and verbal comprehension.

There seems to be a lack of research in Iran regarding the relationship between motor skills and language in mentally retarded children; even in other countries, this issue has not been thoroughly investigated. Therefore, this research was considered necessary to understand this area further and explore new treatment approaches. The present study, thus, aimed to investigate the relationship between motor and language skills in children with mental retardation. The secondary aim of this study was to build on previous research and investigate the potential links between motor, cognitive, and linguistic development in children across various mentally impaired spectrums (mild/moderate disability).

2- MATERIALS AND METHODS

2-1. Design and Participants

The current research was a descriptive and cross-sectional study. Our samples were selected from children with mental disabilities referred to Mehr comprehensive rehabilitation center in Najaf Abad city, Isfahan.

Thirty-nine children with mental disabilities (21 girls and 18 boys), ranging in chronological age from 5.5 to 16 years and rational age from 3.3 to 13 years, were

recruited in this study as available samples. All participants were monolingual Persian-speaking children whose oral-motor structure was normal according to the examination performed by a Speech and Language Pathologist (SLP). The demographic information of these participants is shown in **Table 1**.

Table-1: Descriptive statistics of the participant characteristics

Variable		N	Minimum	Maximum	Mean (SD)
Chronological Age		39	5.5	16	9.73 (3.54)
Rational age		39	3.3	13	6.54 (2.2)
Nonverbal IQ		39	25.5	127	58.6 (22.9)
Language Skills	Speech	39	13	32	20.43 (5.13)
	Syntax	39	17	31	22.02 (3.6)
	Inappropriate Initiative	39	14	25	19.51 (3.07)
	Coherence	39	15	25	19.51 (2.5)
	Stereotyped Language	39	14	27	20.02 (3.28)
	Use of Contexts	39	4	20	10.56 (4.23)
	Compatibility	39	26	33	29.48 (1.95)
	Social Interaction	39	19	26	22.97 (2.2)
	Interests	39	23	32	28.25 (2.29)
	Non-Verbal Communication	39	21	27	24.71 (1.68)
	Total CCC-Persian	39	191	277	217.51 (18.97)
Speech Skills	Intelligibility Context Scale	39	2	5	3.42 (0.79)
Motor skills	Gross Motor	39	2	48	24.17 (10.87)
	Fine Motor	39	10	50	34.87 (9.02)
	Goodenough	39	1	40	13.92 (8.88)

The SLP (AA) with a master's degree had 8 years of experience in language and speech therapy for mentally retarded children.

2-2. Inclusion and exclusion criteria

The inclusion criteria in this study were to have moderate or less mental disability (IQ $\geq$ 50) based on the Wechsler test available in the medical records of Mehr center. Additionally, the child's language was to be Persian. Furthermore, based on the teacher's reports and the child's medical records, there should have been no evidence of hearing impairment, blindness, or severe visual impairment. The exclusion criteria were non-cooperation in the research and any child identified as potentially having an autism diagnosis. In such cases, the child was evaluated by a psychiatrist.

2-3. Measures

In this study, the latest version of the Children's Communication Checklist (CCC) in Iran, called CCC-Persian (34) was used to evaluate communication skills. The CCC-Persian has 69 items in 10 subscales, including speech, syntax, inappropriate initiation, coherence, stereotyped language, use of context, compatibility, social interaction, interest, and non-verbal communication (34). The test-retest reliability of CCC-Persian has been reported to be from 0.82 to 0.96 (34). The CCC is an objective assessment of communication difficulties in children aged 5-17 years, which should be completed by parents (35). The items of the CCC-Persian have either negative or positive meaning. The parents select one

answer out of four choices, including "cannot judge=0", "never or rarely=1", "sometimes=2", and "always=3". Then, the total score of a subscale is subtracted from a base score of 30. Lower scores on each subscale indicate greater difficulties for the child in that skill (34, 35).

The Persian version of the Intelligibility in Context Scale (ICS-Persian) (36) was used to evaluate intelligibility of speech. The ICS is designed to obtain parents' opinions about their child's speech intelligibility when speaking with different communication partners. In this scale, parents rate the adequacy of their child's speech in seven different communication partners, using a five-point Likert scale (36). It takes 3-5 minutes to complete the ICS. The test-retest reliability and internal consistency of the ICS-Persian has been reported to be 0.82 and 0.89, respectively (36). Seven communication partners are designed based on the International Classification of Functioning, Disability, and Health (ICF) of children and adolescents. Specifically, the seven communication partners are a) The child's own parents, b) The child's first-degree relatives, c) The child's distant relatives, d) The child's friends, e) other acquaintances of the child, f) The child's teachers, and g) Strangers. The parents select one answer out of five choices, including "never=1", "rarely=2", "sometimes=3", "usually=4", and "always=5". So, the sum of seven scores indicates the child's speech intelligibility. Lower scores indicate greater difficulty for the child in speech skill (36). Lincoln-Oseretsky Test of Motor Proficiency was used to evaluate motor skills (31, 37). This test examines the development of motor skills in children and adolescents aged 5 to 14 years. This test consists of 36 items that gradually become more difficult. This test includes walking backward, standing on one leg, touching the tip of the nose with a finger, etc. This test divides motor skills into five general categories: fine motor, gross motor, two-way coordination, hand-eye coordination, and balance (31). The items are scored based on a three-point grading scale from 0 to 2. The test's internal consistency has been reported to be 0.73 and its validity as 0.82. Lower scores indicate more problems in the child's motor skills (31, 37). Goodenough Draw-a-Man Test was also used in this study. The Goodenough Drawing Test is the first tool to measure the level of nonverbal cognitive development, based on drawing, which is considered as a formal intelligence test (38). This test, which is widely used in the world and in Iran, has been confirmed to have satisfactory validity and reliability in several studies (39). For example, its intra-rater reliability has ranged from 0.88 to 0.96 (38).This test is used to measure children's intelligence. Its execution time is unlimited, but generally, it does not take more than five to 10 minutes. Goodenough draw-a-man test consists of 51 items, and each part drawn by the child is given a score (39).

2-4. Procedure

Sampling of this study was done in fall 2020 in the Mehr Comprehensive Rehabilitation Center of Najaf Abad city, Isfahan. After determining the children's inclusion eligibility, the researcher sent a written consent form to their parents. After obtaining the parents' written consent for participation, the SLP sent CCC and ICS questionnaires to the parents to be completed and returned to Mehr center within one week. Then, the fine and gross motor skills of all these children were accurately evaluated by the occupational therapist of this study (AD) using the Lincoln-Oseretsky Test. After that, the psychologists of this study examined the children with the Goodenough draw-a-man test. The rational age of the children in this study was converted into rational age, based on the conversion table of the raw scores of the Goodenough test. The

nonverbal IQ of these children was calculated using the rational age calculated through Goodenough test. In this method, we divided the child's rational age by his/her chronological age and multiplied the result by 100. The resulting number was called nonverbal IQ.

2-5. Data analysis

Descriptive statistics were used to calculate central and dispersion indices. The Shapiro-Wilk test was implemented to determine the normality of data distribution. Pearson's test was used for comparisons and evaluating the correlations between variables. SPSS version 22 software was used to analyze the data.

3- RESULTS

3-1. Patient characteristics

Out of 39 participants, 21 (53.8%) were females, and 18 (46.1%) males. According to the Shapiro-Wilk test, the distribution of all measured data in the variables was normal. **Table 1** reports the descriptive statistics of children's characteristics.

3-2. Relationship between variables

The correlation matrix of language and speech variables and motor skills by Pearson correlation coefficient is reported in **Table 2**.

Table-2: Correlation between language performance and motor skills

Variable	Speech	Syntax	Inappropriate Initiative	Coherence	Stereotyped Language	Use of Contexts	Compatibility	Social Interaction	Interests	Non-verbal Communication	Total CCC-Persian	ICS
Gross Motor	0.00	0.15	0.05	-0.15	0.00	-0.06	-0.08	0.08	0.06	-0.19	0.00	-0.06
Fine Motor	0.18	0.27	0.24	0.15	0.28	0.23	-0.05	0.24	0.42**	-0.08	0.33*	-0.01
Goodenough	0.56**	0.49**	0.06	0.12	0.07	0.05	0.09	0.35*	0.25	0.00	0.37*	0.41**

*P<0.05, **P<0.01, ICS= Intelligibility Context Scale, CCC-Persian= Children's Communication Checklist-Persian

As can be seen in **Table 2**, there is a positive and significant correlation between interest in language and fine motor skills, as well as, between the total scores of children's communication skills and their fine motor skills (P<0.05). In addition, the scores of the Goodenough test are significantly and positively correlated with the speech, syntax, social interactions, total scores of children's communication skills, and the intelligibility in context scale (P<0.05).

4- DISCUSSION

This study seeks to explore motor skills in correlation to language, speech, and cognitive adjustments in individuals with mental retardation. Enhancing motor functions, language, and speech skills is a major objective of treatment for mentally retarded children as these skills must be accurately evaluated to strategize for

future development. As such, this research aims to assess the connection between motor skills and linguistic, verbal, and cognitive alterations in mentally retarded children.

The present study supports the existence of positive and meaningful relationships between motor and linguistic developmental domains in children with different mental retardation spectrums (mild/moderate disability). The findings of this study are in contrast to numerous prior studies which have suggested that certain cognitive abilities are linked exclusively to gross motor skills (e.g. throwing or jumping) and not related to fine motor skills (e.g. threading beads, painting) (13, 14). In the present study, it was found that some language skills have a positive correlation with some fine movements, while they were not significantly correlated with gross motor skills; and the reasons for this difference in the results can be pointed out by using different tests and evaluation methods. Furthermore, there have been similar results in studies (23, 24). A recent study has indicated that little evidence supports the existence of a relationship between motor and cognitive domains in normal children aged 4-16 years (23). There is more evidence to investigate specific connections: the results of cross-sectional studies have shown that there are connections between certain aspects of motor skills and cognition. Specifically, it has been pointed out that fine motor skills have the strongest relationship with high-level cognitive functions (23).

Among other results of this study, it can be pointed out that there is a clear connection between some language skills and the scores of Goodenough draw-a-man test, whilst in previous reports on children with intellectual and developmental disabilities, there is a disorder and delay in motor skills (27, 33) and language (16, 30). Unfortunately, little research has been done in the field of communication between developmental domains in specific clinical groups. Hassanati et al. compared motor skills of 5-year-old children with their phonological and phonological production disorders, leading to findings congruent with those of the present study. They selected 32 children with phonological and phonological production disorders and examined their language and motor skills, concluding that children with production disorders have poor motor skills, which is probably related to production disorders of phonological origin (31). Similarly, Hartman et al., investigated the relationship between gross motor skills and mental planning (of high-level cognitive skills) in 61 school-age children with borderline intelligence and 36 children with mild intellectual disability; and found a significant relationship between the two examined components (32). In a study in 2008, Wuang et al. found a strong correlation between general movement performance and total IQ in 7-8-year-old mildly mentally retarded children (33). They also pointed out that fine motor skills compared to gross motor skills had twice more impacts on specific cognitive and linguistic functions such as processing speed and verbal comprehension, which is similar to the results of the present study. The findings of this research suggest that rehabilitation programs for children with mental disabilities should address multiple domains, and therapists should devise well-defined, achievable, and applicable objectives. Establishing appropriate objectives by various professionals assists children in reaching their maximum potential and provides clinicians with the ability to gauge the child's progression in skill development.

4-1. Limitations of the study

This study explored the association between motor skills and language

performance in individuals with mental retardation, and based on the evidence of a strong correlation between these two components, further research involving a larger sample population is warranted. Since, due to the Covid-19 pandemic, the number of participants in this study was reduced, and the economic status of the families was not taken into account. Thus, it is essential to take caution when generalizing the findings of this research to other mentally retarded children. Moreover, due to time constraints caused by the virus, no follow-up phase was conducted.In the future, it is advisable to conduct longitudinal and interventional studies exploring additional indicators of motor skills and language in individuals with mental retardation.

5- CONCLUSION

It is anticipated that there will be an increase in motor, language and speech abilities among mentally retarded children when movement and art therapies are employed. It also seems that improving motor skills increases language and speech skills in mentally retarded children and vice versa. Therefore, it can be said that movement therapy (occupational therapy, sports exercises and dance) and art therapy (painting, music and drama therapy) will play an effective role in strengthening the speech and language skills of these children.

6- ETHICAL CONSIDERATIONS

This study was approved by the Ethics Committee of Iran University of Medical Sciences (Ethics code: IR.IUMS.REC.1397.1163).

7- ACKNOWLEDGMENTS

We thank the participants who volunteered to participate in this study. We are also extremely grateful to Ms. Rosita Mokhtari Fard, Roya Hosseini, Akram Ekramian, Zahra Amirkhani, and Marziyeh Payandeh, who collaborated in the implementation of this research at Mehr Comprehensive Rehabilitation Center.

8- FUNDING

This research project was supported by Iran University of Medical Sciences (research code: 13623)

9- REFERENCES

1. Gonzalez SL, Alvarez V, Nelson EL. Do gross and fine motor skills differentially contribute to language outcomes? A systematic review. Frontiers in psychology. 2019; 10:2670.

2. Leonard HC, Hill EL. The impact of motor development on typical and atypical social cognition and language: A systematic review. Child and Adolescent Mental Health. 2014; 19(3):163-70.

3. Alizadeh H, Amraie K. Investigating Motor Profile of Students with specific learning disorder and Students with learning problem. Journal of Pediatric Nursing. 2022; 8(4):50-61.

4. Hofsten CV. Action, the foundation for cognitive development. Scandinavian Journal of Psychology. 2009; 50(6):617-23.

5. Yamauchi Y, Aoki S, Koike J, Hanzawa N, Hashimoto K. Motor and cognitive development of children with Down syndrome: The effect of acquisition of walking skills on their cognitive and language abilities. Brain and Development. 2019; 41(4):320-6.

6. Iverson JM. Early motor and communicative development in infants with an older sibling with autism spectrum disorder. Journal of Speech, Language, and Hearing Research. 2018; 61(11):2673-84.

7. Newell KM. What are Fundamental Motor Skills and what is Fundamental about Them? Journal of Motor Learning and Development. 2020; 8(2):280-314.

8. Widge AS, Heilbronner SR, Hayden BY. Prefrontal cortex and cognitive

control: new insights from human electrophysiology. F1000Research. 2019; 8.

9. Miller JA, D'Esposito M, Weiner KS. Using tertiary sulci to map the "cognitive globe" of the prefrontal cortex. Journal of cognitive neuroscience. 2021; 33(9):1698-715.

10. Holler J, Levinson SC. Multimodal language processing in human communication. Trends in Cognitive Sciences. 2019; 23(8):639-52.

11. Chai JY, Gao Q, She L, Yang S, Saba-Sadiya S, Xu G, editors. Language to Action: Towards Interactive Task Learning with Physical Agents. IJCAI; 2018.

12. Pan C-Y, Tsai C-L, Chu C-H, Sung M-C, Huang C-Y, Ma W-Y. Effects of physical exercise intervention on motor skills and executive functions in children with ADHD: A pilot study. Journal of attention disorders. 2019; 23(4):384-97.

13. Oberer N, Gashaj V, Roebers CM. Executive functions, visual-motor coordination, physical fitness and academic achievement: Longitudinal relations in typically developing children. Human movement science. 2018; 58:69-79.

14. McClelland MM, Cameron CE. Developing together: The role of executive function and motor skills in children's early academic lives. Early Childhood Research Quarterly. 2019; 46:142-51.

15. Benarous X, Iancu C, Guilé J-M, Consoli A, Cohen D. Missing the forest for the trees? A high rate of motor and language impairments in Disruptive Mood Dysregulation Disorder in a chart review of inpatient adolescents. European Child & Adolescent Psychiatry. 2021; 30(10):1579-90.

16. Valentini M, Bernardini C, Beretta A, Raiola G. Movement and language development as an early childhood twin strategy: A systematic review. Sport Mont. 2018; 16(3):107-12.

17. Pulvermüller F, Hauk O, Nikulin VV, Ilmoniemi RJ. Functional links between motor and language systems. European Journal of Neuroscience. 2005; 21(3):793-7.

18. Libertus K, Violi DA. Sit to talk: Relation between motor skills and language development in infancy. Frontiers in psychology. 2016; 7:475.

19. Roebers CM, Kauer M. Motor and cognitive control in a normative sample of 7-year-olds. Developmental science. 2009; 12(1):175-81.

20. Lukito S, Norman L, Carlisi C, Radua J, Hart H, Simonoff E, Rubia K. Comparative meta-analyses of brain structural and functional abnormalities during cognitive control in attention-deficit/hyperactivity disorder and autism spectrum disorder. Psychological Medicine. 2020; 50(6):894-919.

21. Wang MV, Lekhal R, Aarø L, Schjølberg S. Co-occurring development of early childhood communication and motor skills: results from a population-based longitudinal study. Child: care, health and development. 2014; 40(1):77-84.

22. Dyck MJ, Piek JP, Hay D, Smith L, Hallmayer J. Are abilities abnormally interdependent in children with autism? Journal of Clinical Child and Adolescent Psychology. 2006; 35(1):20-33.

23. Van der Fels IM, Te Wierike SC, Hartman E, Elferink-Gemser MT, Smith J, Visscher C. The relationship between motor skills and cognitive skills in 4–16 year old typically developing children: A systematic review. Journal of science and medicine in sport. 2015; 18(6):697-703.

24. Rigoli D, Piek JP, Kane R, Whillier A, Baxter C, Wilson P. An 18-month follow-up investigation of motor coordination and

working memory in primary school children. Human movement science. 2013; 32(5):1116-26.

25. Quistberg KA, Mueller U. Prospective relations between kindergarteners' executive function skills and their externalizing and internalizing behaviors. The Clinical Neuropsychologist. 2020; 34(4):845-62.

26. Houwen S, Visser L, van der Putten A, Vlaskamp C. The interrelationships between motor, cognitive, and language development in children with and without intellectual and developmental disabilities. Research in Developmental Disabilities. 2016; 53:19-31.

27. Rintala P, Loovis EM. Measuring motor skills in Finnish children with intellectual disabilities. Perceptual and motor skills. 2013; 116(1):294-303.

28. Putten A, Houwen S, Vlaskamp C, editors. Motor Functioning in People with Severe or Profound Intellectual Disabilities: A neglected opportunity for research? A literature review. Round table meeting, SIRG-PIMD; 2013.

29. Westendorp M, Houwen S, Hartman E, Visscher C. Are gross motor skills and sports participation related in children with intellectual disabilities? Research in developmental disabilities. 2011; 32(3):1147-53.

30. Schuit M, Segers E, van Balkom H, Verhoeven L. How cognitive factors affect language development in children with intellectual disabilities. Research in developmental disabilities. 2011; 32(5):1884-94.

31. Hasanati F, Khatoonabadi AR, Abdolvahab M. A comparative study on motor skills in 5-year-old children with phonological and phonetic disorders. Bimonthly Audiology-Tehran University of Medical Sciences. 2010; 19(1):71-7.

32. Hartman E, Houwen S, Scherder E, Visscher C. On the relationship between motor performance and executive functioning in children with intellectual disabilities. Journal of Intellectual Disability Research. 2010; 54(5):468-77.

33. Wuang YP, Wang CC, Huang MH, Su CY. Profiles and cognitive predictors of motor functions among early school-age children with mild intellectual disabilities. Journal of intellectual disability research. 2008; 52(12):1048-60.

34. Aghaz A, Kazemi Y, Karbasi-Amel A, Nakhshab M. Diagnostic Accuracy of the Children's Communication Checklist-Persian in Identifying Children with Autism Spectrum Disorder. International Journal of Pediatrics. 2022; 10(2):15482-94.

35. Ajalloueyan M, Aghaz A, Mirdeharbab A, Hasanalifard M, Saeedi M. Long-term effects of cochlear implant on the pragmatic skills and speech intelligibility in Persian-speaking children. International Journal of Pediatrics. 2021; 9(7):14033-41.

36. Aghaz A, Kazemi Y, Hemmati E, Zarifian T. Psychometric Properties of Persian Version of Intelligibility Context Scale in Persian-Speaking Children. The Scientific Journal of Rehabilitation Medicine. 2022; 10(6):1270-83.

37. Khaledi M, Heirani A, Sabaghi A. Effects of Eight Weeks of Selected Virtual-Assisted Montessori-Based Games on Motor Proficiency and Perceived Self-Control in Children with Spastic Hemiplegia during the Coronavirus Outbreak. BioMed Research International. 2022; 2022.

38. Tarigan M, Fadillah F. Inter-rater and Intra-Rater Reliability Test with Goodenough-Harris Drawing Test. The Open Psychology Journal. 2022; 15(1).

39. Baraheni N, Heidarabady S, Nemati S, Ghojazadeh M. Goodenough-Harris Drawing a Man Test (GHDAMT) as a

Substitute of Ages and Stages Questionnaires (ASQ2) for Evaluation of Cognition. Iranian journal of child neurology. 2018; 12(4):94-102.