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Research article

THE PETTLEP METHOD AS A VALID LEARNING METHOD FOR IMPROVING THE JUMP TECHNIQUE OF YOUNG FEMALE RHYTHMIC GYMNASTS

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Abstract. *The PETTLEP motor imagery method is a widely used approach in the process of improving the performance of sport activities. In comparison to more traditional imagery protocols, PETTLEP-based imagery provides a more detailed learning experience. Consisting of many domains that are helpful in achieving better results by applying processes such as physical factors, environmental details, task and time factors, learning and perspective moments, the PETTLEP method is an advanced approach recommended by many studies which confirm its effectiveness. The purpose of this study was to determine the effects of the PETTLEP imagery method in training sessions involving young female rhythmic gymnasts (RGs) on the performance advancement of selected jump techniques in Rhythmic Gymnastics (RG). Forty-nine female RG novices aged 6 to 8.99 and thirty-one aged 9 to 10.99 were involved in this study and divided into two subgroups (training with and without the PETTLEP method). The mutual training methods were hour-long training sessions twice per week, with a mandatory task of learning and improving the technique of the vertical jump with straight legs and with a turn, the "Cabriole" forward jump, and the "Scissors" leaps with a switch of the legs forward. Group two was the one following the PETTLEP method in the learning process. The quality of the jump techniques was evaluated by national and international RG judges according to a modified scale for assessment of the adoption of jump techniques in RG, adjusted according to the FIG Code of Points for RG. The data were analysed with a repeated measures ANOVA, effect size r, and Cohen's d effect. The results of the analysis showed that both groups showed signs of improvement. There was no significant between-group difference in the effect size.*

Key words: *motor imagery, action observation, performance improving*

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INTRODUCTION

The role of the psychological preparation of athletes is very important for success in any sport. Athletes who have undergone psychological preparation are better able to employ their physical capabilities acquired via training in a way that is both rational and effective. This contributes, especially in unfavorable competition circumstances, to performance at competitions that represent the highest degree of stressful situations, and on the other hand, to applying mental learning technique, where the quality of the athletes' technical preparation is influenced by their ability of imagining the motor action (Smith, Holmes, Whitemore, Collins, & Devonport, 2001; Smith, Wright, Allsopp, & Westhead, 2007; Smith, Wright, & Cantvell, 2008).

Numerous studies support the psychological preparation of athletes in the form of effects of mental training-motor imagery on the motor task performance (Battaglia, D'Artibale, Fiorilli, Piazza, Tsopani, Giombini, & di Cagno, 2014; Holmes & Collins, 2001; Jeannerod, 2001; Munzert, Zentgraf, Stark, & Vaitl, 2008; Moran, Guillot, MacIntyre, & Collet, 2012). Mental training efficacy in improving sports performance is widely recognized (Smith et al., 2001, 2007, 2008). Several studies, conducted to establish the mechanism underlying the performance-enhancing effects of imagery, showed overlapping neural representation (Grezes & Decety, 2001). A strong correlation between real and simulated movements was found in several studies (Heremens, Helsen, & Feys, 2007; Nikulin, Hohlefeld, Jacobs, & Curio, 2007; Sharma, Jones, Carpenter, & Baron, 2008).

Motor imagery is a cognitive process of the mental simulation of an action in the absence of physical movement (Jeannerod, 1995). It is also defined as a state of general activation during which a person feels themselves performing an action. "Imagery, in the context of sport, may be considered as the creation and re-creation of an experience generated from memorial information, involving quasi-sensorial, quasi-perceptual, and quasi-affective characteristics, that is under the volitional control of the imager, and which may occur in the absence of the real stimulus antecedents normally associated with the actual experience" (Morris, Spittle, & Watt, 2005).

Through the development of the implementation of imagery used in sport, imagery firstly had a cognitive function closely related to imagery content such as performing either single motor tasks (Cognitive Specific – CS) or executing game plans and strategies (Cognitive General – CG) (Paivio, 1985). The other function, as proposed by Paivio (1985), was the motivational function and was characterized by motivational and emotional imagery content such as goal setting or being self-confident (Motivational Specific – MS), or dealing with arousal (Motivational General – MG). In the 2000s, imagery models were based on how and when athletes use mental imagery according to factors such as the sport situation, the imagery type, the outcome, and the athletes' imagery ability as proposed by Martin, Moritz, & Hall (1999). The development of imagery continued later on, describing in greater detail where, when, and why athletes use imagery, and as well what athletes image (Munroe, Giacobbi Jr., Hall, & Weinberg, 2000). From a functional perspective, the PETTLEP method was proposed by Holmes & Collins (2001). This method was devised to maximize the effect of mental training on sports performance by co-imagining motor action. The model is derived from neuroscientific and behavioural functional equivalence literature, and is based on the proposition that the same areas of the brain are activated during imagery, compared to actually engaging in the task. Consequently, the neuronal activity develops strengths, which leads to performance improvements. The model includes seven identifiable elements which serve as an orientation for both athletes and coaches, helping them to create more effective imagery use: the physical (Physical), the principle of the living environment (Environment), the task (Task), time (Timing), learning (Learning), emotional control (Emotions), and perspective (Perspective) (Holmes & Collins, 2001; Smith et al., 2007, 2008) based on the functional equivalence hypothesis (Finke, 1979; MacIntyre, 1996). The PETTLEP approach should simulate, as closely as possible, all aspects of the motor action execution situation.

The extension of the PETTLEP model includes action observation and imitation of others. The related neurological phenomenon has received considerable attention in the neuroscience literature (Rizzolatti & Craighero, 2004). The influence that watching oneself or others can have on one's own performance, as well as on psychological variables such as self-efficacy and self-regulation, has been well recognized (Mc Cullagh, Law, & Ste-Marie, 2012). Various terms have been used to describe this phenomenon, including observational learning or modelling, and recent research showed how athletes use observation in realistic sport settings to enhance sport performance (Munzert et al., 2008; Ste-Marie, Law, Rymala, Craig Halld, & McCullagh, 2012). Despite the different interpretations of the functional equivalence validity of the PETTLEP model, on top of recent research findings, the importance of matching the imagined and actual motor skills closely is largely recognized (Ramsey, Cumming, & Edwards, 2008; Wakefield, Smith, Moran, & Holmes, 2013). In fact, some studies have found PETTLEP-based intervention to be effective with tasks such as long jumps, gymnastic jumps, and strength tasks (Wright & Smith, 2009; Lebon, Collet, & Guillot, 2010; Reiser, Büsch, & Munzert, 2011). Similar results were found in a study conducted to examine the influence of the mental training protocol with video observation and the PETTLEP mental training associated with physical practice on the improvement of gymnastics jump performance (Battaglia et al., 2014). Smith et al. (2007) found positive effects of PETTLEP-based imagery intervention on a full-turn straight jump on the beam among 7 to 14-year-old gymnasts. In the field of Rhythmic Gymnastics (RG), it can be seen that, given the intense training that rhythmic gymnasts (RGs) undergo (di Cagno et al., 2012) to prevent fatigue-related injuries and to reach a competitive level, mental training programs may be a means of enabling them to enhance their performance and avoid overtraining. Actually, RGs tend to include mental training in their training program only when they are injured or to control competition-related stress (Bertollo, Saltareli, & Robazza, 2009; Guidetti, di Cagno, Gallotta, Battaglia, Piazza, & Baldari, 2009).

Given that the technique of performing all of the movements in RG is characterized by accuracy, precision, amplitude, consistency, softness, expressiveness, for the quality technical performance of elements of movement structures in RG, many years of systematic repetition, practice, and mastering of basic RG movement structures are necessary (Moskovljević & Dobrijević, 2018), as well as an adequate approach to the learning process. This study hypothesized that an eight-week intervention, consisting of video observation and PETTLEP combined with physical practice, could be a useful method for improving jump techniques among RG novices. This study aimed to evaluate whether the combination of video observation, PETTLEP imagery, and physical practice could improve the adoption of the selected jump techniques of RG novices. Another aim of this study was to investigate the difference of the effect of applied PETTLEP imagery and physical practice between the age groups (whether the effect was greater in the older age group or in a younger one), and to investigate if this method is an adequate approach to teaching jump techniques among RG novices aged 6 to 8.99. The purpose of this study was to evaluate the potential benefits of the PETTLEP imagery method in the training sessions of female RGs for the performance improvement of their jump techniques.

METHOD

Participants

Forty-nine female RGs aged 6 to 8.99 and thirty-one aged 9 to 10.99 were involved in this study and divided into two groups: PP – physical practice alone and PP+MI – physical practice with PETTLEP. For each group the results are presented by subgroups: PP age 6 to 8.99 years (n=20), PP age 9 to 10.99 years (n=12); PP+MI age 6 to 8.99 years (n=29) and PP+MI age 9 to 10.99 years (n=19). The participants in both groups are RG novices (beginners without any training experience), "C" program group competitors, members of two RG clubs from Serbia (Club 1 was a PP alone group, Club 2 was a PP + MI group) who were informed about the study and its scientific values and benefits.

Measures

Video recordings of all of the three jump techniques were made for every participant and were taken before and after the applied training method (initial and final measurements, retrospectively). All of the measurements were taken by the authors in a room with optimal climatic conditions (~24^{0}C). The quality of these jump techniques was evaluated according to a modified scale for assessing the adoption of three jump techniques in RG according to the FIG Code of Points for RG (FIG, 2022). This modified scale consists of five scores described in Table 1. Three RG judges of both national- and international-level gave scores independently and according to this scale. From the three marks awarded for each jump, the average mark for the task performed was calculated. Before starting the evaluation of the participants, each judge was fully informed by the authors of the research with the entire evaluation procedure. Also, the study participants were given instructions on how to perform the technique of three selected jumps before the performance. The rest period between three performances of each jump test lasted for 30 seconds, while the rest period between different jump tests lasted for 2 minutes. The overall study treatment lasted eight weeks.

Table 1 The modified scale for assessing the adoption of jump techniques in RG adjusted according to the FIG Code of Points for RG

Score	Description
Score 1:	The jump was not performed, that is, the jump does not have a well-defined, fixed and correct shape.
Score 2:	The jump was performed with a large deviation from the correct shape (execution penalty: -0.50 points, irregular shape with a major deviation), with a large number of technical errors in the body segments position.
Score 3:	The jump was performed with a medium deviation from the correct shape (execution penalty: -0.30 points, irregular shape with a medium deviation), with a medium number of technical errors in the body segments position.
Score 4:	The jump was performed with a small deviation from the correct shape (execution penalty: -0.10 points, irregular shape with a small deviation), with a small number of technical errors in the body segments position.
Score 5:	The jump has a fixed, well-defined and correct shape, and it is without technical errors (no execution penalty).

Experimental design

Mutual training treatment, as shown in Table 2, were hour-long training sessions twice per week, with a mandatory task of learning and improving the technique of the vertical jump with straight legs and with a turn, the “Cabriole” forward jump, and “Scissors” leaps with a switch of the legs forward.

At the baseline, the PP alone group applied training sessions of RG in the following manner: warm up, learning the technical elements, i.e. Difficulties of Body (DB): Jumps/Leaps, Balances and Rotations according to the FIG Code of Points for RG (FIG, 2022), learning Pre-Acrobatic elements and strength exercises. The learning method of the DB in this group consisted of a verbal explanation and practical demonstrations of the motor task. The PP+MI group had the same training session, where the MI was applied in the process of learning the Jumps DB.

Before and after the experimental session, jumps technique was evaluated for each gymnast participating in the study. A repeated measures design was used to compare two different types of training aimed on the improvement of the adoption of jumps technique in RG: (a) video observation and PETTLEP mental training associated with physical practice for the experimental group, and (b) physical practice alone for the control group.

Table 2 Experimental design

	Pre-test							Post-test
Experimental	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
	video observation, PETTLEP and Jumps	video observation, PETTLEP and Jumps	video observation, PETTLEP and Jumps	video observation, PETTLEP and Jumps	video observation, PETTLEP and Jumps	video observation, PETTLEP and Jumps	video observation, PETTLEP and Jumps	video observation, PETTLEP and Jumps
Control	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
	verbal explanation and practical demonstration of Jumps	verbal explanation and practical demonstration of Jumps	verbal explanation and practical demonstration of Jumps	verbal explanation and practical demonstration of Jumps	verbal explanation and practical demonstration of Jumps	verbal explanation and practical demonstration of Jumps	verbal explanation and practical demonstration of Jumps	verbal explanation and practical demonstration of Jumps
	Jumps							Jumps

Before the experimental session began, the participants of experimental group were informed about the learning method that will be applied in their training sessions and how this procedure will take place (the procedure was explained to them in detail).

The mental training protocol used in this study consisted of video observation and PETTLEP mental training. The experiment protocol took place as follows (Groups 2a and 2b): a three-minute video observation of three different jump techniques selected from the FIG Code of Points for RG (FIG, 2022): the vertical jump with straight legs and with a turn, the “Cabriole” forward jump, and “Scissors” leaps with a switch of the legs forward from a 3rd person perspective (a three-minute video showing a video and audio representation of “A” program RGs); five repetitions of imagining each jump technique for three minutes, five performances of each variation of jumps for the same duration (Wright & Smith, 2007; Lebon et al., 2010). The video observation was preferably performed before the visualization techniques, and the jump techniques were performed at each training session. During the video observation, it was necessary for the each of the participants to stand in front of a large screen (112x150 cm) located approximately 1m in front of them.

Statistical analysis

The data were analysed using the Statistical Package for Social Sciences, version 20.0 (IBM SPSS 20.0, SPSS Inc, Chicago, USA). Basic descriptive statistic data were determined for all of the variables: average value (Mean) and Standard Deviation (SD). The normality of data distribution was tested using the Mann-Whitney *U* test. The effects of the treatment on improving the RG jump techniques were determined with the Repeated Measures ANOVA analysis (4x2 RM ANOVA), along with effect size r and Cohen’s d effect. The level of significance was set at $p<0.05$.

RESULTS

The basic descriptive statistic data are shown in Table 3. The results of the Mann-Whitney *U* test show normal data distribution in the majority of the variables. However, there are some statistically significant differences in this test for the variables “Cabriole” in the PP alone group age 6 to 8.99 for the pre-test, at a significance level $p=0.02$; and for the variable “Scissors” and “Cabriole” in the PP alone group age 9 to 10.99 for the pre-test, at a level of statistical significance $p=0.05$ and $p=0.00$, respectively.

The results of the Repeated Measures ANOVA for the Vertical jump are shown in Table 4. The results show statistically significant differences for the variable time and training method ($p=0.00$). These results indicate that this jump technique was improved by the implementation of both training methods. Plot 1. shows that higher results of the assessed jump techniques were gained in the PP alone groups for both of the age subgroups (PP age 6 to 8.99 and PP age 9 to 10.99).

Table 3 The basic statistical data

Groups	Variables	test	Mean	SD	Mann-Whitney U
PP alone 6-8.99	Vertical jump	pre	2.35	1.10	.91
		post	3.15	.94	.85
	“Scissors”	pre	2.20	.59	.34
		post	2.75	.81	.69
	“Cabriole”	pre	1.53	.68	**.02***
		post	2.38	1.15	.51
PP + MI 6-8.99	Vertical jump	pre	1.93	.90	.35
		post	2.61	.78	.45
	“Scissors”	pre	2.05	.70	.99
		post	2.61	.70	.87
	“Cabriole”	pre	1.36	.78	.72
		post	2.15	1.05	.51
PP alone 9-10.99	Vertical jump	pre	3.61	.53	.22
		post	4.00	.35	.45
	“Scissors”	pre	3.28	.51	**.05***
		post	3.89	.54	.47
	“Cabriole”	pre	3.14	1.12	**.00***
		post	4.03	.85	.35
PP + MI 9-10.99	Vertical jump	pre	2.47	.80	.79
		post	3.19	.85	.82
	“Scissors”	pre	2.65	.72	.83
		post	3.14	.69	.18
	“Cabriole”	pre	2.11	1.17	.32
		post	2.98	1.10	.86

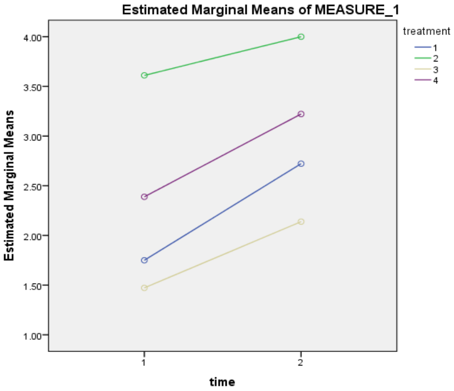
Legend: Mean – average value, SD – standard deviation, Mann-Whitney *U* test – significance, PP alone group (age 6 to 8.99), PP + MI group (age 6 to 8.99), PP alone group (age 9 to 10.99), PP + MI group (age 9 to 10.99), pre – descriptive statistics for the measurements of pre-testing, post – descriptive statistics for the measurements of post-testing, Vertical jump – vertical jump with straight legs and with a turn, “Scissors” – “Scissors” leaps with a switch of the legs forward, “Cabriole” – the “Cabriole” forward jump.
*Statistically significant differences ($p<0.05$)

Table 4 The results of the Repeated Measures ANOVA for the Vertical jump

Multivariate test	Sig	Partial Eta Squared
time	**.00***	.87
training method	**.00***	93
time* training method	.04	.58
Test of between subjects effects	Sig	Partial Eta Squared
time*training method	**.00***	.99

Legend: Sig - Statistically significant differences ($p<0.05$); time – factor 1; training method – factor 2.

The results of the Repeated Measures ANOVA for the "Scissors" jump are shown in Table 5. The results show statistically significant differences for the variables time and training method (p=0.00). These results indicate that the "Scissors" jump technique was improved in both the PP and PP +MI group. In Plot 2. the results show that higher results were gained in the PP alone groups for both of the age subgroups (PP age 6 to 8.99 and PP age 9 to 10.99).

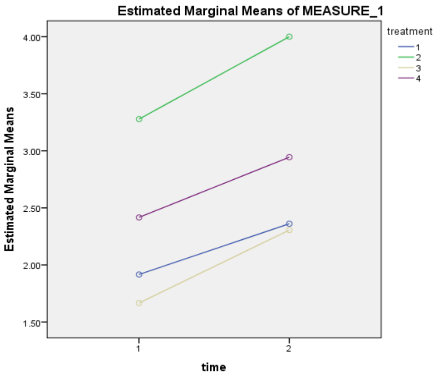


Plot 1 Vertical jump (time* training method)
Legend: training method 1- PP (age 6 to 8.99); training method 2- PP (age 9 to 10.99); training method 3- PP +MI (age 6 to 8.99); training method 4- PP+MI (age 9 to 10.99).

Table 5 The results of the Repeated Measures ANOVA for the "Scissors" jump

Multivariate test	Sig	Partial Eta Squared
time	**.00***	.81
training method	**.00***	.97
time*training method	.38	.28
Test of between subjects effects	Sig	Partial Eta Squared
time*training method	**.00***	.99

Legend: Sig – Statistically significant differences (p<0.05); time – factor 1; training method – factor 2.



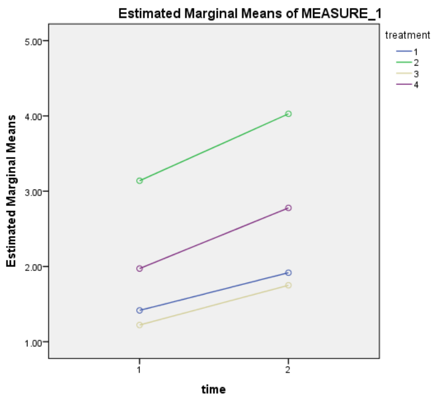
Plot 2 The "Scissors" jump (time*training method)
Legend: training method 1- PP (age 6 to 8.99); training method 2- PP (age 9 to 10.99); training method 3- PP +MI (age 6 to 8.99); training method 4- PP+MI (age 9 to 10.99).

The results of the Repeated Measures ANOVA for the "Cabriole" jump are shown in Table 6. The improvement of this jump technique influenced by the applied training methods is present in both the PP alone group and the PP + MI group for both age subgroups. The results show statistically significant differences for the variables time and training method (p=0.00). Plot 3. shows that the results were higher in the PP alone group for both of the age subgroups (PP age 6 to 8.99 and PP age 9 to 10.99).

Table 6 The results of the Repeated Measures ANOVA for the "Cabriole" jump

Multivariate test	Sig	Partial Eta Squared
time	**.00***	.81
training method	**.00***	.87
time*training method	.39	.27
Test of between subjects effects	Sig	Partial Eta Squared
time*training method	**.00***	0.95

Legend: Sig – Statistically significant differences (p<0.05); time – factor 1; training method – factor 2.



Plot 3 The "Cabriole" jump (time* training method)

Legend: training method 1- PP (age 6 to 8.99); training method 2- PP (age 9 to 10.99); training method 3- PP +MI (age 6 to 8.99); training method 4- PP+MI (age 9 to 10.99).

By analysing the effects of the intervention shown in Table 7., Cohen's d thresholds indicate a large effect of the applied training method for the "Cabriole" jump in the PP alone group age 6 to 8.99 (d=0.90*), the "Scissors" and "Cabriole" jump for the PP +MI group age 6 to 8.99 (d=0.80 and d=0.85, respectively). In the older age group (9 to 10.99) the Vertical jump stands out with a large effect (d=0.87) in both the PP and PP + MI group. All the other effects were in the range of medium effect (d=0.50 and >0.80). The Effect size r thresholds show that all of the results are in the medium range (r=0.30 – 0.50).

Table 7 The Effect size results

Groups	Variables	d	r
PP alone 6-8.99	Vertical jump	.78	.36
	"Scissors"	.78	.36
	"Cabriole"	**.90***	.41
PP + MI 6-8.99	Vertical jump	.66	.31
	"Scissors"	**.80***	.37
	"Cabriole"	**.85***	.40
PP alone 9-10.99	Vertical jump	**.87***	.40
	"Scissors"	.69	.32
	"Cabriole"	.76	.37
PP + MI 9-10.99	Vertical jump	**.87***	.40
	"Scissors"	.70	.33
	"Cabriole"	.77	.36

Legend: d – Cohen's d, r – effect size; the PP alone group (age 6 to 8.99), PP + MI group (age 6 to 8.99), PP alone group (age 9 to 10.99), PP + MI group (age 9 to 10.99), Vertical jump – the vertical jump with straight legs and with a turn, "Scissors" – "Scissors" leaps with a switch of the legs forward, "Cabriole" – "Cabriole" forward jump.
*Effect size (small: r=0.10-0.30; medium: r=0.30-0.50; large: r>0.50)
*Cohen s d (small: d=0.20; medium: d=0.50; large: d=0.80 and >)

DISCUSSION

This study aimed to evaluate whether the combination of video observation, PETTLEP imagery, and physical practice could improve the quality of execution of selected jump techniques among RG novices. Our main results show that both training methods led to an improvement in the assessed RG jump techniques. The main results of this study showed that the quality of these three jump techniques was significantly improved after eight weeks of a mental training protocol combined with physical practice, which is similar to the results of the study done by Battaglia et al. (2014). Further analysis of the intervention in terms of superiority of the PP alone and PP combined with the PETTLEP method of motor imagery indicated that in this population, the physical practice alone method had a little advantage. Considering the age of the participants and their level of experience in RG, this is understandable and expected. However, the positive outcomes in effect size in the group that applied the motor imagery method indicate that this method can be a useful tool in the process of learning and mastering RG content. The study results confirmed the claim that PETTLEP imagery and physical practice could improve the quality of execution of jump techniques among RG novices. In further research, the effect of the PETTLEP method should be examined among more experienced and older RGs, considering that this method provides a more detailed experience for its practitioners and requires more attention, concentration with the aim of making the end result of imagery more successful (Wright & Smith, 2009; Lebon et al., 2010; Battaglia et al., 2014). In previous studies that applied the PETTLEP method, a smaller percentage examined its benefits on a sample younger than nine years old, and the most common age was that of seniors – 16+ years (Wright & Smith, 2009; Lebon et al., 2010; Battaglia et al., 2014). This study contributes to the imagery literature by investigating the effects of this method among participants under the age of nine (RGs start their training process at the age of four) and by highlighting important things that needed to be considered when delivering PETTLEP imagery interventions to children (Quinton, Cumming, Gray, Geeson, Cooper, Crowley, & Williams, 2014).

The testing results of the effect of the applied PETTLEP imagery and physical practice method among the different age groups showed that both groups had similar effect size results in the range of medium effect. The only notable difference that occurred was seen in the scores gained for each jump technique among the older age group of participants (the quality of execution of their jump technique was greater). That means that after only an 8-week long intervention, the older group mastered the performance of these jump techniques better that the younger one. This is justified by the fact that jumps among RGs are a complex motor task. This suggests that applying the PETTLEP method among children 6+ years of age is possible, but certain factors such as experience and competition level must be taken into account (Quinton et al., 2014). Moreover, Quinton et al. (2014) highlighted the important aspects that need to be considered when delivering PETTLEP imagery interventions to children, such as the imagery type used, performance environment, frequency of imaging, and the performer's age and level of experience. Also, the issue of individual preference is absolutely crucial for successful interventions (Smith & Collins, 2004).

The potential benefit of the PETTLEP imagery method in the training sessions of young female RGs is that this method provides a handful of details when learning a motor task, and it can also be a useful tool for mastering the complex motor tasks, but in the case of more experienced practitioners (Smith & Collins, 2004). However, this method can be used for the improvement of strength (Wright & Smith, 2009; Wakefield & Smith, 2011), and the majority of previous studies have assessed flight time and reactivity (Arampatzis, Schade, Walsh, & Brüggemann, 2001) which is highly correlated with jumping ability (Smith et al., 2007; di Cagno, Baldari, Battaglia, Brasili, Merni, Piazza et al., 2008; di Cagno, Baldari, Battaglia, Monterio, Pappalardo, Piazza, & Guidetti, 2009). These studies also showed an improvement in muscle stiffness. Lebon et al. (2010) also reported that a combination of mental training and practice could lead to an improvement in strength, and strength and power are known to be contributing factors to high performance among RG (di Cagno, Battaglia, Giombini, Piazza, Fiorilli, Calcagno, & Borrione, 2013). Considering that jump performance in gymnastics is especially improved by eccentric muscle action (Hilfiker, Hübner, Lorenz, & Marti, 2007), the improvement in the Hopping and Drop Jump reinforces the concept that mental training, video observation, and PETTLEP can be used to enhance jump performance, to limit excessive physical work load, and post-exercise fatigue.

Within sport, deliberate and systematic imagery use has been recognized as a means of facilitating performance improvements through skill and strategy learning, as well as the regulation of thoughts, emotions, and arousal levels (Martin et al., 1999; Cumming & Williams, 2012). Interventions meant to train athletes on how to use imagery have been successfully introduced in a wide range of sports, including figure skating, flat-race horse racing, gymnastics, hockey, netball, and rugby, resulting in enhanced performance and other outcomes such as self-confidence (Cumming & Ste-Marie, 2001; Evans, Jones, & Mullen, 2004; Callow & Waters, 2005; Smith et al., 2007; Wakefield & Smith, 2011; Cooley, Williams, Burns, & Cumming, 2013).

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CONCLUSION

We were guided by the idea that the way we assessed the quality of these selected RG jump techniques was an adequate teaching method for RG novices, considering that the study participants had no previous experience in RG. A beginner training program is based on learning basic sport-specific techniques, and it is not possible to anticipate that it will have a large impact on strength and muscle stiffness and influence jump height. Therefore, we address that implementing PETTLEP with the goal of improving jump techniques in RG. Among children aged 6 to 10.99 it is possible, but certain factors such as experience, level of experience, and imagery ability must be taken into account when applying this method in their training program.

STUDY LIMITATIONS

This study has some limitations that need to be avoided and/or corrected in future research: a small number of study participants; an absence of RG apparatus handling; the method applied only to the learning process of RG jumps of low value (0.10); it was not applied in the learning process of other specific RG body techniques such as Rotations, Balances, Pre-Acrobatic elements, Dance steps combination, etc.; it was not applied with motor tests such as strength, eccentric muscle action; it was not applied with a kinaesthetic analysis of motor tasks; PETTLEP should be included in different gymnastics disciplines; more objective tests are needed; the method was not applied with experienced or more experienced RGs regardless of age. Although the intervention included observation and imagery, we did not assess how much each of these interventions contributed to the effects obtained. Another limitation was that Movement Imagery Questionnaire-Revised was not administered as part of this intervention because of the age of the participants; a pre and post intervention imagery ability assessment would have been helpful to better test the efficacy of this mental training protocol.

REFERENCES

Arampatzis, A., Schade, F., Walsh, M., & Brüggemann, G.P. (2001). Influence of leg stiffness and its effect on myodynamic jumping performance. *Journal of Electromyography and Kinesiology, 11*(5), 355-364.

Battaglia, C., D'Artibale, E., Fiorilli, G., Piazza, M., Tsopani, D., Giombini, A., Calcagno, G., & di Cagno, A. (2014). Use of video observation and motor imagery on jumping performance in national rhythmic gymnastics athletes. *Human Movement Science*, *38*, 225-234.

Bertollo, M., Saltarelli, B., & Robazza, C. (2009). Mental preparation strategies of elite modern pentathletes. *Psychology of Sport and Exercise*, *10*(2), 244-254.

Callow, N., & Waters, A. (2005). The effect of kinesthetic imagery on the sport confidence of flat-race horse jockeys. *Psychology of Sport and Exercise*, *6*(4), 443-459.

Cooley, S.J., Williams, S.E., Burns, V.E., & Cumming, J. (2013). Methodological variations in guided imagery interventions using movement imagery scripts in sport: A systematic review. *Journal of Imagery Research in Sport and Physical Activity*, *8*(1), 13-34.

Cumming, J.L., & Ste-Marie, D.M. (2001). The cognitive and motivational effects of imagery training: A matter of perspective. *The Sport Psychologist*, *15*(3), 276-288.

Cumming, J., & Williams, S.E. (2012). The role of imagery in performance. In S.M. Murphy (Ed.), *The Oxford handbook of sport and performance psychology* (pp. 213-232). Oxford, UK: Oxford University Press.

di Cagno, A., Baldari, C., Battaglia, C., Brasili, P., Merni, F., Piazza, M., ... & Guidetti, L. (2008). Leaping ability and body composition in rhythmic gymnasts for talent identification. *Journal of Sports Medicine and Physical Fitness*, *48*(3), 341-346.

di Cagno, A., Baldari, C., Battaglia, C., Monteiro, M. D., Pappalardo, A., Piazza, M., & Guidetti, L. (2009). Factors influencing performance of competitive and amateur rhythmic gymnastics—Gender differences. *Journal of Science and Medicine in Sport*, *12*(3), 411-416.

di Cagno, A., Battaglia, C., Giombini, A., Piazza, M., Fiorilli, G., Calcagno, G., & Borrione, P. (2013). Time of day-effects on motor coordination and reactive strength in elite athletes and untrained adolescents. *Journal of Sports Science & Medicine*, *12*(1), 182-189.

Evans, L., Jones, L., & Mullen, R. (2004). An imagery intervention during the competitive season with an elite rugby union player. *The Sport Psychologist*, *18*(3), 252-271.

Fédération International de Gymnastique (2022). *2022-2024 Code of Points (Rhythmic Gymnastics)*. Lausanne, CH: FIG.

Finke, R.A. (1979). The functional equivalence of mental images and errors of movement. *Cognitive Psychology*, *11*(2), 235-264.

Grezes, J., & Decety, J. (2001). Functional anatomy of execution, mental simulation, observation, and verb generation of actions: A meta-analysis. *Human Brain Mapping*, *12*(1), 1-19.

Guidetti, L., di Cagno, A., Gallotta, M.C., Battaglia, C., Piazza, M., & Baldari, C. (2009). Precompetition warm-up in elite and subelite rhythmic gymnastics. *Journal of Strength and Conditioning Research, 23*(6), 1877-1882.

Heremens, E., Helsen, F.W., & Feys, P. (2007). The eyes as a mirror of our thoughts: Quantification of motor imagery of goal-directed movement through eye movement registration. *Behavioural Brain Research, 187*, 351-360.

Hilfiker, R., Hübner, K., Lorenz, T., & Marti, B. (2007). Effects of drop jumps added to the warm-up of elite sport athletes with a high capacity for explosive force development. *The Journal of Strength & Conditioning Research*, *21*(2), 550-555.

Holmes, P.S., & Collins, D.J. (2001). The PETTLEP approach to motor imagery: A functional equivalence model for sport psychologists. *Journal of Applied Sport Psychology*, *13*(1), 60-83.

Jeannerod, M. (1995). Mental imagery in the motor context. *Neuropsychologia*, *33*(11), 1419-1432.

Jeannerod, M. (2001). Neural simulation of action: a unifying mechanism for motor cognition. *Neuroimage*, *14*(1), S103-S109.

Lebon, F., Collet, C., & Guillot, A. (2010). Benefits of motor imagery training on muscle strength. *The Journal of Strength & Conditioning Research*, *24*(6), 1680-1687.

MacIntyre, T. (1996). *Imagery validation: How do we know that athletes are imaging during mental practice?* Unpublished Doctoral dissertation, Dublin, IE: University College Dublin, Department of Psychology.

Martin, K.A., Moritz, S.E., & Hall, C.R. (1999). Imagery use in sport: A literature review and applied model. *The Sport Psychologist,* 13(3), 245-268.

Mc Cullagh, P., Law, B., & Ste-Marie, D. (2012). Modeling and performance in the Oxford handbook of sport and performance psychology. In S.M. Murphy (Ed.), *The Oxford handbook of sport and performance psychology* (pp. 250–272). Oxford, UK: Oxford University Press.

Moran, A., Guillot, A., MacIntyre, T., & Collet, C. (2012). Re-imagining mental imagery: Building bridges between cognitive and sport psychology. *British Journal of Psychology*, *103*, 224-247.

Morris, T., Spittle, M., & Watt, A.P. (2005). *Imagery in sport*. Leeds, UK: Human Kinetics.

Moskovljević, L., Dobrijević, S. (2018). *Teorija i metodika ritmičke gimnastike* [*Theory and methodics of Rhythmic Gymnastics*. In Serbian]. Beograd, RS: Fakultet sporta i fizičkog vaspitanja Univerziteta u Beogradu.

Munroe, K.J., Giacobbi Jr., P.R., Hall, C., & Weinberg, R. (2000). The four Ws of imagery use: Where, when, why, and what. *The Sport Psychologist*, *14*(2), 119-137.

Munzert, J., Zentgraf, K., Stark, R., & Vaitl, D. (2008). Neural activation in cognitive motor processes: Comparing motor imagery and observation of gymnastic movements. *Experimental Brain Research, 188*, 437-444.

Nikulin, V.V., Hohlefeld, U.F., Jacobs, M.A., & Curio, G. (2007). Quasi-movements: A novel motor-cognitive phenomenon. *Neuropsychologia*, *46*, 727-742.

Paivio, A. (1985). Cognitive and motivational functions of imagery in human performance. *Canadian Journal of Applied Sport Sciences*, *10*(4), 22S-28S.

Quinton, M.L., Cumming, J., Gray, R., Geeson, J.R., Cooper, A., Crowley, H., & Williams, S.E. (2014). A PETTLEP imagery intervention with young athletes. *Journal of Imagery Research in Sport and Physical Activity*, *9*(1), 47-59.

Ramsey, R., Cumming, J., & Edwards, M.G. (2008). Exploring a modified conceptualisation of imagery direction and golf putting performance. *International Journal of Sport and Exercise Psychology*, *6*(2), 207-223.

Reiser, M., Büsch, D., & Munzert, J. (2011). Strength gains by motor imagery with different ratios of physical to mental practice. *Frontiers in Psychology, 2*, 194.

Rizzolatti, G., & Craighero, L. (2004). The mirror-neuron system. *Annual Review of Neuroscience, 27*, 169–192.

Sharma, N., Jones, P.S., Carpenter, T.A., & Baron, J.C. (2008). Mapping the involvement of BA 4a and 4p during motor Imagery. *Neuroimage*, *41*, 92-99.

Smith, D., & Collins, D. (2004). Mental practice, motor performance and the late CNV. *Journal of Sport and Exercise Psychology*, *26*, 412-426.

Smith, D.K., Holmes, P.S., Whitemore, L., & Devonport, T. (2001). The effect of theoretically-based imagery scripts on field hockey performance. *Journal of Sport Behavior*, *24*(4), 408-419.

Smith, D.K., Wright, C., Allsopp, A., & Westhead, H. (2007). It's all in the mind: PETTLEP-based imagery and sports performance. *Journal of Applied Sport Psychology*, *19*(1), 80-92.

Smith, D.K., Wright, C.J., & Cantwell, C. (2008). Beating the bunker: The effect of PETTLEP imagery on golf bunker shot performance. *Research Quarterly for Exercise and Sport*, *79*(3), 385-391.

Ste-Marie, D.M., Law, B., Rymala, A.M., Craig Halld, J.O., & McCullagh, P. (2012). Observation interventions for motor skill learning and performance: An applied model for the use of observation. *International Review of Sport and Exercise Psychology*, *5*(2), 145-176.

Wakefield, C., & Smith, D.K. (2011). From strength to strength: A single-case design study of PETTLEP imagery frequency. *The Sport Psychologist*, *25*(3), 305-320.

Wright, C.J., & Smith, D.K. (2009). The effect of a short-term PETTLEP imagery intervention on a cognitive task. *Journal of Imagery Research in Sport and Physical Activity*, *2*(1), art1.

PETTLEP METODA KAO VALIDNA METODA UČENJA ZA POBOLJŠANJE TEHNIKE SKOKOVA KOD MLADIH RITMIČKIH GIMNASTIČARKI

PETTLEP metoda mentalnog motornog učenja (učenje putem zamišljanja) je široko primenjivana metoda u procesu poboljšanja sportskih performansi. U poređenju sa tradicionalnijim protokolima mentalnog učenja, učenje putem zamišljanja zasnovano na PETTLEP-u pruža detaljnije iskustvo učenja. S obzirom na to da se ova metoda sastoji od domena koji pomažu postizanje boljih rezultata primenom procesa zamišljanja, kao što su fizički faktori, detalji okoline, faktori zadataka i vremena, učenje i perspektivni moment, PETTLEP metoda je napredan pristup preporučen od strane mnogih studija koje potvrđuju njenu efikasnost. Svrha ove studije bila je da se utvrde efekti PETTLEP metode učenja u treninzima mladih ritmičkih gimnastičarki na poboljšanje tehnike izvođenja elemanata skokova u ritmičkoj gimnastici (RG). U ovoj studiji učestvovalo je četrdeset devet ritmičkih gimnastičarki, početnica, uzrasta od 6 do 8.99 godina i trideset jedna uzrasta od 9 do 10.99 godina, podeljenih u dve podgrupe (sa i bez PETTLEP metode). Zajednički trenažni tretman bili su treninzi RG u trajanju od jednog sata, dva puta nedeljno, sa obaveznim zadatkom učenja i usavršavanja tehnika vertikalnog skoka sa ispruženim nogama i okretom od 3600 tokom leta, „mornarskog" skoka – „Cabriole" napred i skoka „makazice" sa promenom nogu napred iznad horizontale. Grupa 2 je primenjivala PETTLEP metodu u procesu učenja ovih tehnika. Kvalitet izvođenja tehnike skokova ocenjivan je prema modifikovanoj skali za procenu kvaliteta skokova u RG, prilagođenoj prema Pravilniku Međunarodne gimnastičke federacije, od strane domaćih i međunarodnih RG sudija. Podaci su analizirani univarijatnom analizom varijanse za ponovljena merenja, veličinom efekta R i Cohenov-im d efektom. Rezultati analize su pokazali da je do poboljšanja došlo u obe grupe. Nije bilo značajne razlike u veličini efekta tretmana između grupa.

Ključne reči: *motorno učenje, posmatranje motornih radnji, poboljšavanje performansi*