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Artículos científicos

Elite Musicians: More Than a Physical Training

Músicos de élite: más que un entrenamiento físico

Músicos de elite: mais do que treinamento físico

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Abstract

Musical activity can generate various responses, depending on whether the one listening to music is a musician or not. Recent studies proved that brain activity is higher in an active musician, meaning the one who practices music by playing an instrument, than in a passive musician or a non-musician, meaning the one who does not practice music or is just listening. Such studies showed that similar musical activities generate different responses for an active musician and a non-musician. In this article, we have collected various empirical studies to prove that elite musicians go beyond whichever physical activity. Thus, when active musicians are compared to elite athletes, the merit of the first ones is underestimated, because they are required to do physical activity along with a high level of mental activity (much more than concentration), as they perform many different actions at the same time. To complete our study we passed some questionnaires, previously validated by external experts, to specialists in the fields of music, psychology and neurology, through which we were able to know their point of view regarding the activity and effort that the people who study or practice music.

Keywords: elite musicians, music education, music training, musical activity.

Resumen

La actividad musical puede generar varias respuestas, dependiendo de si la persona que escucha música es músico o no. Estudios recientes demostraron que la actividad cerebral es mayor en un músico activo, es decir, el que practica música tocando un instrumento, que en un músico pasivo o no músico, es decir, el que no practica música o simplemente está escuchando. Estos estudios mostraron que actividades musicales similares generan respuestas diferentes para un músico activo y un no músico. En este artículo hemos recopilado varios estudios empíricos para demostrar que los músicos de élite van más allá de cualquier actividad física. Por lo tanto, cuando los músicos activos se comparan con los atletas de élite, se subestima el mérito de los primeros, porque se les exige que realicen actividad física junto con un alto nivel de actividad mental (mucho más que concentración), ya que realizan muchas acciones diferentes al mismo tiempo. Para completar nuestro estudio pasamos unos cuestionarios, validados previamente por expertos externos, a especialistas en los campos de la música, la psicología y la neurología, a través de los cuales pudimos conocer su punto de vista respecto a la actividad y el esfuerzo que realizan las personas que estudian o practican música.

Palabras clave: músicos de élite, educación musical, entrenamiento musical, actividad musical.

Resumo

A atividade musical pode gerar diversas respostas, dependendo se a pessoa que escuta a música é músico ou não. Estudos recentes têm mostrado que a atividade cerebral é maior em um músico ativo, ou seja, aquele que pratica música tocando um instrumento, do que em um passivo ou não músico, ou seja, aquele que não pratica música ou está simplesmente ouvindo. Esses estudos mostraram que atividades musicais semelhantes provocam respostas diferentes para um músico ativo e um não músico. Neste artigo, compilamos vários estudos empíricos para mostrar que os músicos de elite vão além de qualquer atividade física. Portanto, quando músicos ativos são comparados a atletas de elite, o mérito do primeiro é subestimado, pois eles são obrigados a se envolver em atividade física junto com um alto nível de atividade mental (muito mais do que concentração), pois realizam muitas ações diferentes em o mesmo tempo. Para completar o nosso estudo, passamos questionários, previamente validados por especialistas externos, a especialistas nas áreas da música, psicologia e neurologia, através dos quais

podemos conocer o seu punto de vista sobre a actividade e esforço dos estudiosos ou practicar música.

Palabras-chave: músicos de elite, educación musical, treinamento musical, atividade musical.

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Introduction

The activity of a musician includes a set of interrelated actions that are directed by the main conductor: the brain. Musicians must coordinate their muscles, hearing and sight (when reading a score, for example) as they try to stay in tune and rhythm. Also, if they play in an ensemble, they are subjected to coordinate themselves with everybody else according to tempo, character and sonority, and they must take into account dynamics and sonority of the room where the performance is to happen. They have to remain especially focused on their performance as they need to place themselves in a particular period and style along with mastering the technique of their instrument (notes, articulations, sound...). Besides, they must take into account old and new requirements of the repertoire, as well as the responsibility, or fear, that being on stage can involve.

All these actions, although they may seem little when enjoying a good performance, do require a great work and a mental and physical effort, because the first instrument that musicians use is their own body, through which they communicate to an audience, and their instrument (or their voice) is the mean that they use to produce sound.

In recent years, various studies and articles, such as Moreno and Bidelman (2014), Joukamo-Ampuja (n.d.) or Guhn, Emmerson and Gouzouasis (2019, comparing musicians to elite athletes have been published. Yet, there is no scientific or social acknowledgment to the activity of musicians, which we think it goes beyond the activity of elite athletes. Our hypothesis comes from the fact that musicians should not be compared to elite athletes, since playing music signifies a bigger mental effort, because of the mere fact of coordinating all of the brain and the motor system processes. In addition, they should master a musical instrument and a piece that will be differently played depending on whether it is to be performed individually or not.

To test this hypothesis, we will do a little research on *music*, *brain* and *elite*, hoping to find articles where these words be related to athletes. On the other hand, we will briefly review literature about the benefits of music for musicians, and we will collect

information from some specialists in neuroscience, music and psychology. Finally, we will analyze the data collected to start a discussion about musicians' activity and the lack of recognition that they are given in comparison with athletes, attending that the active musical activity (or playing a musical instrument) implies benefits in both curricular and physical domains.

Our goal is to collect information from articles in several databases to support our hypothesis. We expect the lack of connection among *music*, *elite* and *brain* to be evident, so it would reinforce a part of our hypothesis, in which we suggest that studies are mainly addressed to athletes and not to musicians.

From the same database, we have obtained as well an overview of the activity of musicians. Thus, we will be able to give an idea to justify the motivation for our research. Furthermore, and given the advantages that elite athletes currently have in Spain (we compare these to musicians, but the advantages given are quite different), we will prove the necessity to give recognition to musicians (students or professionals) or at least that they receive the same recognition as athletes.

In this regard, we could say that yoga has even more benefits than physical exercise, as Ross and Thomas (2010) explained: "In both healthy or diseased populations, yoga may be as effective as or better than exercise at improving a variety of health-related outcome measures."

Theoretical framework

Recent studies indicate that musical training provides significant and durable biological benefits for our hearing. However, the benefits that music provides go beyond basic perceptive abilities, as they also affect positively in non-hearing functions that are necessary for higher-order cognitive functions, such as memory or intelligence. It has been found that participating in other arts, like the visuals, does not produce the same improvements provided by music. Music activates brain networks and mechanisms involving general cognitive domains. Understanding these processes will facilitate the preparation of "training programs aimed to alleviate people's auditory-cognitive abilities" (Moreno and Bidelman, 2014).

As Wilson (2013) found, "music activates the emotional and reward networks of the brain, because of its capacity to integrate multiple brain systems in the unified act of music making." According to her, only music gives these benefits: "There are more than 100 neuro-imaging studies showing that music activates multiple brain networks only

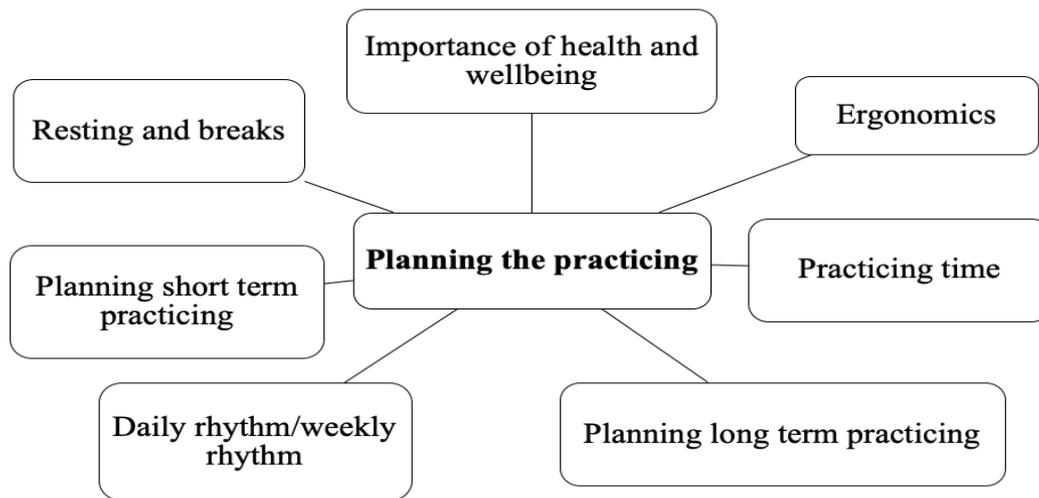
during music listening.” She also explained: “When we compare musicians and no musicians there are substantial differences in size, shape, density, connectivity and functional activity that occur extensively throughout the musician's brain. It is not surprising then, that music has been dubbed the ‘food of neuroscience’.”

A recent article by Jaschke et al. (2018), showed that there is a relationship between academic achievement and music education, where music has a positive impact on cognitive functions such as planning or inhibition. Their program followed a traditional approach (teaching children how to play an instrument or how to sing actively and listening to music in class), and it proved that “children following structured music lessons perform better on tasks measuring verbal IQ, planning and inhibition.” Besides, they noticed that “practicing music for a longer period of time increases connectivity of the corpus callosum, strengthening communication between both hemispheres.”

How do musicians prepare themselves to succeed in their practicing and performance?

According to Joukamo-Ampuja (n.d.) “when speaking of musical practice planning, your body is the other half of the instrument, and you have both an ‘artistic musician’ and a ‘biological musician’ that work together in you”. This means that different physical and mental regions are involved and will affect the skills development of a musician. She explained that “both instrumentalists and vocalists should have a good awareness of their body, joints and muscles, and find a natural basic posture that causes the least strain.” This would suppose a better playing technique, thus, a better performance. The author suggested some tips to achieve great efficiency during the musical practicing, which we summarize in the next figure (Figure 1):

Figure 1. Planning the musical practicing



Source: Joukamo-Ampuja (n.d.)

Regarding this figure, the author aimed to prevent the body from causing trouble when interpreting a challenging repertoire in the future: “Improved body feelings make you mentally more secure in performing too.” She warned that breaks are essential: “It takes your muscles about 24 hours on average to recover from a demanding practice session.” Nonetheless, she explained that each musician is different and so they are the balances of physical needs.

For elite musicians, according to Ericsson and Charness (1994), supervised practice starts at very young ages, but “the effects of extended deliberate practice are more far-reaching than is commonly believed and it can also lead to anatomical changes.”

Regarding the various skills that musicians develop through their practicing and training, it is necessary to look at the study of Guhn, Emmerson and Gouzouasis (2019). They found that music has a positive impact, higher than expected, in both academic achievement and social and personal relationships. They explained that “music learning in childhood may foster competencies (e.g., executive functioning) that support academic achievement, educators may consider the potential positive influence of school music on students' high school achievement.” We agree with these authors about all the existing forms of music education, including composition, music theory, vocal music (singing) or instrumental music (learning and playing an instrument) besides the different processes that music education brings along. For instance, learning how to play an instrument involves various activities: learning how to read music, coordinating hands and space to play an instrument, etcetera. These sorts of activities, according to the cited authors, not

only affect positively to music education, but also to subjects such as Mathematics, Science or Language. The results showed that music students achieve greater efficiency in high-schools.

In our view, music helps all athletes in general, not only the elite ones. García Ucha and Ferrer Maldonado (2015) found that music can serve as a tool to prepare athletes psychologically, although there are some advantages and disadvantages, too. Feelings before a competition are one of the elements wherein music can help. Besides reducing effort or increasing the quality of the training, music improves recovering after exercising, and it modifies physiological parameters.

Again, this reminds us of the positive impact that music has on people, including athletes. For this reason, we consider that musicians are not elite athletes, but elite athletes are actually who they are because they use parameters, exercises and tools of musicians.

Method

Our study, which is descriptive, is based on a method that combines qualitative and quantitative data, by reviewing recognized databases and using questionnaires addressed to specialists in the fields of neurology, music and psychology.

According to Jansen (2012), an inquiry is a correct tool for this type of study, as samples can include a population of a city, a country or members of a specific category. The profiles were deliberately chosen in our case so that we could obtain the best information related to the aim of the study. Although Jansen suggested that inquiries can only provide quantitative data, a qualitative inquiry is also believed to be possible, and it would determine the diversity of a topic, not just averages or frequencies.

The questionnaires were validated by three external specialists, providing brief corrections that were sent by e-mail. After the validation of the questionnaires. It was sent randomly to different professionals in specific fields (neuroscience, psychology, professional music). The sample was n14 for the professional musicians' questionnaire, n6 for experts in psychology and n6 for experts in neuroscience

Results

We show the results of our research on platforms of scientific journals in the next table. As we can observe, the number of articles found according to the search words, on platforms that have quality articles indexed (Table 1):

Table 1. *Articles research in some archives*

Source	Music – Brain – Elite Result	Music – Brain – Benefits Result
World Web Science	551 articles.	709 articles.
Springer Link	Among more of 4000 articles, there is just one including the three words, and it is addressed to athletes (“A Sound Design for Acoustic Feedback in Elite Sports”).	18072 results, but not interrelated. Only one article in Spanish, but only one coincidence with the words of the research.
DOAJ	We found two articles, one of them related to car racing. This one does mention the word “elite” but addressed to athletes.	Thirty-one articles, bigger coincidence with the words of the research. No results in Spanish.
SciElo	No results.	No results in Spanish, but when the words are introduced in English, there is one in Spanish.
ProQuest	We found seven articles, but none of them related to the three words of the research.	We found twenty-eight results, none of them in Spanish.
Mendeley	We found twelve articles. The one related to the words of the research was addressed to athletes. No results in Spanish.	Using the three words in English, we found 696 articles. In Spanish, we found seventeen results.
Dialnet	We found one article related to architecture (a doctoral thesis).	We found eight documents in English and eleven in Spanish.

Source: self-made

We had no problems finding articles that directly related to elite athletes, although this was not our objective and for this reason, we did not provide any data in this regard, on the other hand, in our search directed to elite musicians, in addition to not finding documents that are relate directly to the theme, others appeared that related our search to car racing, or relation with athletes. Therefore, we can say that even doing a select search, élite and sport provide more documents than elite and musicians, where we have not found anything, except three documents, which we can see in table 2.

In the following table we show the selection of articles that support the problem raised. As we can see, there have not been many articles, which shows an important lack in this context.

Table 2. *Selection of articles*

Wilson S (2013)	“Powerful amongst these is the ability of music to prime the brain for future learning, while more broadly promoting our individual and social wellbeing.”
Moreno S and Bidelman G (2014)	“Importantly, the behavioral advantages conferred by musical experience extend beyond simple enhancements to perceptual abilities and even impact non-auditory functions necessary for higher-order aspects of cognition (e.g., working memory, intelligence).”
Guhn, M., Emerson, S. D., & Gouzouasis, P. (2019)	“Benefits of music learning and its influence on social and personal skills as well as succeeding in subjects such as Maths, Science or English.”

Source: self-made

These three articles, shown in the table above, rank music practice as an important activity for the brain, social skills, and other skills not related to auditory function. The first article cites that there are more than 100 neuroimaging studies showing that music activates multiple brain networks during listening, responding to, and performing music. The second article highlights that the musical experience uniquely takes advantage of a hierarchy of brain networks that serve a variety of auditory and general cognitive functions. It follows that the transfer of a specific musical experience to a broad cognitive benefit could be mediated by the degree or level the musical training. For the third article, we highlight that high musical performance in school is positively related to scores in all subjects

Regarding questionnaire answered by expert in neurology/neuroscience (see appendix 1) we have focused on the contents that we have considered more significant, from the different answers of the specialists who have collaborated with us, highlighting the following opinions:

It intervenes in both hemispheres, in the melodic, harmonic and rhythmic perceptions. It also intervenes in the cerebellum and the subcortical regions.

It acts by increasing the level of their activity.

The right hemisphere is prioritized, especially for both melodic and harmonic perception. Rhythm and tempo are prioritized in the left hemisphere.

It acts by stimulating sensations.

Hearing regions, motor regions, prefrontal regions, cerebellum, insula, occipital (when reading a music score).

When playing or performing, there are possibly more emotional regions being activated. Therefore, besides the ones I have said, I would add the nucleus accumbens and hypothalamus, among others.

The movement of fingers, arms, feet (drum set) or mouth (wind instruments).

A lot of muscles and bones of the body are involved, depending on which instrument is being played. Also, if it is a wind instrument, diaphragmatic breathing is very involved, and it increases or improves lung capacity.

These answers can give us an idea of the importance of the global mind and body in musicians.

The psychology specialists' questionnaire (see appendix 2) provided us with knowledge about emotions and other skills that we summarize below:

There is scientific evidence that supports that studying music for years provides many benefits: development of capacities such as memory, comprehension, analysis or synthesis; increase of listening and learning skills; discipline; teamwork; pride; confidence and self-esteem; sense of belonging; responsibility; self-expression and creativity; team spirit, social development and pleasure; emotional expression. Music education helps students improving their writing and communication skills. There is a relationship between music students and motivation to succeed in school.

Happiness, communication, social relationships

Understanding themselves and others, comradeship, perseverance, motivation, cognitive improvements, relationship skills, emotional skills, perceptive improvements...

A great diversity of knowledge and physical and emotional skills.

Order, pleasure, emotional connection.

Brain development, disease prevention, motivation increase, serotonin, endorphin, social relationship improvement.

Emotional connection, pleasure, amusement.

Improvement in self-perception and group perception, sense of belonging, avoiding loneliness, muscle tone improvement, activation, adrenaline, serotonin, endorphin.

Happiness, communication, social relationships.

Emotional connection, memories

Listening, concentration, memory, basic abilities for respecting turns, group rules.

It reinforces a lot of skills, such as concentration or attention.

Empathy, perseverance, effort, self-esteem, concentration.

Retention capacity, the conscience of sensations, learning skills.

Physical control, coordination, fine and gross motor.

Motor skills, rapidity of physical responses, reflex, coordination, motor memory.

Development of fine motor skills, coordination.

From the previous contributions, we observe how musical practice is not only related to emotions, but also to education, social and personal skills, as well as concentration or teamwork. Positively influencing body and mind.

To know the skills and competencies that are developed from the musical practice we have the questionnaire of music specialists (see appendix 3) whose contributions we point out briefly below:

Intellectually, it provides clarity to my ideas, logic and mathematical analysis, conceptualization, classification, organization.

Encouragement and intellectual challenge.

Music keeps me training my mind and increasing my knowledge.

Significant cognitive progress.

A better understanding of the social and cultural environments.

It helps me understanding abstract concepts. Mental tasks can be made simultaneously, when playing in an ensemble, for instance.

Music is very important to the brain, and it powers both hemispheres. In particular, singing gives me security and self-confidence. It allows me to relax, to organize my thinking, my ideas. It helps me analyzing and better structuring situations, it enlarges my memory.

Breathing and correct body posture.

Expression, creativity, emotion.

To express my emotional "self".

A way to release feelings, both positives and negatives.

It is like my soul's engine, and it gives me spiritual peace.

Happiness, harmony, emotion management.

It is like my soul's engine, and it gives me spiritual peace.

For me, music is emotionally necessary. It allows me to be peaceful, joyful, sensitive... When I sing or play an instrument, I enlarge my principles, patience, perseverance, self-confidence, security and inner strength. I see life differently through music. Actually, music is like the engine of my life.

Peace, tranquility, serenity and good relation with myself.

Socialization, getting closer to other people, empathy, determination.

Social interaction, empathy, communication and capacity for adaptation.

Interpersonal relationships.

It is like a language and as so, it facilitates my interpersonal competences.

Empathy, communication skills.

I think it is really good for social and personal issues. It establishes friendship and trusty ties, the fact of belonging to a group (when playing or singing). It also increases exchanges with no further interests, and tolerance, self-esteem, expression. It can be like therapy, too. Finally, we can find a way to have fun and joy.

Serenity, activation, ineffable experiences, vitality.

Attention, concentration, perseverance and presence.

Being creative.

Concentration, discipline, responsibility and teamwork.

Spirit of sacrifice.

Mind structure, perseverance in a job, following long-term and short-term goals, motivation.

I think music gives me more capacity for thinking, organizing, analyzing, listening, memorizing, relaxing... I think it is very useful for other tasks.

I would miss empathy, determination and a deep view of life.

Creativity, interpersonal relationships.

Discipline in my job.

I will have a lack of work and curiosity. I would miss that break from reality that music makes you experience.

I would be less organized when doing my daily chores.

If I were not a musician, I believe that I would need to become one, because of all the benefits that music provides. Moreover, I think everybody has to receive a musical education since they are born or even before.

Consciousness of an audio-mental-corporal connection.

The contributions of the musicians have positively surprised us, as we expect comments regarding music (such as interpretation or technique on the instrument), however, they highlighted that musical practice helps them in their emotions, in social and personal relationships, in addition to concentration and teamwork. Valuing the sacrifice and effort involved in dedicating yourself to music professionally.

Analysis and discussion

Given these results, we have selected some articles to support our hypothesis about the capacities and skills of musicians, beyond those of athletes.

Results obtained from our research prove that there are more studies related to athletes than to musicians. However, the content of those articles shows that musical activity (or learning how to play a musical instrument) requires physical and mental conditions up to the highest level, which does not mean that a musician is required to do sport. In our view, any physical activity, such as dancing, can keep a musician in a good physical condition (even yoga).

In our select search, we discovered that there were more articles by elite athletes, even when the search did not go to find them, which shows us that there is indeed more interest in elite athletes than in elite musicians.

The responses given by specialists (musicians, neuroscientists or psychologists) describe what practicing music can involve: improved cognition, focusing, creativity, perseverance, effort and work appreciation, self-consciousness, better personal and social relationships, etcetera. From a neurological or neuroscientific point of view, it should be noted the connection existing between both hemispheres when playing music. This connection also improves the sense of hearing, the motor and prefrontal regions, and the activation of emotional regions of the brain.

Regarding the psychological view, improvements in emotions must be highlighted, since music is able to improve all of them. Besides, it affects the brain favorably, and it promotes social and personal relationships. It also increases the level of serotonin and endorphin, and it is believed to be able to prevent some types of illnesses. It also has an impact on psychomotricity, coordination, reflex or motor memory, among other benefits.

Capacities and skills of elite musicians

From our research and analysis of the results obtained, we can make a first estimation of musicians' abilities and skills, not as elite athletes, but as entirely elite persons. We summarize it in the next table (Table 3):

Table 3. Capacities and skills of elite musicians

Capacities and Skills			
Social	Personal	Cognitive	Motor
Leadership Teamwork Collaboration Cooperation Empathy	Self-esteem Effort Self-motivation Critical spirit	Concentration Attention Discipline Memory Mathematical processes Linguistic processes Technological processes	Breathing Fine motor skills Gross motor skills Corporal expression Physical effort Physical efficiency

Source: self-made

Observing this last table, we can make a general map of the skills that musicians develop in their practice and interpretation, highlighting the motor part, by relating it to athletes, but putting in value the rest of capacities and skills, such as those related to cognitive, social and personal processes.

Conclusions

We started our research to test the hypothesis that musicians' activity goes beyond elite athletes'. We have seen that there are barely a few reviews, studies, or articles explaining the significance of the activity of musicians over the activity of athletes. Nevertheless, if we google “elite musician”, almost every result is related to sport. When we found an article about elite artists, we tried to link some important points, but it took us back to sports.

Musicians, music students, or performers do some activities that do not exist in other professions. Not even in sport. Those working in music, practicing music, teaching or performing, do develop abilities and skills that make them specials. Therefore, the effort of these persons should be valued as well as the contribution to society that they make. Besides the entertainment, there is a more significant part coming from music education. Schools from all stages offering music in the curriculum do provide a better education. Athletes' recognition involves advantages such as university admissions, competition permits, or grants. These advantages are equally (or more) deserved for

musicians. In a country where equality, non-discrimination and inclusion are sought, we find that those making bigger efforts in their learning and training obtain significant disadvantages. Moreover, those have to invest more time and money for equipment and other resources, as indicated by the answers of the experts in the questionnaires.

To conclude, we cannot forget the answers given by the respondents (neurologists, psychologists and musicians), the power of music into the human brain, the capacities in which it can positively interfere and the potentiality that it has to grow as an individual. In our view, and given the documentation collected, we consider that music, in both professional and amateur fields, is necessary for the life and development of a country.

Putting together all the contributions, we consider that musicians' activity is more significant than athletes' because music intervenes, at cognitive and physical levels, in both social and personal relationships. It also improves the quality of life, and our hypothesis for a future study is that all these factors can enhance the employability and the sustainable development of a country.

However, we consider that a broader investigation is necessary to allow us to put together control and experimental groups among musicians and athletes, as well as a review of other countries regarding the advantages and disadvantages that elite musicians and athletes have.

Future Research Lines

In this paper, we have seen that there are barely a few reviews, studies, or articles explaining the significance of the activity of musicians over the activity of athletes. When we found an article about elite artists, we tried to link some important points, but it took us back to sports. Musicians, music students, or performers do some activities that do not exist in other professions. Not even in sport. Those working in music, practicing music, teaching or performing, do develop abilities and skills that make them special. Therefore, we present below some of the future research lines:

- Work on the design of competences and skills for elite musicians.
- Design a definition to recognize elite musicians.
- Set up working groups to elaborate the contents of the possible categories of elite musicians, which could be: high-performance musicians and high-level musicians

Ethics approval and Availability of data and material

Participants were informed of the study to be conducted and authorized their commitment to disseminate the data and results.

The most relevant data is available in this paper. The sources consulted are freely available.

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Appendix 1: Expert in neurology/neuroscience

1. How does music act in a musician's brain?
2. How does music act in a non-musician's brain?
3. What brain connections are activated when practicing a music instrument?
4. What brain regions are activated when playing music?
5. What motor actions are developed when practicing a musical instrument?

Appendix 2: Specialists in psychology

1. Which emotions can music improve?
2. What can music provide children with?
3. What can music provide adults with?
4. What can music provide older people with?
5. What abilities can music reinforce?
6. What physical aspects can music contribute to?

Appendix 3: Specialits in music

1. What does music provide you intellectually?
2. What does music provide you emotionally?
3. What does music provide you, related to social and personal skills?
4. What does music provide you, related to other jobs or chores?
5. What do you think you would be missing if you were not a musician?