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The effect of classical music on balance, emotional state, and perceived effort in precompetitive artistic gymnasts and trampoline athletes

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ABSTRACT

Purpose. In artistic gymnastics (AG) and trampoline (TR), athletes must be able to combine strength, flexibility, and artistry. The purpose of the study was to examine the effect of classical music on balance, emotional state, and perceived effort in precompetitive AG and TR athletes after a 6-week intervention training program.

Methods. The sample consisted of 36 athletes (20 AG and 16 TR athletes) who were randomly divided into two equal groups: experimental (with music) and control (without music). Balance ability was assessed with the Balance Error Scoring System (static balance) and the Y-balance test (dynamic balance). Before and after the intervention, participants completed the RPE-FS questionnaire which included a perceived fatigue scale (PFS) and an emotion scale (ES) to assess perceived fatigue (PF) and emotional state. The total sample followed a 6-week intervention training program, twice per week. TR athletes performed all exercises on a TR, whereas AG athletes performed their exercises on the floor. During the 6 weeks, the athletes completed the questionnaire before and after each training session.

Results. The results showed a statistically significant improvement in static and dynamic balance in female athletes of both sports ($p < 0.05$), with the percentage of improvement in AG athletes being comparatively higher than that of TR athletes. There were also significant differences in individual measures of emotional state and perceived fatigue in the examined sample.

Conclusions. Classical music differentiates the rate of performance improvement in precompetitive young female athletes in these two sports.

Key words: balance, emotional state, perceived fatigue, trampoline, artistic gymnastics

Introduction

High levels of strength and balance are necessary for participants in artistic gymnastics (AG) and trampoline (TR) to meet the technical demands of the routines. Anthropometric parameters, age, sex, experience in sports, and different neurophysiological pathways all seem to have an impact on balance [1]. Numerous studies [2–4] have examined the effect of intervention programs on balance and psychological parameters in unhealthy populations that were accompanied by music [5, 6]. Dissociation and distraction during exercise are factors that drastically reduce the perception of fatigue and effort [7, 8].

The effect of music on performance has been examined over time, revealing a wealth of evidence regarding the benefits during exercise and training. Exercise performance through music is influenced by three different mechanisms: psychological, physiological, and psychophysiological [9]. Additionally, many studies have investigated the effect of music on healthy subjects [4, 10], patients [2, 3, 11], and adult athletes [12, 13]. Other studies have revealed positive effects of music on performance [7, 14, 15] by lowering feelings of exhaustion [7, 16] and assessing effort during exercise [5, 6, 17–19]. Majid and Mohammad [20] showed that music has a positive effect on the cognitive and mental aspects by improving the physiological aspect and coordination of movement. Conversely, some argue that higher levels of arousal and neural activity [21, 22], as well as better mood, enjoyment of exercise, and increased feelings of power, are the main causes of improved performance outcomes.

Listening to music during different periods of time

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(warm-up, training) is believed to improve mood and motivation and aid in achieving top performance levels in high-level athletes [23]. Terry et al. [18], who examined the effects of music on psychological (feeling scale), physiological (heart rate and oxygen consumption), psychophysical (perceived exertion score), and performance parameters, found that music is positively correlated with more positive emotions and positively affects all the variables examined, primarily in individuals who engage in physical activity rather than sports. Elliott et al. [6], who investigated the impact of motivating music on untrained students during a 20-min maximum cycling program, assessed participants' emotional states, perceived effort rate on certain rating scales, and the distance required for each attempt. They found that both motivational and neutral music can significantly increase the distance travelled in the program. Alrashid [12], who examined the effect of modern music on female undergraduate physical education students during a 6-week training program, revealed a higher percentage improvement in the examined gymnastic skills. In contrast, Alwasif [13], who investigated the effect of Egyptian music on healthy physical education students learning gymnastics skills on floor exercises, parallel bars, and vaulting horse twice a week for a total of 120 min, found that although there was no difference between the music and non-music groups; both groups significantly improved their performance. The impact of music on resistance training and warm-up in well-trained men, using four different protocols to assess physiological and psychological factors before, immediately after, 15, 30, 45, and 60 min following the protocol, demonstrated that perceived effort was higher during resistance training and warm-up phases performed without music, although cardiovascular variables increased in the examined protocols [5]. It should be noted that dynamic balance occurs when female athletes in both sports attempt to maintain or regain balance while performing these skills, whereas static balance occurs in skills requiring a "stable–immobile position" of the individual body parts of rhythmic athletes. The feet define the foundation of support within which the centre of mass is situated during calm posture. The centre of mass does, however, continue to move; this is known as "postural sway" and indicates that the body is not completely still [24]. The Balance Error Scoring System (BESS), as defined by Riemann et al. [25], was used to evaluate static balance. A 50 × 41 × 6 cm closed-cell foam Airex Balance Pad (Alcan Airex AG, Sins, Switzerland) made up the unstable surface. The carpet had a slight pile and was sturdy. Researchers have shown that the BESS has high intratester reliability (intraclass correlation coefficients of 0.78 to 0.96) and fair to good validity (r = 0.42 to 0.79) for the Star Excursion Balance Test SEBT [26]. The Y-balance test (YBT) is a reliable method for assessing dynamic balance with an inter-rater correlation of 0.54 to 0.82 and standard error values of 5.9% in children [27].

Listening to music, such as soothing tunes, the Bluebell Polka, and classical music, has a positive impact on postural balance in young people [28] and healthy participants [29, 30]. Listening to "Jupiter" by Mozart has been discovered to have favourable effects on both static [29] and dynamic balance [30], suggesting that this particular genre of music should be included in rehabilitative procedures to prevent falls. Adults' dynamic balancing control was the subject of an investigation by Carrick et al. [30] into the effects of daily exposure to various musical genres. According to their findings, some musical genres, such as Mozart or Nolwenn Leroy, considerably improve dynamic posturographic scores. However, there is a paucity of research on the impact of classical music on static and dynamic balance, as well as perceived effort in precompetitive AG and TR athletes. It was hypothesized that classical music improves balance performance, emotional state, and perceived effort in precompetitive AG and TR athletes.

Materials and methods

Participants

Twenty female AG and 16 female TR athletes made up the sample. All participants were healthy and without injury to the lower limbs in the last 6 months. After being informed about the purpose of the work and the experimental procedure, parents signed a relevant document declaring their participation in the study. The athletes had a chronological age from 8 to 12 years and were at a precompetitive level with 3–4 years of training experience. Their separation into the two groups (experimental and control) was done randomly. Those who did not complete the total number of 12 training sessions were excluded from the study, reducing the original number of 44 participants to 36. Participants in both sports were split randomly into two equal groups before the intervention program's start: the music intervention group (experimental group: EG) and the control group (CG) without music. Both groups followed the identical 6-week regimen, which involved two training sessions per week, each lasting an hour. The regimen consisted of a 15-min warm-up, a 40-min training session, and a 5-min recuperation period. The majority participated in the intervention program.

Experimental procedure

Two visits were made before the start of the intervention program. On the first, they were informed about the purpose of the study, while measurements were made for chronological age, body mass, body height, and the length of the lower limbs. They were familiarized with the apparatuses and exercises used in the intervention program and during the evaluation of the dependent variables. On the second visit, they were assessed on static and dynamic balance, and the RPE-FS questionnaire, which included a scale of perceived fatigue scale (PFS) and an emotion scale (ES) to assess participants' perceived fatigue and emotional state, was completed by each participant. The same regime was applied after the end of the intervention program. Static and dynamic balance were assessed with the BESS [31] and the YBT [32], respectively. For both the BESS and the YBT, participants were required to complete the questionnaire independently for the first assessment. The athletes also filled out the questionnaire both before and after each training session throughout the 6 weeks. For valid and reliable data recording, a camera was used during the BESS test attempts, and a tape measure was used to determine the exact distance in the YBT. The average value was calculated by adding the values of the three directions, then dividing by the length of the leg, and multiplying this value by 100. Lower limb length was measured, with the participant in a supine position, by recording the distance from the anterior superior iliac spine (ASIS) to the most distal aspect of the medial malleolus. To assess dynamic balance, three attempts were conducted to become familiar with the test prior to the measurement, followed by the primary measurement and the completion of the same process after the conclusion of the intervention program. Ten distinct exercises were included in the protocol to enhance both static and dynamic balance. These exercises included depth jumps involving landing on one leg from a height of 20 cm, horizontal balance, one-legged support with eyes closed, continuous jumps on one leg, continuous jumps with forward-backward and right-left direction, and tuck jumps. For each of the subsequent static balancing tasks, participants completed two sets of five repetitions, lasting 10 s each. While the AG group worked out on the floor, the TR group completed all of their exercises on the TR. Following the routine, the participants engaged in their sports exercises.

During the experimental procedure, a 20 cm high elevated level construction was used to perform depth jumps and one-leg landings, as well as a speaker to play a musical stimulus in the training of the EG. The drop height of 20 cm was chosen because previous research data indicate that plyometric jumps from a height of 20 cm are effective for improving physical fitness in young athletes [33, 34].

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Participants in both sports were split into two equal groups before the intervention program's start: the music intervention group (EG) and the CG without music. The identical 6-week regimen, which involved two training sessions per week lasting an hour each, was followed by both groups. The regimen consisted of a 15-min warm-up, a 40-min training session, and a 5-min recuperation period. The majority participated in the intervention program. Ten distinct exercises were included in the protocol to enhance both static and dynamic balance. These exercises included depth jumps involving landing on one leg from a height of 20 cm, horizontal balance, one-legged support with eyes closed, continuous jumps on one leg, continuous jumps with forward-backward and right-left directions, and tuck jumps. For each of the subsequent static balancing tasks, participants completed two sets of five repetitions, lasting 10 s each. While the AG group worked out on the floor, the TR group completed all their exercises on the TR. Following the routine, the participants engaged in their sports exercises.

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Statistical analysis

Statistical analyses were performed using SPSS version 24 (IBM, New York, USA). The normality of the data was confirmed using the Kolmogorov–Smirnov test. The 2 × 2 × 2 (condition × group × time) ANOVA method with repeated measures on the third factor was used. Sphericity was checked using Mauchly's test, and the Greenhouse–Geisser's correction was applied to the degrees of freedom when necessary. In cases where interaction between factors was detected, the simple effects were investigated, and Bonferroni's correction was used. All statistical significances were tested at $\alpha = 0.05$.

Results

Balance

Statistical analysis revealed no significant interaction effects of sports (AG–TR), groups (EG–CG), and time (pre-post) ($F_{(1,34)} = 0.003$, $p = 0.957$, $\eta^2 = 0.000$, power = 0.050) on static balance. Further, no significant interaction was found between sports and time ($F_{(1,34)} = 0.553$, p = 0.462, $\eta^2 = 0.017$, power = 0.111), and time and groups ($F_{(1,34)} = 0.003$, $p = 0.957$, $\eta^2 = 0.000$, power = 0.050). However, a significant main effect was found for time ($F_{(1)} = 28.946$, $p = 0.000$, $\eta^2 = 0.475$, power = 0.999). Mean values for static balance are presented in Table 1.

Table 1. Mean values and standard deviation in static balance (number of errors)

		Pre	Post
AG	EG	20.100 ± 8.93	13.000 ± 4.96*
	CG	22.300 ± 5.05	15.200 ± 8.27*
TR	EG	26.125 ± 6.35	20.875 ± 4.05*
	CG	24.500 ± 4.78	19.000 ± 3.02*

AG – artistic gymnastics, TR – trampoline
EG – experimental group, CG – control group
* $p < 0.05$

Statistical analysis revealed no significant interaction effects between sports (AG–TR), groups (EG–CG), and time (pre-post) ($F_{(1,34)} = 0.449$, $p = 0.508$, $\eta^2 = 0.014$, power = 0.100) for dynamic balance on the right foot. Further, no significant interaction was found between sports and time ($F_{(1,34)} = 2.819$, $p = 0.103$, $\eta^2 = 0.081$, power = 0.370), and time and groups ($F_{(1,34)} = 0.121$, $p = 0.731$, $\eta^2 = 0.004$, power = 0.063). However, a significant main effect was found for time ($F_{(1)} = 14.060$, $p = 0.001$, $\eta^2 = 0.305$, power = 0.953). Additionally, no significant interaction effects were found between sports

Table 2. Mean values and standard deviations for dynamic balance

		Pre	Post
Dynamic balance right foot (cm)			
AG	EG	99.154 ± 9.64	102.665 ± 11.96*
	CG	102.677 ± 4.88	105.240 ± 9.71*
TR	EG	81.401 ± 9.60	87.872 ± 7.93*
	CG	75.158 ± 7.46	84.615 ± 5.46*
Dynamic balance left foot (cm)			
AG	EG	97.649 ± 12.44	100.498 ± 12.54
	CG	107.275 ± 9.65	99.226 ± 15.58
TR	EG	84.091 ± 8.69	88.426 ± 8.72
	CG	80.248 ± 4.38	79.660 ± 7.47

AG – artistic gymnastics, TR – trampoline
EG – experimental group, CG – control group
* $p < 0.05$

Table 3. Mean values for emotional state (standard deviations are presented in parentheses)

Trampoline				Artistic gymnastics			
static balance		dynamic balance		static balance		dynamic balance	
pre1	pre1 after	pre1	pre1 after	pre1	pre1 after	pre1	pre1 after
0.63 (0.61)	1.13* (0.80)	0.81 (0.65)	1.81* (0.75)	3.30 (0.98)	3.95* (0.86)	3.95 (1.14)	4.00* (1.25)
pre2	pre2 after	pre2	pre2 after	pre2	pre2 after	pre2	pre2 after
0.81 (0.65)	1.31* (0.94)	0.81 (0.65)	1.63* (0.88)	3.55 (1.39)	3.75 (1.83)	3.50 (1.47)	3.65* (1.38)

* $p < 0.05$

Table 4. Mean values for perceived fatigue (standard deviations are presented in parentheses)

Trampoline				Artistic gymnastics			
static balance		dynamic balance		static balance		dynamic balance	
pre1	pre1 after	pre1	pre1 after	pre1	pre1 after	pre1	pre1 after
1.31 (1.08)	2.25* (1.00)	2.19 (0.75)	3.06* (0.93)	0.25 (0.64)	1.25* (1.21)	1.15 (1.27)	1.45* (1.35)
pre2	pre2 after	pre2	pre2 after	pre2	pre2 after	pre2	pre2 after
1.63 (0.80)	2.63* (0.80)	2.19 (0.91)	3.06* (0.68)	0.85 (1.31)	1.20* (1.39)	0.90 (1.25)	1.10* (1.55)

* $p < 0.05$

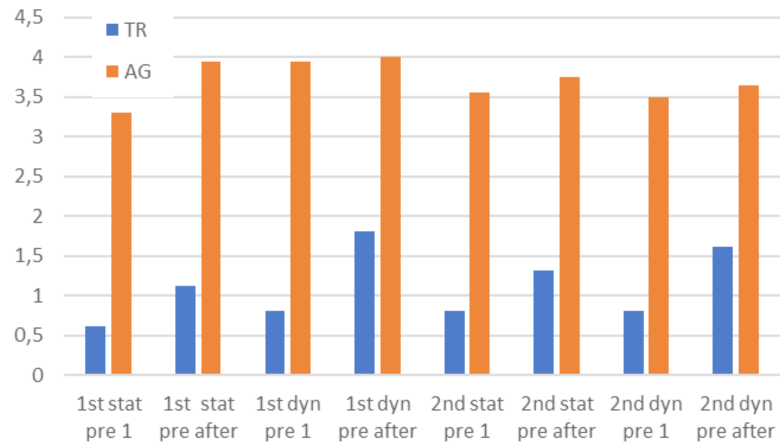

Figure 1. Time course for emotional state

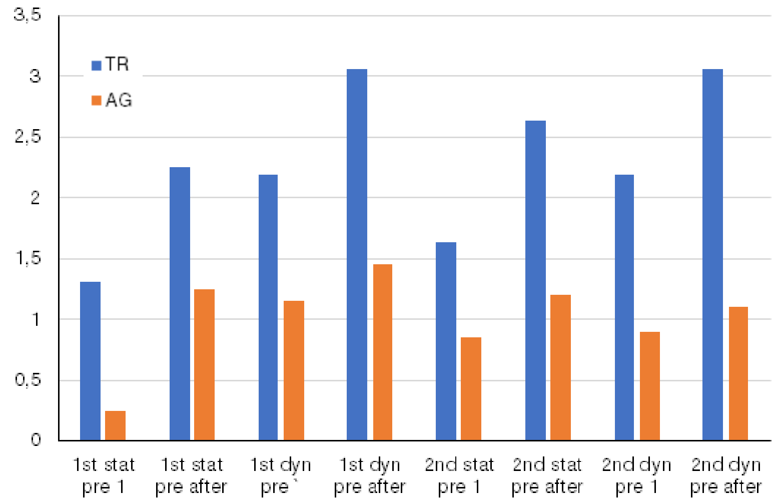

Figure 2. Time course for perceived fatigue

(AG–TR), groups (EG–CG), and time (pre-post) ($F_{(1,34)}$ = 0.723, p = 0.401, η^2 = 0.022, power = 0.131) for dynamic balance on the left foot. Further, no significant interaction was found between sports and time ($F_{(1,34)}$ = 1.622, p = 0.212, η^2 = 0.048, power = 0.235). However, a significant interaction effect was found between time and groups ($F_{(1,34)}$ = 5.074, p = 0.031, η^2 = 0.137, power = 0.589). However, no significant main effect was found for time ($F_{(1)}$ = 0.043, p = 0.837, η^2 = 0.001, power = 0.055). Mean values for static balance are presented in Table 2.

Emotional state and perceived fatigue

Statistical analysis revealed no significant interaction effects of sports (AG–TR) and groups (EG–CG) on emotional state and perceived fatigue (F = 0.870, p = 0.396, η^2 = 0.024, power = 0.171). Further, no significant main effect was found for the factor group ($F_{(1)}$ = 1.297, p = 0.273, η^2 = 0.668, power = 0.424). However, a significant main effect was found for time ($F_{(1)}$ = 11.955, p = 0.001, η^2 = 0.255, power = 0.940). Mean values for emotional state are presented in Table 3.

Mean values for perceived fatigue are presented in Table 4.

The time course for emotional state and perceived fatigue is presented in Figures 1 and 2, respectively.

Discussion

Both static and dynamic balance were significantly improved ($p < 0.05$) in AG and TR athletes. AG athletes outperformed TR athletes in terms of percentage improvement. EG in AG demonstrated a 35.65% improvement in static balance, whereas the similar proportion for TR athletes was 20.09%. On the other hand, the TR group saw a 6.55% increase in dynamic balance, compared to EG in AG, where the change was 3.22%. For AG and TR athletes, the percentage improvement of the CG overall in dynamic balance was 5.45% and 11.84%, respectively. It is noteworthy, however, that although the female athletes' skilled leg improved in the final measurement (2.50% and 12.57% for AG and TR, respectively), these percentages were significantly influenced by the decline in performance observed in the athletes' non-skilled leg (left) for both sports. The findings demonstrate that the EGs' greater improvement in both static and dynamic balance is in line with previous studies by Ricotti et al. [35], who found that young athletes' static balance improved after a 6-week music intervention program, and Alrashid [12], who reported a significant improvement in balance in groups receiving music intervention. Further, the results reinforce previous studies that support the beneficial effect of music on postural control in healthy subjects in static [29] and dynamic balance [30] and young adults [28]. Additionally, the findings align with Waer et al. [36], who found significant positive effects on postural balance under sensory manipulation in middle-aged women, young adults [37], and older adults [38].

Previous data suggest that music helps athletes block out uncomfortable emotions and fatigue-related sensations, which may account for the substantial impact of music on RPE [39]. However, there are more variables that might impact balance, including anthropometrics, age, gender, athletic background, and different neurophysiological processes [1].

In contrast to AG athletes, who only showed a significant difference in static balance, TR athletes demonstrated significant differences in emotional state and perceived effort prior to and immediately following the evaluation on both static and dynamic balance in all assessments. The peculiarities of the sport may be the cause of the variations in these previously stated factors. In both static and dynamic balancing, TR athletes showed statistically significantly lower emotional states and greater subjective tiredness levels than AG athletes.

The findings indicate that while there was no statistically significant difference in the emotional state between the two sports, each participant's emotional state increased on the individual balancing assessment measures (both before and after the intervention program started). The percentage of differentiation in the assessment of static balance before the start of the intervention fluctuated at approximately the same levels in the two sports (79.36% and 83.54% for TR and AG, respectively), while correspondingly in the assessment of dynamic balance, TR athletes showed higher values than AG athletes (123.45% and 98.75%, respectively). This means that higher values in emotional state lead to increased happiness in participants. In both sports, there was an increase in values for perceived fatigue across all individual measures. The statistically significant difference in perceived fatigue in both sports is in agreement with findings by Terry et al. [18], who support the association of music with more positive emotions. Moreover, our results align with previous studies conducted by Thompson et al. [16], which revealed that music positively influenced mood, feelings of happiness, and perceived fatigue. Training while listening to music has been shown by Hutchinson et al. [40] to maintain a "good" mood. Moreover, Archer [41] asserts that exercise performance may be impacted by psychological responses in the domains of well-being, cognition, emotion, and behaviour.

According to research, music might help people stay focused on physically demanding tasks by taking their minds off the prospect of feeling uncomfortable [42]. Fast-paced music often raises adrenaline levels during physical activity, whereas calming music generally lowers norepinephrine levels [43]. Classical music has been associated with lower plasma catecholamine levels. It has been proposed that the reductions in catecholamines are a reflection of a drop in sympathetic output, which may impact the transport of blood and oxygen to peripheral skeletal muscles [43]. Furthermore, our results are in line with findings by Akhshabi and Rahimi [44], who demonstrated that auditory stimuli, such as music, improve not only the mental and cognitive aspects but also the physiological aspects and movement coordination, reducing fatigue and increasing motivation. In general, there is growing evidence that music appears to change how one understands or responds to fatigue-related symptoms, even though RPE may not be susceptible to external attentional manipulation during high exercise intensities [45]. However, given that the study's subjects were young athletes at the precompetitive level and that the intervention program only addressed a single training component over the course of 6 weeks, its findings cannot be broadly applied. It cannot, therefore, be used for other age groups or particular sports.

Conclusions

In conclusion, classical music enhanced both dynamic and static balance in both sports, although AG athletes showed a higher percentage of improvement compared to TR athletes. Additionally, emotional state and perceived fatigue showed an increasing trend in both types of balance during individual assessment measures, both before the start and after the end of the assessment.

Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the Institutional Ethics Review Committee of the National and Kapodistrian University of Athens (approval No.: 1445/14-12-2022).

Informed consent

Informed consent has been obtained from all individuals included in this study.

Conflict of interest

The authors state no conflict of interest.

Disclosure statement

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