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The Eye-Hand Assessment in Pupils Attending the Second Year of the Primary Schools in the Province of Salerno

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ABSTRACT

The 2007 Italian National Guidelines for the curriculum of primary school require the achievement of motor skills related to visual motor coordination as one of the goals for skill development at the end of primary school, measurable through a different use of evaluation tools. Among the several motor assessment tests recognised by the international scientific community, the VMI Developmental Test of Visual-Motor Integration (Beery & Buktenica, 2000) represents a valid instrument of assessing the visual-motor coordination skills and their constitutive elements. The aim of the research was a comparative analysis of City of Salerno's primary schools about eye-hand coordination assessment. This research has highlighted the importance of a use of motor evaluation assessment in the primary school that is required to bring out potentialities and plurality of limits of each pupil, which are essential for effective customized teaching planning of educational activities.

Key words: Eye-hand coordination, primary school, VMI test.

INTRODUCTION

The study of the motor coordination requires to inquiry all the quality factors that may be noticed during a motor activity. Several theoretical models from different fields of scientific research have tried to describe in detail the main features of the coordinated movements.

Specifically, the theoretical model proposed by Meinel-Schnabel(17) provides a complex and multidisciplinary descriptive-interpretative perspective of the qualitative factors required by coordinated motor actions, as "the organization of motor actions towards a definite goal or purpose"(17). Accordingly, Meinel -Schnabel states that the coordination of movement may be defined as the natural harmony "of phases of the movements, single movements or partial movements of the body"(17) and its parts, and cannot be described either from a neuromuscular perspective as the regulation of the activity of synergistic and antagonistic muscles and of the respective nervous system processes or as the synergy of different impulses regulated for motor execution, but it may be summarised as the ability to "harmonise all the motor parameters".(17)

In the mid of the twentieth century N.A. Bernstein has defined the coordination as a complex process of motor control which selects "*the degrees of freedom available in different systems of the motor activity*"(5) Particularly, in Bernstein's theoretical model of motor coordination echoed by Meinel and Schnabel in their book "theory of movement: sketch of a theory of motor sport in the educational aspect", the motor control apparatus is shown as a *block diagram* which highlights the role and the combination of "*many partial functions*"(5) that help the motor coordination. It is indeed a hierarchic multi-levels model which allows the selection and the gradual shaping of movements that are more and more suitable to solve motor problems and hence the motor coordination. According to this view, the movement is not only the result of a proper functioning of the anatomical and physiological profile but, according to Bernstein, it is the product of a process of construction in which other factors become important determinants of the action. In 1947 Bernstein clearly showed in his work "*On Construction of Movements*" that the motor learning process is a gradual upward movement on a ladder (Bernstein's ladder). He defined the hierarchy of the movement as the ability to order movements according to natural movement architecture, consisting of a "functional synergy" of muscle movements regulated by the neural system. Bernstein's works (1967) show a deep study of the mechanics of movement and the unique properties of the 'actuators' responsible of the movement.

According to Bernstein, the "process of mastering the degrees of freedom of the body in motion" (5) can indeed be defined as the proper acknowledgement to the ability to select and control the movements conforming to the body's directions.

Particularly, the proprioceptors play a main role of guidance, control and selection in the execution

of movements. They allow to dominate the extreme redundancy of the intrinsic degrees of freedom, reducing them according to the functional needs of each specific activity. The mechanisms of regulation and coordination of the basic motor skills are defined by a complex system of muscles and joints, which has got a great number of degrees of freedom, which change according to the changes of the position and the density of the muscles and in relation to the environmental inputs that encourage them.

Therefore, according to Bernstein, the analysis and the study of the movement need to understand the relationship between anatomical and physiological functional elements involved in the execution of the movement and the influence of environmental factors.

Since 1935, Bernstein has stressed the role of the feedback in the control of the motor system, assuming that the feedback is part of the control system itself. (5)

In fact, he discovered that the execution of the movement could be organized in different levels of the nervous system: starting from the arc reflection, a sort of short circuit between stimulus and response (5) passing through the thalamus-striatum level (also called the level of coordination) and ending with the cortical layers, involved in changing movements in the space and conditioned by the presence of symbolic objects.

Bernstein and Anochin symbolize the transfer from reflexology to *neurophysiology*. During the second half of the twentieth century they both studied the neurophysiologic aspects of the movement, highlighting that, on a psychological level, a purpose action requires a team of nerve cells that makes them self up in a functional system. Therefore, to study the movement, it is important to observe the involvement of different brain areas and their neuronal connections.

In addition to Bernstein's interesting theoretical studies, between the late 50s and early 70s, Anochin's reflections fit within the theoretical framework of the Russian psychology. Anochin retrieves and summarizes Bernstein's model, indicating the development of a combination of movements in the regulatory function of three circuits. Coordination is the result of a regulation system between information perceived from a neuromuscular and a more proper cognitive point of view and the sensory feedback information responsible of the action aimed at achieving the executive purpose. In particular, he commits the control of each motor action to three circuits (7) of the movement, so allowing the planning of a suitable action.

According to Anochin, the movement is the result of the 'integration of neuromuscular signals, sensory signals and environmental signals which allow the regulation of the motor response (afferent synthesis). Therefore, the motor activity output is a comparison between the central planning and the peripheral sensory perception, defined by the process controlling the movement coordination. This process is defined by the function of receiving and processing five sensory analyzers that provide information in different ways on the quantity and usability of the various inputs, playing a main role with regard to the collection of information on the course of the movement. Each analyzer provides different information that, once combined, contributes to the definition of "*the perfect harmony of movements*"(7), connected together in every coordinated motor process.

In 1971 Adams (1-2) has usefully contributed to a more extensive definition of those factors characterizing the motor coordination: he has clarified the role of the elaboration process underlying motor actions by his Closed Loop Theory. He has introduced one of the first theories of motor learning, describing the function of the information processes underlying the motor activity. According to Adams, the motor response is mainly determined by feedback from the moving limbs.

All movements are made by comparing the ongoing feedback from the limbs to a reference of correctness that is learned during practice which termed the perceptual trace (Schmitd & Lee 2005). Therefore; the sensory feedback is continuously evoked during the execution of a movement.

According to Adams' hypothesis, the continuous interaction between peripheral feedback and central nervous system suggests the existence of a perceptual trace that is "a storage device containing all the sensory consequences which any correct movement should generate" (2). Such model indicates that the interaction between the newly acquired information and the information stored during the previous executions allows to acknowledge and then retrieve a certain coherence between the perceptual trace and the feedback, in order to select the most appropriate motor response in consideration of the goal to be achieved and it also allows to strengthen motor learning through the potential adjustment of movements. It can thus entail that Adams' theory contains a description of motor coordination based on the modalities and on the quality of "the motor learning of a specific movement" (1) directed to the execution of a motor task.

The Italian Ministry of Education's Programmes and Guidelines have introduced a specific dimension

of coordination concerning eye-hand relation, the ability to integrate the anatomo-functional features of the eye with the specific and synchronic actions of the hand, thus emphasizing the importance of eye-hand coordinative competence within the formative process. From this perspective, every study on children's motor coordination should therefore take into account the different developmental stages and the different functions of the qualitative systems related to movement control.

Meinel and Scnabel about the eye-hand relation in motor coordination, explains how the prerequisites for coordinated action affect the "functional ability (functional maturity) of the organs of movement control" (7) to perceive, elaborate and transfer environmental information and to develop functionalities according to experience. During the first phase of school age, the daily interactions with the surrounding environment may affect the development of coordination skills, in particular the eye-hand coordination.

Even Piaget studied the functional and cognitive significance of the motor experience that includes the sensory-motor coordination. According to him, coordination is the product of the integration of "*a new element to a previous scheme*" (9)that's the product of an evolutionary development which gradually helps the subject get motor schemes more and more able to deal with the environment. Particularly, Piaget states that even in the early months of life there are some primitive forms of eye coordination and prehension, which can be considered as one of the earliest ways to combine one purpose action. The child's relationship with the reality is mainly granted by the synergic functionality of the sight with the movement of the body and its parts. According to Piaget, in fact, the visual image is "*the product of imitation both with the body and the eyes' movements*" *(10).*

Meinel and Scnabel explain that the manipulation, involving a tactile-visual sensory dimension, provides the gradual ….

Hence, child's interaction with reality seems to be provided in the first place by the synergic relation between the visual system and the body and its parts; specifically, the manipulation phase, involving a tactile-visual sensory dimension, would provide the gradual "awareness of the objective < palpable> existence, of the nature of material world through the cooperation between motor organs and sense organs" (7).

According to Meinel-Schnabel the representation of the world of perceptions would be provided by the syntonic use of movements and visual system, so that "locomotion movements and hand tactile manipulations" (7) would be necessary conditions "to perform a group of motor activities to develop the motor coordination of several types of movement" (7).

In this sense, the "distinction between the different kinds of movement" (7) related to early childhood, would be the first, noticeable sign of "the rapid increase of motor learning skills" (7) based both on children's psychophysical characteristics and school experience. In this regard, Meinel Schnabel emphasizes the key role of "physical education in school" (7) in the motor development, since primary education may favour the increase of "the specific features of motor learning development" (7) in school-age children.

Coherently with these theoretical considerations, which are, moreover, "supported by consent of all contemporary studies on Physical Education Methodology" (7), the National Directions for Italian Primary School (2007) contain a clear reference to the "Body, movement and sport" disciplinary area, to promote, through the didactics of movement, the acquisition of motor skills "to acknowledge, classify, ,memorize and elaborate sensory information (visual, auditory, tactile and kinesthetic sensations)".

It needs underlining that the National Directions, according to Meinel and Schnabel's studies, regard the motor skills development as a necessary prerequisite for the transformation and adjustment of movements, development which is "at its inception in children this age" (7). It is also necessary to provide for "the free and organized possibility to choose tuition methods, tools and times in accordance with the plurality of methodological options" (8) in order to guarantee the achievement of the formative goals set by the Ministry of Education.

More specifically, the National Directions give the teachers the "responsibility of assessment" (8) which "gains a crucial formative function by supporting the learning process and promoting continuous improvement" (8) thus stressing the importance of the assessment "before, during and after the curricular courses" (8). In this regard, Meinel-Schnabel insists that teachers should "have clear in mind" (7) which are the most suitable goals, tools and methods for "their students' age, motor experience and knowledge" (7), in order to better define and analyse the motor prerequisites which "affect the coordination skills and the pre-existing movement skills" (7). From this perspective, the potential use of battery of motor assessment tests in school may help teachers obtain information about their students' initial motor performance level and accordingly plan their didactic activities to "acquire accurate data on relevant circumstances for a correct diagnosis of students' performances" (6) through a

standardised procedure for the measurement and analysis of the levels of psychophysical maturity. The use of scientific assessment tools in scholastic contexts guarantees the systematic data collection and interpretation leading, as an integral part of the educational-didactic process, to the definition of a "value judgment aimed at the educational action" (8). Following Meinel and Schnabel's considerations, it is possible to affirm that, in the Italian school context, the use of battery of tests represents a valid analysis tool which allows teachers to "collect a series of general educational principles" (7) to properly base tuition on, in order to "increase the students' learning activity" *(7)*.

Among the several motor assessment tests recognised by the international scientific community, the VMI Developmental Test of Visual-Motor Integration (Beery & Buktenica, 2000) represents a valid instrument of assessing the visual-motor coordination skills and their constitutive elements, since it is designed to "identify how individuals integrate their visual and motor skills" (Beery & Buktenica, 2000). The VMI (Beery & Buktenica, 2000)is a "paper-and-pencil"test; it can be either group or individually administered and it is designed to assess individuals' visual-motor integration skills. Examinees are asked to copy a booklet containing 27 increasingly complex geometric figures. After administration of the VMI, being it a battery of tests, it is possible to administer two supplemental tests for the assessment of the visual perception and motor coordination skills. The visual perception supplemental test assesses the examinee's capability to identify up to 27 geometric figures in a three-minute period, while the motor coordination supplemental test requires the examinee to trace with a pencil the stimulus forms without going outside double-lined paths in a five-minute period. Since these tests are structured to be administered to individuals from age 3 to adulthood, divided into age groups, the necessity of a longitudinal study on the coordination skills development level is then fulfilled. Because of its structural and content-related characteristics, the VMI test can be easily administered within the scholastic context as a little "sketchbook" containing geometric figures to be copied. The VMI test's analytic utility in primary school has been recognised by the section of the National Directions concerning "the body and its sensory-perceptual functions"(8), which stresses the importance of the development of the ability to identify and graphically represent the body and its parts, learning how to elaborate and decode visual, auditory, tactile and kinaesthetic information.

To this end, the VMI test provides a clear analysis, for each age group, of the coordination and visual-motor integration level, assuming that the visual-motor integration "corresponds to the coordination level between visual perception and finger/hand movements"(Beery & Buktenica, 2000). Thanks to this test, it is possible to obtain a detailed analysis of the eye-hand coordination skills and to collect potential diagnostic information to support, on a scientific basis, the construction of further educational interventions for "those children who might need an extra help" (13)on a didactic level. The Italian Ministry, when defining the purposes and duty of the educational system, has stated that schools of any level and grade must provide for "research, experimentation and development activities" since primary school in order to monitor, also as a preventive measure, each student's needs and demands. Hence the necessity to undertake research activities on eye-hand coordination analysis and assessment in primary school children as prerequisite for the definition of an effective motor-oriented didactics.

MATERIAL AND METHODS

Objectives

During early childhood, particularly at the age of 6 or 7, it can be observed a "remarkable increase of the distinction between different forms of movement" (7) which are defined by a goal determining a progressive change in movement execution.

Aim of the present research has been to provide, through the use of the VMI battery of tests, an integrated model of eye-hand coordination assessment, in order to allow a more accurate analysis of the sensory-perceptual initial levels in primary school children.

Methodology

Methodology has provided integrated use of an action-research and an experimental research model for a both qualitative and quantitative analysis of data.

Action-research has acted as a link between theory and praxis, basing on the cooperation between those studying the phenomenon (researchers and their reference scientific paradigm) and those living the phenomenon within the educational system (teachers and their didactic experience), thus encouraging both parties to share each and every phase of the research.

The present study has been built as a confrontation, communication, cooperation and co-action experience, made it possible by the constitution of a school-university work team involving primary school teachers and researchers from the University of Salerno, to arrange the

experimental research on Salerno's second grade students.

The choice and the definition of the reference target and the scientific rigor have been pivotal elements throughout each and every phase of the research.

The research protocol has therefore involved definite procedures, jointly followed by schools and University which shared goals and methods.

The team of school-university researchers has complied with the following criteria:

- Sample's auxological and psychomotor characteristics
- Involvement of handicapped subjects and handicap typology
- Integrated and rigorous use of the VMI tests battery in scholastic environments according to the research project in order to be harmonically suitable for educational activities and to improve tuition and educational actions.

Families have been involved through collective meetings, where research's methodologies and goals have been introduced, explaining its potential effects on children, both from a preventive and formative perspective.

During the "group training" phase, teachers have been trained to the proper administration of the VMI battery of tests.

The development of the experimental phase of the research involved the primary schools for:

1. School-university integrated planning of research's goals, methods and procedures.
2. VMI administration training for the teachers involved.
3. Administration of the VMI "short" version (18 geometric figures, specifically designed for children aged from 3 through to 7 years)
4. Administration of the VMI test.

The team of researchers, in cooperation with each class' regular teachers, has provided for the group administration of the VMI test, in compliance with the VMI Manual, section "VMI Test Administration", regarding administration modes, times and professional attitudes. Oral instructions have been provided about the use of the test materials and examples have been drawn on a blackboard to help children understand the procedure. Children have been asked to copy the given geometric figures without any erasures following a numerical ascending order in a ten-minute period.

5. Assessment: the VMI test, either in its full or short version, is a small 12-page booklet; the title page reports the examinee's personal information and a section for the recording of raw score, standard score, percentiles and VMI supplemental test score. The booklet also contains a section for possible notes and suggestions.
6. Data Collection:

   A group of university experts, together with the teachers of each classroom, provided a group of tests, according to the modalities, times and professional attitudes described in the section "Administration of the VMI test" of the VMI test handbook. Verbal directions have been given to show how to open the pencil and examples on the blackboard, obviously different from those given in the paper, have been shown to make the students understand how to copy the figures.

It has been made clear that the figures had to be copied in no more than 10 minutes and according to a predetermined order and without deletions.

Using the standard form, they took surname, name, classroom, school name and the test answers of each student. The test answers were assessed by a couple of experts according to the handbook of the VMI test. The final results were reported on the front page, next to the name.

Statistics

It was established to make a comparison between pairs of schools and between group of town schools and schools of the province group and a comparison between average standardized scores obtained in VMI test by pupils of second-grade primary school and the average National standardized value to determine whether values are significantly equals or there are differences in visual-motor skills.

Null hypothesis states that there aren't significantly differences, alternative hypothesis that average values are significantly different, without specifying which one is greater.

For this reasons, the average values have been compared through two-tailed Student's t test with level of significance 5%.

Sample

The present research has involved a sample of 114 students attending the second grade of primary schools in Salerno, in cooperation with the Department of Education Science of the University of Salerno.

Equipment

In the first page of VMI test there are blank spaces to be filled with personal data and the scores (raw, weighted, percentile) of the pupils both for the VMI and the additional tests; in the following pages there are the instructions for the tests with some examples. Then in the final page there are blank spaces to be filled with comments and educational and/or diagnostic recommendations.

Analysis and Comparison

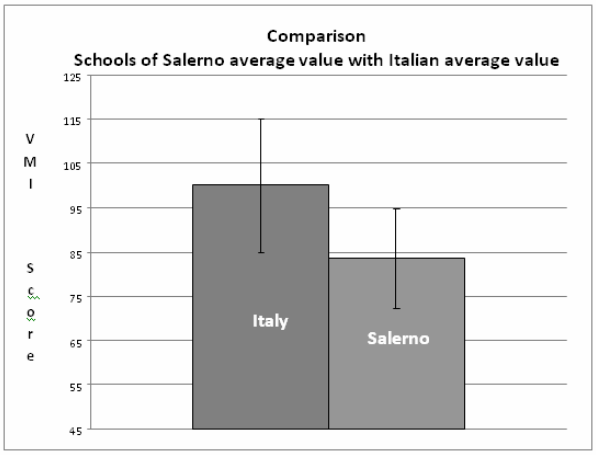
The average values for pairs of schools have been compared through Student's t two-tailed test with level of significance (alpha level) of 5%. The average values, the Standard Deviations (S.D.), the Coefficients of Variation (C.V.) and the p-values are shown in the tables below.

School	N	Mean	S. D.	C. V.
Salerno	68	83,81	18,43	0,22
Calvanico	9	85,60	4,44	0,05
Fisciano	17	84,47	8,93	0,11
Pizzolano	13	79,08	14,27	0,18
Canfora	7	75,86	13,31	0,18

p-values			
	Fisciano	Pizzolano	Canfora
Calvanico	0,72	0,18	0,048
Fisciano		0,21	0,08
Pizzolano			0,63

As reported, only the comparison between the school of Calvanico and the school of Canfora allows to reject the null hypothesis and to state that the average values are significantly different at 5% (Results of Calvanico are better than results of Canfora); for any other case, being the p-value>0,05, the null hypothesis cannot be rejected and the difference among the reported average values cannot be considered as significant.

For the whole set of schools, the average value is lower than the National average with level of significance 1%. Standardised values, reported in the literature for the Italian population, are Mean 100 and Standard Deviation 15.



Comparison with Italian average value	
Group of schools	P Value
Province of Salerno	<<0,001
Town of Salerno	<<0,001

Then we proceeded to compare the average values of the group formed by schools of the town of Salerno with the group of schools in the province of Salerno and each of them with national data: the average values of each group were significantly different (lower) than the standard average with 1% significance, while in the comparison between the two groups, the respective mean were significantly equal (alpha = 5%).

p-value	
	Salerno
Prov.Salerno	0,84

RESULTS

The results of the research among the 5 schools of the city of Salerno has shown a slight significant difference only between two of the schools taken into account (p-value<0,05), while it has been noticed that all the schools have reached lower levels than the National standards. In particular, the results show that on a sample of 114 second-grade children the 94,73% do not reach the National average level.

For the whole set of schools, the average value is significantly lower than the national average with 1% of significance.

Average values of the group of school in the town of Salerno and the group of school in the province are significantly equals (p-value = 0,84).

CONCLUSIONS

The results of VMI tests administered at 114 pupils of the second grade of primary school in the province of Salerno show an average level of visual-motor integration (eye-hand) equal to 83, thus

significantly lower than the National average of 100 (p-value<<0,001).

In particular, the 94.73% of the pupils (108 of 114) has obtained a result significantly lower than the National average.

This failure, severe and extensive, suggests a review of appropriate teaching methods in the schools of Salerno chosen as sample for the achievement of objectives related to eye-hand coordination studies curricula provided by the Italian Ministry of primary school.

Therefore, it would be desirable to create a research group composed of teachers and university experts to identify problematic issues concerning the teaching of motor activities, possibly with the application of additional tests of VMI (both only ocular and only manual), trying to prepare appropriate teaching methods to achieve specific objectives and, following the application of these methods, to verify their effectiveness through an additional VMI test administration in its complete form in schools of Salerno previously involved in research, to compare the results.

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