The impact that fine and gross motor development have on the oral motor development and the pronunciation of sounds in early age

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Abstract: This research explores the intricate relationship between fine and gross motor development and their impact on oral motor development and pronunciation skills during early childhood. A comprehensive investigation was conducted to understand the interplay between these developmental domains, aiming to contribute valuable insights to the fields of developmental psychology and early childhood education.

The study involved a diverse sample of 70 children aged 2-5 years, utilizing standardized assessments to measure fine and gross motor development, oral motor skills, and pronunciation proficiency. Correlation and regression analyses were employed to examine the associations between these variables.

Results reveal significant correlations between fine and gross motor development and oral motor skills. Moreover, the study identified critical periods during early childhood when motor development plays a pivotal role in shaping oral motor competence and pronunciation abilities. The regression analyses further illuminated the unique contributions of fine and gross motor development to the variance in pronunciation outcomes.

In conclusion, this research contributes to the growing body of knowledge on the impact of motor development on oral motor skills and pronunciation in early age. By shedding light on these relationships, the study aims to inform educators, parents, and clinicians, fostering a more nuanced and effective approach to supporting the holistic development of children during this crucial developmental stage.

Keywords: motor development, pronunciation of sounds, impact, early age

1. INTRODUCTION

All of us as individuals happen to face children in our daily lives who may have developmental difficulties in various areas. These difficulties that children face can be of different types or areas, whether in the field of intellectual development, visual, in terms of language, speech or even in physical terms. A large number of parents who have children who encounter such difficulties often feel frustrated by the various situations that children face, both in their daily lives and in the learning process. And this doctoral seminar is directly related to the development of motor skills in children, both gross, fine and oral motor skills, together with the development of certain sounds, which are included in speech.

The main focus of this research is on the understanding of a connection between the development of gross and fine motor skills in the development of oral motor skills, and the role of oral motor skills in the correct pronunciation of sounds during speech.

During the review of the literature in different countries of the world and also in the countries of the Balkans, and especially in the country where I live in Kosovo, it can be confidently said that there are no researches that refer to the subject in question. All the researches that are used for this doctoral seminar touch one or two of the areas with which the topic is related (gross, fine, oral motor and the pronunciation of sounds), thus, we can refer to the mentioned researches, either from the countries of different parts of the world, or the research completed in the Balkan countries, only superficially for our topic.

This doctoral seminar will have a positive impact on the initiation of research that affects such a topic, mainly in the state of Kosovo, in order for the community, parents, teachers and schools to understand the sensitivity of treating children with such disorders. And in this way, they can basically understand the different definitions of these fields, the way of using strategies, techniques and adequate methods for their use.

1.1 Literature review

The majority of parents throughout their lives try to give their best so that their children grow up healthy, become intelligent and are independent in the actions they do. Thus, children are constantly expected to show different abilities, whether physical, mental, social, and a proper growth development related to their age. This author also shows that the greatest attention in proper development is the development of motor skills, both fine and global (Gidion, 2020).

Gidion's conclusions were confirmed even earlier, when Henniger (2009) explains that fine and global movements are the center of a child's life, which positively affects all other aspects of children's development. Meanwhile, Palmer (2001) concluded that the elements of motor development, which are related to movement, consist of body parts, which includes actions such as: walking and dancing, then the ability of movements such as: near/far and down/up, such as the quality of movement: fast/slow, the ability to perform activities such as: grasping objects, cutting, etc. And in this case, it can be emphasized that at the beginning of a child's development, when the child is able to respond to the parents' requests, whether by moving the limbs, by crawling, then by learning to walk, etc., are the basis of the development of the fields of other children.

Oral motor, or oromotor includes the proper development of the lips, cheeks, jaw and tongue, organs that play a role in the ability to speak and feed in children. If a child shows a problem in oromotor development, he may have a weak ability to eat and interfere in the development of speech in children, which then greatly affects their social aspect (Camarago & Pinzon, 2012).

During the first year of a child's life, it is the time when the different movements of the mouth part can be developed (Boshart, 1999). And in this case, it is worth noting that orofacial skills have to do with the child's ability to touch food or an object with the lips, to understand the taste of food, to understand if the food is cold or hot and finally to make the adequate movement of the tongue inside the mouth (Sampallo-Pedroza et al., 2014). Motor development and language development have historically been considered separately and viewed as independent domains from different theoretical perspectives (Gesell & Amatruda, 1945; Lennenberg, 1967). However, in recent decades, ecological and dynamic systems approach to development (Gibson and Pick, 2000, Thelen and Smith, 1994) and the embodied cognition approach (Clark, 1997, Varela et al., 1991) have stimulated many researchers to study the co-development of motor and language skills, exploring the possibility of cross-domain interactions resulting in cascading changes during periods of developmental transition (Rothman et al., 2019).

It is worth noting that Piaget (1952) was among the people who gave great importance to the motor development of children and constantly studied this field. According to him there is a link between motor and cognitive development and he noted that babies' own actions and the resulting sensorimotor experiences are critical to their learning about the environment and the objects within it. After Piaget, different authors also began to pay great attention to this field, where in different years they have shown us that motor skills are at the core of the daily actions and interactions of babies (and adults) and therefore influence in subsequent perceptual, cognitive and social development (Gibson, 1988; Bushnell dhe Boudreau, 1993).

During different years, starting from Greenfield (1991) then Thelen & Smith (1994) until Iverson (2010) it has been established that the various disorders related to language and speech are also related to motor skills.

Because children with specific language impairment (SLI) by definition show dissociation between aspects of cognitive and language development, they provide a particularly strong test of whether and how domain-general mechanisms may interact with language. Some theorists propose a common mechanism underlying language and motor processing in SLI (Tomblin, Maniela-Arnold, & Zhang, 2006; Ullman & Pierpont, 2005), while others suggest a comorbidity, with independently associated deficits with language and motor components (Locke, 1997). The development of oral motor skills is directly related to the development of gross motor skills, where we are dealing with the ability to hold the head in different ways, then with the ability to sit and hand-eye coordination (Department of agriculture policy, 2001), depending on these development also begins the development of the parts for articulation, where the Vagus nerve receives the appropriate information and then applies that information either with the movement of the tongue or the organs that participate in the articulation of words (Morris & Dunn, 2000).

In the oromotor development to see the process of movement, which is known as motor differentiation (Castañeda & Porras, 1999), we give great importance to perceptive abilities, also muscular, which is observed if it is developing in the right way based on the strength, tone of individual and stability during speech. Besides these, we see if the neck, head, jaw and tongue are in the right position (Connolly & Dalgleish, 1989).

Oral motor differentiation is calculated as the perfect ability to move the different parts of the mouth, which take part in the articulation of letters or words, this differentiation occurs during continuous acquisition, connected with physiological processes, which develop continuously (Castañeda & Porras, 1999; Boshart, 1998).

The development of speech requires several years to be acquired, while the more years pass, the more it is perfected. In order to produce a message, through speech, all physiological, phonological, linguistic and oral motor skills interact with each other (Castañeda & Porras, 1999). Then, if we talk about speech in babies, it can be said convincingly that they do not manage to control the neurons and muscles that participate in speech, for this reason, different strategies are used with children to help them develop their speech gradually. Also, it is very important to mention that in babies we have some basic positions, which help us understand that the development of speech will be at the right level, and also help us understand the formation of muscle tone and the stability of the body. These positions have to do with the ability of the child to stay on the back, which includes the age of 0-3 months, then the way the child is held by the shoulder, which includes the age of 3-6 months, the way the child manages to sit, which includes the age of 6-9 months, and finally the way the child stands, which includes the age of 9-27 months (Reyes & Rivera, 2000).

A large number of researches have tried to study oral motor development in young children, but this development is directly related to the way children are fed or to limited developmental abilities (Fucile et al., 2005; Johnson & Harris, 2004; Mason et al., 2005; Rogers & Arvedson, 2005). Even though this large number of researches that were mentioned, done in the field of oral motor skills, none of them has studied how the poor development of oral motor skills affects children's speech.

Well, we have the research of Alcock et al. (2000) which shows us that there is a correlation between oral motor development and language development in children, since according to this study the development of these two comes when they have a coordination with each other. Meanwhile, Mateer & Kimura (1997) informed us much earlier that oral dyspraxia and dysphasia in children are closely related to each other.

Language difficulties have been found to be highly heritable (Spinath et al., 2004). More research is needed on potential shared genetic factors that influence the development of both abilities. Factors such as socioeconomic status (Payne et al., 1994), history of parenting difficulties (Choudhury & Benasich, 2003), or low birth weight (Ribeiro et al., 2011) are known to influence language and skills motor. Thus, a child with slow development in one of the areas will also be at risk of delayed development in the other (Wang et al., 2014).

In other words, motor movements and interaction with the surrounding environment can significantly affect the production of spoken language. Motor skills acquired during interaction with the environment include the process of motor learning (Oxendine, 1968).

This doctoral seminar is built on a number of theories. There are a large number of theories that describe the progress of motor development. These theories are: Pribram's TOTE Model (Miller, Galanter & Pribram, 1960), Motor Learning Stages (Fitts & Posner, 1967), Closed Loop Theory (Adams, 1971), Schema Theory, for discrete learners of motor skills (Schmid, 1975), Theory about learning based on exploration (Newell, 1980), Neuropsychological theory of learning motor skills (Willingham, 1998).

Also, some different theories are discussed which have to do with the acquisition of children's speech. They are: Behaviorist Theory (Skinner, 1957), Nativist Theory (Chomsky, 1980) and Cognitive Theory (Piaget, 1945). Language-oriented theories are compared with learning-oriented theories and four controversial issues of stimulus frequency, imitation, extension, and meanings are reviewed.

2. METHODOLOGY

2.1. Subject of the research

The research in question was completed in the state of Kosovo. The participating cities were Pristina (as the capital of Kosovo), then Mitrovica, Gjilan, Peja, Gjakova, Ferizaj and Prizren.

The respondents of this research were children aged 2 to 5 years, who were part of early childhood education centers and were in preschool. The number of children participating in this research was 70 children who some of them had difficulties in gross, fine, oral motor skills or in pronouncing letters, the children's participation was divided with the right proportion, where 35 of them had difficulties or delays in motor development and 35 of the others did not have delays in motor development, thanks to this the development of speech or the correct pronunciation of letters was also analyzed. The selection of the respondents was done deliberately. From each city, 10 children are chosen in order to distribute the respondents equally, depending on the cities. The children's participation was divided with the right proportion, where 35 of them had difficulties or delays in motor development and 35 of the others did not have delays in motor development, thanks to this the development of speech or the correct pronunciation of letters was also analyzed.

Initially, a kindergarten or a preschool was selected from each city. Their selection was made deliberately, depending on whether we had a teacher or a school principal whom we know. The principals of the schools were informed about the purpose of the research, then with their permission we talked with the teachers who gave us information about children with certain difficulties and enabled us to cooperate with the children's parents. The consent for the children to be part of this research was obtained from the parents or legal guardians, before the children were subjected to participation in the research.

2.2. The instruments used for the research

The instruments that were used for this research were two tests and one questionnaire, which helped us to understand the development of the four areas as separate parts.

The first instrument that was used for this research, which will helped us to understand the development of fine, global motor skills and the action of children's perception, was the questionnaire: "Early Motor Questionnaire (EMQ)" (Libertus & Landa, 2013).

This questionnaire was divided into three parts.

I. The first part contained 49 variables that have to do with the different behaviors displayed by the child during activities and everyday life to identify the level of gross motor development.
II. The second part included 48 variables that have to do with the different behaviors that the child displays

during activities and everyday life to identify the degree of fine motor development.

III. The third part included 31 variables about the action of perception, in which case the child's visual and receptive skills were understood.

The second instrument that was used for this research, which will helped us to understand the development of oral motor skills even during the time when the child does not speak and performs other activities even during the time when the child speaks, is the test: "Oral Motor Activities for School -Aged Children" (Mackie, 1996).

This test was divided into two parts:

I. The first part "Assessment of Oral-Motor Functions During Non-Speech Tasks" through the variables that are presented in the form of observation, by the parents, helped us to get the right information about the oral structure based on regarding strength, stability, mobility and differentiation.

II. The second part "Assessment of Oral-Motor Functions During Speech Tasks" was done in order to understand control, mobility, stability and differentiation of the oral structures during speech productions. This part was completed by the researcher, observing the child along with an articulation test.

The third instrument that was used for this research was a test compiled according to the standards of the Albanian language, about the difficulties of articulation that the child may encounter. This test will include 36 variables, which contain the letters of the alphabet of the Albanian language, in the initial, medial and final aspect. At the moment when the child pronounces the word requested by him, the observation of the oral motor skills during speech will also be done.

2.3. Statistical processing of the results

The three instruments that were used in this research, the questionnaire and the two tests contained closed type questions. The first questionnaire, which affects motor development, included variables that give the opportunity to answer with the Likert scale (example: Sure, that child does NOT show behavior; Child probably does NOT show behavior yet; Unsure whether child could do this or not; Child probably shows this behavior; Sure, that child shows this behavior and remember a particular instance). The second test, which was about the development of the child's oral part, helped the researcher, to observe the child's behavior and respond with the nominal scale, where the values refer to different parts of the mouth, such as the lips, cheeks, teeth, tongue and movements that the child is able to make depending on oral development. Meanwhile, the third test contained the correct pronunciation of sounds while formulating words with the observation space with the ordinal scale (example: the letter is pronounced well and the letter is not pronounced well).

The closed-ended questions of both the questionnaire and the tests allowed us to use the Social Science Statistical Package to analyze the data and find the results. In this case, the variables of the questionnaires were grouped according to the same field, with "Computer Variable" and then the analysis of frequencies, correlation, T-test, and regression were used.
It is important to note that the children's participation was voluntary, and also children were not allowed to be part of the research without their parents' permission, and then in order for the research to be of a high ethical level, it was also preserved confidentiality of the participants, the data will always be confidential and anonymous.

3. RESULTS

3.1. Correlation analysis

Based on the correlational analysis, it can be said that there is a significant positive correlation between fine and gross motor skills, $r= .717^{**}$, $p<0.01$ so the higher the development of one of the motor skills, the higher the development of the other motor skills. Also, it is worth noting that there is a significant positive correlation between the development of fine motor skills and the development of oral motor skills $r= .703^{**}$, $p<0.01$, so the

higher the development of fine motor skills, the higher the development of oral motor skills and vice versa. There is also a connection between gross motor development and oral motor development, r= .748**, p<0.01 so the higher the gross motor development, the higher the oral motor development will be and vice versa. It is worth noting that there is also a connection between the three areas of motor development (fine, oral, gross) and a child's ability to pronounce letters, "Fine Motor Skills and Pronunciation of letters" r= .740**, p<0.01; "Gross Motor Skills and Pronunciation of letters" r=.622**, p<0.01, "Oral Motor Skills and Pronunciation of letters" r= .813**, p<0.01 and vice versa.

Table 1 The relationship between the variables of the instruments used

		1.Fine Motor Skills	2.Gross Motor Skills	3.Oral Motor Skills	4.Pronunciation of letters
1.Fine Motor Skills	Pearson Correlation	1	.717**	.703**	.740**
	Sig. (2-tailed)		.000	.000	.000
	N	70	70	70	70
2.Gross Motor Skills	Pearson Correlation	.717**	1	.748**	.622**
	Sig. (2-tailed)	.000		.000	.000
	N	70	70	70	70
3.Oral Motor Skills	Pearson Correlation	.703**	.748**	1	.813**
	Sig. (2-tailed)	.000	.000		.000
	N	70	70	70	70
4.Pronunciation of letters	Pearson Correlation	.740**	.622**	.813**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	70	70	70	70

3.2 Regression analysis

Linear regression analysis was performed to test whether the fine and bruto motor skills significantly predicted the oral motor development. The regression results showed that the model explained 13.2% of the variance and that the model was significant, F (1,173) = 23,168 p <.001.

Table 2 The role of fine and gross motor skills on oral motor development

	R	R square	Adjusted R Square	Std. Error of the Estimate	F.	Sig.
Oral Motor Development	,363[a]	,132	,126	1,28045	23,168	,000

a. Dependent variable: Oral Motor Development
b. Predictor: (Constant), Fine and Bruto Motor Skills

Linear regression analysis was performed to test whether oral motor skills significantly predicted pronunciations of sounds. The regression results showed that the model explained 12.4% of the variance and that the model was significant, F(1,154)= 21.844, p<.001.

Table 3 The role of oral motor skills on the correct pronunciation of sounds

	R	R square	Adjusted R Square	Std. Error of the Estimate	F.	Sig.
Oral Motor Development	,363[a]	,132	,126	1,28045	23,168	,000

a. Dependent variable: Pronunciation of Sounds
b. Predictor: (Constant), Oral-Motor Skills

3.3. T-test analysis

According to the results of the analysis, the average of 35 participating children without delays in motor development is 38.4340 (M = 38.44340, DS = 5.11600), and the average of 35 participating children with delays is 43.2136 (M = 43.2136, DS = 3, 91490). So, there is a big difference between people who have delays and those who do not have delays in motor development: t (154) = -6,488, p <, 05.

Table 4 T-test analysis about group statistics based on the students' instruments

		Variable	No.	MA	SD	Errors in SD
Motor Skills	Equality of variance supposedly	Without delays	35	38,4340	5,11600	,70274
	Equality of variance not to assuming	With delays	35	43,2136	3,91490	,38575

Table 5 Independent Sample Test based on the students' instruments

		Leven Test for Equality of Variance		t-test for Mean Equality						
		F	Sig.	t	df	Sig.(2-tailed)	Change in MA	Errors in SD.	95% Reliability Interval of changes	
									Lower	Upper
Motor Skills	Equality of variance supposedly	4,939	,028	-6,488	154	,000	-4,77963	-,73664	-6,23486	-3,32440
	Equality of variance not to assuming			-5,962	84,162	,000	-4,77963	-,80165	-6,37375	-3,18551

IV. DISCUSSIONS

This research was built on several goals, but its main goal was to understand the developmental connections where we are dealing with the complex connections between the development of fine and gross motor skills, then the development of oral motor skills and the pronunciation of sounds during early childhood are explored. The goals raised, especially the first and main goal, we manage to support by means of various analyzes and the conclusions section. Also, this research was based on a main hypothesis and two sub-hypotheses. The main hypothesis "There is a positive correlation between fine and gross motor development in early childhood and the development of oral motor skills and pronunciation of sounds" is verified based on the correlational analysis, the description of which can be found in the paragraph below.

Based on the correlational analysis, it can be said that there is a significant positive correlation between fine and gross motor skills, so the higher the development of one of the motor skills, the higher the development of the other motor skills. Also, it is worth noting that there is a significant positive correlation between the development of fine motor skills and the development of oral motor skills, so the higher the development of fine motor skills, the higher the development of oral motor skills and vice versa. There is also a connection between gross motor development and oral motor development, so the higher the gross motor development, the higher the oral motor

development will be and vice versa. It is worth noting that there is also a connection between the three areas of motor development (fine, oral, gross) and a child's ability to pronounce letters and vice versa.

In an unpublished dissertation, Yingling (1981) approached this issue by exploring the possibility that the achievement of unsupported sitting (which results in substantial changes in respiration and the position of the speech articulators) is accompanied by changes in the characteristics of infant vocalizations. Based on these considerations, Yingling (1981) hypothesized that the achievement of independent, unsupported sitting would initiate a transitional period in which vocalizations progress from being highly variable to more closely resembling well-timed, patterned speech. To test this prediction, she followed a group of infants aged 0;5.5 longitudinally through the transition to unsupported sitting, with observations prior to and following attainment of independent sitting.

Regression analysis also helps us to understand that higher levels of motor development are associated with clearer articulation and pronunciation of sounds. Thus, based on this analysis the raised sub-hypothesis is also verified which says "Higher levels of gross motor coordination, particularly in oral motor movements, will be associated with increased speech fluency in young children".

There are data indicating links between characteristics of vocalizations and features of objects that are being concurrently manipulated. Bernardis, Bello, Pettenati, Stefanini and Gentilucci (2008) presented infants between the ages of 0;9 and 0;11 with small (2 cm) orlarge (4 cm) wooden objects one at a time. On each trial, an experimenter drew attention tothe object, manipulated it and then placed it on the table in front of the infant. All vocalizations produced during object manipulation were recorded and spectrograms of these vocalizations were analyzed. Findings indicated that when infants vocalized while manually manipulating objects, characteristics of those vocalizations tended to vary as a function of object size. Specifically, the first formant in the voice spectra (F1) was significantly higher for large relative to small objects. F1 is related to internal mouth aperture, with a higher value indicating a larger opening. In light of evidence indicating the existence from birth of a tight link between the manual and oral/vocal systems (Bates & Dick, 2002; Iverson & Thelen, 1999), the authors interpreted these data as suggesting that when an infant prepares to manipulate alarge object, the motor command to increase the opening of the fingers for large object manipulation is also sent to the mouth, resulting in a larger aperture that gives rise to the higher F1 values observed in co-occurring vocalizations. It is noteworthy that this effect isnot limited to infants: a study of adults and older children revealed that execution of grasping influences the simultaneous pronunciation of syllables, such that when large objects are grasped, lip opening and F1 increased in a fashion that corresponded to changes in finger shaping during grasp movements (Gentilucci, Santunione, Roy & Stefanini, 2004; Gentilucci, Stefanini, Roy & Santunione, 2004).

The T-test analysis helps us verify the raised hypothesis, which says "Children with advanced motor skills will exhibit more accurate articulation in speech compared to those with less developed motor skills". Thus, based on this analysis, there were differences between children with delays in motor development and those without delays in motor development. In this case, children with high motor skills also had their articulation at a higher level, while children with delays in motor development had articulation at a lower level.

A study from Cermak et al. (1986) was designed to examine the relationship between articulation disorders, soft neurological signs, and motor abilities. Fifteen children with articulation problems, as measured by the Templin-Darley Articulation Screening Test and a connected speech sample, were compared with a normal control group (matched for sex and age) on the Quick Neurological Screening Test, the Imitation of Postures test (from the Southern California Sensory Integration Tests), and the 1984 version of the Stott Test of Motor Impairment that has been revised by Henderson. A Significant difference was found between the groups on the Motor Impairment Test and the Quick Neurological Screening Test, supporting the hypothesis that the articulation disorder children would have more motor coordination problems and soft neurological signs than the normal children in the control group. There was no between-group difference on the Imitation of Postures test, suggesting that as a group, children with articulation deficits are not dyspraxic. This study supports other research findings stating a relationship between articulation problems and motor impairment, but it also indicates that this motor impairment is not necessarily dyspraxia.

Baruti-Sylejmani and Rashikj-Canevska (2023) in research done about the parents' perceptions of the correlation between motor development and speech development in children come to the conclusion that there is a positive relationship between these two. So, according to them, the more developed motor skills are in children, the more developed their speaking skills will be. Without leaving aside that motor development has a pretty big impact on the development of speech in children.

The same authors (Baruti-Sylejmani & Rashikj-Canevska, 2023) in the same year have done another, similar research, but which has to do with the perception of teachers about the development of language and speech in children. in this case, based on this research, they come to the conclusion that the higher the motor development in children, the higher the development of language and speech in children. And in this case, the more the children are able to understand - that is, they have developed the language, the more developed they are in terms of speaking.

V. CONCLUSIONS

Based on the findings of the research, we have reached a large number of conclusions which help us to give the final shape to this research. During the various analyses, it was noticed that there is an important relationship between the development of fine motor skills, the development of gross motor skills, the development of oral motor skills and the pronunciation of sounds, in children of early age (2--5 years).

During these analyses, it was observed that fine and gross motor skills significantly influence the development of oral motor skills during early childhood. In this case, it was realized that children who had no problems in the development of fine and gross motor skills, did not have a delay in the development of oral motor skills.

Proper motor skills contribute greatly to clearer and more accurate speech production at an early age. Children who were able to complete all the instructions that included gross motor, then also fine and oral motor, were able to speak clearly and accurately.

It is important to emphasize that teachers and parents through this research will be able to better understand all the difficulties that the child faces in motor development, also if the difficulties in speaking are due to a low development of motor vehicles. Thus, in classroom and home conditions, they should use different activities that develop children's skills, with the aim of positively influencing children's speech.

At the end, it can be said that this research has some limitations.

As a first limitation, there is the fact that in the Albanian language and also in other languages there are no topics that address this topic directly, but we have researches that we can superficially use for our research.

As a second limitation, the sample is small in number and is not determinative for the entire state of Kosovo. It is more important to use a larger sample to represent our country in other similar researches.

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