MULTISENSORY TRAINING: MOTOR LEARNING AND SPORTS PERFORMANCE IN YOUNG ATHLETES

ALLENAMENTO MULTISENSORIALE: APPRENDIMENTO MOTORIO E PERFORMANCE SPORTIVA NEI GIOVANI ATLETI

Anna Maria Mariani[a], Luna Lembo[a1]

[a]*Heracle Lab, Università degli Studi Niccolò Cusano - Telematica, Roma, Italia*

[a]*Heracle Lab - Niccolò Cusano Net University, Rome, Italy*

annamaria.mariani@unicusano.it

luna.lembo@gmail.com

Abstract

The article proposes a review of the international literature concerning sensory stimulation in a sport training context of adolescent athletes. The investigation focuses on the analysis of the effects of a multisensory stimulation on the motor learning of young athletes and, consequently, on the sport performance, working on skills such as predictive ability, anticipation, reactivity, response accuracy, information acquisition, but also, muscle strength and power, balance and coordination. On the basis of scientific evidence collected, a protocol of intervention, supplementary to conventional training sessions, is proposed, based on the use of specific instruments, such as stroboscopic glasses, vibro-acoustic poufs and audio-visual material. Future developments move towards measuring the effectiveness of the intervention on a sample of adolescent athletes, evaluating the impact on performance and on constructs of self-esteem, self-efficacy and school learning.

L'articolo propone una revisione della letteratura internazionale inerente la stimolazione sensoriale in un contesto sportivo di allenamento di atleti adolescenti. L'indagine si concentra sull'analisi degli effetti di una stimolazione multisensoriale sull'apprendimento motorio dei giovani atleti e, di conseguenza, sulla performance sportiva, lavorando su abilità quali la capacità previsionale, di anticipazione, la reattività, l'accuratezza di risposta, l'acquisizione dell'informazione, ma anche, forza e potenza muscolare, equilibrio e coordinazione. Sulla base delle evidenze scientifiche raccolte, viene proposto un protocollo di intervento, integrativo delle sessioni di allenamento convenzionali, basato sull'utilizzo di strumentazioni specifiche, quali occhiali stroboscopici, pouf vibro-acustici, e materiale audio-visivo. Gli sviluppi futuri si muovono verso la misurazione dell'efficacia di tale intervento su un campione di atleti adolescenti, valutandone l'impatto, sulla performance, sui costrutti di autostima ed autoefficacia e sull'apprendimento scolastico.

Keywords

Motor learning, adolescence, multisensory stimulation, sports performance.
Apprendimento motorio, adolescenza, stimolazione multisensoriale, performance sportiva.

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Introduction

Sports plays an important role in the well-being of people and in the quality of life of those who have an active lifestyle. In adolescence it has a greater importance, both for the benefits it brings at psycho-physical level and the possibility of inclusion, socialization and personal and group growth it promotes (Giulianotti, 2010). Sport context is a space where adolescents can experience their emotions, recognize and regulate them, assume self-awareness and optimize the constructs of self-esteem and self-efficacy (Batista et al., 2016; Wagnsson et al., 2014). Sports responds positively to the biopsychosocial approach, which emphasizes the need and importance of focusing on the person and responding to his/her needs, 360 degrees, considering the physical, psychological and social levels.

Adolescence is critical in order to enhance an active lifestyle and, for those who practice activities at a competitive and semi-competitive level, it is the phase where the sports drop-out occurs frequently (Vella et al. 2020; Mc Clone, 2015). It is during this transitional phase that the young athlete decides to persist in sports or drop out. Determinants related to quitting or persisting include motivation to succeed, competitiveness, and the desire to excel (Soares et al. 2020). Last but not least, also positive performance is an important determinant (Mc Clone, 2015). From these premises, the study turns towards the opportunities related to multisensory stimulation for the improvement of sports performance and, consequently, the motivational levels of young athletes, mitigating or dissipating the drop out phenomenon, with a neuroscientific perspective.

The human brain has always evolved, learned and acted in multisensory contexts, where information is integrated, through the recruitment of different sensory channels (Bota et al., 2017; Shams et al., 2008). Learning, as the acquisition of new information, therefore, can receive a positive influence by working in a multisensory environment.

Multisensory strategies, having the advantage of the completeness of the information baggage, accelerate the learning potential, in different educational areas (Bota et al., 2017). This happens when, at the time of the acquisition of an information, it is internalized with the simultaneous recruitment of the different sensory channels, from visual to acoustic, to tactile-kinesthetic. Thanks to the co-participation of the senses, the recall of information, as well as its retention, will be faster and more effective, thus improving the learning capacity of the subject (Seitz et al., 2006).

It is interesting to move the benefits that multisensory learning brings in general learning processes, towards a greater specificity, in motor learning, body and corporeality.

Several studies highlight the importance of a completeness of information which is determined by the simultaneous use of different sensory channels. Specifically, it results in an increased awareness that involves a refinement of the sense of movement, which is part of an improvement in the athlete's performance (Effenberg et al., 2016). In this sense, multisensory stimulation takes the form of complementary training sessions to conventional ones. These are aimed at optimizing the acquisition, retention and recall of information, whose optimization translates into better learning, of any motor sequence, useful to perform a given technical gesture.

The multisensory environments, initially created for non-invasive rehabilitation and therapeutic purposes, are endowed with a versatility that allows to use them in different areas, also in a learning context with a specific focus on body, almost bypassing cognition.

According to scientific literature, our brain is naturally predisposed to multisensory learning, since the way people experience the world constantly involves sensory integration (Shams et al. 2008). This natural predisposition ensures that multisensory learning is preferable in information acquisition phase, compared to learning that does not involve the recruitment of all senses. Considering that sensory interactions are present in the process of perception elaboration, it's possible to say that multisensory can be exploited to optimize information processing in terms of coding and learning (Seitz, et al. 2006). The coding, archiving and retrieval of information, therefore, for an innate and natural predisposition, work optimally in a multisensory environment. In a uni-sensorial context, however, the processing capacity would seem not to exploit all the potential. Speaking about motor level, this potential translates into greater activation of the motor cortex, better response accuracy and a decrease in response latency times (Butler et al. 2011).

In recent years, studies highlighted how multisensory benefits movement, thanks to the greater effect on motor perception, optimizing motor control, motor learning and the precision of actions (Effenberg et al. 2016).

Based on existing scientific evidence, our study moves towards sensory integration within the athlete's motor learning. We hypothesize that the benefits that multisensory stimulation brings to learning processes translate into an improvement in sports performance. After an examination of the different types of sensory stimulation, a multisensory training protocol for the motor learning of young athletes is proposed as integration of physical training.

1 Sensory integration in motor learning

Starting from the results that emerged in scientific research in the sports field, the interest was focused on the different sensory channels and on the impacts that any specific channel can have on some cognitive and physical abilities, such as forecasting ability, ability to anticipate, reactivity, accuracy of response, balance, strength and muscle power of the young athlete.

1.1 Visual stimulation

The visual stimulation is already widely used in sports, mainly through the use of stroboscopic glasses. An eyewear equipped with LED lenses, with strobe lights, intermittent, which determine an alternating frequency of dark-light. This frequency induces the brain to have a faster processing of information coming from the sensory channel responsible for vision, optimizing the athlete's ability to anticipate, forecast and react, in terms of reduction of latency times of response. The use of a tool such as the stroboscopic glasses can bring, therefore, benefits to a classic training. Research on this topic move from tennis, to volleyball, to badminton, with consistent results, in confirming the effectiveness of the training (Rentz et al., 2019; Bonato et al., 2019; Zhou et al., 2020). Visual cognitive systems are considered and used as an opportunity to create movement patterns, or even mental representations of a given movement, by stimulating the athlete's reaction and perception with visual stimuli.

The versatility of the models allows the adaptability to different sports, based on each specific technical gesture (Cotar et al., 2020). It is important to consider, however, the environmental variables in which visual training is performed. The scientific literature in this sense is still in progress, so it becomes interesting to continue research in this direction, including the environment as a variable to be considered among the factors influencing the effectiveness of the training. Some studies have shown that visual training, not necessarily in sports context, can improve cognitive performance such as reaction time, executive control and perceptual speed, while it seems to be less effective for sport-specific skills in terms of technical gesture. This evidence suggests that the environment in which visual training is performed plays a key role in improving performance, while supporting the ecological approach to sports learning (Formenti et al., 2019).

Visual training within sports sessions, even if used to improve performance, also offers a preventive advantage. Some studies have shown a correlation between visual training with stroboscopic glasses and different tracking exercises and a lower risk of concussion. Stimulating the visual field and peripheral vision improves athletes' ability to scan the visual field for oncoming objects or opponents, thus anticipating head impacts and increasing the likelihood of avoiding them. (Kung et al., 2020; Clark et al., 2015; Graman et al., 2015; Honda et al., 2018).

1.2 Acoustic stimulation

If sight is considered fundamental in sports, also sound is among the fundamental factors that influence sports performance and, before that, motor learning. There is a human specialization that is the auditory motor circuit related to locomotion, which generates a close connection between sound and movement, considering also that auditory perception determines an activation of the motor areas of the brain (Sors et al., 2016). What makes the auditory stimulus central for learning is the completeness of information. Specifically, as many scientific findings highlight, integrating acoustic information with motor information results in better learning and construction of the mental representation that follows. For example, we can consider the ease in remembering the text of a song compared to the text of a poem without musical accompaniment. The sound, in some way, gives shape to the movement itself, gives it a rhythm that makes it easier, not only to acquire but also to recover. It is proven that the association of the technical gesture and the sound it produces, during the learning phase, improves sports performance (Agostini et al., 2004).

Scientific research mainly deals with sonification of movement, meaning the transformation into sound of the motor sequence, useful to perform a specific technical gesture in any sport. This is widely used in sports to refine the perception of movement, coordination and to have improvements on the acquisition of the specific motor sequence (Effenberg et al., 2005; Effenberg et al., 2011; Boyer et al., 2014).

Sonification produces sound feedback, not only improves performance as a result of improved motor learning, but is also used for rehabilitation purposes, for example in patients with stroke or Parkinson's disease. The effects resulting from sonification are applicable in different domains, thanks to the optimization generated by the association between acoustic stimulus and movement (Bevilacqua et al., 2016).

Although the auditory channel in sports is little recognized in terms of importance, neuroscience shows its value, as the motor and premotor cortices are activated through acoustic stimulations (Bengtsson et al., 2009; Chen et al., 2008). This connection, between hearing and movement, again embraces the notion that a cross-modal approach is to be favoured in learning contexts, precisely because of the facilitation of acquisition, retention, and retrieval that results.

1.3 Vibro-acoustic stimulation

Vibroacoustic stimulation has a significant role in both rehabilitation and nonrehabilitation settings. On this topic, research have been conducted with samples of healthy and with pathologies subjects and both cases have shown positive results.

The study by Katusic et al. (2013) performed on a sample of children with cerebral palsy showed an improvement in motor performance, in terms of gross motor function and spasticity. Subsequently, another author evaluated the benefits of vibration on a population of adults with cerebral palsy. Consistent with the previous study, the results showed that vibration affects neuromuscular structures. The benefit is associated with acted stimulation on alpha motor neurons and mechanoreceptors which, when activated, result in increased strength and muscle mass (Kantor et al., 2019). Considering the benefits that vibroacoustic stimulation brings to the body in persons with pathologies, it has been tested also in other areas to investigate its effects. Recent studies show interest in the application of vibrations in sports. The results obtained with groups of healthy people are consistent with the previous ones. Vibrations work on increasing the excitability of the nervous system and the use of devices that produce vibrations, picked up by the body, improve one’s response in terms of accuracy, increase the power of nerve processes and improve the ability to balance (Khasanov et al., 2020).

Vibroacoustic stimulation also brings positive influence in terms of motor control. This happens to the extent that the stimulation produced by vibrations on muscles, during motor control exercises, acts at the level of sensorimotor control, bringing a significant improvement in neuromuscular control of the trunk (Boucher et al., 2015). Existing research on this topic highlights the versatility of vibration. The potential of vibroacoustic stimulation takes a role in a variety of areas and has a positive influence on multiple abilities and functions. Among them, scientific studies report its benefits in terms of psychomotor skills. The research by Mikheev et al. (2018) investigated the effects of vibrational training on the psychophysiological qualities among a sample of athletes. The results confirmed an important improvement in motor response speed (Mikheev et al., 2018). Vibrational training is also used to improve muscle strength and power. Relevant studies have investigated the extent of improvements, following the use of vibration, identifying some factors influencing the treatment. Overall, it is evident that vibroacoustic stimulation is positive for muscle strength and power. Efficacy depends on the type of instrument used, the sex of the person and the training level. In fact, it is evident that experienced athletes receive greater benefits than non-experienced athletes (Marin et al., 2010).

Our multisensory training protocol uses a vibrational training session as a support to the motor training of young athletes.

2 The project

Our study aims to investigate the influence that multisensory stimulation sessions, combined with the physical training sessions, have on the quality of learning, leading then, in a better athletic performance of the athlete and a greater sports motivation. With this purpose, a multisensory training added to sports training is proposed in adolescent athletes. The protocol includes six sessions of multisensory stimulation, weekly and with a duration of thirty minutes each. Each multisensory training session will be structured according to a program that provides different but linked experiences. Each session begins with a short meditative practice of about seven minutes. The literature highlights how a mindful approach prepares people for optimal stimulus reception (Maclean et al., 2010; Bakker et al., 2012; Kerr et al., 2013). In fact, mindfulness fosters the ability to process sensory stimuli and increases awareness of one's sensory experience; specifically, mindfulness optimizes the ability to filter input into the sensory neocortex and organize the flow of sensory info, improving perceptual discrimination and sustained attention (Kerr et al., 2013; Maclean et al., 2010). Specifically, it is the concept of sensitivity to sensory processing that makes mindfulness a valuable tool to use, in terms of a greater predisposition to capture the stimulus and consequently to process it, a greater openness to the surrounding context, such as to be more sensitive and therefore more receptive to sensory input. Mindfulness fits into this context as this sensitivity is influenced by awareness and acceptance of the present experience, the “here and now” constructs that derive from meditative practice (Bakker et al., 2012). Following meditation, a specific multisensory stimulation work is proposed, articulated in:

- visual stimulation with the use of stroboscopic glasses, exploiting the alternation of dark light that comes from them, to work on the athlete's anticipation, prediction and reactivity skills (Clark et al., 2015; Kung et al., 2020).

- acoustic-visual stimulation, in terms of sonification of movement, but also audio-video material, to implement the completeness and redundancy of the stimulus, in order to promote and optimize its learning and retention (Agostini et al., 2004; Effenberg, 2005). The aim is to propose the motor sequence, useful to perform the technical gesture, with a completeness of sensory information, resulting from the activation and simultaneous recruitment of different senses;

- vibro-acoustic stimulation, exploiting the ability of the vibro-acoustic pouf to transform low sound frequencies into vibrations. These ones, being picked up by the whole body of the athlete, will stimulate the strength, the power and the muscular mass, optimizing also the equilibrium, the motor control and the accuracy of answer of the person. All of this is identified in an overall improvement in motor performance (Katusic et al., 2013; Kantor et al., 2019; Khasanov et al., 2020).

The schedule and timing proposed is the result of an evaluation of existing studies on the subject and the feasible applicability of the protocol in a training context of adolescent athletes. For these reasons, we will evaluate the possibility to make modifications, if necessary, during the implementation of the protocol.

3 Conclusions

The versatility and innovation of multisensory environments give the opportunity to be used in different contexts. We have seen how the multisensory room was born for rehabilitation purposes for those with intellectual disabilities. The benefits deriving from multisensory stimulation have been evaluated not only in the rehabilitation but also in other fields, such as sports. The research group's interest in multisensory integration in motor learning aims to optimize the athlete's potential, improving performance and working on the motivation that comes from positive sports results. This can be possible by working with the stimulation of different sensory channels, with the use of an equipment for specific skills and motor responses. The peculiarity of the room, in this sense, is the possibility it offers to create an ad hoc protocol for each athlete, based on the strengths and areas of improvement. There's the possibility to use the most appropriate and effective equipment, designing a training that takes into account the individuality and specificity of each person.

Another important focus of the research is the possibility of contributing to limiting the phenomenon of sports drop-out that occurs, mainly, in the adolescent period, as it is connected with motivation, with sports results and the desire to succeed. Sport is an opportunity for adolescents to socialize, a moment to give space to their potential and a challenging environment where to build and strengthen the constructs of self-esteem and self-efficacy, fundamental to the personality of the person.

The research interest, in addition to the above mentioned, turns towards a deeper understanding of the influences that different stimuli can have on performance, in sports and in rehabilitation after injury. In addition, it will be important to discriminate stimuli on different sports in order to highlight their specific peculiarities and broaden the investigation to other areas, in particular the educational and didactic ones.

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