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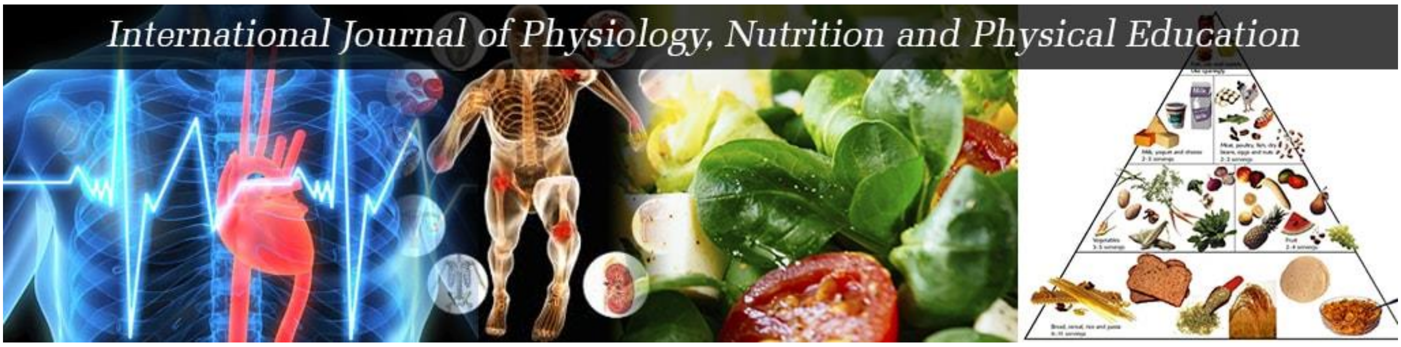

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The review of psychological and molecular effects of music and meditation on performance of sports persons

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Abstract
This paper provides a description review of recent theory, research and applications relating to the psychophysical effects of Synchronous and asynchronous music in the sport and exercise fields. The beneficial effect of using music in competitive sport has a long history and a strong instinctual appeal. Music has the capacity to capture attention, stimulation, generate emotion, change or regulate mood, evoke memories, increase work output, reduce inhibitions, and encourage rhythmic movement. All the above said variables have potential applications in sport and exercise..A simple example involves the tendency for humans to respond to the rhythmical qualities of music by synchronizing movement patterns to tempo. Synchronous music has been reliably shown to produce an ergogenic effect. Therefore, if athletes or exercisers work in time to music, they will likely work harder for longer. Responses to asynchronous, or background, music are less predictable and beneficial effects are less reliable, although considerable potential remains if certain principles are followed. An example is that fast, upbeat music produces a stimulative effect whereas slow, soft music produces a sedative effect. Several evidence-based examples are presented of how music has been used effectively in our work as applied practitioners with groups ranging from exercise participants to elite athletes.

Keywords: Psychological, molecular, music, meditation

Introduction
Synchronous and Asynchronous Music
Synchronous music is when the pace and tempo of the music matches that of the activity, i.e. it falls in Synchronous. Asynchronous therefore, is when the music does not match the pace of the activity.

Most research has examined the impact of music as an adjunct to a physical task; where music is simply played in the background. Asynchronous use of music, as this is known, occurs when there is no conscious synchronization between movement and music tempo. With asynchronous applications, tempo is postulated to be the most important determinant of response to music (Brown, 1979; Karageorghis et al., 1999) and preference for different tempi may be affected by the physiological arousal of the listener and the context in which the music is heard (North & Hargreaves, 1997). This suggests there might be a stronger preference for fast tempo music during physical activity, although some research has indicated that slower tempi may increase physiological efficiency and thus prolong exercise performance (e.g., Copeland & Franks, 1991) [2]. To address this issue, Karageorghis, Jones, and Low (2006) [4] examined the relationship between exercise heart rate and preferred tempo. Participants reported their preference for slow, medium, and fast tempo music selections in each of three treadmill walking conditions at 40%, 60%, and 75% of maximal heart rate. A significant main effect for music tempo was found, whereby a general preference for fast and medium tempo music over slow music was evident ($\eta p2$ =.78). An intensity by tempo interaction effect was also observed ($\eta p2$ =.09), with participants reporting a preference for either fast or medium tempo music during low and moderate exercise intensities, but for fast tempo music during high intensity exercise.

Music is a source of motivation and inspiration that is much valued within the realms of sport and exercise. Given the ubiquity of music in such environments, its application as a mild but perfectly legal ergogenic aid has raised considerable interest among researchers over the last four decades. To date, synchronous music has been used extensively in the context of structured exercise classes; however, it has seldom been used in a structured and systematic way in the sports domain. One notable exception concerns the celebrated Ethiopian athlete Haile Gebreselassie, who famously synchronized his stride rate to the rhythmical pop song Scatman when breaking the indoor 2000-m world record in February 1998.

The synchronous use of music involves performing repetitive movements in time with its rhythmical elements such as the beat or tempo. By way of contrast, the asynchronous use of music involves performing while listening to music playing in the background – without any conscious effort to stay in time with the rhythm (Karageorghis & Terry, 1997 Karageorghis, C. I. and Terry, P. C.1997. The psychophysical effects of music in sport and exercise. Research have not always supported the benefits of motivational music. For example, Elliott, Carr, and Savage (2004) [3] showed that, compared to a control condition, motivational music increased arousal and enhanced affect during submaximal cycle ergometry, but showed no benefits over oudeterous music; and neither music condition influenced the distance cycled. However, the motivational music tracks scored relatively low on the BMRI (M = 20.93; BMRI max score = 33.33), which may explain the lack of support for theoretical propositions.

Although this review has been eclectic rather than exhaustive, emergent trends are: (a) slow asynchronous music is inappropriate for exercise or training contexts unless used with the intention to limit effort exertion; (b) fast tempo asynchronous music played for high intensity activity yields high preference scores and is likely to enhance in-task affect; (c) an increase in tempo from slow to fast might engender an ergogenic effect in aerobic endurance activities; (d) asynchronous music played during submaximal exercise reduces RPE but it remains unclear whether this effect is moderated by the motivational qualities of music; (e) the most sensitive marker of the psychophysical impact of asynchronous music appears to be in-task affect, and (f) asynchronous music probably loses its benefits during very high

Theoretical development of Evidence-Based Examples of Music Use

In working with the Great Britain bobsleigh squad at the 1998 Olympic Winter Games in Nagano, Japan, the first author impressed upon the four-man team that this was a rare opportunity – their moment in time – to clinch an Olympic medal. As the team drove to the bob track each day for training and competition, they would listen to Whitney Houston's *One Moment in Time* while visualizing themselves calmly and decisively seizing the moment; which is precisely what happened on race day with a storming last run that clinched GB's first Olympic medal in the sport since 1964. Exactly the same strategy, indeed with the same song, was implemented successfully with gold medalist, double trap shooter Richard Faulds, at the Sydney 2000 Olympic Games.

Another Olympic champion, superheavyweight boxer Audley Harrison, studied sport psychology under both authors in the four years preceding the 2000 Olympics. He tapped the arousal control qualities of music through listening, perhaps counter-intuitively, to Japanese classical music prior to each bout. This served to temper his pre-fight anxiety, reduce tension, and create an inner state of calm and tranquility.

The second author works with elite track and field athletes in the UK and has applied music interventions to athletes' training for many years. One such intervention entails first conducting a brief survey among the athletes to identify tracks they find most inspiring for training, which are mixed to punctuate circuit training so that work periods are accompanied by music and rest periods by silence. This approach to regulating the session reduces perception of effort while greatly enhancing in-task affect and enjoyment. A similar approach can be adopted for a range of exercise activities. The second author has also applied synchronous music to training in several motoric activities, including long-distance running, cycling, and rowing.

The use of synchronous music takes a great deal of preparation as the motor patterns of training activities and preferred motor rhythms of the athletes need to be studied carefully before selections are made. The music tempo is digitally altered to remain constant from track to track. Also, tempo is selected to coincide either with expected work rate, in which case the training activity is simply made more pleasurable, or to be marginally ahead of an athlete's preferred motor rhythm, in which case it stimulates athletes/exercisers to push their boundaries. Finally, the second author often uses music to improve young athletes' motor skills. One simple example uses the track *Push It* by Salt-n-Pepa to help athletes hone shot putt technique. The lyric reinforces the need for athletes to putt (i.e., push) the shot rather than trying to throw it, the most common technical error, which enhances the learning process.

These few examples of applying music with athletes and exercise participants highlight the importance for practitioners to be conversant with the potential benefits of music in order to tap its psychophysical and ergogenic properties with precision. It is also imperative that athletes or exercise participants are involved in the selection of tracks, as this is likely to increase the potency of music-related effects

The influence of music in the promotion of flow state in an exercise context has been the subject of recent research interest (Karageorghis, Vlachopoulos, & Terry, 2000), with the prevailing view being that carefully selected music may promote flow. Careful selection of music entails consideration of participants' ages, socio-cultural background, and preferences as well as the task that the music is intended to accompany (see Lucaccini & Kreit, 1972; Karageorghis & Terry, 1997; Karageorghis et al., 1999). One mechanism through which music may impact on flow is by enhancing pre-performance mood. Indeed, in a recent review, Terry (in press) presented a strong case for the mood-enhancing effects of music in a sport context. Further, Jackson (1992) reported that pre-performance mood was a key antecedent of flow among elite figure skaters.

Karageorghis and Deeth (2002) assessed the effects of asynchronous (background) motivational music and oudeterous (defined as neither motivational nor de-motivational) music on perceptions of flow during an endurance shuttle running task. Significantly, this was the first study that controlled for the possible confound of variability in pre-performance mood (cf. Jackson, 1992; Terry, in press). Results from the repeated measures design indicated that the motivating music condition engendered significantly higher flow scores, as measured by the FSS, when compared to the no-music control condition.

The strong link between music and changes in motor behavior and cognitive states may be explained in terms of Norman and Shallice's (1986) cognitive model of behavioral control. The model proposes that the cognitive system is comprised of a large, distributed set of specialized processing systems under the guidance of a two-tiered cognitive control system. In routine situations, behaviors may be controlled exclusively by the operation of low-level cognitive control structures or schemata, which are triggered by cues in the internal and external environment in accordance with a contention scheduling mechanism, which operates automatically without consuming attentional resources. This low-level of control is considered to be an automatic process, requiring neither attention/awareness nor volition for its operation.

Research has found that Synchronous music and Asynchronous both can increase performance. However, the existing studies do not compare one against the other; they all compare the asynchronous music to a no music i.e. meditation and control group, meaning it is hard to distinguish which is more effective. Considerable effort by researchers has been directed at understanding these effects.

As an optimal psychological state, flow represents those moments when everything comes together for the performer. Flow is often associated with high levels of performance and a very positive experience. Csikszentmihalyi (1975) developed the concept after investigating the experiences of diverse groups during times when everything came together during performance of one's chosen activity. These activities included surgery, dancing, chess, and rock climbing. Despite such diversity in settings, there was considerable consistency of responses regarding what was felt during moments that stood out as being special in some way for the performer.

Since his initial investigations where the term "flow" was chosen to denote these special absorbing experiences, Csikszentmihalyi (e.g., 1990, 1997) continues to examine the flow construct and how it is experienced. Flow has been examined in settings that range from daily living (Csikszentmihalyi, 1997) to major scientific discoveries (Csikszentmihalyi, 1996) J Remarkable consistency has been found in the described flow experiences of individuals across diverse settings. Flow is regarded as a special psychological state, one that brings the recipient much enjoyment. Flow can occur at different levels of complexity, but by definition flow is intrinsically rewarding regardless of whether it involves a simple game of throw and catch or a complicated and dangerous gymnastics routine. Csikszentmihalyi (1975) referred to the different levels of flow experience as micro and macro flow. Micro flow experiences were postulated to fit the patterns of everyday life, whereas macro flow was reserved for experiences associated with higher levels of complexity and demand on the participant. Flow occurs when one is totally involved in the task at hand. When in flow, the performer feels strong and positive, not worried about self or of failure. Flow can be defined as an experience that stands out as being better than average in some way, where the individual is totally absorbed in what she or he is doing, and where the experience is very rewarding in and of itself.

What tasks are benefitted most by music?

Music has been shown to increase the performance of both endurance tasks and short power tasks. Endurance tasks such as holding a weight for as long as possible or walking until exhaustion have all been performed with better results when accompanied by music. High intensity short power tasks such as rowing sprints showed similar results. However, sports with a clear rhythm such as rowing were much better affected by synchronous music.

Therefore, the research clearly shows a vast amount of support for the use of music to improve performance. But how exactly does music improve performance? One benefit is that music has been shown to be a positive distraction. When music is playing, we are more likely to divert our attentional focus away from the pain or discomfort we may be experiencing and onto the external music. Therefore it helps us to temporarily forget our fatigue, and carry on for longer.

Fast paced music has also been shown to increase arousal, which is great for 'psyching up' before performance. However, slow paced music can also have a beneficial effect when arousal levels are too high, as it has been shown to have a relaxing effect and reduce arousal.

Another added bonus is the enhanced positive mood that music can bring about. This is enhanced even further when the music has a faster tempo, creating a positive buzz to drive your workout!

So the evidence is fairly conclusive. Music has a massive impact on us in a variety of ways. No wonder it has become such an integral part of the fitness world. Some further clarity could be gained into what type of music generates the most benefit to performance, but all the evidence is certainly in favour of music being a crucial part of anyone's training tool kit.

The role of the autonomic nervous system in cardio-protection is well established. Autonomic regulation of the heart may be measured noninvasively as variation in the time series of intervals between consecutive R waves (the representation of depolarization of the ventricles) in the electrocardiogram. RR interval variability (RRV) at high frequencies (0.15–0.50 Hz) reflects cardiac parasympathetic modulation, and variability at lower frequencies (0.04–0.15 Hz) reflects both sympathetic and parasympathetic influences in the heart. RRV is a strong prognostic indicator for the development of cardiovascular disease and death in community-dwelling nonclinical populations and for progression of heart disease in patients, suggesting a role for the autonomic nervous system in the pathophysiology of coronary artery disease. Low levels of RRV also predict death after acute myocardial infarction and heart failure, consistent with the hypothesis that increased cardiac parasympathetic nervous system regulation protects against arrhythmic death.

Most studies report that aerobic conditioning enhances autonomic control of the heart, as indicated by training-induced reductions in heart rate or increases in RRV, but the evidence is only partially consistent with training-induced autonomic benefits. Many studies report no effect of training or no difference between trained and sedentary participants in heart rate or RRV Cross-sectional studies often contrast highly trained athletes with sedentary controls, raising the possibility of self-selection biases. Longitudinal studies of training often have only a small number of participants or lack a control group, and many include men only.

To address these concerns, we contrasted the cardiac autonomic effect of aerobic conditioning with that of strength training in a large sample of healthy young men and women. We hypothesized that cardiac autonomic regulation would be improved by aerobic conditioning but not strength training.

Meditation, like music is considered to exert cardiac autonomic effects and attention and cognition. It has defined the highest state of concentration where the mind and body harmonize to perform better in any mental and body performance. Several studies using Yoga and meditation have been shown to produce health promoting effects and regulate emotions, especially in patients with attention disorder, schizophrenia and ADHD. Solberg et al showed that meditation enhances the performance of shooters after meditation, however, comparative effects of whether it is superior to asynchronous music intervention has never been examined British Journal of Sports Med. 1996 Dec;

30(4):342-6 although the effects of a variety of meditation techniques has been examined in other sports, postural balance, sleep with special focus on measuring the heart rate variability.

Recent research finding on the effect of music

Petri Laukka & Lina Quick, (2011) investigated that Music is present in many sport and exercise situations, but empirical investigations on the motives for listening to music in sports remain scarce. In this study, Swedish elite athletes ($N = 252$) answered a questionnaire that focused on the emotional and motivational uses of music in sports and exercise. The questionnaire contained both quantitative items that assessed the prevalence of various uses of music, and open-ended items that targeted specific emotional episodes in relation to music in sports. Results showed that the athletes most often reported listening to music during pre-event preparations, warm-up, and training sessions; and the most common motives for listening to music were to increase pre-event activation, positive affect, motivation, performance levels and to experience flow. The athletes further reported that they mainly experienced positive affective states (e.g., happiness, alertness, confidence, and relaxation) in relation to music in sports, and also reported on their beliefs about the causes of the musical emotion episodes in sports. In general, the results suggest that the athletes used music in purposeful ways in order to facilitate their training and performance

Stuart D. Simpson &Costas I. Karageorghis (2001) revealed the effects of motivating and oudeterous (neither motivating nor demotivating) synchronous music on 400-m sprint performance while controlling for the potential confound of pre-performance mood. A panel of volunteer Caucasian males ($n = 20$; mean age = 20.5 years, $s = 1.2$) rated the motivational qualities of 32 musical selections using the Brunel Music Rating Inventory-2. An experimental group of volunteer Caucasian males ($n = 36$; mean age = 20.4 years, $s = 1.4$) completed three 400-m time trials under conditions of motivational music, oudeterous music, and a no-music control. Pre-performance mood was assessed using the Brunel University Mood Scale (BRUMS). A series of repeated-measures analyses of variance with Bonferroni adjustment revealed no differences in the BRUMS subscales. A repeated-measures analysis of variance on the 400-m times showed a significant effect ($F_{1.24, 42.19} = 10.54$, $P < 0.001$, $\eta^2 = 0.24$) and follow-up pair wise comparisons revealed differences between the synchronous music conditions and the control condition. This finding supported the first research hypothesis, that synchronous music would result in better performance than a no-music control, but not the second hypothesis, that performance in the motivational synchronous music condition would be better than that in the oudeterous condition. It appears that synchronous music can be applied to anaerobic endurance performance among non-elite sportspersons with a considerable positive effect.

Karageorghis and Deeth (2002) assessed the effects of asynchronous (background) motivational music and oudeterous (defined as neither motivational nor de-motivational) music on perceptions of flow during an endurance shuttle running task. Significantly, this was the first study that controlled for the possible confound of variability in pre-performance mood (cf. Jackson, 1992; Terry, in press). Results from the repeated measures design indicated that the motivating music condition engendered significantly higher flow scores, as measured by the FSS, when compared to the no-music control condition.

The main proponent of flow, Csikszentmihalyi (1975, 1990) explained that it represents an optimal psychological state that is characterized by a near perfect match between the challenge imposed by a particular situation and the skills that the performer brings to it. During flow, one is totally absorbed in the task leading to optimal physical and mental functioning. It is seen as an altered state of awareness in which one feels deeply involved in the activity and where mind and body operate harmoniously. Flow represents the apotheosis of intrinsic motivation; ostensibly, the activity is enjoyable in its own right and not engaged in for the derivation of external rewards and benefits (Vlachopoulos, Karageorghis, & Terry, 2000).

In an investigation of the physiological processes underlying the benefits of music, Szmedra and Bacharach (1998) [11] showed that background music was associated with reduced heart rate, systolic blood pressure, exercise lactate, norepinephrine production, and RPE during treadmill running at 70% VO_2 max. They suggested that music allowed participants to relax, reducing muscle tension, and thereby increasing blood flow and lactate clearance while decreasing lactate production in working muscle. However, it is notable that the beneficial effects of asynchronous music seem to disappear once exercise intensity reaches close to maximum. For example, a study of performance on the Wingate anaerobic test (a maximal effort over 30s) showed no benefit of music (Pujol & Lengenfeld, 1999). It appears likely that the intensity of physiological feedback would overwhelm the effects of music at maximal and supra-maximal intensities.

Szabo, Small, and Leigh (1999) found that switching from slow to fast tempo music produced an ergogenic effect during cycle ergometry. The implication of this finding is that a change of music tempo from slow to fast may enhance participants' motivation and work output, especially when work level plateaus or in the latter stages of an exercise bout. Similarly, Atkinson, Wilson, and Eubank (2004) [1] indicated that the careful application of asynchronous music during a simulated 10 km cycle time-trial could be used to regulate work output. The music was particularly effective in the early stages of the trial when perceived exertion was relatively low. Utilizing the BMRI to rate the accompanying music, results supported the prediction that the rhythmical components of music contribute more to its motivational qualities than melodic or harmonic components.

Karageorghis and Terry (1999) assessed affective and psychophysical responses to motivational and oudeterous music during submaximal treadmill running at 50% VO_2 3 max using RPE, affect, heart rate, and post-exercise mood as dependent measures. They found affect differences between all conditions in the predicted direction and differences between the motivational music and control for the vigor component of mood and RPE. The results indicated that asynchronous music was more effective in influencing *how* participants felt (affect) rather than *what* they felt (exertion). This conclusion was corroborated in a subsequent study (Tenenbaum et al., 2004) using a hill running task at 90% VO_2 max which showed that although motivational asynchronous music did not influence perceptions of effort, it did shape participants' interpretations of fatigue symptoms. Considerable research has confirmed the effectiveness of background music as a strategy for mood enhancement (e.g., Hewston, Lane, Karageorghis, & Nevill, 2005; Terry, Dinsdale, Karageorghis, & Lane)

Yogic Meditation

There is not one type of meditation which is “Yogic Meditation”, so here it is meant the several meditation types taught in the yoga tradition. Yoga means “union”. Tradition goes as far as 1700 B.C, and has as its highest goal spiritual purification and Self-Knowledge. Classical Yoga divides the practice into rules of conduct (yamas and niyamas), physical postures (asanas), breathing exercises (pranayama), and contemplative practices of meditation (pratyahara, dharana, dhyana, samadhi).The Yoga tradition is the oldest meditation tradition on earth, and also the one with the widest variety of practices. The following yogic meditation techniques have been very effective in sports:

Third Eye Meditation
Gazing Meditation (Trataka)
Kundalini Meditation
Sound Meditation (Nada Yoga)
Tantra
Pranayama

Necessity of Variables such as HRV and Salivary Cortisol

Parameters derived from HRV have been proved to be useful in prognosis and diagnosis of heart diseases. Finding and analyzing hidden dynamical structures of these signals are of basic and clinical interest. Most recently, the applications of HRV have been also extended to sports field. HRV analyses for the athletes have been attempted to monitor sports training. Most of such studies are focused on evaluating modifications of cardiovascular system regulated by the ANS resulting from physical exercise, exploring HRV indicators of fatigue induced by overreaching and overtraining for endurance athletes, as well as quantifying alterations of HRV measures related to workloads and training intensity during different exercise periods (Sztajzel et al., 2006). Influence of mental stress on heart rate (HR) and spectral measures of heart rate variability (HRV) has been well documented. It has been reported that various types of mental stresses performed in laboratory conditions increase HR and decrease HRV (Pagani et al., 1995).

In previous studies HRV analysis has been applied to human 24-h ambulatory electrocardiograms. Although the information obtained has value in risk stratification, the large amount of artifact, ectopy and non-stationary heart rate behavior that is present in these long term recordings renders analysis difficult and poorly reproducible (Jiri et al., 2002).

Salivary Cortisol

The neuroendocrine response (i.e. the release of hormones) as part of the physiological stress response has seen a surge in interest in recent years concerning anxiety and stress research in general, and with respect to sport competition in particular (Salvador, 2005; Salvador and Costa, 2009). Neuroendocrine stress markers include catecholamines such as nor-epinephrine and dopamine as markers of the sympathetic adrenal medullary system, and cortisol as the primary marker of the hypothalamic pituitary adrenal system (HPA) (Katharina et al., 2010). Cortisol is a hormonal response to acute stress and has been measured to be higher before competition than at resting conditions (Salvador et al, 2003). The body produces varying amounts of Cortisol depending on the situation. Some researchers have found that athletes produce higher levels of Cortisol before games than before non-competition situations (Filaire et al., 2007; Filaire et al., 2001; Haneishi et al., 2007; Salvador et al., 2003). Similarly, Filaire et al., 2007) found that Cortisol levels were significantly higher immediately prior to competition than on resting days for elite, male paragliders.

Studies investigating the neuroendocrine response to competitions have also mainly focused on the activity of the HPA. Generally, a rise in cortisol secretion has been found in response to a competition. Filaire and his colleagues, for example, found an anticipatory rise in cortisol in female gymnasts during weeks leading up to a competition as compared with levels observed in a control group (Filaire et al., 1999). Until recently there were difficulties in assessing the effects of stress on levels of cortisol in the blood, since taking a blood sample in itself induced stress in the subject, which confounds the experimentally induced stress. In recent years, however, salivary cortisol has been shown to reliably reflect levels of unbound cortisol in the blood and raised levels have been found to be associated with stress in normal subjects (Kirschbaum and Hellhammer, 1994).

According to Kirschbaum and Hellhammer (1994), measurement of cortisol in saliva has become a valuable alternative due to the non-invasiveness and laboratory independence of sampling. Cortisol levels in saliva are not affected by saliva flow rate since the hormone probably enters saliva by passive diffusion. In addition, the acinar cells lining the saliva glands prevent proteins and protein-bound molecules from entering saliva. Thus, salivary cortisol determination is a simple measure of the unbound “free” hormone fraction and has a number of potential advantages over the more conventionally used total serum concentrations. These advantages include a stress-free and non-invasive collection procedure and the measurement of a parameter which is believed to reflect the serum concentration of biologically active unbound cortisol.

Conclusion

The above present literature manifests the effect of music and meditation on psychological and physiological facets, associated with the performance of athletes. The paramount of the selected study is to bridge the gap in present literature, and augment the knowledge for future perspective. The following study anchored on discovering the significant and authentic evidences, to evince the degree of effectiveness of music and meditation on flow state, salivary hormones and other neuro-psychological domains, which can be helpful in predicting and enhancing the future performance of athletes in different sports and certainly, filling up the aperture in the present literature

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