THE USE OF AUDIOVISUAL STIMULATION IN LEARNING GYMNASTIC ELEMENTS

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Abstract

Nowadays, more and more people are aware of the difficulty to reach imposed goals and in their craving to improve their performance they often turn to different methods that help them realize their goals. The market offers many services, methods, products and machines that guarantee and promise better results. The purpose of this research was to study the impact of audio-visual stimulation (hereinafter: AVS), followed by visualization of gymnastic elements, on the improvement in performance of those gymnastic elements. The study was conducted on 39 first year students of the Faculty of Sport in Ljubljana, which attended the classes of Gymnastics and 19 of them, who were in the experimental group, attended AVS lessons twice a week. We expected AVS and visualization sessions to effect motor learning of gymnastic elements positively. Through the students' execution of gymnastic elements it was established how much the students had improved from the first lesson to the assessment. For audio-visual stimulation, the device "Therapeut", where the participants attended an 11 minute program, that stimulated alpha and *beta waves and should leave the participants refreshed and creative. Meters to determine heart rate and blood saturation, music and questionnaires with a scale to determine well-being were used. Progress of motoric learning of gymnastic elements, heart rate decline as well as changes in saturation and well-being were monitored. No results obtained in the observed parameters showed that we had any impact on the improvement and our study did not reveal any impact of AVS on the improvement of the observed parameters.*

Keywords: *audio-visual stimulation, motor learning, imagery, heart.*

INTRODUCTION

More and more people are aware of the difficulty to reach imposed goals without good mental preparation (Kajtna & Jeromen, 2013). In their craving to improve their performance, results and to be more successful in business, private life and sports, they turn to many methods that help them reach and realize their goals (Gallucci, 2008; Harwood & Anderson, 2015). The market offers many services, methods, products and machines that guarantee and promise a quicker path towards achieving those goals. One of those methods is also audiovisual stimulation (AVS), which claims to change the functioning of a person by subjecting the person to sounds and visual patterns of frequencies, that match different brain waves (Poznik, 1990).

Alpha waves (8 - 12 Hz) are one of the more simple forms of brain activity. They are present in people who are awake, relaxed and processing information automatically (Davies, 2012). The highest amplitudes of alpha waves come from the frontal and occipital cortex. Alpha waves appear also during physical activity, but only when athletes are very focused (Ricker, 2015; Evans & Turner, 2017). Beta waves (13 Hz and higher) are present at fast and intensive brain activity, for example in people who are awake and attending to internal (mental) or external events. Beta waves are strongest in frontal cortex and indicate brain functioning on the highest level. They have high frequencies, but lower amplitude than alpha waves (Ricker, 2015). Theta waves (4 – 8 Hz) indicate that a person is in a light sleep from which he or she can be awakened easily. They can also appear shortly when a person is awake and exposed to stressful circumstances or events (Davies, 2012). Theta waves originate in hippocampus and limbic system (Ricker, 2015). Delta waves have the highest amplitudes (< 4 Hz) and indicate deep sleep or even vegetative state in which people are not aware of their surroundings. They are dominant in children up to 1 year of age (Ricker, 2015; Davies, 2012). Davies (2012) and Evans and Turner (2017) support the claim that if we create these waves in the environment, then the brain will tune in to them and start functioning in the same wave length, thus creating corresponding psychological states. For example, a person exposed to light and sound of alpha frequency will become relaxed and will process information automatically.

Motor learning is a process of acquiring new motor skills and new motor knowledge, which is reflected in new synaptic connections in the brain, i.e. central nervous system, exercise is what helps store this motor knowledge in the brain, mainly in the motoric part of the cortex (Ušaj, 2003). The more we exercise and practice a skill, the stronger are synaptic connections and the more automated the process of execution this motor skill. Motor abilities are in part innate and in part acquired during the development (Pistotnik, 1999). We differentiate the following forms of motor abilities: speed, balance, power, coordination, flexibility, precision and persistence (Videmšek, Berdajs, & Karpljuk, 2003). These abilites are limited by biological as well as psychological factors (learning requires conscious control of movement), therefore we can also categorize them as psychomotor abilities.

Martens (1997, in Kajtna & Jeromen, 2013) and Fitts and Posner (1967, in Magill, 2011) defined three phases of motor learning:

- Cognitive stage: it begins when we decide for learning and ends when we know basics of movement. Athlete understands the movement and has a correct perception of it.
- Associative stage: athletes are able to execute movement correctly, but only in known circumstances and without additional challenges. Basic movement is fluent and almost automatic, which means that the motor skill is almost completely learned and control of movement decreases. Execution of movement is becoming more and more consistent, the number of mistakes decreases. Athletes are able to detect mistakes on their own, which enables them better control of training.
- Autonomous stage: athletes execute movements accurately and precisely. Motor skill is learned – it is realiable and perfected. Movements are economic and fluent, athletes are selfconfident. Automatisation of movement enables them to focus their energy on details and their surroundings.

Another model for motor learning is the Gentile's two stage model (1987, in Magill, 2011), which stets that in the first stage of motor learning is "getting the idea of the movement", which involves getting to know the patterns of movement, learning appropriate motion, coordinating different parts of the movement… The second stage is “fixation/diversification” and it involves adapting the movement pattern to the different situations in the environment and improving the consistency of the movement. Schmidt and Lee (2011) state that mental practice (or visualization) can enhance motor learning in all stages.

The term visualization refers to the cognitive process of intentionally generating visual mental imagery of a certain movement, skill or experience, without actually executing the movement (Cox, 2012). Visualization or imagery, as it is also called, is a technique, frequently used in sport psychology to help the person learn new motor skills or prepare for an execution of movement (Williams, 2010), it is often a part of athlete’s precompetitive routines (Cox, 2012). When the athlete imagines jumping, the reaction of brain, and thus nerves and muscles, is similar to that of the real jump – it creates the same pattern of brain activation, as shown by EEG, it is only smaller in amplitude (Gallucci, 2008; Karageorghis & Terry, 2011). Thus visualization is often used as a method of mental training for acquisition or improvement of motor skills, motivation, self-confidence, technical and tactical elements in sport (Kajtna & Jeromen, 2013), it can be used for problem solving, pain control and in rehabilitation (Vasundhara & Noohu, 2014).

The effectiveness of visualization was proven in an experiment by Vasundhara and Noohu (2014). They studied the effect of mental training on a group of 30 amateur basketball players. One group trained by classic methods, while other group also used mental practice, a term, which is also frequently used for visualization. The progress was more significant in second group that used also visualization, they also found that visualization and actual movement create ta similar reaction in the brain, only different in intensity (Vasundhara & Noohu, 2014). Even though they looked for effects of visualization on improvement of strength and balance in recreational basketball players, not on its effect of learning new motor skills in novice learners, they show its use in the field of improving motor abilities. Other authors found thet learning is faster when mental and physical practice are used together - McBride and Rothstein (1979) found this in precision tasks and Meacci and Price (1985) came to the same conclusion in golf. If visualization is performed regularly and in a structured manner, it can importantly improve motor skills in sports. Mental preparation, which includes visualization, also contributes to better focus and helps prevent burnout (Stankovič, Raković, Joksomović, Petkovič, & Joksomovič, 2011). Schott, Frenkel, Korbus, and Francis (2013) believe that visualization is the most effective when joined with relaxation. Visualization was used in this study in order to strengthen the memory of learned gymnastic elements, while the AVS was intended to enable frequencies of brain waves, which enable relaxation and readiness to learn, therefore Alpha and Beta waves (Davies, 2012)

Visualization is most effective when performed in a peaceful and relaxed state, which enables better focus during the training. To be relaxed means to have a calm body and a calm mind. State of relaxation can be achieved not only through physical rest, but also through activity (mental or physical). In this case people have a feeling of an easy, effortless execution and pleasant tiredness after activity, therefore even relaxation is a form of activation (Jeromen & Kajtna, 2008). Eason, Brandon, Smith, and Serpas (1986) claim that relaxation in sport helps to achieve better focus and attention, decreases anxiety, heart rate, frequency of breathing and muscle tension.

Hanafi, Hashim, and Ghosh (2011) stress two techniques of relaxation, progressive muscle relaxation (PMR) and autogenic training (AT). PMR was developed by Jacobson in the early 1920s, its purpose is to teach people relaxation by first teaching them the difference between relaxed and tense muscles (Gallucci, 2008) - it is an active method of relaxation, which is also quite adaptable to the individual using it. AT is a more passive relaxation technique and is based on autosuggestion – it's founder Schultz has shown that we start to feel what we suggest ourselves to feel (Lindemann, 1988). Hanafi et al. (2011) tested the effects of those techniques on top athletes in between two highly intensive workouts and measured several characteristics, for example: heart rate, maximum usage of oxygen during the workout ($VO2_{max}$), reaction time and subjective grade of effort. Results showed no short or long-term effects of relaxation for most of the measured characteristics, the only positive effect was seen for reaction time, indicating improvement of psychomotor abilities. Besides that the heart rate descreased during relaxation - a similar effect in children was found by Lohaus, Hebling-Klein, Vogel, and Kuhn-Hennighausen (2001). They found out that the use of relaxation techniques, such as guided fantasy, resulted in lowered heart rate in children, who also claimed they feel better after execution of relaxation techniques. In our study we used AVS to relax, as additional use of relaxation techniques would have been too time consuming for the participants.

Audio and visual stimuli in the process of AVS is represented by monotonous and rythmic sounds and flashes of light (Davies, 2012; Evans & Turner, 2017). The brain responds to the stimuli with an electrical impulse, which travels through the brain and becomes the sound/picture we hear/see. Audio visual stimulation effects people on two levels ("Audio-vizuelna stimulacija s focus-om 101", 2015):

- autonomous nervous system effects relaxation of a person - it decreases heart rate, muscle tension and blood pressure;
- central nervous system changes center of thalamus to a negative level, consequently people become more alert.

The use of AVS means that a person is subjected to sound and light impulses of a certain frequency, which is chosen according to the desired intention. If we wish to enable learning, we expose the person to the frequencies of Beta waves, if we want relaxation, to Alpha waves. The brain should then synchronize with those impulses and the hypothesized outcomes are (Poznik, 1990):

- Improved capability to stay calm in stressful situations
- Deep muscle relaxation
- Termination of negative routines
- Improvement of immune system
- Changed sleep rhythm
- Improved learning abilities
- Improved focus and visualisation

Not much research has been carried out in the field of audio-visual stimulation, however few papers that exist prove positive effects of it. Siever (2006) performed audio-visual stimulation on a group of elderly people with stimuli of 18 and 20 Hz (Beta waves) for left and 10 Hz (Alpha waves) for right brain hemisphere. Results showed significant mood improvement and significant decrease in symptoms of depression. Siever proved positive effects of AVS also in other circumstances. For example, he reports significant improvement of technique, visualisation, motor learning and results in professional golf players. Besides that Siever (2012) also proved significant improvement of memorisation, focus and grades in students after AVS.

Budzynski and Budzynski (2001) report significant improvement of mental capabilities after AVS in 75-year old male. Cruceanu and Rotarescu (2013) proved that the exposure to 30-minutes of audio-visual stimulation with the frequency of 10,2 Hz significantly improves cognitive skills. Based on their research, authors claim that people need to be exposed to AVS at least for 20 minutes in order to achieve positive effects. Even first signs of relaxation (body movements, body language, tension of face muscles) appear only after 15 minutes of exposure to AVS. Kennerely (2004) on the other hand reports about positive effects of AVS after 5 minutes of exposure. Goodin et al. (2012) claim that even shorter period of time is needed. They noticed changes in brain waves two seconds after the beginning of AVS. So even if AVS is often referred to as a method to improve learning, it is rarely tested in experimental and verifiable conditions and the purpose of our research was to do just that – to verify the effects of audio-visual stimulation on motor learning and progress in gymnastics.

In our research we focused on motor learning of gymnastic elements. Sports gymnastics is one of the basic sports, its elements are of extreme importance for motor development of an individual, as it teaches conscious control of body position and movement (Čuk, 1996). One of the most important tasks of gymnastics is therefore to enable development of basic motor skills, such as power, coordination, flexibility, balance and speed (Zajc, 1992). Learning of motor skills depends on the amount of experience, which is enabled through visualization (Cox, 2012). We wanted to see if participants would gain gymnastic skills faster by being exposed to visualization, especially as we supported this process by first establishing brain waves, which enable relaxation and readiness to learn through AVS.

Our research questions are:

- How does exposure to AVS affect motor learning of gymnastic elements? According to research of Siever (2012), Budzynski and Budzynski (2001) and Cruceanu and Rotarescu (2013) cognitive abilities and learning are improved upon exposure to AVS – is our experimental group going to be more successful in learning gymnastic elements after attending both gymnastics lessons and AVS sessions, followed by visualization than the control group, who will only attend gymnastics lessons?
- How does exposure to AVS affect heart rate and blood saturation through different time points? Kennerely (2004) and Goodin et al. (2012) mention different times to be needed for achieving desired results and we wanted to see what happens during the exposure to AVS.

Upon reviewed literature we set the following hypothesis:

H1: AVS, followed by visualization, effects motor learning of gymnastic elements positively.

H2: AVS is going to decrease heart rate.

H3: AVS is going to decrease oxygen saturation in blood.

METHODS

Participants

39 students of Faculty of Sport at the University of Ljubljana participated in the study, 20 of them (10 male and 9 female) were assigned to experimental and 19 (10 male and 10 female) to control group. The number of participants was chosen according to the size of groups in the subject at the Faculty and the small size of samples was taken into account when performing statistical procedures. All participants were students of first year of bachelor program Sports Education and had no prior knowledge of gymnastics. Participants were included in subject Sports gymnastics for the first time. We chose them based on their grades of gymnastic elements, that they performed on the first hour of subject. The sum of grades was obtained by summing up the grades they obtained in the initial evaluation of 8 gymnastic elements, which was performed by teachers of the subject.

Table 1

T test for differences in gymnastics knowledge for control and experimental group.

Variable	Status	*M*	*SD*	*t*	*p*
Sum of grades for gymnastics elements	Experimental group	26,84	2,22	0,11	0,92
	Control group	26,70	5,57		

Legend. *M* - mean, *SD* – standard deviation, *t* – t value; *p* - significance

Table 1 shows that the level of statistical significance of *t* is 0,92, which shows that there were no significant differences in expertise level of gymnastics between students of control and experimental group before the beginning of the study.

Instruments and materials

Audio-visual stimulation was carried out with a tool for stimulation called Therapeut (Poznik, 1990.) and music background. Therapeut is a device that stimulates brain waves and brain activity through usage of headphones and glasses – sound of desired frequency are emitted through headphones, while flashes of light of the same frequency appear inside the glasses. Its goal is to reach a certain frequency of brain waves (alpha, beta, theta or delta) therefore the device produces stimuli (sound and light) with a chosen frequency of brain activity. The stimuli is reproduced in peoples brains in a form of electrical impulses that have the same frequency as external stimuli from the device. Final effect of exposure to Therapeut is a psychophysical relaxation, which feels similar to state of light sleep. People's minds are still present and conscious to a certain extent, while their bodies are completely relaxed (Poznik, 1990). The use of this AVS device was selected as it is was the only one, where several people could attend the AVS programme at the same time and from the perspective of our study design this was necessary.

For the measurement of mood we used Brunel Mood Scale (Terry & Lane, 2010), where participants evaluate 24 of their feelings and moods on a scale from 0 to 4, 0 being worst and 4 being the best possible feeling. The feelings and moods are then summed up into 6 categories, examples of feelings and moods for each category are given in parenthesis: depression (unhappy), tension (panic), fatigue (sleepiness), anger (bitterness), vigor (active) and confusion (indecisive). The Slovene translation of the scale was used (Šešum, 2015).

Finally, to measure oxygen saturation and heart rate we used Oxymeter by Guandong Biologht Meditech Co. Ltd.

Gymnastics elements and routines in the research were carried out with the help of following apparatus: vault, balance beam, floor, uneven bars and rings.

Procedure

Pre-test procedure was distributing the students into two equal groups according to their knowledge of gymanstics, as evaluated by the teachers of the subject. Then the experimental group participated in AVS programme (followed by visualization) for 3 months, 2 times a week, and attended the subject Sports gymnastics, while the control group just participated in the subject without attending the AVS sessions. The experimental group attended AVS programme immediately after lessons of practical exercises of gymnastics so that as little time as possible passes between practising and then solidifying the knowledge. The control group received no treatment because we wanted to see what the progress would be like just by attending the classes and lectures of the subject at the Faculty. After 3 months of AVS and lessons of Sports gymnastics both groups of students took a practical exam of gymnastics skills, which was graded by two professors on a scale from 5 to 10 points, with differences of 0,10 point between grades. We compared control and experimental group based on grades of this practical exam. Students performed 13 gymnastic elements, which are all part of the exam:

- straddle vault
- squat vault
- connection of two rolls backwards
- round- off with 180 turn forward
- handspring forward (flip forward)
- headspring forward
- parallel bars routine
- balance beam routine,
- floor routine,
- uneven bars routine,
- horizontal bar routine,
- swinging ring routine
- still ring exercise.

For audio-visual stimulation on a device Therapeut we chose program number 4 that combines alpha and beta waves, which exchange for 11 minutes. Manual describes the chosen program as refreshing and creative. The duration of this program corresponds to the duration of frequently used relexation techniques, such as AT or PMR (Kajtna & Jeromen, 2013).

Students were in a lying position during AVS. The light in a room was slightly dimmed in order to create calm and peaceful environment. In the background we also included calm music, which was composed by K Brandstaetter fort he relaxation exercises in the book called Relaxation – my little manual (Jeromen & Kajtna, 2008). AVS lasted for 11 minutes. Throughout AVS we also measured heart rate and oxygen saturation – and checked the values before and after the conclusion of the AVS session.

After 11 minutes of AVS students visualised gymnastic skill they practiced at gymnastics that week. After every executed skill, students filled the Brunel Mood Scale and answered two open type questions about their feelings and thought during exercises. Last two questions measured focus and calmess during AVS on a scale from 1 (not at all) to 5 (very).

Besides AVS students participated at class Sports gymnastics, which contains theoretical (1 hour per week, all together 15 hours) and practical (3 hours per week, all together 45 hours) part. The purpose of this class is to inform students about characteristics and importance of gymnastics in schools and sports association (Čuk, Bolkovič, Bučar-Pajek, Turšič, & Bricelj, 2006). Lectures (theoretical part) followed didactic principles, recommended order of teaching of gymnastics skills and motor development of students.

Data analysis

Data was analyzed using SPSS 21.0 for Windows, we used descriptive statistic for checking changes in emotional states, heart rate and oxygenation after AVS and visualisation sessions and t – test for verifying the differences between the experimental and control group before the experiment began and after the conclusion of the experiment.

RESULTS

Firstly we tested differences between control and experimental group in exam grades for the previously stated gymnastic elements. Comparison of grades of each element of students in the experimental and control group and of the number of successfully completed elements show, that there were no differences in the grades for each element, but that the students in the control group successfully completed more routines at the final exam ($M = 6.10$, $SD = 1.65$) than the experimental group participants ($M = 4.47$; $SD = 2.41$) ($t = -2.44$; $p = 0.02$). Control group received better grades for execution of gymnastic skills than experimental group in 8 out of 13 elements. Experimental group executed better only 5 elements and despite described differences between control and experimental group, we need to stress that grades of control and experimental group were very similar and statistically insignificant. Groups were thus significantly different only in number of executed routines, which was higher in control group.

Furthermore, results of analyses of heart rate after audio-visual stimulation are shown in Figure 1. Figure 1 shows unsystematic heart rate change after every measurement, therefore we can not detect a specific trend of changes. We found no reference values for a similar type of research, so it's not possible to evaluate the size of the change in heart rate.

Next we focused on change in oxygen saturation after audio-visual stimulation. Results are shown in figure 2.

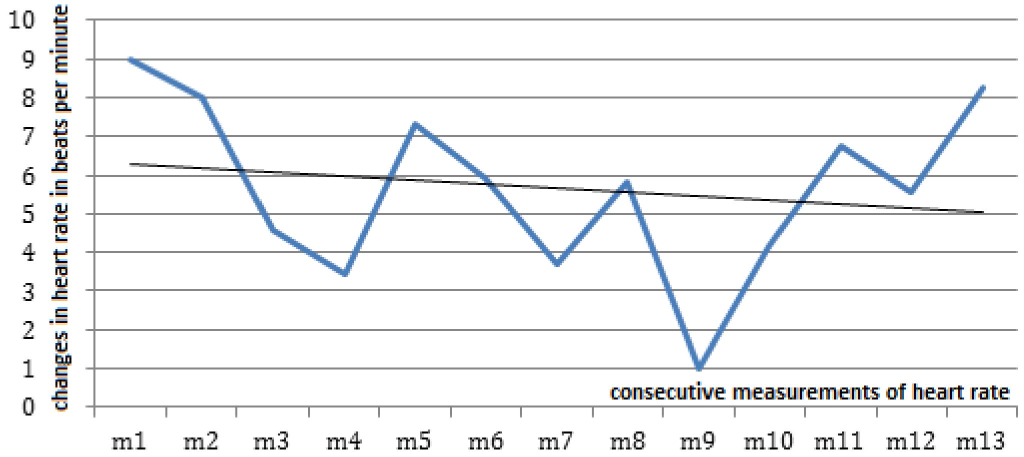

Figure 1. Mean group changes in heart rate before and after AVS and visualization sessions.

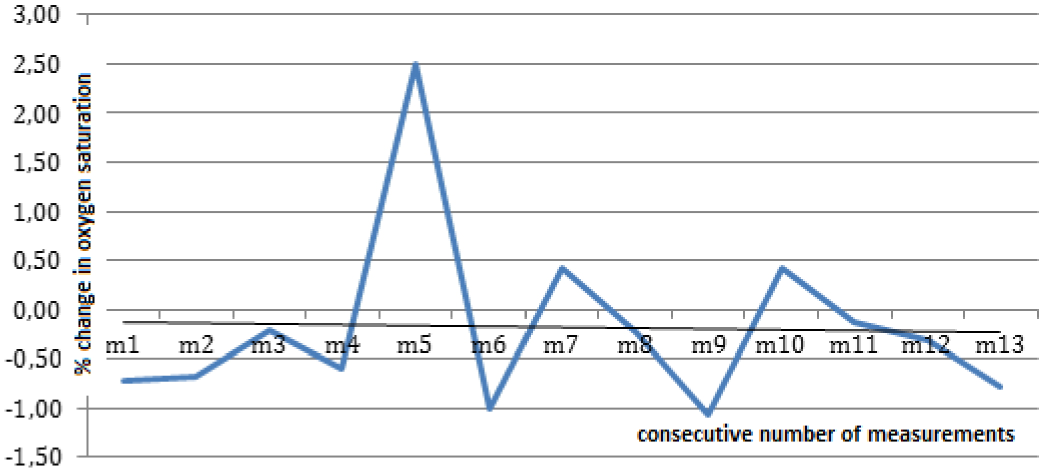

Figure 2. Mean group changes in oxygen saturation before and after AVS and visualization sessions.

Figure 2 shows that changes in oxygen saturation are not consistent or systematic, in some measurements levels dropped, while at others the levels of oxygen saturation increased. We found no reference values for a similar type of research, so it's not possible to evaluate the size of the change in oxygen saturation.

Table 2 shows results of questionnaire about mood and feelings of students after exposure to audio-visual stimulation.

Most of the feelings (depression, tension, tiredness, anger and confusion) decreased in time, while liveliness changed unsystematically in-between measurements. Moreover we examined students assessments of their focus and calmness after AVS. Results are shown in Table 3.

Table 3 shows there were no significant changes in focus and calmness of students after AVS. Students reported a medium level of calmness during AVS, similar is also true for focus.

Table 2
Grades of feelings after AVS.

Variable	m1 *M*	m1 *SD*	m2 *M*	m2 *SD*	m3 *M*	m3 *SD*	m4 *M*	m4 *SD*	m5 *M*	m5 *SD*	m6 *M*	m6 *SD*	m7 *M*	m7 *SD*
Depression	1.22	1.05	1.21	1.47	1.00	1.54	1.33	1.61	1.26	1.82	0.89	1.94	1.60	2.53
Tension	1.66	1.58	1.63	1.57	1.53	2.67	2.22	2.05	1.16	1.46	1.28	1.84	1.47	1.96
Tiredness	6.18	2.67	6.58	3.44	6.82	4.17	5.00	3.87	5.89	3.86	5.33	3.24	4.33	3.64
Anger	1.23	1.75	1.05	1.58	1.00	1.50	1.56	1.58	1.11	1.49	0.89	2.30	1.40	2.13
Liveliness	5.17	1.96	5.32	3.61	3.41	2.98	4.83	3.68	3.21	3.29	3.39	3.42	3.87	3.52
Confusion	3.68	1.89	3.84	3.13	2.18	2.40	2.17	2.48	1.95	2.15	1.44	1.89	1.87	2.00

Variable	m8 *M*	m8 *SD*	m9 *M*	m9 *SD*	m10 *M*	m10 *SD*	m11 *M*	m11 *SD*	m12 *M*	m12 *SD*	m13 *M*	m13 *SD*
Depression	1.63	2.58	0.50	1.00	1.25	2.82	0.43	0.65	0.44	1.20	0.56	1.15
Tension	1.19	2.04	0.67	0.89	1.25	2.41	0.86	1.41	1.33	2.22	0.67	1.28
Tiredness	5.00	4.86	4.33	2.81	4.69	3.40	3.57	2.74	4.39	3.15	5.28	3.75
Anger	0.88	1.75	0.25	0.62	1.31	2.70	0.36	0.84	0.28	0.75	0.78	1.52
Liveliness	3.50	3.74	5.00	3.57	3.94	3.97	3.07	3.22	3.72	3.98	2.89	3.34
Confusion	1.69	1.96	1.42	1.98	1.88	2.28	1.29	1.44	1.22	1.73	0.78	1.26

Legend. m1, m2, m3 … consecutive number of measurement; *M* - mean, *SD* – standard deviation.

Table 3
Focus and calmness after AVS.

	m1 *M*	m1 *SD*	m2 *M*	m2 *SD*	m3 *M*	m3 *SD*	m4 *M*	m4 *SD*	m5 *M*	m5 *SD*	m6 *M*	m6 *SD*	m7 *M*	m7 *SD*
How much I calmed down ?	3.85	0.77	3.79	0.71	3.88	0.78	3.22	1.26	3.74	0.87	3.61	0.70	3.73	0.80
How focused was I during AVS ?	3.97	0.51	3.95	0.85	3.53	1.12	3.50	0.99	3.53	0.90	3.56	0.86	3.67	1.11

	m8 *M*	m8 *SD*	m9 *M*	m9 *SD*	m10 *M*	m10 *SD*	m11 *M*	m11 *SD*	m12 *M*	m12 *SD*	m13 *M*	m13 *SD*
How much I calmed down ?	3.88	1.02	3.75	0.97	3.87	1.13	3.79	0.89	4.17	0.71	3.56	1.20
How focused was I during AVS ?	3.56	1.36	3.92	0.79	3.93	1.10	4.00	1.04	3.89	1.08	3.67	1.28

Legend. m1, m2, m3 … consecutive number of measurement; *M* - mean, *SD* – standard deviation.

Lastly, students answered an open question about their mood and general wellbeing during AVS. Most of the students reported feeling relaxed, nice, sleepy, exhausted or tired. Some participants stressed that they could not relax during AVS because of glasses and sound in the initial stages, but after three sessions most of theem said that they got used to disturbances and relaxed more easily at the end of our experiment. Two students reported that the sound of AVS is uncomfortable throughout the duration of the experiment. Most of the students found AVS very soothing and helpful for visualisation of gymnastic elements.

DISCUSSION

Our research was based on three goals. Firstly we wanted to analyze how exposure to AVS, followed by visualization, effects motor learning. Most of research in the field of AVS is not consistent with our findings and reports about significant positive effects of AVS. For example, Siever (2002) proved an improvement of technique and results in professional golf players after 12 minute exposure to AVS. To sum up, we cannot conclude that exposure to AVS effects motor learning, as our students in the experimental group did not do better than the control group in learning gymnastic elements after being exposed to AVS. We also have to reject our two hypotheses that AVS effects motor learning of gymnastics elements positively and that students, exposed to AVS, are going to receive significantly better grades for gymnastic elements than students in control group. As the AVS trainings were done in the same day as regular lessons of Sports gymnastics, we also cannot argue that the results were the result of some confounding variable such as loss of information due to forgetting.

One of the possible explanation for insignificant results could be length of exposure to AVS. Our participants were exposed to it for 11 minutes, while some authors (Cruceanu & Rotarescu, 2013) suggest that at least 20 minutes is needed for the positive effects to take place.

Furthermore, part of our reserach was also visualization of gymnastic skills, performed after AVS. Previous research consistently proved positive effects of visualization for motor learning (Vasundhara & Noohu, 2014), motor skills, performance and rehabiliation (Schott et al., 2013; Stankovič et al., 2011). Our results are not in agreement with these findings, since visualization did not have a significant positive effect on motor learning of students. However, we believe that the cause of ineffectiveness is not visualization as such, but lack of motivation and elaboration of students in visualization of gymnastic elements. Students participated at classes in groups of 20 to 25 people, therefore we had difficulties keeping all of the students motivated. We also could not determine whether every single participant understood instructions well enough for successful visualization.

Our second goal was to analyze, how does exposure to AVS effect heart rate and blood saturation through different time points. As brain waves are supposed to change during AVS, the response should be visible in the heart rate and oxygen saturation in order to see if there are any physical effects of the AVS. We used a program of AVS, which included Alpha and Beta brain wave frequencies, which was supposed to induce calmness, relaxation and readiness to learn. As general activation of the organism decreases when we relax, this is shown in lowered heart rate and increased oxygenation, we measured them to see if the AVS was efficient - the ideal measure would be to follow EEG, but as we were unable to measure EEG in our faculty, we resorted to heart rate and oxygen saturation. Results did not show conclusive trend of heart rate and oxygen saturation changes through time. Heart rate was highest after first measurement, which can be contributed to fear before first exposure to AVS or to expectations. In some measurements we noted decline of heart rate and oxygen saturation, while at others heart rate and blood oxygen saturation increased. We have to acknowledge that students came to AVS with different levels of energy and tiredness, which could influence their heart rate. Some of them were probably also nervous or stressed, which has an indirect effect on oxygen saturation. If students were not able to relax during AVS, because of other stressors in their life or tiredness, that influenced their heart rate and oxygen saturation. Besides that some students also claimed that the sound of AVS is unpleasant, which could also prevent relaxation and influence heart rate and blood oxygen saturation. Based on our results we have to reject our hypotheses, that AVS is going to decrease heart rate and oxygen saturation.

All in all we did not confirm positive effects of AVS for motor learning or decrease in heart rate and blood oxygen saturation. Since AVS is a form of relaxation we expected results similar to previous research on relaxation (for example Eason et al., 1986), which claims that relaxation contributes to better focus, decreased anxiety, heart rate, blood pressure and muscle tension. While heart rate in our case did decrease somewhat, the change was small. Therefore we can not confirm positive long term effect of AVS, only positive short term effects in some cases. Similar conclusion was produced also by Conte (2013), who reports about decreased heart rate only during AVS. The reason for our inconclusive results could be in number of AVS sessions. Hanafi et al. (2011) found out that even 12 sessions of relaxation are not enough to produce long term positive effects of relaxation, we had 13 sessions. On the other hand, Lohaus et at. (2001) claim that even five session should result in long term positive effects. Our results do not support their claim.

In our research students also filled out questionnaires about their feelings and mood during AVS. Results show that feelingss of liveliness and tiredness decreased with time. Also feelings of confusion decreased linearly with time, probably due to the knowledge about procedure. We noted a very small decrease in feelings of tension and depression, which we did not expect, since more sessions of relaxation were supossed to result in less tension and depression.

Lastly, we asked students to assess their focus and calmness after AVS. They reported feeling most focused between measurements 3 and 7 and 8 and 11. After measurement number 11 focus of students decreased, probably due to feelings of boredom , since students did not notice improvement of their gymnastic skills after visualisation. We have to point out that chosen sample of students had a lot of activities besides our research, therefore it is possible that thew viewed AVS and visualisation as a burden without a reward and were consequently less motivated for execution of it. Motivation is a key factor in improvement of psychomotor skills (Cucui & Cocui, 2014), which could explain lack of improvement of motor skills in our research. We noticed signs of decreased motivation in students with time. For example many students said they can not relax due to the visual and audio stimuli, in time they showed less and less interest for AVS and motor learning. We also have to stress that we had no control over how much effort students put into execution of motor skills. It is possible that some students did not try their hardest in execution of exercises. Lack of improvement in motor skills can therefore be explained also with lack of motivation and effort in students, not only with ineffectiveness of AVS. We could also discuss the stage of motor learning the participants were in – as they started out their learning was in the cognitive stage and during three months it already probably crossed into the associative stage, as stages are described by Fitts and Posner (1967, in Magill, 2011). They also state that the visualization is a very useful tool in these two stages, but we believe that this could not be a confounding variable, as all participants started out with a similar amount of knowledge of both gymanstics and visualization.

CONCLUSION

Our research is one of the first analysis of AVS in Slovenia and has contributed to knowledge of students and faculty about AVS. We recognize that we could improve our work in many ways. Firstly, in order to obtain more valid results we could include more participants into research, especially in experimental group, however then we would need to find a way to keep them motivated, as this was a problem. It would also be beneficial to offer rewards for participation in order to increase motivation of students. Furthermore, students should be better acquainted with the technique of visualization from the beginning, which would guarantee better basis for correct execution of it. Lastly it could be positive to expose students to more or longer sessions of AVS in order to obtain more valid results.

AVS is a relatively new field of research, which offers many prospects for the future. Although our research did not confirm positive effects of it for motor learning, there are many other fields where AVS could have positive effects and should be researched more extensively (for example rehabilitation, cognitive skills, health behaviors…), however we would like to emphasize that the market offers several quick solutions and fast ways to get results, AVS being amongst them and we suggest coaches and athletes be careful when deciding upon it without fist checking for scientific proofs of its validity. We can not say that AVS is a verified method, as the results of studies are controversial, therefore we rather suggest to use methods, which have continuously proven themselves to be useful, such as relaxation techniques and visualization.

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