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UNIVERSITY BABES-BOLYAI CLUJ NAPOCA FACULTY OF PHYSICAL EDUCATION AND SPORTS
PHD SCHOOL

THESIS

-SUMMARY-

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UNIVERSITY BABES-BOLYAI CLUJ NAPOCA FACULTY OF PHYSICAL EDUCATION AND SPORTS

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MOVEMENT BIOMECHANICS IMPROVEMENT THROUGH THREE – DIMENSIONAL MODELLING AND MENTAL TRAINING IN HANDBALL

Keywords: dimensional analysis, mental training, biomechanics, handball, studying the movements,motor correction, cognitive science

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Introduction

Learning in sports has certain peculiarities when compared to the specific learning of other subjects and activities (mathematics, linguistics, philosophy, different professions) mainly due to the use of alternating or simultaneously (in most cases) of verbal and nonverbal languages, especially gestural motrics.

Numerous studies on motric learning, especially in the area of pedagogy make a difference (with a didactic purpose, though) between the conceptual approach (verbal) through the method of explanation and motric body language, demonstration and proper execution.

Motric learning was approached by many scientists (teachers, psychologists, physiologists, cognitivists, physicists) who have made important contributions considering this field peculiar in science (Secenov Pavlov, Walon, Sherington, Piaget and Robinson, Babanski, Bruner Cratty and young Paillard, famouse, Fleurance, Durant, Schmidt, Singer, etc.).

In our country substantial theoretical and experimental contributions broughtthe following: Gh. Zapan, PP Neveanu, A. Rosca P. Golu, A. Vaidean, M. Epuran, M. Zlate, A. Dragnea, S. Teodorescu, M. Stanescu and others.

The points of view from which learning was analyzed did sometimes form a shattered picture, specialists in specific activities, focusing on an aspect, particularly the objective one, "practical" to perform the act or motive which are the object of learning. However, this approach is justified, given its role of visual image in learning.

Our paper takes into account the ratio of intent, input, representation, computational processes and output following the model of analysis of information processing in the brain. Applying this methodology to motric learning leads to new ways of understanding the idea of performance development. According to this idea, between sensory, cognitive and representational are established not only from sensory to cognitive and representational relationships, but also the reverse activity, which is called projection. This way, movements analysis is a turn from sensorial to cognitive, understanding and then projecting them as an exponential step. At the mental level we operate with symbols and concepts that are processed by different forms of intelligence.

Part I - Introduction

Chapter 1

1.2. The importance of the theme

The theme chosen for the research we aim to highlight the concept in which training is continuously changing and progressing. Teams that use in training psychological assistance are those which reach the highest level in sporting competition . Therefore we believe that the theme chosen is of great importance and actuality.

Moreover, the inefficiency at the 7-meter Handball throw revealed a weak point: in many key moments handball players value four opportunities out of ten available, while a percentage of 40%, seems incompatible with targets at any competitional level. Wen we talk about the 7-meter throw, we must consider two components: the technical capacity of the executing athlete – meaning his skill with the ball – and his power of concentration.

Defining the scope and general objectives of theme

1.3.1. Research purposes

The first purpose of this paper is to highlight the massive use of as many movements dynamic parameters in the analysis, given that they form a complex picture of mental motric structure analyzed. Representations developed enable computaional analysis almost entirely through mental training.

The second purpose of this paper is to clarify the differences between a series of concepts designating activities in the psychological preparation of athletes, such as mental preparation, mental training, cognitive training, mental image and representation in cognition and emphasizing mental cognitive mechanisms underlying any movement, implicitly those belonging to various branches of sport.

The third purpose of this paper is to experimentally buil through mental preparation and mental training, as independent variables, data from three-dimensional analysis
"Captured" by the "MOVEN" - inertial motion capture.

1.3.2. Research Objectives

• Analysis of emerging concepts in sport psychology, applying their knowledge borders and methodological device used in the preparation of the athletes.
• Analysis of representations and their exploitation in the cognitive conception of the separation of actions, and motor learning in different stages of training.
• Giving value to dimensional experimental analysis techniques in the preparation of the mind, through mental training, applied in cognitive conception aimed at: awareness movements and mental imagery creative exploitation in order to better learning efficiency.
• Highlighting the integrative properties of the process of preparation of athletes
(professional handball players) by using biomechanical research into the psychological preparation - mental workout. Demonstration of the relations between conceptual and objective.
• Highlighting the relationship between the two forms of representation by ascending analysis from stimulus to function and the second form: from creation to execution, from conception to action.
Intense processed elements are well represented in the mental image.
• Using mental imagery resulting from experience and from reading and description of movements through biomechanical analysis systems, creative concepts. The evocation of the technical or sequences of play given that the only remaining memory are elements that can be categorized.
• Highlighting the relationship between objects (complete 3D analysis techniques) and cognitive or knowledge base that initiates the downward analysis raised or created.
• Demonstrating the role of visualisation through mental training and electromyographical objectifying of the impulses transmitted to the muscles.

Chapter 2 - THE HISTORY OF MOVEMENTS STUDYING FROM THE CAVE DRAWINGS TO THE DIMENSIONAL ANALYSIS OF MOTRIC ACTIONS AND ACTS

2.1. The beginnings of human movement analysis

At the beginning, biomechanics was not divided from anatomy. Knowledge of human movement was obtained by direct observation of man in motion, having different activities of work, fight and play.

The famous Roman physician Claudius Galen (131-201) from the gladiator school in Pergamon made the first breakthroughs in proving that movements start from the brain to the muscles via nerves motric impulses under the influence of whose muscles contract, producing movement of the body segments through the joints.

The first work of EJ Marey (1855) refers to a long jump which shows that the center of gravity of an athlete follows a parable in the flight phase. In the description of the jump are represented the successive positions of the legs and the direction of the impulsion when the sole is on the ground and the axis parabola on which the center of gravity it's moving. The first studies of the impulsion of reaction of the ground, injured by an athlete.

EJ Marey studied for the frist time the force of reaction of the soil injured by an athlete during a vertical jump. He highlighted the kinematic mechanism and dynamic concept of jumping, that of the force of action. In this sense he invented the dinamographic platform that translates the intensity of the feet pressure on the ground. Information on ground pressure were perceived by a writing needle after nine repetitions.

The concept of force impulsion is widespread today in sports. It is known that the pressure of feet on the ground preceding a jump varies constantly. Changes do not appear on the dinamographic machine speed curve, and the speed is zero when pushing feet on the ground.

2.2. Elements of biomechanics in handball. Biomechanics of throwing on goal.

Biomechanics of physical education and sport is the part that deals with the study of movements and body postures provided in the program of physical education and sports training. It appeared as a necessity linked to the continuous development of physical education and sport movement.

Physical education and sport biomechanics studies how the general laws of mechanics apply to biological peculiarities of the human body, such as muscle forces arisal and how they act interdependently with external forces exerted on the body.

Based on these interdependencies, mechanics and biomechanics establish their effectiveness and indicate practical methods for increasing the performance depending on the purpose of physical training.

In our country, biomechanics research has emerged as a result of functional anatomy orientation thanks to Fr. Ruinei (1920) and was continued by the school he created. Valuable work in this field or related fields also developed prof. Dr. E. Repciuc, I. Th. Riga, Kromecher, Gheție and others. Also in Institute of Physical Education and Sport research have been conducted in both methodical at medical disciplines. Data from surveys conducted worldwide, as their own findings, have enabled the foundation and development of the science involved in the vast field of physical education and sport, able to inform and equip professionals with particularly useful knowledge, which conditions the effectiveness of the motor improvement process, regardless of the level at which it is held.

7-meter-throw

7-meter-throw must be taken as a shot on goal, within 3 seconds after the referee's whistle signal.

The player taking the 7-meter throw must position behind the 7-meter line but no more than one meter of it. After the whistle, the pitcher must not meet or exceed the 7-meter line before the ball has left his hand. After the throw, the ball can not be reached again by the performer or his team mates unless it touched the opponents or the goal posts.

While the 7-meter throw is being executed, team mates must remain outside the free-throw line until the ball has left the thrower's hand. If they did not proceed in this way, e free throw will be given against the team that was supposed to execute the 7-meter-throw.

During the execution, opponents of the thrower must remain outside the free-throw line, and at least 3 meters from the 7-meter line, until the ball has left the thrower's hand. If not done in this way, the 7-meter throw will be repeated, unless a goal has been scored.

7-meter-throw will be repeated if the goalkeeper has crossed the line of limitation to 4 meters before the ball leaves the thrower's hand and if a goal was not scored.

Biomechanical analysis of muscular effort in handball highlights a number of general peculiarities common to any sports game and the specific characteristics of each technique.

General peculiarities are characterized by combining static muscular effort of balancing eith the muscular effort ensuring the movements and techniques with extreme variability and finesse. Each biomechanical muscular effort has its importance and can not be considered separately, but in close interdependence.

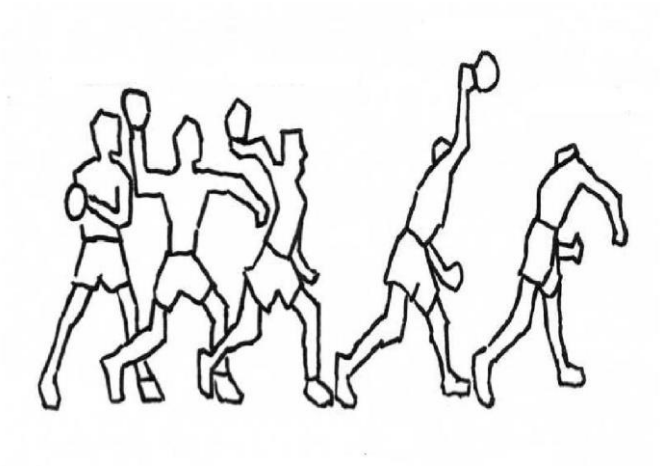

Fig.6. Example of the 7-meter-throw Van den Tillaar, International SportMed Journal, vol. 6 (1)2005.

Chapter 3 - Cognitive Science of Learning and Correcting Motricity

3.1. Cognitive psychology and relationships with other cognitive sciences

The appearance and then development of cognitive science were made possible by the simultaneity of the discoveries of different science produced in mid-twentieth century.

Major scientific breakthrough occurred in mathematics, cybernetics and information theory on acclimatization, formalization and creating formal systems and defining calculability. These findings revealed that any function can be calculated "beeing specified in models and decomposed into a finite number of components" (Miclea, 1994.2003), regardless of their nature (numeric, linguistic, behavioral). The discovery of the relationship between input and output underlying the function of human behavior can be reproduced through mechanical means.

The development of information theory which aims to study information as a category, along with matter and energy, was meant as a revolution in telecommunications, homing rockets etc, enabling the development of the first mathematical theories of information (Shanon) and the emergence of information processing machinery (Von Neuman). Converted to calculable functions, information has made it possible to create premises and conditions for the emerging of computers.

In psychology are vested observing, recording, quantification of observable behaviors, this approach underlies behaviorism. This concept has its merits, but over the years in the second half of the twentieth century were diminished by the emergence of electronic computer which showed (late 1950s and early 1960s) that it could solve complicated problems by processing information. Often the computers operate in a manner similar to man. (Gardner, 1998). It was obvious that the tools created by man were capable of thought, making it possible the acceptance of mental activity of those entities. So it started the cognitive revolution, an intellectual current that has given rise to an interdisciplinary field called cognitive science.

3.2. Mental training (definitions, method of deployment, examples)

Mental Preparation accompanying athletes' psychology merges with the multitude of factors involved in the designing, management training process and participation in competitions (performance assessment). In this regard, we have developed many models of performance: B. Cratty (1967) picked by Cannon (1980), R. Thomas (1975.1986), Weineck (1983), Burke (1977), Edv. Fleishman and Quintace (1984), Epuran (1990), A. Dragnea, S. Mate. Teodorescu (2002), Guy Missoun (1998), Calmels C. (1988).

From the analysis of these models it is found the heterogeneity of stakeholders and especially the psychological factors identified. The complexity of the models depends on the depth of the analysis performed, widened as the analysis grows thorough.

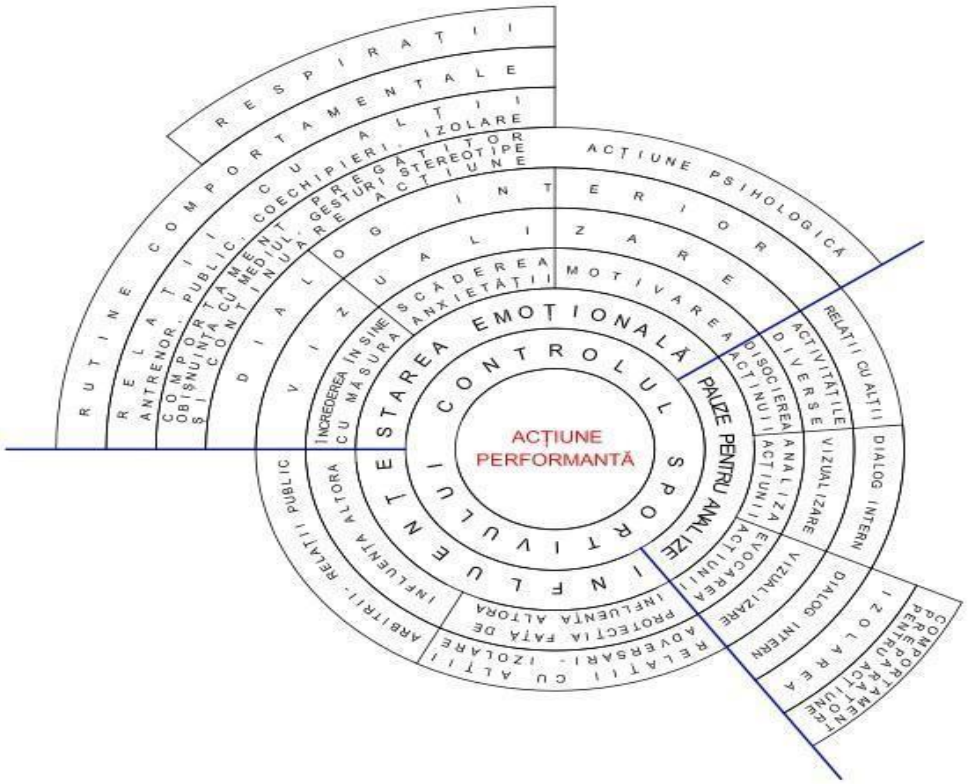

Figure 10. systematization of the modes of mental preparation of gymnasts of high performance (C. Calmels 1988)

Part II - PRELIMINARY RESEARCH ON THE IMPLEMENTATION OF MENTAL TRAINING AND TRIDIMENSIONAL ANALYSIS OF MOVEMENTS IN HANDBALL

Chapter 4 - ORGANIZATION AND PRELIMINARY RESEARCH METHODOLOGY

4.1. Preliminary research purpose

Preliminary research aimed to verify if mental training causes certain reactions or not in muscle groups involved in the making of the 7-m-throw in the process of throwing and the degree of transformation of biomechanics of this process of throwing under the influence of mental training.

4.2. Preliminary research objectives

1. Testing muscle activity in the muscle groups involved in the execution of a 7-m-throw by the process of flinging during a mental workout.
2. Establishing the connection between brain activity and muscle under the influence of mental training and the extent to which this link or cause a significant change in the execution of the process of throwing.
3. Estimation of the dimensional kinematic parameters involved in analyzing pitching 7-meter by flinging process.
4. Measuring the angles that form in the arm and between arm and torso during the 7-meter throw by throwing process.
5. Comparative analysis between throws made before mental training and throws made after mental training.

4.3. The mental workout centered on the 7-meters

Mental training itself consists of 15-20 minute sessions in terms of relaxation, 3-4 times per week by raising awareness and setting goals, learning and improving their mental abilities by planning training. If the anxiety starts the training should be discontinued. The subject is situated in a central position in favorable pleasant fantasy that lead to increased self confidence.

Mental training must take place in a limited framework. Participate in training only and subject psychologist or, if there is no possibility that the training would be done by a psychologist, it may be replaced by coach or teacher. It explains clearly and precisely what will be done during mental training that the subject would be aware and respond to stimuli during mental training. Mental training program is as follows:

Clear description of mental training with specific indications

Films with the execution of the 7-m-throw are presented to the subjects. Discuss and establish the correct parameters for the throw. Methodic indications received must be clear and precise, subjects knowing exactly what to do during training. 7-meter-throws mentally represented by the subjects during training, must be represented as biomechanically correct as possible. Shots run from 7 meters with ball handball, according to the game rules, the finish being always positive. The subject has to change every corner at each execution, the process remaining the same.

Mental relaxation before training subjects

Subjects are placed in the dorsal lying position on the massage table; they should close their eyes and relax for 2-3 minutes.

Systematic desensitization by inducing a state of well-being

Respondents are transmitted to unleash their mind, to position in a quiet, pleasant, relaxing, on a beach, on the shore of a lake, in the calm breeze of the wind, easy to control their breath, to feel how the air comes out and enters their body, then become increasingly relaxed, relaxing their legs, trunk and upper limbs.

Awareness of the subject's task to be performed (verbally exposed by the psychologist)

"You are in a gym during a handball match. Your team is under attack and received a 7-meter throw for a foul committed in the space of 6-m of the opponents. The coach designates you to execute the throwing . You acknowledge this and you are going to the 7-meter-line, where you must throw. You recover the ball and get ready to throw in front of the 7-meter-line, waiting for the whistle. (in our case the signal "Start" - shoot on goal and at the signal "Stop" –you stop, recover the ball and get ready for the next roll) "

Repetition of the mentally viewed throws

The subject is ready to throw, and at the expected receipt of the signal he begins execution. Repeat throws 6 times for each subject. Each execution represented must be positive, i.e. subjects should mark every execution, changing the throwing corner in part, keeping the same process of throwing, flinging.

The relaxation of mind and body after mental training

After terminating, the subjects are asked to relax, to imagine themselves in the same place to relax: on a beach or a lake, to focus on breathing as normal, begin to feel their legs, trunk and arms slightly bent, opening eyes slowly and then slightly to sit on the massage table and slowly get down from it, before returning to his original state befor the mental training.

4.4. Preliminary research stages

Preliminary research consisted of the following two phases:

Phase I: testing aimed muscle activity during mental workout.

Phase II was intended to assess the three-dimensional biomechanical analysis equipment in handball.

4.4.1.2 Lessons learned after recording muscle activity during mental training

EMG routes obtained from data collection during mental training, shows two muscular responses (contractions), the indications shot on goal psychologist, answers muscle brachial triceps and biceps.
EMG routes of other muscle groups does not reveal answers to indications shot on goal.

.4.2.3 Conclusions on the use of equipment for biomechanical evaluation of the execution of the 7-meter throwing

Graphic recordings performed revealed that the equipment used in the analysis of three-dimensional movement is effective if besides evoking movement information and advice are being provided to the subject to follow a certain approach of thinking and also to compare the mental image to the visual image developed by Moven system .

After analyzing data recorded by Moven suit, it was shown that it could be used to objectivise a specific technique to the handball game.

The costume is useful for teaching, correcting and improving technical elements of handball.

Part III - EXPERIMENTAL RESEARCH ON THE IMPLEMENTATION OF MENTAL TRAINING AND DIMENSIONAL ANALYSIS OF MOVEMENTS IN HANDBALL

Chapter 5 - PREMISES AND ASSUMPTIONS OF THE EXPERIMENTAL RESEARCH

5.1. Premises of the experimental research

Knowledge of biomechanical problems allows coaches and specialists in the field to know the factual data on:

- Increase exercise capacity;
- Deeper understanding of sports technique for creating programs that have as purpose the acquisition of correct techniques;
- Improving primary selection criteria for sport performance;
- Avoid and prevent accidents in sport performance;
- Objectification parameters in training movements that help coaches to eliminate technical errors in the learning phase and consolidation.

In physical education and sport biomechanics aims to streamline movements or technical performances of athletes, bringing to their attention some skills and measurements made by modern technology.

Mental training in handball is important both in the tactics of the game and at improving individual techniques in this regard is emerging idea to get a breakthrough in performance from the junior level in the light of further research and activating the preparedness level seniors.

5.2. Experimental Research Hypotheses

1. Studies and investigations have been initiated by us is the development, testing and validation of a training project for mentally handball players nominated for coach of the throwing of 7 m.
2. This draft of mental training is a novelty in preparation for handball, it no longer found in the literature studied.
3. It is assumed that there is muscle activity during mental training, measured with existing equipment.

4. It is assumed that the draft mental training will help improve the biomechanics of throwing 7m by flinging process.
5. It is assumed that the draft mental workout will improve the percentage of successful throws 7m by flinging process.
6. To the extent that the draft mental workout will be used consistently in training, it is assumed that it will positively affect concentration and success in the throw of 7m by flinging process.
7. We believe that the introduction of mental training as a method of working with players designated to take the throw-7m, will favorably affect the player's game.

5.3. The purpose of experimental research

Experimental research aimed conducting a pedagogical experiment to validate or invalidate assumptions made in connection with the draft mental workout designed.

5.4. Experimental Research Objectives

1. Performing measurements and comparative analysis of the biomechanics of throwing a 7 meter by flinging process between subjects in the experimental group and control subjects.
2. Making measurements and analyzes on muscle activity during mental training the experimental group.
3. The performance measurements and benchmarking between executions and efficiency of the 7-meter executed by subjects in the experimental group and control subjects by flinging process.

Chapter 6 ORGANISATION AND EXPERIMENTAL RESEARCH METHODOLOGY

6.1. The organization and conduct of research

The research had the character of a long process that took place in several stages. Begun under the auspices theoretical study the document thoroughly and carefully specialist assured me a solid start, research has continued with methodical practical activity, in which the main mission was a pilot experiment. The succession of moments of order once the research was achieving the objectives, but also achieve the ultimate goal, which is testing the mental workout.

Experimental research stages

Experimental research has been divided into seven steps:

Phase I objective was testing the players in the gym to see the initial stage of the 7-meters in two groups.

Phase II aimed recording subjects of the two groups to analyze the initial executions biomechanically.

Phase III aimed implementation of mental training in subjects in the experimental group.

Stage IV aimed to test muscle activity during mental workout.

Stage V aimed retesting subjects in the two groups to analyze executions biomechanically.

Phase VI was aimed to test all subjects in a contest of 7-meter throw.

Step VII was to analyze the record sheets gaming control subjects carried out by the National Junior Championship on the 7-meters.

6.1.2. Subjects enrolled in experimental research

All subjects enrolled in the study had the quality of sports for junior team CSS 6 Bucharest, members of the same team following, following the same workout plans, with the same annual program of training, therefore, the selection of these players was made by the coach

nominating the players to throw from 7 m. Their total number was 6, 3 n control group and 3 in experimental group.

Table Nr. 12 subjects enrolled in experimental research

NR. CRT.	NUMELE ŞI PRENUMELE	DATA NAŞTERII	LOC NAŞTERE	CLASA	POSTUL /ECHIPĂ	TALIA CM	GREUTATEA KG	GRUPA
1	**C. A.**	26.02.1996	București	a XII-a	Inter	175	60	Experiment
2	**V.M.**	28.09.1997	București	a XI-a	Centru	162	62	Experiment
3	**M.E.**	21.07.1996	București	a XII-a	Pivot	173	63	Experiment
4	**N.B.**	14.07.1997	București	a XI-a	Pivot	163	63	Control
5	**M. V.**	03.04.1997	București	a XI-a	Inter	177	68	Control
6	**S. A.**	23.08.1997	București	a XI-a	Extrema	169	58	Control

6.1.3 The place of experimental research

The research took place in the hall of Biometrics of the National Institute Research in Sport and Exercise room of Bucharest CSS 6 team. Regarding the theoretical foundation focused mainly on gathering data and information, it has taken place in other locations, such as Lucian Blaga Central University Library Cluj-Napoca, National Research Institute for Sport Bucharest, Faculty Library Physical Education and Sport Cluj-Napoca, etc.

6.2.2. Mathematical statistical methods and techniques of data processing

Valorisation of research results would not have been possible without the use of statistical methods and mathematical techniques. In order to relieve the laborious and time-consuming calculations, I used the computer, it has software (programs) specialized, formulas, algorithms, methods and statistical tests. Because of the computer, subjects' performance could be processed with very high accuracy, thereby facilitating precise interpretation of research results.

Statistical activity began with registration and group performances of subjects. This operation has meant the inclusion of raw data captured MVN 3D image format, MOVEN specific analysis

software. We cut sequences that we were interested in, were exported from the format MVN in the format MVNX which in turn were exported EXCEL.

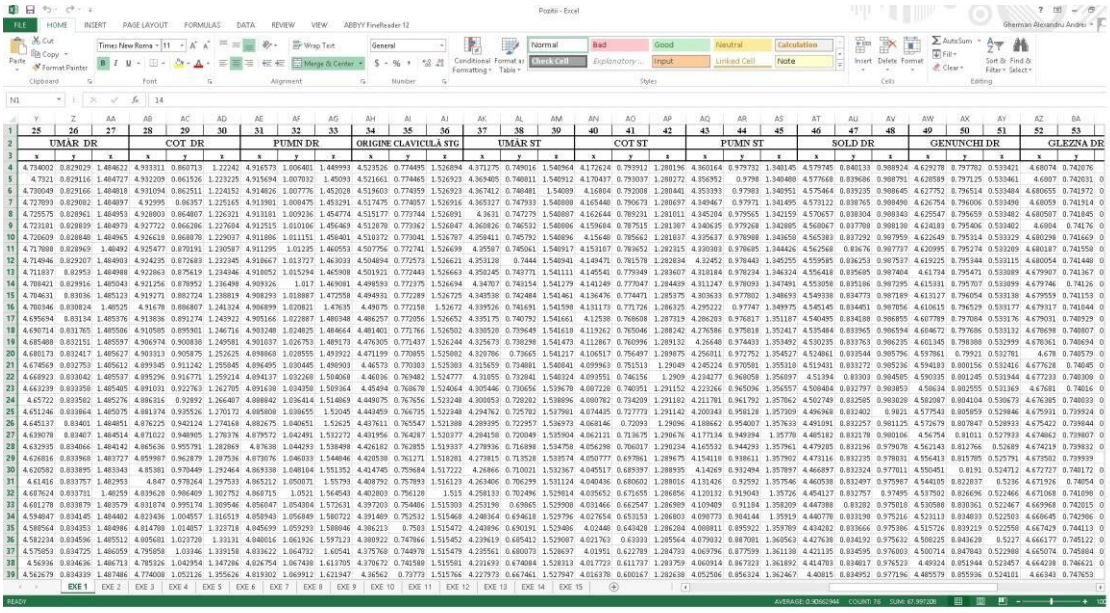

Fig. 39 Table data imported EXCEL

We selected columns of data that we were interested and in position to calculate angles using the Pythagorean Theorem in Space:

$$a^2 + b^2 = c^2$$

It moved to the outside of the pelvis hip joint so that it can calculate the angle formed by this point with the right shoulder and right elbow using our Pythagorean theorem in space described above. It calculated the evolution of the three points in space that interests us: the extreme side of the right hip, right shoulder and right elbow joint. To calculate angles at the shoulder using the formula:

$$\alpha = A\cos\left(\frac{(a)^2 + (b)^2 - (c)^2}{2 \times a \times b}\right) \times (180 : \Pi)$$

where:

letter a - represents the position of the pelvis, letter b - arm position, letter c - elbow position,

7.2. The test results of muscle activity during mental training

Those three subjects participated separately in mental training in Psychology Laboratory of the National Research Institute for Sport, Bucharest, connected to the same EMG respecting the same work protocol like the pilot test.

Mental training or ideomotor (Holdevici I., 2007) is:

Intentional mental and systematic repeatition of the act of motor. Our brain has the ability to update, by word, perceptual-motor experience gained through practice.

Accuracy is very important for an athlete. Mental training has been defined as the process of maintaining and strengthening the representation of motions and actions, resulting in activation of neuromuscular bands and thus increase the efficiency of practical work.

Mental training is used for training and not for learning. No form of psychological training has any effect in the absence of tactical and physical preparation. We can not replace physical training with mental training.

7.3. Final results from measurements in the laboratory

It used the same equipment Moven suit three-dimensional evaluation and EMG to see which muscles work and what amplitude they have during the throw. Subjects, after having dressed suit and EMG sensors, which were mounted on the aforementioned muscle groups, groups that were monitored during mental training, executed 5 rounds of 7-meter-throws by flinging process. It was asked that throws are executed in a fixed point for them to be analyzed biomechanically. With the suit Moven have collected data about the angle of arm-torso angle formed by the arm horizontally and acceleration of the punch to determine the speed of the arm and key points in the throw, i.e. when the movement begins, when subjects give way to throw the ball and when it ends. The EMG sensors collected data on the intensity of the muscle contractions, their amplitude during execution measured in volts.

Data will be presented as graphs for each execution. I put one under another EMG charts representing amplitude of muscle during throwing and the arm-torso angles, hands horizontally

measured in degrees, and speed of the fist measured in meters per second. The trend line joining the two graphs represents the moment when subjects turn on the ball, which is represented graphically as a peak speed of the wrist.

7.4. Initial results from testing on the playing field

We organized a competition between subjects to see their motor luggage in the 7-meter throw in the gym of the team. Subjects were not given any information about how they should throw, what steps must be followed during the throw, the only requirement was to be as serious as you would during a match. Biomechanically, throws could not be compared with each other, the subjects were free to shoot on goal as they wish, with feint or without feint, but there was a good training and a motor baggage developed the subjects: they throw light, which showed a good preparation for playing handball. In the first test of the 7-meters there were recorded a total of 120 throws, 20 by each subject, where there was a total of 85 goals, 12 were defended by the keeper, 17 wide and 6 were in the bar.

Table Nr. 13 initial Throws to 7 meters

NR. CRT.	NUMELE	TOTAL ARUNCĂRI	GOLURI	APĂRATE PORTAR	PE LANGĂ /PESTE	BARĂ	GRUPA
1	**C. A.**	20	16	2	2	0	Experiment
2	**V.M.**	20	15	1	4	0	Experiment
3	**M.E.**	20	15	4	0	1	Experiment
4	**N.B.**	20	15	0	5	0	Control
5	**M. V.**	20	10	3	4	3	Control
6	**S. A.**	20	14	2	2	2	Control
TOTAL		120	85	12	17	6	

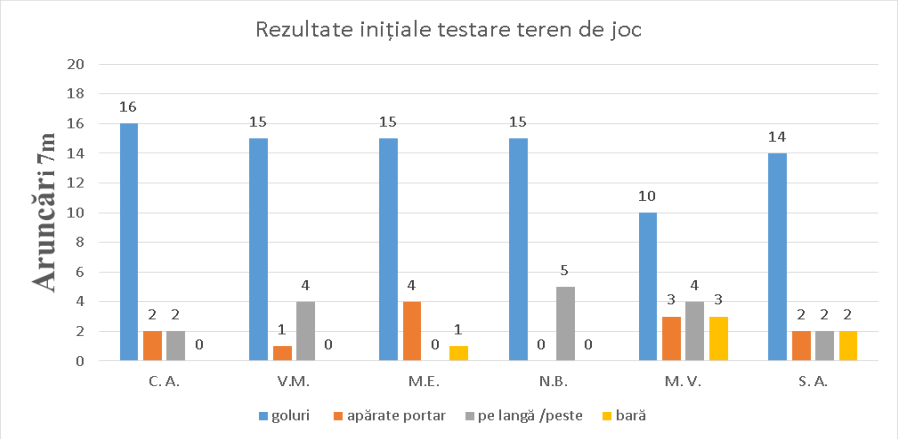

Fig. 109 Initial Results of tests on the playing field

7.5. The final results of the testing on the pitch

After the implementation of mental training and data registration, we have resumed testing in the gym, organizing another competition of throws at 7 meters. Compared to the first test, there was an improvement in execution techniques to experimental groups. I raised the stake, trying to bring a little pressure on executors, pressure that occurs during official games. Subjects persisted and felt the spirit of competition between them.

The team of the subjects in the experimental group won with a total of 53 goals in 60 throws versus control group with 46 goals in as many throws. Subjects in the experimental group were visible biomechanically of throwing more accurate, much more precise throws and managed to meet theur goals much easier. Of the 7 throws missed by the subjects in the experimental group, all the balls hit the bars, protruding outside the playing area.

Table Nr. 14 7-meter final throws

NR. CRT.	NUMELE	TOTAL ARUNCĂRI	GOLURI	APĂRATE PORTAR	PE LANGĂ /PESTE	BARĂ	GRUPA
1	**C. A.**	20	18	0	0	2	Experiment
2	**V.M.**	20	19	0	0	1	Experiment
3	**M.E.**	20	16	0	0	4	Experiment
4	**N.B.**	20	15	0	5	0	Control
5	**M. V.**	20	15	3	1	1	Control
6	**S. A.**	20	16	2	2	0	Control

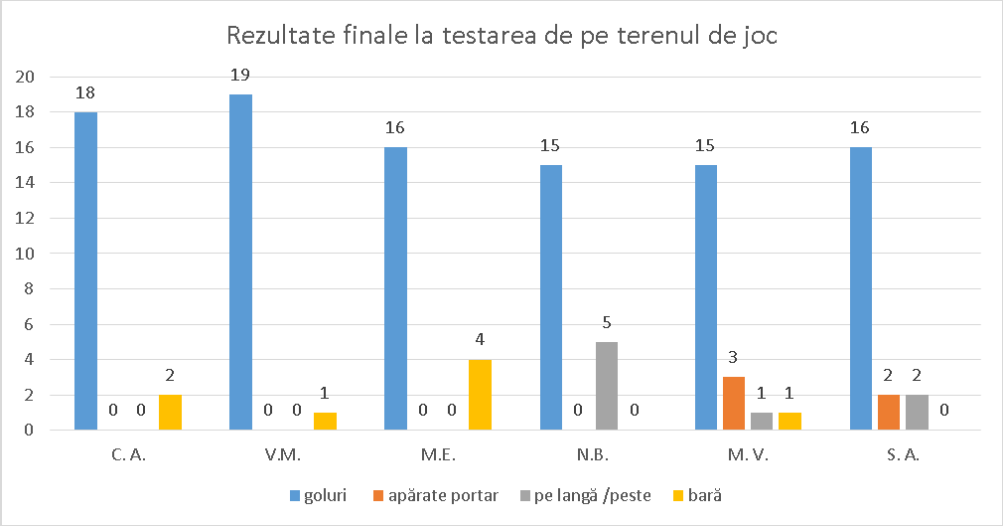

Fig. 110 Final Results of tests on the playing field

7.6. The analysis of the progress of the subjects in competition

With the help of the team coach, I did a brief analysis of the 7-meter-throws performed during National Handball Championship 2014 to 2015. In this championship CSS 6 Bucharest team had a total of 67 throws from 7 meters. Of those 67 throws were scored 42 goals and have missed 25 throws. The subjects in the experimental group made 64 throws of which were scored 48 goals. The most impressive percentage was the one of the V.M. who out of 47 7-meter-throws scored 38 goals, missed 9 executions, which indicates a percentage of 80.85% of the successful 7-meter throw. This was followed by C.A. who scored 8 goals in 14 throws, and M.E. with 3 throws and 2 goals, which although has a better percentage (66.66% versus 57.14%) is less successful (at the end of the game, goals are counted and not percentages). N.B. has two misses of 2 throws and M.V. 1 throw and 1 failure.

Table Nr. 15 subjects during the competition throws at 7 meters

NR. CRT.	NUMELE	TOTAL ARUNCĂRI	GOLURI	RATATE	PROCENTE
1	**C. A.**	14	8	6	57,14%
2	**V.M.**	47	38	9	80,85%
3	**M.E.**	3	2	1	66%
4	**N.B.**	2	0	2	0%
5	**M. V.**	1	0	1	0%
6	**S. A.**	0	0	0	0%

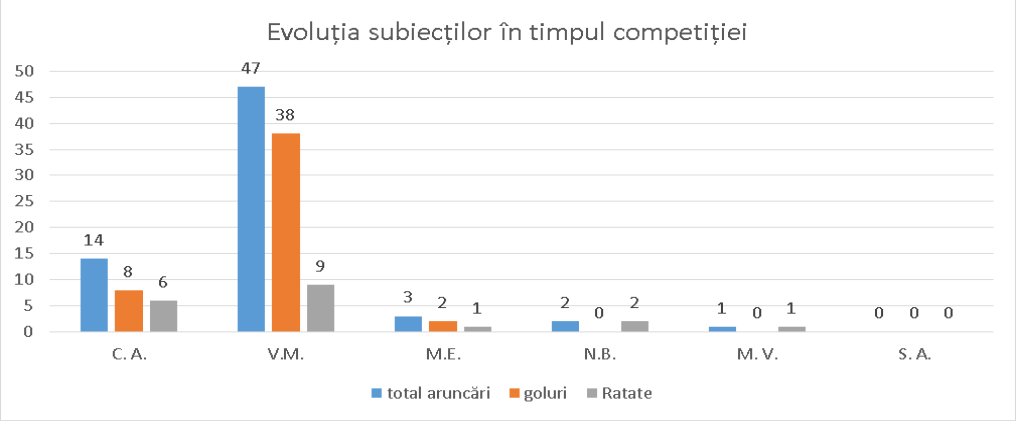

Fig. 111 Evolution of the subjects during the competition

Chapter 8 - CONCLUSIONS AND RECOMMENDATIONS

Following the completion of scientific endeavor yielded a number of conclusions which we have selected and grouped in this section. The content of these findings relate to a series of theoretical and practical aspects of methodical.

8.1. Theoretical Conclusions

1. designing and drafting mental workout, which was the subject of a pedagogical experiment was conducted in full accordance to the standards of modern training-specific training from professional handball.
2. In the research was detained and seized a critical mass of data and information obtained by studying specialized documents, materials related to the preparation of handball players and after some exchanges of experience that I had the opportunity to participate in, either in systematic dialogues that we had with several specialists in physical education and sport.
3. The project of mental training, developed and experimented, had the significance of a curricular hypothesis, consisting mainly of:
- A set of specific objectives and targets;
- Complex structures and specific exercises of handball with direct reference to throwing 7m by flinging process;

8.2. Practical and Methodical conclusions

1. In terms of our hypothesis, that assumes that during mental training there is measurable muscular activity, we can draw the following conclusion:
EMG graph of the mental training is recorded as a plateau from which we realize that on the mental workout there is signal amplitude in the muscle, muscle activity, amplitude measured in volts. The EMG chart during the mental training of subjects, we have on the X-axis a value that starts at a value from 0 to 0.00005 volts and at EMG chart signal during throwing, we have a value that goes from 0 to 0.0009 volts. If the same scale was to be used during mental training such as during executions, there would be a 0-line that we would not be able to see. The subject's

C.A. mental training would not be seen on the scale, only the final amplitude peak that rises suddenly, and it would be 10 times less stronger than on mental workout schedule. Brahioradial activity during mental training on the subject C.A., compared to the executive throws is 20 times smaller during the mental training than during the move, which corresponds to a conscious action because of a mental workout.

In the 70th second of the mental workout schedule of the subject C.A. several peaks appear on brahioradial muscle, peaks which we can not consider, as they are not a pattern of movement, which we sought in motion, but rather an involuntary movement. It does not mean that if nothing is seen at EMG, the pattern can also not be seen, the activity level does not reach the muscles. You should have a device that can measure neural activity in certain areas of transmission, signal monitoring or other equipment maping neuro brain to see how it activates nerve centers, amplitude, order duration. Mental training can have influences to create a pattern in mental training, but might be needed more than an EMG so that we could identify what is happening. This could be a further direction of this thesis.

2. Comparing subjects' executions of the two groups in terms of the biomechanics of throwing from 7m we, conclude that subjects in the experimental group made progress on a biomechanics throws after mental training. The subjects in the experimental group, after mental training, is observed that the amplitude of different muscle groups. If the subject C.A., before the mental workout, was using more the pectoral in the throw, it can be seen clearly that after this mental workout, he uses the amplitude of the trapeze. Even if the muscular group changed during throwing, the speed of execution remains largely the same between a minimum of about 8 meters per second and a maximum of about 10m per second. In the final testing is clearly observed as, compared to trunk-arm angle increases to 90 ° and maintaines in that area until the ball leaves the throwing arm. Subject V.M. experiment presented in the initial test by throwing a cross of arm angles with the horizontal trunk and arm both before and after disposal.

After the mental training, the crossing of the angles before the thorw disappeared, which means that the subject corected his way of the throw. After the throw, it is normal for the angles to overlap, the arm descends and continues the natural move from the throw.

Subject M. E. has a large amplitude in all the muscles throughout executions in the initial testing which means a high waste of energy. After mental training can be seen a slight decrease in the amplitude of muscle before throwing and almost insignificant after dropping. This tells us

that the subject has corrected or that he understand better how to make the throw, which makes less power consumption.

Subjects in the control group retains the same throw pattern both in the initial and in the final testing. There can be noticed little differences between executions. Like at the subject M.E large amplitude can be observed in various muscle groups during performances both before and after the ball leaves the throwing arm.

Subject M.V. (control group) is important for the group to which it belongs, he has disorganized throwing, with vary widely angles between them, which indicates that the subject does not have in the motric baggage, a pattern formed in throwing, each execution beginning and ending in intervals of different time, some being shorter others being longer, evidence of the fact that he has not made a mental training.

3. In terms of improving the throw percentage at the 7m-throw, there are important too, the results of the two groups of subjects research conducted initial testing and final play in the gym as a competition. In the first test of the 7-meters-throw, has been recorded a total of 120 throws, 20 by each subject where there was a total of 85 goals, 12 were defended by the keeper, 17 were attached or wide and 6 were the bar 46 goals which are marked by the subjects in the experimental group. The final testing team also won the subjects in the experimental group with a total of 53 goals in 60 throws in the control group with 46 goals in as many throws, with seven successful progress and growth of 11.6% efficiency.

Subjects in the experimental group had the biomechanics of throwing more accurate, much more precise throw and managed to achieve their goals much easier. From the 7 throws missed by all subjects in the experimental group, all the balls hit the gate and went outside the playing area. Also, the improvement of the percentage of the 7-meters-throws, emerges from analysis of the record sheets that the subjects played during the National Junior Championships. The centralized data, highlight the success rate between 80.85% and 57.14 summarized% for subjects in the experimental group who performed mental workout and 0% for the control group. These data were summarized and included in Tab. Nr. 15 Fig.111

4. Mental training framework has its role in sports training. Mental training is not used for learning but for training. No form of psychological training has no effect in the absence of tactical and physical preparation. We can not replace physical training with mental training, but can complement, becoming a sine qua non to the great performance. Methodical instructions that

were given were part of mental training and targeted guidance on how to move the throwing arm, that position that it must have (raised above the head, bent at the elbow at 90 °), its movement and the speed of the execution. It chose recording angles with the horizontal arm and arm with the format of the trunk line to see which method is more accurate indication saying that the arm must be raised above the head, elbow bent to 90 °. It is recommended to bend the arm for the movement to be executed biomechanically correct, this way we throw more force and better accuracy. Items graphic performed revealed that devices used three-dimensional motion analysis is effective if evoking movement besides giving information and advice to follow a particular topic thinking approach and also to compare the mental image of the visual image. As for execution are large variations among the highlights of the route when leaving throwing arm, and the arm when the ball leaves his trail after releasing the ball. This helps us a lot because we can define key moments, we can make clear and prominent analysis of throwing and biomechanically correct execution helps us to increase the percentage of success. We can also increase the throwing power and can form a pattern of movement to deceive the goalkeeper to the area where the performer wants to throw the ball in order to score. All the above conclusions lead us to say that mental training project developed and experienced by us was validated and can be applied to players nominated by coaches to the 7-meters-throw.

8.3. Recommendations

Following the results found and the conclusions drawn from developed research, we propose:

• that the project of mental training developed and successfully tested, to be taken over and exploited by many handball teams, in order to get a reference system, a model, or a fundamental point, in psychological preparing training, for the performing sports teams.

• the participation of a larger number of handball players nominated by coaches for the 7-meters-throw in the mental training sessions.

• establishment of standards of methodological guidance for the project of mental training emited by us;

• organizing training sessions with other components of teams too, regardless of the station that they play, in order to improve biomechanics shot on goal;

• expansion of the project of mental training and other technical and specific actions handball but not exceeding the motric potential of each subject;

• the use of the training program which is based on mental training, in various exchanges between different teams;

• capturing and highlighting the practical nature of the contents of the mental training in leisure and in the daily activities;

• we recommend that mental training should not be done only in the individual maneer and in terms of relaxation and relative isolation from environmental stimuli, but as the dialogue with coaches or teammates, by mentioning the objectives pursued at the time and by remembering and mentioning in detail the characteristics of the technical execution, the social environment, and to live with the great satisfaction of achieveing the result.

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