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Original research article

EFFECTS OF PROPRIOCEPTIVE TRAINING ON BALANCE SKILLS AMONG SPORT DANCE DANCERS

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Abstract. *The aim of this research is to determine effects of proprioceptive training on the improvement of balance skills among sport dance dancers. Proprioceptive training is realized throughout tasks that included the establishing and maintenance of various positions on balance boards of different dimensions, working surfaces and the size of the backbone. In this study, 38 sport dance competitors participated, both male and female, divided into an experimental and control group. The experimental group took part in a proprioceptive training program over a period of 12 weeks (3 x 30 minutes per week). The control group (at the same time as the experimental) had regular sport dance training. At the beginning and at the end of the experiment, balance skills were measured by means of 7 different balance tests: the one-leg balance, two-leg balance, balancing with open or closed eyes. Basic descriptive statistics were calculated for all of the results. The effects of the applied proprioceptive model were determined using a multivariate (MANCOVA) and univariate (ANCOVA) analysis of covariance. Statistically significant differences among the groups in the final measurement (p=.00) show a positive effect of the applied proprioceptive training program on the development of balance skills with the experimental group, in all the tests. Therefore, the use of a proprioceptive training model, as an innovative approach in individual and group fitness dance training, is recommended.*

Key words: *proprioceptive training, balance, sport dance.*

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INTRODUCTION

The modern approach to developing fitness training generally, and especially in dance, gives great significance to the proprioceptive training program. This kind of exercise is also known as sensory-motor training. Proprioception is inborn "talent" for body awareness and knowing just where the body is positioned in space. This body sense is intimately tied to our feeling of muscle tone, and perceptions of effort and balance. Specialized nerve endings originate in our muscles, fascia, tendons, ligaments, joints, and some scientists even include the skin. These "afferent" (sensory) receptors perceive deformations of the tissue – the amount of pressure (stretch or simply, placement), the speed at which movement occurs and the rate at which the speed changes (velocity), the direction of movement, and when deformation is extreme – pain (Batson, 2008). The proprioceptive system, in general, enables the correct functioning of the loco-motor apparatus during movement and sport activities, maintains muscle tonus and helps us to precisely differentiate isolated body moves that are particularly attractive in sports dance choreographies. At the same time, it helps in the more secure expression of static and dynamic balance skills that are manifested in both individual and couple choreographies. It also has an influence on the stabilization of joints, which is very important for the prevention of sport injuries. The ability to manage different manifestations of balance gives the possibility of easier interaction of dance couples in terms of precise dosing of progressive movement dynamics. The importance of balance in presenting sport dance choreographies was also indicated in the latest proposal of the sport dance judging system (WDSF - World Dance Sport Federation, 2011). According to that system, balance (static-dynamic, individual-couple) takes a high position as the first component of evaluation, which is a confirmation of the significance of this motor ability for success in sport dance.

An improvement of motor abilities using proprioceptive training is noticed in some research with uninjured and untrained individuals (Šimek, 2006; Myer, Ford, McLean & Hewett, 2006; Šebić-Zuhrić, 2007). What is especially interesting are the studies in the field of balance (Hoffman & Payne, 1995; Rozzi, Lephart, Sterner & Kuligowski, 1999; Blackburn, Guskiewiez, Petschauer & Prentice, 2000; Kollmitzer, Ebenbichler, Sabo, Kerschan & Bochdansky, 2000; Elis & Roesnbaum, 2001; Heitkamp, Horstmann, Mayer, Weller & Dickhuth, 2001; Ziegler, Gibson, & Mc Bride 2002; Hrysomallis, 2007) where proprioceptive training has proved its role in development. The studies regarding the application of this training model also confirm its contribution in the field of upper-leg muscle strength (Heitkamp et al, 2001; Blackburn et al., 2000; Ziegler et al., 2002). However, there are only a few studies on the effects of this training model made with active and healthy athletes (Tropp & Askling, 1998; Perin, Deviterne, Hugel & Perrot, 2002; Simmons, 2005). The affirmation of the proprioceptive training model in the fitness preparation of athletes will redirect the traditional comprehension that this type of training belongs only to preventive, maintaining and rehabilitation fitness programs. The main aim of this research is to reveal the effects of the proprioceptive training model to balance the motor ability of sport dance dancers. That is how we could look into this model of training and test its impact on the development of balance of healthy athletes, and contribute to a confirmation of its developing effect in dance fitness training. Some new studies on the significance of proprioceptive training will innovate the approach to fitness planning and programming in sport dance. Having in mind that balance is one of the crucial factors of sport dance success (Uzunović, 2004; Uzunović & Kostić, 2005; Lukić, 2006; Lukic & Bijelić, 2009), the results of this research will greatly enrich previous knowledge in the field of the sport dance fitness training process.

THE METHOD

The sample of participants

The sample of participants consisted of 38 sport dance dancers, male and female, aged 15-19, divided into two groups: an experimental E (n = 19) and control C (n = 19) group. The participants are active competitors of the Dance Sport Association of Bosnia and Herzegovina. They have been involved in the training process for at least 4 years with a minimum of 3 training sessions per week. They compete at higher dance levels (level B), which allows them to perform more complex dance choreographies.

The sample of variables

This study includes the variables of balance motor ability (one-leg balance, two-leg balance, balancing with open or closed eyes). Balance variables were covered with 7 standardized motor tests (Metikoš, Hofman, Prot, Pintar & Oreb, 1989) with necessary metric characteristics. All of the tests were measured at the faculty sports hall by trained recorders. Each participant had three attempts per test (both during the initial and final measurement) and the best one was taken into consideration. The maximal duration of each individual test was 180 sec. The tests included: the Flamingo balance test (FLAMIN); Transverse standing on one leg on the balance bench, with eyes open (MBAP10); Standing on one leg longitudinally on the balance bench, with eyes open (MBAU10); Transverse standing on two legs on the balance bench, with eyes open (MBAP20); Transverse standing on two legs on the balance bench, with eyes closed (MBAP2Z); Standing on two legs longitudinally on the balance bench, with eyes open (MBAU20); Standing on two legs longitudinally on the balance bench, with eyes closed (MBAU2Z).

The proprioceptive experimental program model

The proprioceptive experimental program model was conducted over a three-month period (twelve weeks). The experimental group had three proprioceptive trainings per week, with different durations, depending on the level of difficulty. The maximal duration of the proprioceptive training (performance, pauses between tasks, a change of balance boards and so on) did not exceed 30 minutes. The experimental program was conducted before the dance training, but after the specific warm-up of the dancers. During that kind of training, balance boards of different dimensions, working surfaces and sizes of backbone were used: a moving roller, T-board, semi-roller, semi-ball, asymmetrical cone, "Bosu" ball, Pilates ball, soft mat and unstable polygons. The duration and number of repetitions were determined by the difficulty of the tasks. On the other hand, difficulty was determined by body position during the exercise, jumps on a balance plate, distraction during exercise, and the use of different additional requisites which made the performance more difficult in that particular body position (tennis balls, ball for rhythmic gymnastics, medicine balls). Certain tasks were performed with eyes closed. The participants were organized in several unstable polygons where they worked out in pairs on one balance plate. They had three series, on each one of those boards, with a pause between them in a 1:1 proportion (Jukić, Milanović, Šimek, Nakić & Komes, 2003). The total time of one proprioceptive training (its realization) per participant did not exceed 10 minutes, in order to avoid nerve-muscular fatigue. While the experimental group had both proprioceptive and dance training, the control group had only regular dance training, three times a week.

Statistical analyses

The data gathered during this research were analyzed using statistics programs for personal computers SPSS 11.0 and statistic package STATISTIKA 7.0 for Windows.

For the analysis of basic statistic data and the distribution of the results during the initial and final measuring of the experimental and control group, basic descriptive parameters have been calculated: arithmetic mean, minimal value, maximal value, standard deviation. From the field of comparative statistics, discriminative procedures were used. The multivariate and univariate analysis of variance (MANOVA, ANOVA) were used as the quantitative indicators for testing the significance of group differences during the final measurement. The multivariate analysis of covariance (MANCOVA) and univariate analysis of covariance (ANCOVA) were used to determine the existing effect of proprioceptive training which came as consequence of its influence at the final measuring. The reason for the application of these analyses was to neutralize (unify) the differences between the groups at the initial measuring. The significance of the conclusion is based on the $p < .05$ level.

RESULTS

Table 1. The results of the descriptive parameters of the initial and final measuring of the experimental (E) and control (C) group.

	Groups	E				C			
Variables		Mean	Min	Max	StdDev	Mean	Min	Max	StdDev
FLAMIN	initial	15.78	12.4	19.88	2.32	15.92	12.67	19.58	2.11
	final	20.82	15.34	25.78	3.51	15.94	12.22	19.13	1.78
MBAU20	initial	3.42	2.21	6.11	1.32	3.51	2.26	6.56	1.34
	final	9.39	7.04	10.98	1.02	3.55	2.09	6.34	1.35
MBAU2Z	initial	1.97	1.24	2.59	0.43	2.21	1.42	3.71	0.68
	final	5.34	4.01	6.76	0.95	2.55	1.45	3.16	0.49
MBAP20	initial	2.23	1.57	3.28	0.5	2.77	1.67	4.21	0.93
	final	6.29	3.45	8.44	1.65	2.62	1.08	4.55	1.08
MBAP2Z	initial	2.17	1.3	3.76	0.77	2.44	1.56	3.89	0.83
	final	5.35	2.03	8.15	2.03	2.87	1.58	4.34	0.84
MBAP10	initial	2.21	1.48	3.63	0.7	2.34	1.38	4.09	0.75
	final	6.65	5.78	7.88	0.71	2.98	1.87	4.77	0.84
MBAU10	initial	5.61	2.12	8.67	1.94	5.26	2.25	8.72	2.11
	final	10.84	7.34	12.99	1.55	5.31	3.03	8.76	1.74

Legend: Mean – means; Min – minimal value; Max – maximal value;
StdDev. (Standard Deviation) – average deviation of the obtained results from their arithmetic mean;

The results of the initial measuring of both groups show that values of most of the observed test are in the expected ranges for this population. All of the tests of balance of the experimental group have better results in the final measuring. The most different initial and final measuring of the experimental group was noticed in the Flamingo balance test (5.04), Standing on two legs longitudinally on the balance bench, with open eyes (5.97) and Standing on one leg longitudinally on the balance bench, with open eyes (5.25). The participants from the control group have slightly better results in the final measuring on almost all the tests. In the case of the "Standing on two legs longitudinally on the balance bench, with open eyes" test, the results have better values in favor of the initial measuring (0.15). However, the biggest difference in favor of the final measuring of the control group was obtained for the "Standing on one leg longitudinally on the balance bench, with open eyes" test (0.64). In any case, these are minor variations that do not require a more detailed analysis. Generally, the experimental group showed better results at the final measuring in all the studied balance tests.

Table 2. The multivariate analysis of variance differences between the experimental and control group at the final measuring - MANOVA model.

Wilks Lambda	F	df 1	df 2	p
0.02	53.88	15	18	.00

Legend: Wilk's Lambda – the value of Wilk's test for the equality of group centroids; F - value of the F-test coefficient of significance of Wilk's Lambda; df1 & df2 – degrees of freedom; p – coefficient of centroid difference significance

According to the results shown in Table 2, it is noted that there are significant differences (p=.00) between the groups at the final measuring.

Table 3. The univariate analysis of variance differences between the experimental and control group at the final measuring - ANOVA model.

Test	Mean E	Mean C	MS effect	MS error	F	p
FLAMIN	20.82	15.94	202.47	7.71	26.24	.00
MBAU20	9.39	3.55	289.43	1.44	200.95	.00
MBAU2Z	11.07	10.76	.78	.32	2.40	.13
MBAP20	5.34	2.55	66.19	.57	115.25	.00
MBAP2Z	6.29	2.62	114.55	1.95	58.46	.00
MBAP10	5.35	2.87	52.27	2.43	21.49	.00
MBAU10	6.65	2.98	114.92	.61	187.35	.00

Legend: Mean –value of arithmetic mean; MS effect – middle sum of arithmetic means squares between groups; MS error - middle sum of arithmetic means squares inside groups; F – the value of the F-test coefficient for the significance of Wilk's Lambda; p – the coefficient of centroid difference significance

Table 3 shows a detailed analysis of the quantitative differences between the experimental and control group tests at the final measuring. The results show the existence of statistically significant differences (p=.00) between the groups for six studied balance tests (FLAMIN, MBAU20, MBAP20, MBAP2Z, MBAP10, MBAU10). Only one test, studied as the part of this group of tests (MBAU2Z) did not show statistically significant differences between both groups (p=.13).

Table 4. Testing the significance of the effects of proprioceptive training on the development of some forms of balance using the multivariate analysis - MANCOVA model.

Wilks Lambda	F	df 1	df 2	p
0.02	130.4	7	19	.00

Legend: Wilk's Lambda – the value of Wilk's test for equality of group centroids; F - value of the F-test coefficient for significance of Wilk's Lambda; df1 & df2 – degrees of freedom; p – coefficient of centroid difference significance

Table 4 shows the effectiveness of applied proprioceptive training using the method of the multivariate analysis of covariance (MANCOVA) to neutralize any differences between the experimental and control groups at the initial measurement. These statistical procedures have analyzed the inter-group differences at the final measurement. It may be noted that there is a statistically significant (p=.00) inter-group difference. Recorded differences occur under the influence of the applied experimental program, which leads to the conclusion that proprioceptive training had a positive influence on improving the balance of the experimental group. This is supported by the results shown in Table 1, where the values of the means of the balance tests and their positive changes in favor of the final measuring are numerically expressed.

Table 5. Testing the significance of the effects of proprioceptive training on the development of some forms of balance by using a univariate analysis – ANCOVA model.

Test	Adjusted mean C	Adjusted mean E	MS effect	MS error	F	p
FLAMIN	15.92	20.83	161.85	5.18	31.19	.00
MBAU20	3.47	9.48	242.6	0.78	310.06	.00
MBAU2Z	2.53	5.36	53.91	0.56	95.49	.00
MBAP20	2.32	6.59	122.76	1.46	83.65	.00
MBAP2Z	2.91	5.31	38.58	2.16	17.79	.00
MBAP10	2.96	6.37	92.07	0.58	157.18	.00
MBAU10	5.23	10.91	216.87	1.95	110.72	.00

Legend: Adjusted mean – the adjusted value of arithmetic means; MS effect – the middle sum of arithmetic means squares between groups; MS error - middle sum of arithmetic means squares inside the groups; F – the value of the F-test coefficient for significance of Wilk's Lambda; p – the coefficient of centroid difference significance

Individual univariate inter-group differences in all the tests are determined using a univariate analysis of covariance (ANCOVA) in Table 5. The greatest contribution to group differences in the final measuring in favor of the experimental group (Table 5) was noted for the Standing on two legs longitudinally on the balance bench, with eyes open test (F= 310.06). The great contribution to these differences was also noted for tests using one leg, the Transverse standing on one leg on the balance bench, with eyes open test (F=157.18) and the Standing on one leg longitudinally on the balance bench, with eyes open test (F=110.72). As we can see, the greatest improvement made using proprioceptive training refers to the gaining and maintenance of balance using one leg. That is clearly understandable considering the fact that the sample consisted of sport dance dancers. Movements in sport dance (Latin American, Ballroom) are based on dosed (determined by tempo) transfer of body weight from one leg to another, where progressive movements dominate. There are just a few standing positions where dancers use both of their legs at the same time. A proprioceptive experimental program set tasks that were supposed to be realized on one leg in different circumstances of balance maintenance. That is why the greater influence on the result of balance maintenance using one leg is fully understandable.

DISCUSSION

This research intended to show the significance of a proprioceptive training model in developing fitness preparation of sport dance dancers. Previous studies of this model of training were more oriented towards preventive and rehabilitation conditional programs. The goal was to establish nerve-muscle functions after injuries, then the reduction of those injuries and the improvement of functional stability of certain joint systems (Wedderkpp, Kaltoft, Lundgaard, Rosendahl & Froberg, 1999; Cerulli, Benoit, Caraffa & Ponteggia, 2001; Liu Ambrose, Taunton, MacIntyre, McConkey & Khan, 2003; Verhagen et al., 2004; Pánics, Tállay, Pavlik & Berkes, 2008; Zebis et al., 2008). However, this research searched for an answer to the question of whether proprioceptive training can be used as a stimulus for the improvement of nerve-muscle function with healthy trained athletes and through that influence the improvement in balance.

The results of this study, involving sport dance dancers, gave some positive answers. Namely, the proprioceptive system, on a conscious level, enables the correct function of the loco-motor one, because it gives the correct information about the position of the body, or some parts of the body in space (kinesthetic sense). We are aware of our movements and we can direct our attention to the fine details of sensory awareness at any time, as we do when we pay attention to all the specific movements in dance. At a subconscious level, it retains muscle tonus, which automatically affects joint stabilization and the maintenance of a balanced position. It is especially expressed in situations of sudden changes in muscle contractions made because of unexpected changes in the movements of the entire body or some of its parts. Without this inner sense of timing and accuracy, the rate of injury would be a lot higher, and, of course, simple movements would take up an enormous amount of cognitive energy. It is assumed that by proprioceptive training, faster data transfer throughout "afferent" and "efferent" paths can be achieved. That would result in the momentary activation or inhibition of certain muscle groups which provide effective movement (Bruhn, Kullmann & Gollhofer, 2004). By proper coordination of the obtained information, we can influence the efferent and reflex paths through which muscle tension is being regulated. In addition, we could also accomplish better coordination of agonist and antagonist muscles, providing information about dynamic stability and ease of movement. This makes it possible for us to conclude that the well-timed reaction, based on afferent information, is the essence of muscle activity control during maintenance of balance and movement. Many studies have shown (Hoffman & Payne, 1995; Bernier & Perrin, 1998; Rozzi et al., 1999; Heitkamp et al., 2001; Islam et al., 2004; Holm et al., 2004; Emery, Cassidy, Klassen & Rowe, 2005; Šimek, 2006; Šebić-Zuhrić, 2007; Perrin et al., 2007) that proprioceptive training can be used as adequate training method for the improvement of balance. In this study, the effect of proprioceptive training showed an improvement of "one leg" balance in particular. That is of great importance for sport dance dancers, since complex movements are conditioned by the constant transfer of body weight from one leg to another. Similar results were obtained in the study of the effects of proprioceptive balance skills training (Heitkampet et al., 2001; Islam et al., 2004; Šimek, 2006), involving one and two leg balance tests. The obtained results can be explained by the specificity of implemented experimental programs (static and dynamic one leg balance exercises), which are structurally similar to the conducted balance tests. The significant improvement of balance at the end of the proprioceptive training program is explained by a better central and peripheral adaptation of nerve-muscle system under the influence of this model of training. It can be assumed that this program strengthened the activated muscle groups (primarily joint stability muscles), which caused more balance efficiency.

At the same time, some other studies (Wolf-Cvitak, Grčić-Zubčević & Dolančić, 2002) indicate the fact that learning certain movements can be accelerated with reliance to the kinesthetic sense which is improved using exercising with eyes closed. That is the reason for using this kind of exercise in this study. It resulted in better concentration when performing eyes closed balance, and through that the faster reaction of joint stability muscle activation. According to that, the contribution of proprioceptive training refers to the establishing of body mechanisms responsible for eyes closed balance as well.

Some other studies (Streskova & Chren, 2009) focusing on the effects of fitness and a gymnastic experimental program on a sample of sport dancers also show positive changes in static and dynamic balance and an improvement in the efficiency of dance in general.

CONCLUSION

This study, in general, had the aim of investigating the effect of the use of innovative methods in the fitness preparation of sport dance dancers. The obtained results indicate the positive effects of the application of proprioceptive training on the improvement of balance with healthy (not injured) sport dance dancers. These findings will be of use, not only for sport dance fitness training programming, but also for a better and more efficient systematization of training effects. The application of proprioceptive training will be based primarily on the valorization of the proved neuromuscular function. The aforementioned valorization refers to the reduction of muscle reaction time around the main joint and faster muscle adaptation to body agility movements. Specifically in dance, practicing and refining the proprioceptive sense means greater speed, accuracy, and quality of movement, as well as expressiveness.

Based on the author's knowledge, studies on the effects of proprioceptive training, with the aim of practical application in improving the fitness training of athletes, including healthy and active sport dance dancers, are rare. Future observations about the effects of that kind of training could be included in studies about specific motor abilities used in sport dance. The fact that this training concept could be applied in other fields of sport with similar conventional structural movements (skating, synchronized swimming, rhythmic gymnastics, and so on) is one of the practical benefits of this research.

Studies on the effects of different transformational training processes are categorized as more or less applicable for the achievement of better sports results. This, in particular, represents some sort of contribution to training organization in conventional sports with an emphasized esthetic criteria, where precisely dosed and controlled dynamic movements are particularly significant.

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UTICAJ PROPRIOCEPTIVNOG TRENINGA NA SPOSNOBNOST ODRŽAVANJA RAVNOTEŽE MEĐU SPORTSKIM PLESAČIMA

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Cilj ovog istraživanja bio je da se odredi uticaj proprioceptivnog treninga na poboljšanje sposbnosti održavanja ravnoteže na primeru sportskih plesača. Proprioceptivni trening se realizije kroz zadatke u koje spadaju uspostavljanje i održavanje različitih poza na spravama za održavanje ravnoteže raznih dimenzija, radnim površinama, uz razne veličine kostiju kičme. U ovom istraživanju učestvovalo je 38 sportskih plesača, muškaraca i žena, podeljenih u eksperimentalnu i kontrolnu grupu. Eksperimentalna grupa je imala proprioceptivni trening tokom perioda od 12 nedelja (3 x 30 minuta svake nedelje). Kontrolna grupa (u isto vreme kao i eksperimentalna) je imala redovni trening sportskog plesa. Na početku i kraju eksperimenta, sposobnosti održavanja ravnoteže su merene upotrebom 7 različitih testova održavanja ravnoteže: ravnoteža na jednoj nozi, ravnoteža na dve noge, održavanje ravnoteže sa zatvorenim i otvorenim očima. Osnovni deskriptivni parametri su izračunati za sve rezultate. Posledice primenjenog proprioceptivnog modela su određeni upotrebom multivarijantne (MANCOVA) i univarijantne (ANCOVA) analize kovarijanse. Statistički značajne razlike između grupa na poslednjem merenju (p=.00) ukazuju na pozitivni efekat primenjenog proprioceptivnog treninga na razvoj sposobnosti održavanja ravnoteže kod eksperimentalne grupe, na svim testovima. Samim tim, upotreba proprioceptivnog modela treninga, kao inovativni pristup individualnom i grupnom fitnes plesnom treningu, se preporučuje.

Ključne reči: *proprioceptivni trening, balans, sportski ples.*