

Influence of music therapy on anxiety and salivary cortisol, in stress induced by short term intense physical exercise

Influența terapiei prin muzică asupra stării de anxietate și a cortizolului salivar, în stresul indus de efortul fizic intens și de scurtă durată

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Abstract

Background. Music therapy (MT) has been shown to have a beneficial effect on anxiety and cortisol levels.

Aims. The objective of the study is to highlight the modulation by MT of anxiety and salivary cortisol in stress induced by short term intense physical exercise, in sedentary subjects.

Methods. The subjects (n=22) were selected according to the inclusion criteria of the study. Stress was represented by short term intense physical exercise, performed with a Monark Ergomedic 839E cycle ergometer. The analyzed indicators were anxiety and salivary cortisol. Selected music was Concert No. 21 by W. A. Mozart. Statistical analysis was made on the basis of the Student test.

Results. Following administration of MT, anxiety and salivary cortisol were reduced immediately pre- and post-stress compared with subjects who did not follow any treatment.

Conclusions. 1). Under the influence of MT, compared with the untreated subjects, anxiety and salivary cortisol were significantly reduced immediately pre- and post-exercise, in stress caused by short term intense physical exercise, in sedentary persons. 2). It was proven that the influence is significantly more intense on anxiety than on salivary cortisol in the moments immediately pre- and post-stress, in the case of MT. 3). There are differences between the experimental group of MT and the untreated control group regarding the dynamic evolution of anxiety, as well as salivary cortisol. 4). We suggest the use of MT in the modulation of stress caused by short term intense physical exercise in persons with a sedentary life-style.

Keywords: stress, anxiety, short term intense physical exercise, salivary cortisol, music therapy.

Rezumat

Premize. Terapia prin muzică (MT) s-a dovedit a avea un efect benefic asupra anxietății și cortizolemiei.

Obiective. Obiectivul studiului este de a pune în evidență modularea prin meloterapie a stării de anxietate și a cortizolului salivar din stresul indus de efortul fizic intens și de scurtă durată, la subiecți sedentari.

Metodă. Subiecții aleși (n=22) au fost selectați conform cerințelor studiului. Stresul a fost reprezentat de un efort fizic intens și de scurtă durată, realizat cu un cicloergometru Ergomedic 839e Monark. Indicatorii analizați au fost starea de anxietate și cortizolul salivar. Muzica selectată a fost Concertul nr.21. de W.A. Mozart. Evaluarea statistică s-a făcut pe baza testului Student.

Rezultate. În urma administrării MT starea de anxietate și cortizolul salivar au fost diminuate imediat pre- și poststres la subiecții cărora li s-au administrat, comparativ cu subiecții care nu au urmat nici un tratament.

Concluzii. 1). Sub influența MT, comparativ cu subiecții netratați, starea de anxietate și cortizolul salivar au fost semnificativ reduse, în momentele imediat pre- și post efort, în cazul stresului cauzat de efortul fizic intens și de scurtă durată, la persoane sedentare. 2). S-a dovedit că în cazul MT, influența este semnificativ mai intensă asupra stării de anxietate decât asupra cortizolului salivar, în momentele imediat pre- și poststres. 3). Există diferențe între lotul supus tratamentului cu MT și lotul netratat, măcar, atât pentru evoluția dinamică a anxietății, cât și pentru cea a cortizolului salivar. 4). Sugerăm utilizarea MT în modularea stresului cauzat de efortul fizic de scurtă durată și intens, la persoane sedentare.

Cuvinte cheie: stres, efort fizic de scurtă durată și intens, anxietate, cortizol salivar, terapie prin muzică.

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Introduction

Music is widely used to enhance well-being, reduce stress, and distract patients from unpleasant symptoms (Kemper & Danhauer, 2005). Results indicate that listening to self-selected or classical music, after exposure to a stressor, significantly reduces negative emotional states and physiological arousal compared to listening to heavy metal music or sitting in silence (Labbé et al., 2007). The most beneficial music for the health of a patient is classical music, which holds an important role in music therapy (Trappe, 2010; Yoshie et al., 2009). Patients who would receive the most benefit from classical music include those with anxiety, depressive syndromes, cardiovascular disturbances, and those suffering from pain, stress, or sleep disturbances (Trappe, 2012). **Mozart's music can reduce stress and tension in a busy and hectic general practice, piano concertos being the best as they are smooth, without rapid changes of rhythm and sound, and with greater continuity (Carelli, 2009).** In the case of our country compared with other countries, music therapy is quite little used or unused in an institutionalized form.

Hypothesis

Music has always been a source of harmony for the body, mind and spirit and thus, a way of diminishing the effects of stress. W. A. Mozart's compositions have been shown to have beneficial effects on the human psyche, the Mozart effect being well-known. The influence of the music of this composer on stress induced by exercise has been less explored.

Objectives

We aim to evaluate the influence of music therapy through Concert No. 21 by W. A. Mozart on the psychological and hormonal dimension in stress induced by short term intense physical exercise, in sedentary subjects, by the comparative investigation of two indicators, anxiety and salivary cortisol.

Material and methods

The study and measurements were carried out in August 2010, in the Rai Mina General and Traditional Medicine Practice in Cluj-Napoca. The time interval of the research was from August 2010 until December 2010.

a) Groups

The participation of all subjects in the study was voluntary. Subjects were tested on the cycle ergometer. The selection of subjects was made based on the questionnaire for detecting the state of anxiety, STAY X 1. Persons with mental disorders, cortisone therapy and toxic addictions - alcohol, tobacco, drugs, coffee, were excluded from the trial. Two groups were explored: the control group (C), which received no therapy, and the experimental group (E), which was administered PP. Both groups were subjected to the same type of stress caused by short term intense physical exercise.

b) Subjects

The number of subjects in a group was 22 (11 men, 11 women), both for E and C. The mean age was 26.2 ± 2 for E and 21.6 ± 4 for C (Table I). Participants were asked not to consume alcohol, coffee, not to smoke and not to use

any medication or antioxidant on the day before physical stress. All participants were sedentary subjects.

Table I
The number and type of subjects in the groups.

Group	Experimental stress (E)	Control (C)
No. of subjects	22	22
Mean age	23.4 ± 3	21.6 ± 4
Gender	Women (12) Men (12)	Women (12) Men (12)

c) Study design

For stress caused by physical exercise, a model of short term intense physical exercise on the cycle ergometer was chosen. Before physical testing, the participants performed a 5 min muscle warm-up, on the ergonomic bike, adjusted to 20 watts. After a 5 min break, followed the testing session carried out on a MONARK ERGOMEDIC 839E cycle ergometer. The test exercise was carried out at a pedaling rate of 60 rotations/min, starting with a power of 30 watts for three minutes, followed by a gradual increase of power up to 30 W more, every three minutes, and continued until the appearance of the feeling of fatigue.

The same music therapy was chosen for all subjects, namely Concert No. 21 by W. A. Mozart, which was listened to by headphones by each subject, at the same volume of sound, for a week, at the same time, starting one hour prior to testing and throughout physical exercise.

d) *The indicators determination program* was the same for C and E, being carried out as follows:

time 1 = first determination (Pre Stress 1 = T_1) - the day before the test, at 8.00 pm; time 2 = second determination (Pre Stress 2 = T_2) - 30 min before the start of the sample, at 8.00 in the morning of the day of stress exercise; time 3 = third determination (Post Stress 3 = T_3) and time 4 = fourth determination (Post Stress 4 = T_4) - 15 min, and 24 hours, respectively, after exercise.

e) Explorations

The examinations consisted of measuring psychological (anxiety) and endocrine (salivary cortisol) parameters. The values of the group before the administration of MT, M_1 , and time T_2 were considered as the reference.

- Psychological assessment

The self-assessment questionnaire, STAI X1, X2 (Inventory of trait-state anxiety) was used for anxiety (A) (Spielberger, 1983). STAI scores range from a minimum score of 20 to a maximum score of 80 in both A-State and A-Trait scales. Subjects respond to each item of STAI, by assessing themselves on a 4-item Likert scale (Jurcau et al., 2012b). The A-State scale is balanced with 10 directly quoted items and 10 reverse scored items; the reverse scored items in the A-State scale are: 1, 2, 5, 8, 10, 11, 15, 16, 19, 20. The A-Trait-Scale has 13 directly quoted items and 7 reverse scored items, in which case it is not possible to have a fully balanced scale; the reverse scored items in the A-Trait scale are: 1, 6, 7, 10, 13, 16, 19. The psychometric properties of STAI are good, with a Cronbach α (Cronbach, 1951, 2004) of 0.83, higher than the conventional cut-off value of 0.70.

- Hormonal evaluation

Salivary cortisol was assessed at the Sinevo laboratory in Cluj-Napoca, by immunodetection by electrochemi-

luminescence (straps) (***, 2012; Carozza et al., 2010).

f) *Statistical evaluation*

- The results obtained were analyzed using the SPSS 13.0. statistical package.

- For continuous data examination, Student's t test was used.

- The differences were considered significant at $p < 0.05$.

Results

Note that the *reference values* were those of C and the *reference time* was considered to be T_2 .

a) *Anxiety* for C (Jurcău et al., 2012b) was significantly increased at time T_2 , both compared with T_3 ($p < 0.05$) and T_4 ($p < 0.005$). The increase in the parameter values for E at T_2 was insignificant both compared to T_3 and T_4 . At all peri-stress times, anxiety values in M were higher than in E, significant differences being found at times T_2 ($T_2C - T_2E$, $p < 0.01$; $T_3C - T_3E$, $p < 0.005$) (Fig. 1). There were no significant gender differences, for anxiety values.

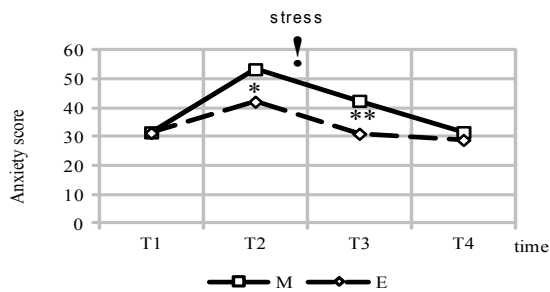


Fig. 1 - Anxiety score changes, under PP influence, in stress caused by short term intense physical exercise. C = control group, E = experimental group, * $p < 0.01$, ** $p < 0.005$, * = $T_2C - T_2E$, ** = $T_3C - T_3E$; "stress" = time of short term intense physical exercise.

b) *Salivary cortisol*, for C (Jurcău et al., 2012b), significantly increased from T_2 to T_3 ($p < 0.01$) and T_4 post-stress parameter values continued to be moderately significantly higher than T_2 pre-stress values ($p < 0.05$). For E, the increase in the parameter value at T_2 was insignificant compared to T_1 and T_3 . At all peri-stress times, cortisol values for C were higher than for E ($T_2M - T_2E$, $p < 0.05$; $T_3M - T_3E$, $p < 0.005$) (Fig. 2). There were no significant gender differences, for salivary cortisol values.

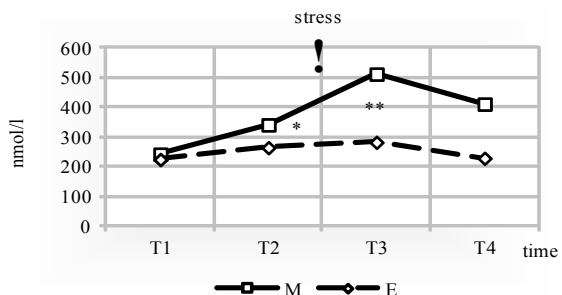


Fig. 2 - Salivary cortisol changes, under PP influence, in stress caused by short term intense physical exercise. C = control group, E = experimental group, * $p < 0.05$, ** $p < 0.005$, * = $T_2M - T_2E$, ** = $T_3M - T_3E$; "stress" = time of short term intense physical exercise.

c) *Comparison of peri-stress evolution of the analyzed indicators* shows that MT has an influence on the dynamic values of the parameters in C compared to E. Thus, in the group treated with MT, stress impact is reduced, E-C compared differences being significant at T_2 and T_3 , both for anxiety ($p < 0.01 = T_2M - T_2E$, $p < 0.005 = T_3M - T_3E$), and salivary cortisol ($p < 0.05 = T_2M - T_2E$, $p < 0.005 = T_3M - T_3E$) (Fig. 3).

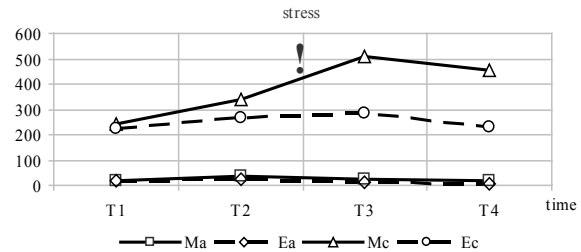


Fig. 3 - Comparison of variations in the studied parameters. Groups: Ca = Control - anxiety, Cc = Control - salivary cortisol, Ea = experimental - anxiety, Ec = Experimental - salivary cortisol; "stress" = time of short term intense physical exercise.

d) *Percentage differences between times T_2 and T_3* for C and E highlight the moments of the most powerful MT impact on the studied indicators. For E, the most intense MT impact is at T_3 for anxiety ($p < 0.005$), and also at T_3 for salivary cortisol ($p < 0.005$). The MT impact on E is significantly greater on anxiety ($p < 0.01$) than on salivary cortisol (Jurcău et al., 2012b) (Fig. 4).

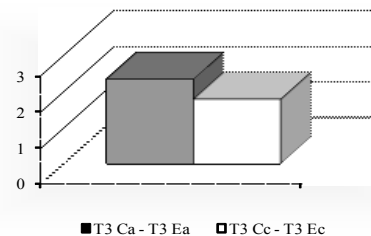


Fig. 4 - Percentage differences between C and E at times T_2 and T_3 , for anxiety - Ca and Ea and salivary cortisol - Cc and Ec.

Discussion

The present study was based on the idea that music therapy is a useful, enjoyable and accessible procedure to cope with physical and emotional stress. Many and varied studies prove the beneficial roles of music therapy on the human being, to convert different forms of distress into eustress. Music therapy is a form of gentle therapy, affordable and effective. Numerous studies have already proved that music has profound psychological and physiological effects (Tusek et al., 1996; Snyder & Chlan, 1999; Toda, 1993).

Music is a non-pharmacological intervention that is considered an ideal therapy for reducing stress (Keegan, 2003). The central nervous system, however, has 2 main components involved in stress response: the hypothalamic-pituitary-adrenal (HPA) axis and the sympathetic nervous system (SNS) (Johnson et al., 1992). It turns out that music

affects indirect markers of activity of the SNS (Chlan, 1998; Wong, 2001; Almerud & Petersson, 2003). It has been assumed that the **hard-wiring of emotion/music and cardiovascular neural systems probably involves many subcortical descending projections from the forebrain and hypothalamus (Holstege, 1987; Holstege et al., 1985; Swanson & Kuypers, 1980), and participation of frontal lobe, especially the medial agranular region, temporal lobe, the ‘sigmoid’ cortex, subcallosal gyrus and cingulate gyrus and septal area (de la Torre, Stefano, 2000; Deutsch et al, 1997). It is considered that the mechanism of action of relaxing music on the psyche occurs via opiate, the hormonal system and nitric oxide NO. This happens because the lateral hypothalamus has long been recognized for its role in the regulation of motivation and emotion and the autonomic concomitants of related behaviors (Saper et al., 1979), and NO has been shown to be a necessary molecule in the development of the auditory system (Fessenden & Schacht, 1998), which is required to enable music to act as a relaxant.**

The results obtained by testing anxiety, under MT via Concert No. 21 by W. A. Mozart, are consistent with the data provided by recent studies related to changes of this parameter under the influence of music, especially the classics. Thus, providing music to caregivers may be a cost-effective and enjoyable strategy to improve empathy, compassion, and relationship-centered care (Kemper & Danhauer, 2005). In Ancient Greece, kithara (*κίθαρα* – a harp-like instrument held on the lap) and flute music was played during the Olympic Games with the goal of improving sporting activities. It has been shown that music leads to better athletic performances (about 15% improvement) (Trappe, 2012). Although there are wide variations in individual preferences, music appears to exert direct physiological effects through the autonomic nervous system (Kemper & Danhauer, 2005). Musical interventions have been used in health care settings to reduce patient pain, anxiety, and stress, although the exact mechanism of these therapies is not well understood (Nilsson, 2008). The highest benefit for health is visible in the case of classic music, meditation music, whereas heavy metal music or technosounds are ineffective or dangerous and will lead to stress and/or life threatening arrhythmias (Trappe, 2009). It has been shown that music composed by Bach, Mozart, and Italian composers is the most powerful in “treating” patients (Trappe, 2012). **Mozart’s music, and more specifically the piano concertos, is the best in Carelli’s experience. The effects on patients are always very welcome; creating a relaxed environment and buffering any tension (Carelli, 2009).**

The previous results of the authors in the field of stress induced by short term intense physical exercise in sedentary subjects (Jurcău et al., 2011; Jurcău et al., 2012a; Jurcău et al., 2012b) justify the interest of the authors in continuing to assess this type of stress seen through the prism of music therapy through Concert No. 21 of W. A. Mozart, especially on anxiety and salivary cortisol.

a) Anxiety

The effect of MT on anxiety has been a constant concern of specialized research.

It turned out that music is inexpensive, easily administered, and free of adverse effects, a mild anxiolytic (Matsota

et al., 2012). In another study, music showed consistent physiological responses with different styles in most subjects, in whom responses were related to tempo (Kemper & Danhauer, 2005). Music effectively reduces anxiety (Fachner et al., 2012), improves mood (Kemper & Danhauer, 2005) and has positive effects on reducing patients’ anxiety and pain in approximately half of the reviewed studies (Nilsson, 2008). The mean anxiety score was significantly decreased after the intervention of music, but not in the control group (Li & Dong, 2012). Listening to meditation music could reduce anxiety while increasing performance on an attention task (Telles et al., 2012). Autonomic responses are synchronized with music, which might therefore convey emotions through autonomic arousal during crescendos or rhythmic phrases (Trappe et al., 2009).

The results obtained by testing anxiety, under the action of MT through Concert No. 21 by W. A. Mozart, are in accordance with data of recent studies on the changes of this parameter under the action of music, particularly classical music. The difference in relation to the mentioned studies is that while they show the effect of MT on anxiety in general or in perioperative situations, our study demonstrates its effect of diminishing anxiety caused by stress induced by physical exercise. In addition, this study proves that the effect of Mozart’s music, intensely studied through its action on memory, is also effective in reducing anxiety caused by stress induced by short duration intense physical exercise in sedentary subjects.

b) Salivary cortisol

The link between MT and *cortisol* has been investigated by many literature studies.

It was found that in the presence of music, the salivary cortisol level ceased to increase after the stressor, whereas in silence it continued to increase for 30 minutes (Khalifa, et al., 2003). Another study showed that listening to music resulted in a marked reduction in the salivary cortisol level and after one hour the relative decrease was similar to that observed in control (non-surgical) patients (Miluk-Kolasa et al., 1994). A short series of GIM sessions may positively affect mood and reduce cortisol levels in healthy adults (McKinney, 1997).

Our results obtained by testing on salivary cortisol, under the action of MT, are consistent with the data provided by the latest studies related to cortisol changes under MT. The difference compared to the mentioned studies is the fact that, while they show the MT action on blood cortisol, our study demonstrates the MT effect of decreasing salivary cortisol levels via Concert No. 21 by W. A. Mozart, in sedentary subjects undergoing stress induced by short term intense physical exercise.

Conclusions

1. Under the influence of MT, compared with untreated subjects, anxiety and salivary cortisol were significantly reduced immediately pre- and post-exercise, in stress caused by short term intense physical exercise, in sedentary persons.

2. It was demonstrated that the influence was significantly more intense on anxiety than on salivary cortisol in the moments immediately pre- and post-stress, in the case of MT.

3. There were differences in the dynamic evolution of anxiety as well as in salivary cortisol levels between MT subjects and the untreated control group.

4. We suggest the use of MT in the modulation of stress caused by short term intense physical exercise in sedentary persons.

Conflicts of interest

Nothing to declare.

Acknowledgement

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