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The Efficiency of Neuromuscular Control Training in Increasing Psychomotor Potential in Argentine Tango Dancers

Csongor KICSI Ph.D.[1]
[1] *National University of Physical Education and Sports,* Faculty *of* Physiotherapy*, Bucharest, Romania*

Abstarct: The research highlights the role of neuromuscular control training in the case of Argentine tango, as a performance sport. This means of training is a huge reserve of performance, in the current context in which, the training factors known on a large scale, bring more and more limited progress. Methods: The study was conducted in 2019, using the Ergosim condition simulator in order to analyze proprioceptive sense and neuromuscular control in the trunk for the subjects involved in the study. It is a "real experiment" type investigation in which the emphasis is placed on the component parameters of the model, respectively: the force level, the brake constant and the length of the movement. The recording of the mechanical effect of neuromuscular control was performed by applying an isotonic exercise, specific to Argentine tango on the two groups of subjects. The exercise was performed in different directions (left and right), with and without visual stimulus. Results: 10 Argentine tango dancers participated in the study. Statistical analysis revealed differences in A left ($p < 0.10$), B right ($p < 0.08$) for the procedure "Without feedback in real time" and C left ($p < 0.01$), D right ($p < 0.005$) for "Feedback in real time". Significant differences were observed for C left and D right within $p < 0.05$, but not for the procedure without visual stimulus. Conclusions: An effective training program on neuromuscular control has benefits in improving the technique of tango dance, with a high degree of increase in the psychomotor potential of the dancer.
Keywords: argentine tango; psychomotor development; neuromuscular control; perception; dance, motion capture

1. Introduction

Dance is a phenomenon between art and sport, being an integrative system that provides the necessary strength to overcome all the limits of the human body (Edmonds et al., 2019). The Argentine tango consists of a system of typical elements that has as a technical procedure the closed and open embrace, in which the partner supports the partner's arms symmetrically, in the mirror (Trossero, 2010, p.21). This procedure has three directions: instigation of advancement, pivoting with rotational movements of the trunk and jump variants in the case of advanced choreography. All this involves numerous isometric positions in the upper torso. (Angioi et al., 2009)

From the point of view of the investigation of advancement, there are four possibilities to move from one foot to another or even to return to the original leg: moving forward, backward, sideways and diagonally. (Schantz & Astrand, 1984) Tango is based on these directions, on the simple transfer of weight from one foot to another, or on the spot. (Koutedakis & Jamurtas, 2004) The final movement of the technical process is performed by transverse coordination between the upper right and the lower left of the body, and vice versa. (Benzecry-Sabá, 2008, p.148) Thus, the tango technique requires a performance focused on a major pressure in the hip when moving during the dance without causing instability. (Woodley, K.; Sotelano, 2010, pp. 125-127)

The various movements that occur in the embrace are fundamental in Argentine tango and depend on the independent logical and technical functioning of the body. The body is divided into two upper and lower areas, producing different movements and rhythms during the dance. (Nanni & Lovisolo, 2011)

Youngsoon et al. (2019) concluded that the rotational movement of the trunk in this dance means a dissociated movement between the lower part of the body correlated with the upper part. This allows a great freedom of movement of the legs, in various positions and situations, while the upper torso can remain connected in the dancing position. The action is performed by a torsion of the spine, estimated up to 135°.

The use of the term dissociation in tango dance refers to the upper half of the body (head, shoulders, arms, torso) that rotates left or right, as a unit, around the dancer's spine, independent of the lower half. of the body (hips, thighs, knees, ankles and feet). This movement is the forerunner of most movements in this style of dance.(Fujii et al., 2014)

The term dissociation and isolation is often used in the preparation of the Argentine tango style. The isolation movement is an independent movement of body parts, depending on the time and speed of change. (Youngsoon et al., 2019)

In tango, the dissociation indicates the area where axial rotation occurs and is defined from T10 (joint T10-T11) to S1 (joint L5-S1) as torsion of the twisted body. That is the status in which the thoracic plane and the pelvic plane have an axial rotatory angle different from zero. (Youngsoon et al., 2019)Because of the fact that dissociation is an act of psychomotor organization allows us to emphasize the following requirements: relaxation of the position during the motor act and positioning of the pelvis within the three axes.(Youngsoon et al., 2019)

For this purpose, the dissociation of the trunk with the pelvis will be a consequence of the relaxation, placement and passive extensions of the sacro-spinal muscles of the spine. It is a skill requiring slow assimilation. So, we can define dissociation in tango-specific motion as an advanced passive extension that is obtained later, after control is gained over relaxation and the correct position of the pelvis. (Tateo, 2014) If the dance technique is properly mastered, complex movements become easy to perform and contribute to an optimization of movement coordination between partners.

In the research, the style technique is based on the movement of passing one leg over the other with pressure on the left hip and landing on the other leg, transferring the pressure on the right hip. (Cioroiu, 2017, p.88-90) Two muscle groups are involved in this movement: the extensors of the spine (iliocostalis, longissimus, multifidus) and the flexors of the spine (abdominal and iliopsoas). (Izzo et al., 2012) In order to maintain the dance position at the level of the upper limbs, we encounter the involvement of the following moving muscle groups: arm - deltoid abduction; anteduction arm –serratus anterior, large pectorals and brachial biceps; elbow flexion - brachial biceps and finger flexion - finger flexors. (Bennel et al., 1999)

The motor activity of the dance style is formed the basic movements and elements of gross and fine motor skills. (Palumbo et al., 2019) Thus, following the optimal development of the components of psychomotor skills in adults through the ability of the musculoskeletal system to manipulate various objects or to perform certain movements in relation to the relationships of space and time is called coordination (Krasnow& Chatfield, 2009, p. 101-107)

The coordination of neuromuscular control is the ability of the human brain to perform voluntary activities involving one or more skeletal muscles. (Simpson et al, 2013) The optimal neuromuscular control is the activity of increased involvement and attention, as well as awareness of the movements that need to be performed (Raymond et al., 2005) and the development of visual perception is achieved by identifying the presence and degree of deficit visual-perceptual and visual integration in adults. (Quiroga – Torres et al., 2018)

The neuromuscular control training in the improvement of the tango technique is based on the following stages:

1. Mobility is characterized by the possibility of initiating and performing a motor act along the entire range of motion;
2. Stability is the ability to maintain gravitational and antigravity positions, this being possible due to the simultaneous contraction of the muscles around the joints;
3. Controlled mobility ensures the development of motor activity regardless of the position adopted and for this to be possible it is necessary to: the presence of muscle force on the amplitude of the movement; the presence of the balancing reflex and the increase in the amplitude of certain movements;
4. The ability is achieved without taking into account the posture, becoming the highest step in terms of motor control. The ability is based on manipulation and a good knowledge of the external environment through exploration. (Shimizu & McDonough, 2006)

Moreover, through the specific training of the technique, the level of motor intelligence increases due to the knowledge baggage that specific movements offer through their complexity, (Rand, 2018) through the increased level of coordination of motor actions, through the skills and skills specific to this type of effort. (Neagle et al., 2004)

Currently argentine tango therapy has physical benefits including improving aerobic power, lower body muscle endurance, strength and flexibility, balance, agility, and gait (Youngsoon et al., 2018) which subsequently improved significantly spatial cognition and disease se-verity, motor and non- motor manifestations, balancing and walking. (Rodrigues-Krause et al., 2019) It can successfully constitute an extra or maintenance activity after work, as well as a high performance activity, (Banio, 2015) in a pleasant and harmonious environment with the possibility of socialization and development. (Kicsi, 2019)

The essence of the research is based on the mechanical efficiency of neuromuscular coordination by using the component of the motor "trunk-eye coordination". (Ballard et al., 1995) This is the ability of the perception system to analyze and guide the information captured by the eyes to the trunk, (Jana et al., 2017) keeping the upper and lower limbs in isometric action (dance position), during the execution of the rotational movement of the trunk. (Bar-Haima et al., 2013)

Recent studies have confirmed that trunk-eye coordination is based on the ability to perceive the eyes in order to perform a task with the trunk. (Gauthier et al., 1988)

The novelty of the study consists in correlating the mechanical efficiency of the neuro-muscular control (Jiang et al. 2018) with the motor activity of the dance style - Argentine tango in adults and in outlining the psychomotor profile of the dancer drawing the possibilities for its improvement and harmonization. (Orhan et al., 2018)

The use of the ERGOSIM simulator in the research can contribute to the detection of dance position, execution errors and to the correction of specific movements during the dancers' training sessions.ERGOSIM is a very successful program based on a computer-assisted simulator. It is designed by the National Research Institute for Sports, Romania and was patented in 1944 by a team of specialists. Through, it the subject receives real-time visual information helping to correct the movement in a relatively short time.

The operating principles of the simulator are the following:

- Allows the development of movement in various regions;
- Ensures the dynamics and freedom of movement specifically;
- Creates conditions for measuring the identified parameters;
- Provides real-time feedback;
- Allows individualization of movement;
- Plays on the screen a reference model for the requested exercise by setting the parameters of force, time, movement length, etc.
- Possibility of storage, processing and interpretation of scientific data.

The aim is to determine whether the degree of psychomotor development is superior in relation to the time and quality of motor information processing in achieving the rotational movement of the body, with real-time feedback, with or without visual stimulus.

2. Materials and Methods

The research involved a number of 10 dancers (5 males and 5 females) between 23 – 41 years old. The participants in this study were young adults - professional Argentine tango dancers (DP) with international results, and practice averaging 12.8 ± 4.2 years, and social dancers (DS), with 4 ± 1 years of practice, table 1 and 2.

Table 1 Subject list

No.	Name	Age	Argentine tango/years	Group
1.	ARO	41	13	Professional dancers
2.	SL	39	14	
3.	HCP	34	11	
4.	AAT	28	17	
5.	KCS	23	9	
6.	CMG	40	5	Social dancers
7.	CAP	39	5	
8.	OMC	33	3	
9.	AAV	31	3	
10.	MA	29	3	

Tabel 2 Sports performance

Study group Professional dancers	Result	Competition
K.C.S.	1st place	6th European Tango Championship, Todi, Italy, 2015
	2nd place	4th International ”Tango de Salon” Championship, Budapest, Hungary, 2012
	Finalist	Mundial de Baile en la categoria ”Tango de Pista”, Buenos Aires, Argentina, 2015
	Semifinalist	”Romania´s Got Talent ”, Bucharest, Romania, 2017
	10th place	5th European Tango Championship, Todi, Italy, 2014
S.L.	1st place	4th UK Tango Festival & Championship, London, UK, 2017
A.R.O.	1st place	4th UK Tango Festival & Championship, London, UK, 2017

H.C.P.	Finalist	5th European Tango Championship, Todi, Italy, 2014;
A.A.T.	Jury	Finale Nazionale Campionato Metropolitano Tango, Rome, Italy, 2016;

The selection process of the participants was carried out within the various sports actions where the Argentine tango took place both in terms of performance and social level. Before enrolling in the study, all completed an informed consent form in accordance with the Helsinki Declaration. The research was carried out with the consent of the Faculty of Physical Education and Mountain Sports, Transilvania University of Brașov, Romania.

The research design is of the "real experiment" type with control group, only with post-test phase. The independent variables are represented by the long preparation as performance in the Argentine tango, and the variables dependent on the two stages of the evaluation, the one without visual stimulus and the one with visual stimulus.

In order to observe how the adult brain reacts to a given stimulus, we used the ERGOSIM condition simulator that provides real-time feedback.

In order to be able to observe how the body segments react to a given stimulus, the ERGOSIM conditions simulator was used, which provides feedback in real time. "ERGOSIM" is a program developed with great success based on a computer-assisted simulator, and it was designed by the National Research Institute for Sports in Bucharest, Romania.

The computer-assisted simulator offers the ability to highlight and measure the neuromuscular processes that provide access to objective and instantaneous information. This type of information allows real-time fixing of the technique and corrections of the movement parameters during the act of movement or during the transition from one movement to another. (Salgua, 2018)

The novelty and originality of the device, which also provides its value of uniqueness, is its ability to analyze the motion parameters obtained while working at the desired speed on an accelerating motion, achievable in all planes, in a multitude of angles, with ideal amplitude, without forced return effect as in classical devices. (Dumitru, 2009)

Introducing thus real-time information (visual feedback), respectively informing the subject in real time about their execution, centimeter by centimeter and millisecond by millisecond, over all the parameters involved in the execution of the type of exercise.

The subjects were asked to perform an isotonic exercise by performing 12 tractions, such as a helcometer, assisted by ERGOSIM, on a given model, fig. 1. The executions were made with regard to the screen, constituting the first part of the test (ex-equation with visual stimulus) hereinafter referred to as T1, and T2 tried to make a drawing on the screen as close as possible to the given model.

The subject must perform the movement following a pattern projected on the computer screen (Figure.1).

The pattern parameters are the following (Buzescu et al., 2021):

- the level of force used (expressed in dekanewton, 1 dan is approximately equal to 1 kg);
- the brake constant (k), representing the resistance of the device to the dancer's movement;
- the length of movement in cm (it is the parameter that interests us the most, because it represents the amplitude of the execution of a movement).

For each traction, a graph appears on the screen according to the amplitude, speed and force with which the movement is performed. The settings of the isotonic exercise were: brake 0%, speed threshold 0 m / s, clock 10 ms, guides 10%, number of strokes 12, length of movement 20 cm., Graph with one or more curves with coordinates set on the two axes: OX: Left / right position, OY: Left / right force. The settings of the model represented by the yellow rectangle were at 2 daN (decanewton) force and at 20 cm for the traction length (fig. 1.). For each movement on the screen, a line of a certain color appears. The first shots were set to appear on the monitor in green, then gradually change to red until the end. The first 6 tractions are colored with shades of green from dark to light and the next 6 from orange to very dark red so that they can each be evaluated in a bunch of 12.

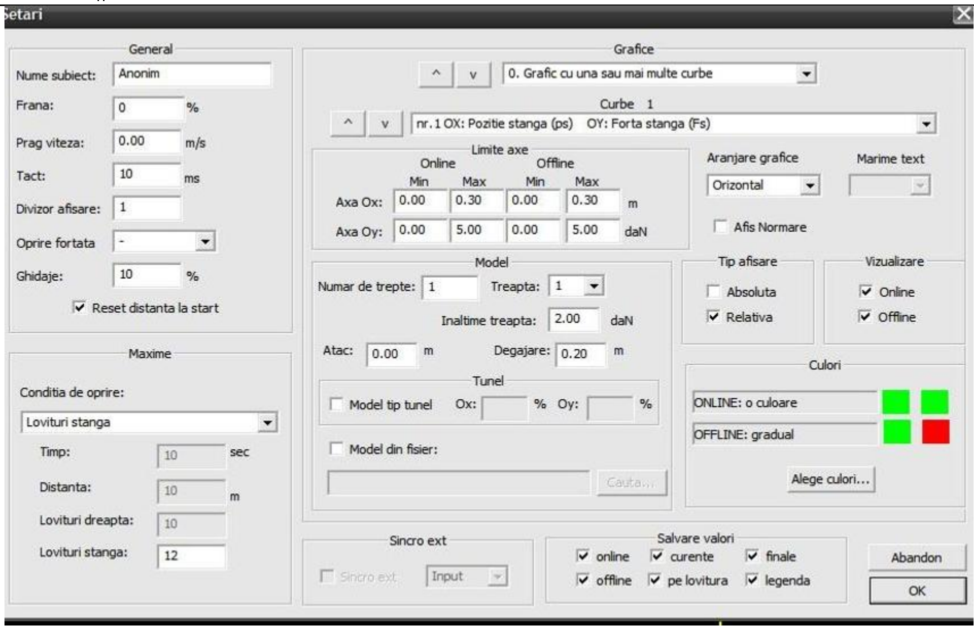

Fig. 1 Setting the specific motion parameters on the ERGOSIM condition simulator

The recording of the mechanical effect of the neuromuscular control was obtained by testing an isotonic exercise specific to Argentine tango in different directions: left and right.

1. T1 testing - isotonic movement specific to Argentine tang, with visual stimulus (A).

In the T1 test, differing from T2, the subjects received the information that the performed movement must `draw` a line as close as possible to the pattern (Figure 2. - yellow chart) on the screen, position force plateau, 12 times, with visual feedback, tracking the scree in real time.

2. T2 testing - isotonic movement specific to Argentine tang, without visual stimulus (B);
   - Initial position: Standing, feet apart, with the simulator's moving arm positioned as a ring at the shoulder joint, maintaining the position of the Argentine tango in an isometric position, twisting the torso in the dance position - with emphasis on locking the pelvic area - to the left and to the right, and holding the position force plateau.

Performing 12 repetitions, the simulator was set to 20cm, 2daN and k 0%. In general, depending on the cortical stability, the same path was followed, without any explanation. For this test, only the lines indicating the force plateau were counted (maintaining the parallelism with the predetermined force, without exceeding the given distance), leading to cortical stability.

For each movement the screen shows a chart depending on the amplitude, speed and force with which the movement is performed, Figure 2-3.

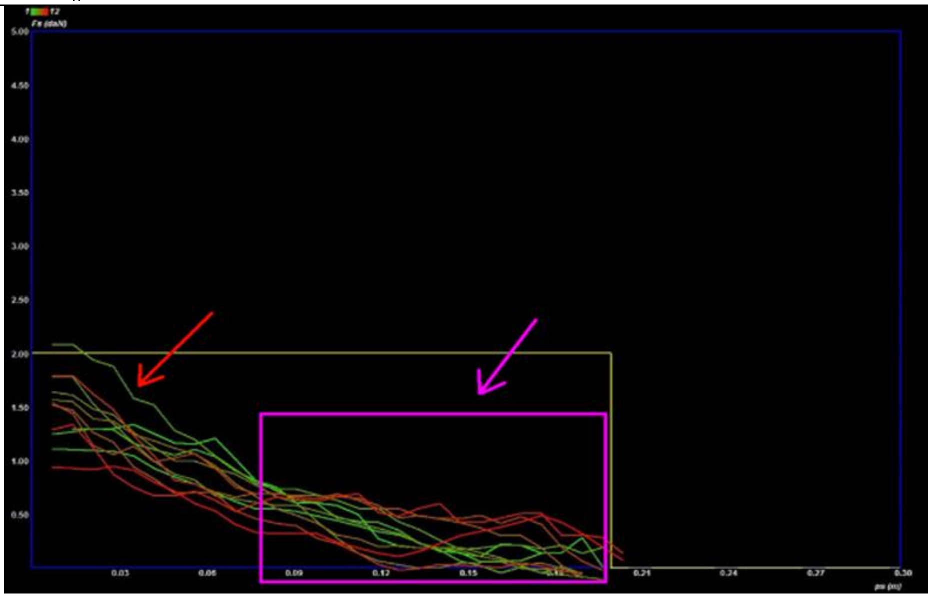

Figure 2. T1 testing - isotonic movement specific to Argentine tang, with visual stimulus (A)

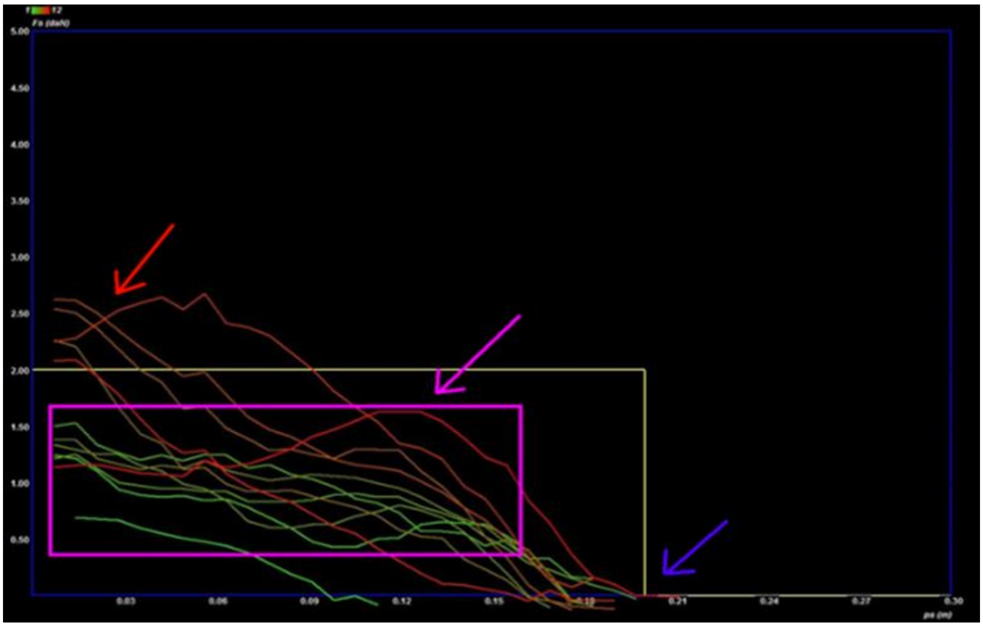

Fig. 3 T2 testing - isotonic movement specific to Argentine tang, without visual stimulus (B)

The results were processed with IBM SPSS Statistics 20 (Armonk, NY, USA). The statistical indicators used were: arithmetic average (x), standard deviation, standard deviation (SD) and student "t - test" (t), for independent samples, for the two groups of subjects.

3. Results

In this section the most relevant results are presented, and the descriptive information of the study on the execution procedure of the vision-psychomotor schemes by the dancers included in our study.

Following the statistical processing, the values of the statistical indicators presented in Table 3. were extracted from the SPSS outputs.

Table 3. Statistical description of the research activity indexes

Procedure Group		No.	X	SD	Student Test t	Semnificație p
A. left	DP	5	6.86	0.86	1.89	0.10
	DS	5	6.02			

B. right	DP	5	2.66	1.08	-1.79	0.08
	DS	5	3.77			
C. left	DP	5	5.97	1.62	3.74	0.01
	DS	5	2.50			
D. right	DP	5	4.45	2.67	4.60	0.005
	DS	5	1.77			

Note. A - Without feedback in real time - left ; B - Without feedback in real time – right; C - Feedback in real time – left; D - Feedback in real time – right; No. – number of subjects; X – Arithmetic average; SD – standard deviation; t-test; p<0.05; DP- group professional dancers; DS – group social dancers

Two T1 and T2 tests were created to assess how the brain reacts to a given stimulus (ERGOSIM) to see if there were significant differences depending on the specifics of the movement.

The results indicate a significant increase in visual stimulus testing of 2.67, which has a $t = 4.60$, $p < 0.005$ given that participants have visual control and can use visual input to adjust their movement.

There are improvements in conditions without visual stimulus, but the differences are not statistically significant of 1.08 with $p < 0.08$, although they still appear in favor of those who practice tango for many years.

In addition to the quantitative data obtained, we further present an example of the graphs obtained at T1 (visual input test) and T2 (non-visual test), respectively:

- in this test all the tractions present a rectilinear situation in which a force plate on the position is confirmed, fig.4;
- In fig. 5 of the 12 tractions only 11 have a rectilinear with an oscillation of over 0.50 daN, according to "Strong plateau - position with oscillations> 0.50 daN". Of the 11 tractions, only 10 tractions have an oscillation of less than 0.50 daN over a distance of at least 10 cm, according to "Force plate - position with oscillations <0.50 daN over a length of 10 cm". The 11 uniform tractions are evidenced in a purple rectangle;
- At Specific exercise - left side -BLIND tractions start at a high force level and decrease suddenly without any neuromuscular control;
- Fig. 7 shows some values similar to the left side, where the tractions start with a high traction force (marked with a red arrow) and in the middle of the movement the decrease occurs, but instead the movement becomes uniform until the end. From the purple rectangle, we can see that all tractions have a "Force plate - position with oscillations> 0.50 daN", but only 8 tractions have "Force plate - position with oscillations <0.50 daN on a length of 10 cm".

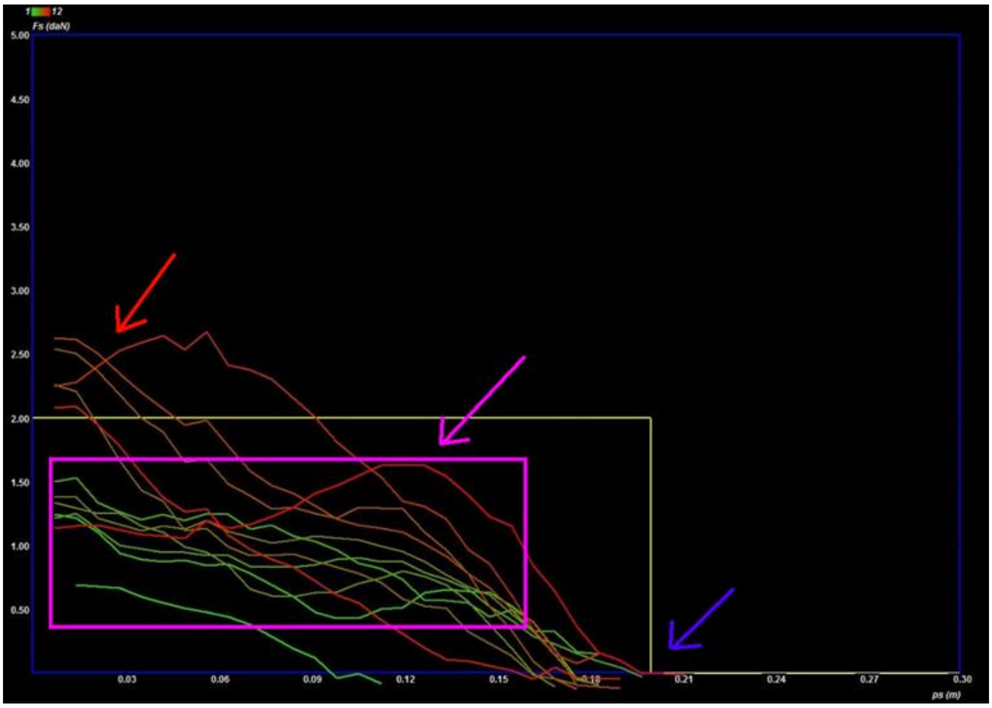

Figure 4. Specific exercise – right side – BLIND

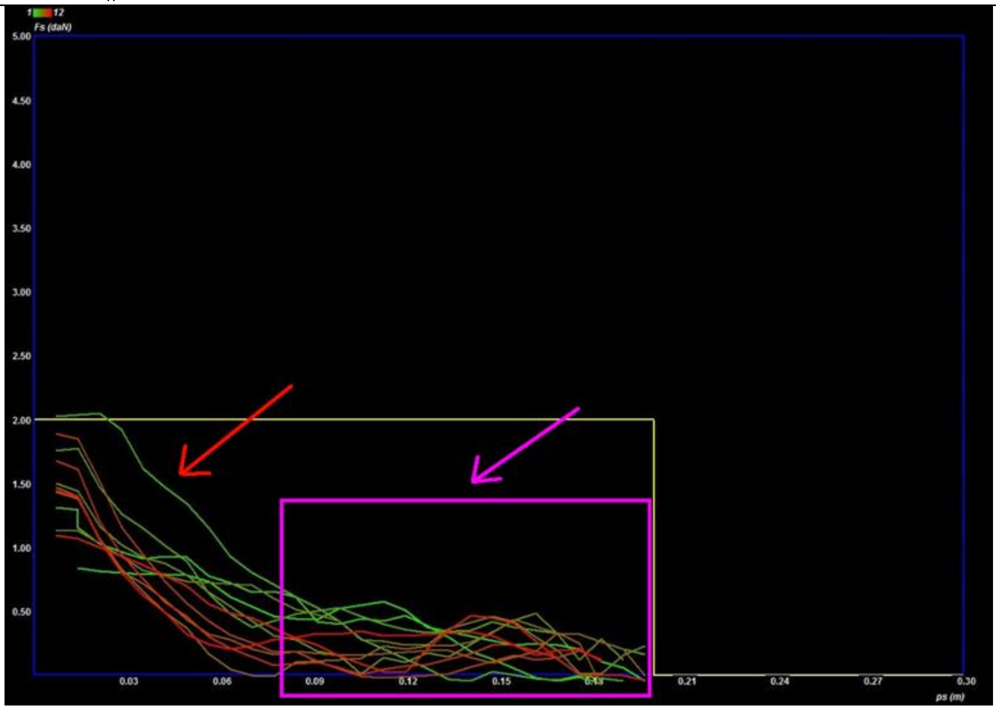

Figure 5. Specific exercise – right side – MODEL

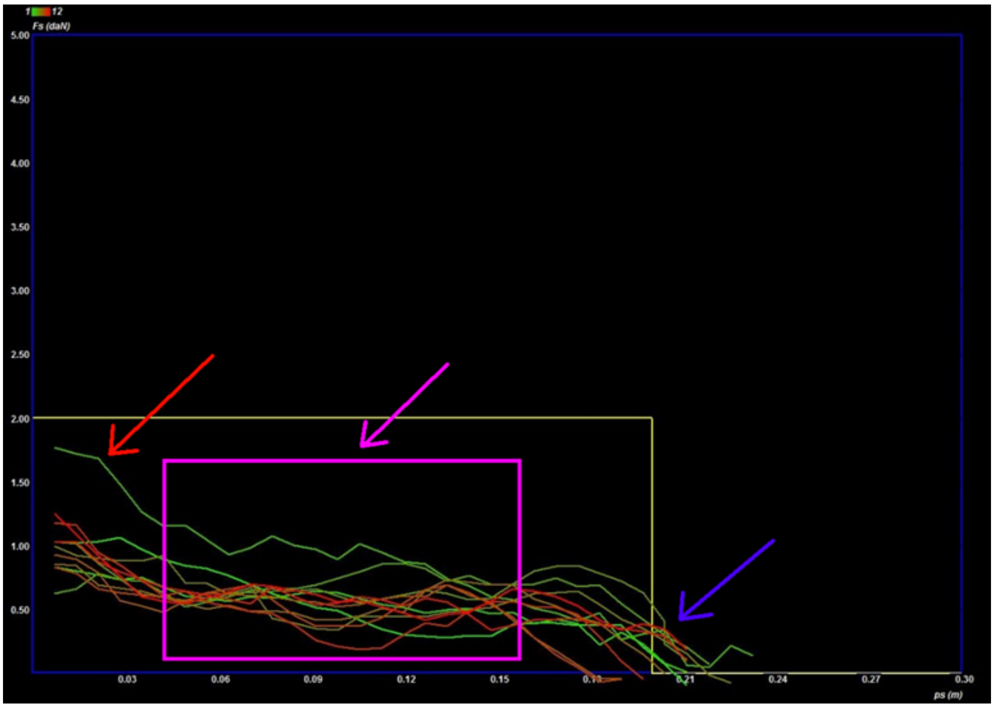

Figure 6. H.C.P. Specific exercise – left side -BLIND

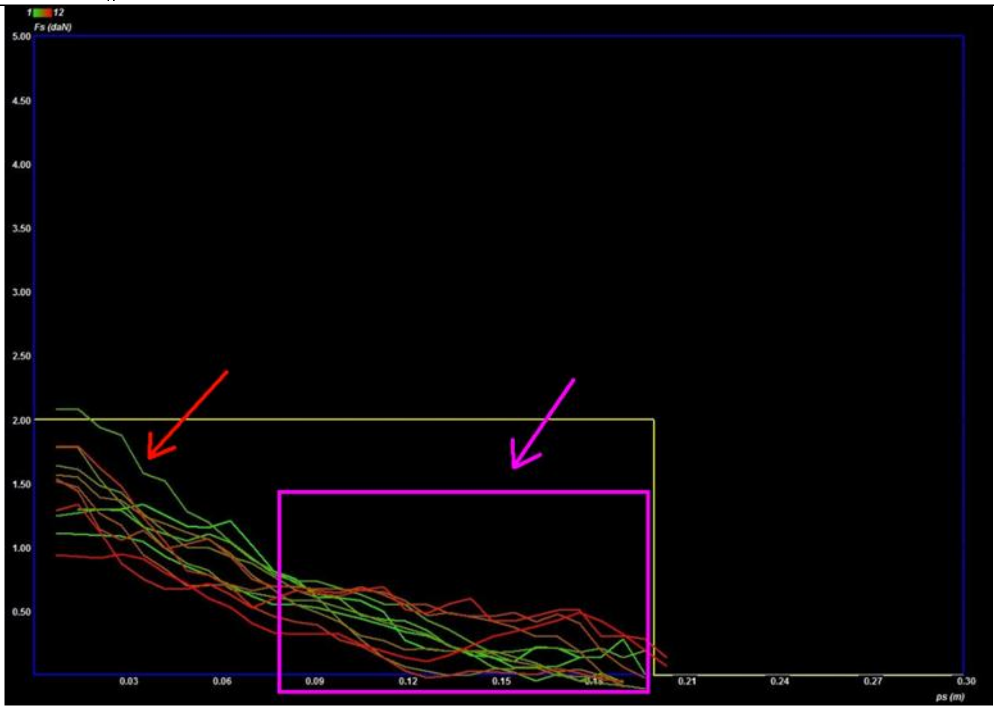

Figure 7. H.C.P. Specific exercise – left side – MODEL

4. Discussion

The results of this research suggest that dance is beneficial for the neuromuscular control of body posture.(Valverde-Guijarro et al., 2020)

The effect of the indices provided to the neuro-motor control on the motor capacity of the dancer was studied while the simultaneous, sequential and rhythmic movements were monitored with the help of the Ergosim simulator.

The Argentine tango dance style, used in the research, requires specific steps combining walking forward/backwards, changing directions, and turns, while monitoring the coupling movements according to the role of the participant (Murillo-Garcia et al., 2020)

Through our results, our study contributed to the identification of aspects regarding the importance of neuromuscular control training in the improvement of the Argentine tango technique. The results of the study are correlated with previous studies. The study highlighted the correlations between: the efficiency of neuromuscular control and the speed of adaptation of the motor act according to a visual stimulus or if the conscious and concentrated performance of a motor act is superior to a motor act turned reflexive.

The possibility of evaluating and observing a psychomotor model of the adult presenting differences in the realization of the imposed model and of the brain's reaction to maintain at a certain force plateau the trajectory of the movement.

A study led by Buzescu et al. (2021) aims to assess the knowledge of imposing an isotonic exercise on 51 subjects to determine whether the degree of psychomotor development with real-time feedback is higher in terms of time and quality of information processing as an adaptation of motor act depending on the visual stimulus.

The ability of subjects to become aware of movement and shape isometric exercise was also studied by Sirpa A et al. (2017) implementing the principles of body awareness therapy during movement. They described three descriptive categories that reflect the conceptions about the phenomenon of movement quality as a process of extension: I: Getting in touch with movement experiences, II: Variety of movement qualities and III: Quality of movement as professional development.

In correlation with our study, the aim of the performance of the technique was based on motor simulation interventions that incorporate motor images and the observation of the deadly action. The current understanding of motor efficiency and the introduction of a new, conceptual model of motor simulation and performance are the expected performance improvements to be associated with involvement with motor skills at expertise levels. (McNeill et al., 2020)

Boroushak et al. (2021)consider that the motor stimulation process is built on a deep learning framework based on complex task-specific optimization and design experiments to verify the performance of the model.

Limitations: Our study consisted of a small number of subjects and a relatively short duration of development. Even if the results were great due to the fact that there was no alternative experience as a benchmark, it could be extended to a larger number of subjects for different sports.

Research shows that the tax model has certain effects, which can satisfy real needs and can provide theoretical references for further research.

5. Conclusions

This study highlights the relationship between the mechanical efficiency of neuromuscular control and the improvement of the movements specific to Argentine tango from a psychomotor point of view, in professional and social dancers.

The study showed that there are insignificant differences in cortical stability (translated by strength, balance and attention-concentration), between individuals who have been practicing performance tango for many years, compared to those in society. Subjects, when they do not have a visual scheme as the required learning information, can maintain effective neuromuscular control during movements, developing similar ratios in terms of position-strength, between successive repetitions.

It demonstrates that in visual schema learning, having real-time feedback can maintain in time clues closer to the required model. What is important is that professional subjects can return with efferent correction stimuli during a wrong move, much better than those in the group of society. Based on the visual schemes, through internal representations of the physical and mental actions, they evolved by assimilation and accommodation to a superior neuromuscular control in order to approach the given model.

When performing the isotonic exercise, a confrontation system analyzes and sends to correct any wrong movements that were previously formed in the programming system. The confrontation system also manages to highlight the degree of disproportion between the real movement and its representation. The correction of movements takes place at the level of programming systems having as main objective, a more accurate and correct representation of a previously programmed motor act. In the process of developing coordination, it must be taken into account that the basis is the vestibular reflexes and the role of leader of the human body in terms of a good execution of movements.

Dance could be an efficient tool for solving motor tasks through the relationship: mechanical efficiency of neuromuscular control and the improvement of movements specific to this contemporary procedure.

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