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DIFFERENT TYPES OF MUSICAL TRAINING BASED ON THE ELEMENTS OF MUSIC: RHYTHM, MELODY AND HARMONY

AND THEIR RELATIONSHIP WITH THE PERFORMANCE OF EXECUTIVE FUNCTIONS

Modified version of the Doctoral Thesis Project II. Objectives, hypotheses and methodological aspects, based on the feedback of the candidature presented on May 30, 2017.

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Introduction

Extended musical training over time could generate various cognitive advantages. This is probably the reason music has become relevant to human development research in last decades. Literature, since Bever & Chiarello (1974), shows evidence of differences in the cognitive processing between people who have received musical training and people who have not.

In essence, music has different elements, which conform a musical work. Composers use rhythm, melody and harmony to generate various musical textures. With this kind of music treatment, composers are able to make music more expressive for the audience's experience.

Although there is no absolute definition of "music training," it is necessary to distinguish between interpretation (i.e., playing a musical instrument) and music appreciation (i.e., the hearing of music). This distinction is relevant since, as it will be revised later, music hearing usually contains all the music elements whereas music interpretation does not necessarily.

There is a robust theoretical basis and empirical evidence that the music elements are processed in a different way in our cognitive system (Snyder, 2000; Levitin, 2006; Patel, 2009; Platel, 2009; Tan et al., 2010). Musical instruments tend to respond in greater proportion to one music element rather than to all of them together. Thus, theoretically, music interpreters maintain a different neurological stimulation during the personal training time, which varies according to the brain areas that are stimulated.

In neuroscientific terms, areas that involve music activity (and where these differences are generated) are linked to some aspects of cognition related to the processes of executive control (Snyder, 2000; Levitin, 2006; Patel, 2008). The evidence in cognitive psychology agrees with the neuroscientific issues, showing that the population with music training has a more efficient cognitive processing, despite the great variability that the studies have and the methodological discussions that are presented in literature.

This study aims to generate more evidence on the eventual cognitive advantages that people with music training may have. Data will be analysed according to the preponderance of the music element that is stimulated in the hours of soloist study, considering that this training involves specific zones of the brain in comparison to others. Theoretically, this stimulation differentiated by the predominant element of music training will correlate with the performance in executive control.

Music Elements

The human ear has the ability to hear a range of frequencies, ranging from about 20 to about 20000 hertz (Olson, 1952). This range is called sound. Music is *sounds and silences in order*, and this order can have or lack the following elements:

a) Rhythm

Rhythm is understood as the sequencing of short or long sounds, regular or irregular in time. Neurologically, rhythm is understood as a human characteristic defined as the ability to solve acoustic events with up to twenty separations per second (Snyder, 2000). At the same time, rhythm tends, to a greater extent in comparison to other brain areas, to use circuits of the cerebellum and the motor cortex (Levitin, 2006). In general terms, these sound sequences are grouped in binary or ternary accents. Although there are more complex alternatives, these are just a mixture of sequences of two and three accents, as shown in diagram 1. The cognitive difference between the binary and ternary distribution happens because these is a natural distribution of accents. In the binary sequences, the first accent is strong and the second is weak, whereas in the ternary distribution the first is strong, and the second and third are weak.

Diagram 1: Binary and ternary sequences. Complex sequences example.

Binary sequence:	Strong accent: >
> . > . > . (etc.)	Weak accent: .
Ternary sequence:	
> . . > . . > . . (etc.)	
Complex sequences example:	
5 (2+3) > . > . .	
5 (3+2) > . . > .	
7 (2+2+3) > . > . > . .	
7 (2+3+2) > . > . . > .	
7 (3+2+2) > . . > . > .	
(…∞)	

b) Melody

Melody is defined as acoustic events organized sequentially at “high” or “low” levels (without overlapping). It is required that these acoustic events have a defined frequency within the human auditory range, so that the musical note is generated. There are recognizable patterns of sound contours in this human auditory discrimination (Snyder, 2000). The neurological discrimination of melody occurs in an area of the brain different from rhythm, specifically in the primary auditory cortex. here, the sounds or higher frequencies (sounds such as the female voice compared to the male voice, or a soprano flute in comparison with a bassoon) are discriminated towards the central zone of this cortex, and sounds in lower frequencies (the voice of Barry White compared to a Michael Jackson voice) are discriminated towards the outer limits of this area of the brain (Tan et al., 2010). Some milliseconds after melody sounds are processed in the organism, the frontal cortex dorsolateral is involved in electrical activity (Levitin, 2006). Diagram 2 exemplifies a melody written in a score. As can be seen, two sounds are never presented simultaneously, thus, it is a sequence that distributes a single sound that varies in frequency (musical note) over time.

Diagram 2: Melody example

c) Harmony

From a musical and neurological perspective, *Harmony* involves the most complex case. There is a great discussion from musicology to consider a minimum of sounds in order to classify a sound event as “harmony”. While some authors postulate harmony requires a minimum of three notes sounding simultaneously, others consider necessary only two notes. For purposes of this study, harmony is defined as *more than one musical note sounding simultaneously.* Neurologically, the areas involved in auditory discrimination in harmony would be wider than the areas of the two previous elements (rhythm and melody), involving the dorsolateral frontal cortex in greater proportion than the melody, and in addition to the areas of Brodmann 44 and 47 (Levitin, 2006).

The following diagram illustrates harmony, showing a fragment of a piece written for piano. It can be seen that unlike melody, on the Y axis of the image, there is more than one note sounding simultaneously, and in this case, the interpreter must be attentive to control many more sounds.

Diagram 3: Harmony example

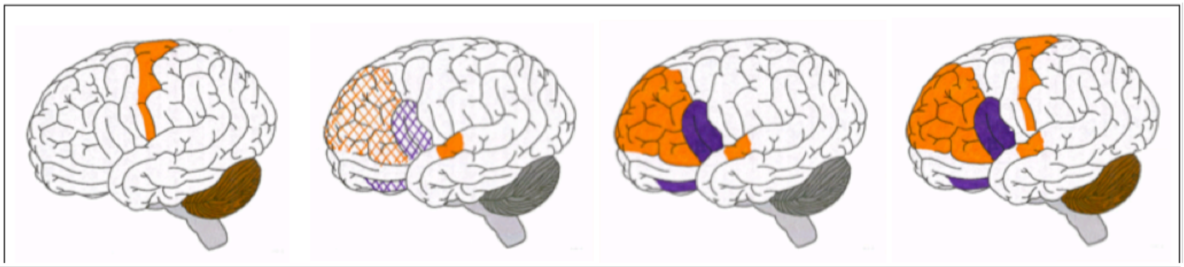
Cognitive processing: listening and music interpretation

There is strong enough empirical support to link the exercise of music appreciation (listening) with stimulation of all brain regions, starting from subcortical structures and moving posteriorly from the auditory cortex to all other regions of the brain (Levitin, 2006). In addition, from the patterns of neural processing that listening entails, there exists an interchange of brain activity that involves some neurons getting excited and others inhibiting their processing (Plack et al., 2005), same as it occurs in other cognitive processes. On the other hand, active music listening (conscious appreciation of music) involves complex cognitive representations (Patel, 2008; Koelsch, et al, 2013).

Different from appreciation, music interpretation may consider activating different elements of music (rhythm, melody and harmony), which are processed differently in the brain. rhythm addresses the use of circuits of the cerebellum and motor cortex (Levitin, 2006), melody attends to the use of the primary auditory cortex and dorsolateral frontal cortex in a low proportion (Levitin, 2006; Tan et al, 2010), and harmony involves the participation of the dorsolateral frontal cortex in greater proportion to the melody, adding the areas of Brodmann 44 and 47 (Levitin, 2006). These findings are also supported by reports of investigation about people with brain damage that present interference in tone discrimination (frequencies) but not in rhythmic issues or in their time perception (e.g., Liégois-Chauvel et al., 1998). These results would show a difference in the brain areas associated with the elements of music.

The following diagram contains images based on the theory and empirical evidence of studies that have been performed with different techniques of analysis (mainly electroencephalography and magnetic resonance) for rhythm, melody and harmony. It suggests a difference between the exercise of interpretation and the one of musical appreciation.

Diagram 4: Sectors stimulated in the brain and cerebellum with the use of rhythm, melody and harmony in music performance, and all the elements in music appreciation.



Rhythm	Melody	Harmony	All elements
Music interpretation			Appreciation

Music appreciation considers listening to music with all its elements in almost all cases. Few musical compositions lack the use of any of the elements of music, because these same elements enable the auditor to experience rich sound qualities, a characteristic searched for composers. This music appreciation differs in terms of neurological and cognitive processing with instrumental interpretation, which involves training the prevailing use of some music elements, and with it, the stimulation of only some areas of the brain during the periods of autonomous study (soloist) of the musicians.

Literature about the relations between music training and development of complex cognitive processes often makes the distinction between appreciation and music interpretation. At both levels, when there is training, further development of complex cognitive processes is demonstrated, particularly in executive functions, also called cognitive control or executive control.

Executive Functions

The executive functions (EF) are “a general purpose control mechanism that modulates the operation of several cognitive sub-processes, regulating the dynamics of human cognition” (Miyake, et al., 2000). It is a concept used globally to describe more specific skills or functions. Among the sub-processes that make up the EF are: working memory, cognitive flexibility, cognitive and behavioural inhibition, planning, monitoring and ideas organization (Miyake et al., 2000; Diamond, 2013). The EF are the result of a long evolutionary process, which is supported and facilitated by the development of the prefrontal cortex (Centre on the Developing Child at Harvard University, 2011).

There are three executive functions that are proposed as fundamental according to Diamond (2013): inhibitory control, cognitive flexibility and working memory. The first, inhibitory control, allows us to consciously direct attention, the course of thought, behaviour, and emotions. It has the effect of cancelling both internal and environmental predispositions. Cognitive flexibility allows us to switch from problem-solving strategies to new situations, detaching ourselves from newly conceived ideas. In case of working memory, this corresponds to the ability to operate with a certain number of mental representations.

Music training and executive functions performance

In the last decades, research has been deeply linking the aspects of cognitive development that could be favoured by music training. On the cognitive sciences side, the findings show evidence in favour of the advantages for EF due to prolonged music study time. These evidences have become robust in terms of main effects in literature. However, there are reports that show more detailed differences for each EF. The main findings of the literature for EF, and the differences between the studies, will be explained in favour of presenting the different paradigms in which musical training for psychology and neuroscience has been covered.

Most of these studies do not consider the same definition for *music training* (MT). For example, some researchers consider MT to be extra-curricular music workshop to schools (Schellenberg, 2009; Degé et al., 2011; Moreno y Farzan, 2015), whereas others consider it as the interpretation in some musical instrument (Zuk, 2014; Ramachandra et al., 2012; Omahen, 2009). In this way, a single definition of MT can not be achieved.

Another problem that arises when reviewing the bibliography is that several studies regard appreciation and music interpretation in the same level. In the appreciation exercise, there is indeed a lot of neuronal stimulation. However, the motor aspects required by the interpretation are greater than in the exercise of hearing, and therefore, this requires a performance that involves wider cognitive skills.

A final problem is generated because the cognitive evaluation tests considered in the investigations vary every time.

In the following sections, we will review some evidence that shows how different types of music training affect performance in EF, and some aspects of cognition. Studies on instrumental interpretation will be emphasized, because this is precisely the aspect that could have differences in stimulation and cognitive performance, according to the training in different musical instruments.

Relations between music interpretation, executive functions performance and another aspects of cognition.

The musical interpretation consists of making the activation of some musical instrument, taking care to develop the sound qualities, in the way that the musical work has been designed (composed). To achieve a higher musical performance, the interpreters devote much of their work to the soloist study, on the basis that an interpreter with greater ability can make the interpretation more expressive. Developing this kind of musical skills is not an easy work. This is why the amount of autonomous work of each musician is usually extensive in terms of number of hours of weekly dedication and years of study.

Some investigations show that when musical performance is prolonged over time, there are advantages in flexibility (Hanna-Pladdy & MacKay, 2011; Zuk et al., 2014), inhibitory control (Palmer, 2013; Moreno & Farzan, 2015), attention (Degé, Kubicek & Schwarzer, 2011), working memory (Meinz & Hambrick, 2010; Pallesen et al. 2010) and monitoring when reading executing music simultaneously (Drake & Palmer, 2000; Oechslin, et al. 2013).

Regarding the evidence that is presented for cognitive flexibility, Hanna-Pladdy & MacKay (2011) conducted a study that measured various performance tests in EF, in adults groups of musicians and non-musicians. These tests were performed in a population of 60 to 83 years old, in three types of groups: musicians with more than ten years of training, musicians with less than ten years of training, and people who have never received musical training. They concluded that the group of people with ten years of MT present better development in EF as a main effect. On the other hand, the same group shows a great advantage in cognitive flexibility (measured by Trail B Test). Regarding the definition of musical training, this study differentiates experts and non-experts in terms of ten years of experience, and the musicians who participated in the research were all musical performers. In another study by Zuk et al. (2014), the evidence presents that musicians have advantage for cognitive flexibility when compared to non-musicians. Regarding young participants, children had to have at least two years of musical training, which requires the interpretation of a musical instrument. In case of adults, musicians were considered people who had a degree in music and who were practicing music as professionals at the time of data collection. They used the Delis-Kaplan Executive Function System, showing differences in favour of the population that had any type of musical training, particularly in flexibility. In the case of children, a multimodal flexibility test with fMRI was also used, where significant differences were observed for the population with musical training versus the one that did not have this type of training.

In terms of inhibitory control, a study conducted by Moreno and Farzan (2015) examines the results of electroencephalography (EEG) and a battery of measurement for children (Wechsler Pre-school and Primary Scale of Intelligence, WPPSI), looking for the correlation that exists between the test and the EEG. They take children from schools that belong to two groups of extracurricular workshops: visual arts and music. Finding show that the group with musical training presents advantages compared to the visual arts group, they postulate that music strengthens non-auditory functions, which in turn generate benefits to behaviour, such as inhibitory control. This particular ability suggests a strengthening given by music when compared to other types of extracurricular training that do not show the same findings.

A very important point to note is that there is evidence that the cerebellum, in addition to motor functions, has implications on cognitive and affective functions (Garriga-Grimau, et. al., 2015). As previously reviewed, musicians who have rhythmic music training strengthen the electrical activity involving these zones of the system, suggesting that in the case of these musicians (rhythmic), a difference in some cognitive aspects may be seen in comparison to musicians with melodic or harmonic music training (non-directional).

The nature of the association between musical training and intelligence is not fully understood, despite the great amount of evidence that playing a musical instrument improves cognitive abilities. On the other hand, it is not understood if this relation is direct or there are other variables that act as mediators. Schellenberg (2011) designed a study that poses the EF as the main mediator between that relation. It takes 106 participants and divides them into four groups: people with more than three years of music training, people with up to two years of music training, and two control groups for each study range for the groups of musicians. He uses the Wechsler Abbreviated Scale of Intelligence (WASI) test battery. He concludes that with the evidence that his data shows, he cannot assure that there is mediation of EF with intelligence. However, Degé, Kubicek y Schwazer (2011) based on replicating Schellenberg's research (2011), propose to include a report from the parents in the design, which can better estimate the musical heritage of each student. In addition, they propose to include some data concerning the socio-economic status and an enhanced battery of EF called NEPSY II (Developmental Neuropsychological Assessment for Children). They, contrary to Schellenberg's work (2011), confirm that the relation between music lessons and intelligence is mediated by EF. In addition, attention is particularly favoured. On the other hand, they clarify that the methodological problem of Schellenberg (2011) is that it considers its variables categorically, and they propose the analysis of data from the multiple regression, generating ranges of musical training to do the regressions.

Regarding working memory, Meinz and Hambrick (2010) performed a series of tests whose main objective was to determine if there was a correlation between this cognitive level and musical ability. They take a sample of music students and others who received different trainings. The results show that for working memory there is an advantage in music students compared to students who have other types of extra curricular training. In turn, Pallesen et al. (2010) present a study performed with n-back Tasks Test (1 and 2) to measure working memory in addition to other passive listening tests, looking at correlations between these tests, blood oxygenation (BOLD), and brain activity (fMRI). The evidence generated by this study showed differences in working memory in favour of students who had MT, as did other studies, and these correlated positively with measures of oxygenation and brain activity.

Finally, it is interesting to cite the research of Ramachandra et al., (2012). This approach (coming from a descriptive study) contributes to the generic understanding of the study of MT and EF. Phonological memory and central executive components tests were taken for two groups of undergraduate students, where “musicians” were considered individuals who had played a musical instrument before the age of ten, and who played around of four hours a day, whereas the control group was defined as “non-musicians”. They conclude that the population with MT was more efficient in some basic processes such as processing speed, storage and processing of simultaneous information, executive attention, mental union and suppression of irrelevant information. According to the analysis of their findings, the major approach proposed by researchers is that people with prolonged MT have “enhanced” cognitive processing, supported by evidence that indicates a higher ability of these people to process important and predictable elements of the income signal sensors, and the high sensitivity of differentiating between speech and noise.

From the investigations reviewed, it is seen that MT contributes some aspects of human cognition. The evidence offers results in favour of cognitive and behavioural inhibition, flexibility and working memory, and other cognitive aspects.

What is understood by music training?

Studies currently encompassing cognitive aspects and human musical training provide a fairly robust framework of evidence for the area. However, these studies differ from the same definitions for music training (MT) and the way they regard an expert or non-expert musician.

Ericsson & Lehman (1996) and Omahen (2009) propose a dividing line between a before (amateur) and an after (expert) in the musical exercise. They found differences in measurement of tests involving high cognitive processes while measuring musical activity or ability. The researchers propose that this dividing line would be around ten thousand hours of training in a specific instrument. The evidence that fuels this proposal is drawn from studies involving particularly pianists, none of whom had had less than ten thousand hours of piano exercise. According to their performance, in the musical and cognitive fields, such as the EF, it was possible to appreciate significant differences in favour of the cognitive aspects in musicians, categorizing in that way experts and non-experts musicians. These figures distributed in years (considering a training of thirty to forty hours of dedication per week), would translate between four and five years of exercise in music to cross that line. This evidence allows having a temporal reference in which an expert musician differs from a non-expert (or a non-musician).

From this point of view, the MT is implicitly understood in music interpretation, in other words; the execution of any musical instrument. MT definition moves away from musical appreciation, since it only considers a part of the training, which is reduced to listening, leaving aside the learning that individuals can have when playing a musical instrument. Basically, listening to music could make you an expert only in terms of knowing how to appreciate it and knowing its differences (e.g., knowing the difference between rock and reggae music), but it does not lead to brain plasticity that is generated when playing music (Jäncke, 2009).

Literature lacks some important aspects to consider for music and cognitive performance. The amount of time training takes, the type of training, the elements of the music that are involved in greater proportion in the soloist study, and the musical ability that the individuals have are factors that can help to understand more completely the study of music and psychology.

Control variables that could intervene in the relation between Musical Training and performance in Executive Functions.

Many factors could influence cognitive performance. There is a diverse bibliography for both (music and psychology) that shows influential factors in executive functions. It is necessary to include control variables in any type of studies that relate the performance of EF to this type of factors, in order to control any research design.

Bilingualism could be a relevant factor in analysing EF performance. Bialystok & DePape (2009) show evidence that population with monolingual music training obtain similar results with non-musician bilingual population in terms of EF. On the other hand, bilingualism generates advantages in EF performance, as seen in Bialystok et al. (2009). Management of a second language should be considered when measuring EF and MT, on the basis that bilingualism may explain much of the variance but not necessarily MT.

Laterality it is also been important factor to consider in the development of EF. Robust evidence is generated from three studies that cover from different angles the findings that show performance in cognitive tasks, different for right-handed or left-handed people. Studies with different designs show discrepancies in the development of cognitive aspects between right- and left-handed people, being the latter who develop these skills better. The case of Beratis et al. (2013) shows that there are significant differences in favour of lefties in flexibility, inhibitory control and operations involving working memory, between these two groups. This evidence is supported by findings such as that of Nettle (2003), where the statistical problem that suggests studies in laterality through evidence found in multiple regression. A final study that analyses the development of EF and involves laterality is a study by Powell et al. (2012) using fMRI as the main analytical technique for correlating EF. This study shows evidence that lefties have a lower working memory development, which would be related to prevalence in the area of language in the brain during working memory tasks. The findings that are supported in this section suggest including laterality as co-variable in the study of MT and EF.

One of the recurrent analyses that can be seen in the literature regarding cognitive development is the incorporation of the *socio-economic status* (SES). Rosas & Santa Cruz, (2013) for example, suggest that cognitive capital in Chile is unequal, and depends largely on the income quintile to which students belong. In favour of research in the area, and for the detriment of education in Chile, it is enough to have few data (parents' educational level and school dependency) to know what the main cognitive capital each person has is. As recently mentioned, this factor that influences the development of EF in the Chilean reality is an aspect to be considered in any study that covers these topics, as is this particular case of the study that relates the areas of MT and EF in Chile.

Some of the EF-measuring tests (such as the Wisconsin Card Classification Test, WCST) control their results across the individuals' *ages*. This is due to the accomplishment of meta-analysis of investigations that shows evidence that the EF develop and behave differently according to the age range of individuals (Center on the Developing Child at Harvard University, 2011). From this paradigm it is shown that EF are developed as the principal effect, and with a pronounced upward curve up to twenty-five years on average. Subsequently, this curve decreases progressively and is calculated with data containing EF measurement tests up to the age of 85 in the samples.

As we have seen in this literature review, directly or indirectly, the populations that have had MT have been the object of study for neuroscience and psychology. Of these investigations, some have deepened in the development of EF and MT considering or not, variables that could be related to the cognitive development. One of the questions that has arisen in theses areas is whether the musical ability influences the EF. Slevc & Okada (2015) refer to the structures and processes of language and musical ability, and how they show shared variance in the development of EF. To go deeper into this aspect, Slevc et al. (2016) propose to investigate the correlations between EF and musical ability (measured with the Ollen Musical Sophistication Index, OMSI). This study shows that the higher the musical ability, the better performance in EF.

In this way, the bibliographic review shows that *bilingualism*, *laterality*, the *socio-economic status*, *age* and the *music ability* are variables that could influence the performance of EF, and with this, it becomes necessary to include them as co-variables to be considered in studies that investigate the areas of MT and EF.

Research question

Is it plausible to think that if the stimulation of the processing of the elements of music is different for each musician, there is a difference in the performance of executive functions, grouping musicians according to the elements of the music?

Research proposal

The natural characteristics of the soloist study of musical performers offer an ideal framework for the study of cognition, since the elements of music have not been considered in the literature since the MT, and these are processed differently in the brain. The autonomous work of the interpreters is very extensive, demanding, and requires high-level motor and cognitive control. This control requires years of study to reach a sufficient musical level, which allows to transmit to the auditor what the composer proposed as a musical piece. Interpreters spend many hours working autonomously, depending on the nature of their instrument, and stimulating different sectors of the system, which theoretically will contribute in a different way to the performance in their cognition and EF.

The central thesis of this study is to look for differences in the performance of EF, for rhythmic, melodic and harmonic instrumentalists, on the basis that musical instruments always develop one element of music more than others.

Principal objective of the study

To analyse the performance of executive functions in different groups of musical performers, differentiated according to the elements of music.

Specific objectives

To evaluate the cognitive performance for different musicians in the field of inhibition (cognitive and behavioural).

To evaluate the cognitive performance for different musicians in the field of working memory (verbal and viso-spatial).

To evaluate the cognitive performance for different musicians in the field of cognitive flexibility.

To evaluate the cognitive performance for different musicians in the field of fluid intelligence.

To evaluate the cognitive performance for different musicians in the field of processing speed.

To evaluate the cognitive performance for different musicians in the area of attention (sustained and divided).

To investigate which control variables could affect the study of MT and cognitive performance, by means of using Chilean data and including musical ability as a relevant factor.

Hypothesis

1) Musicians, compared with non-musicians, will show differences in favour of executive functions performance.

2) The groups with musical training will show differences among themselves in the performance of executive functions such as cognitive inhibition, behavioural inhibition, verbal work memory, spatial working memory, and cognitive flexibility, as well as other cognitive aspects such as processing speed, attention divided, sustained attention and fluid intelligence (non-directional hypothesis).

3) There will be a positive correlation between musical ability and performance in executive functions in Chilean data.

4) The group of lower socio-economic level musicians will show results more similar to the high socio-economic level, non-musician group than to low socio-economic level non-musician group, in terms of performance in executive functions and other cognitive aspects.

Methodology

Participants:	N=144, 36 rhythmic musicians, 36 melodic musicians, 36 harmonic musicians, 36 non-musicians (control).
Sample contact:	Step 1: Through the directors (deans) of conservatories (different universities of Chile). Step 2: Snowball sampling, (discriminatory, exponential).
Instruments	- Cognitive Inhibition: Stroop Test - Behavioural Inhibition and Processing Speed: Hearts and Flowers (pure values) - Verbal working memory: Digit Span (WAIS) - Viso-spatial working memory: Binding - Cognitive flexibility, sustained attention: Wisconsin Sorting Card Test (WCST) - Divided attention: Prueba de atención dividida (HAL2) - Fluid Intelligence: FIX (HAL2) - Subjective Social Status: The MacArthur Scale of Subjective Social Status (11 levels). - Laterality: Edinburgh Handedness Inventory

- Music ability: Gold Music Sophistication Index

Procedure - Sample contact

- Data collection (1.5 hrs. each)

- Data analysis

Data analysis

H1) For the first hypothesis, a MANCOVA analysis is proposed. Initially, the necessary assumptions will be checked so that this analysis can be carried out (normality, heterogeneity of variance). In order to detail the weights of each control variable, different analyses will be run in order to see if there is a greater or lesser influence of each of these variables on dependent variables.

H2) For each cognitive aspect, analysis of separate variances (ANOVA) will be used, taking into account each of the control variables inserted separately, and finally all combined. As in the first analysis, the aim is to go into more detail if the control variables have the same weight according to the different dependent variables.

H3) Step 1: A correlation table will be generated in order to see if there is a correlation between the musical ability for each independent variable and the performance in executive functions.

Step 2: Regressions will be generated according to the correlation table for each independent variable, taking into account the musical ability of each group of musicians. Their regression curve will be compared looking for similarity trends.

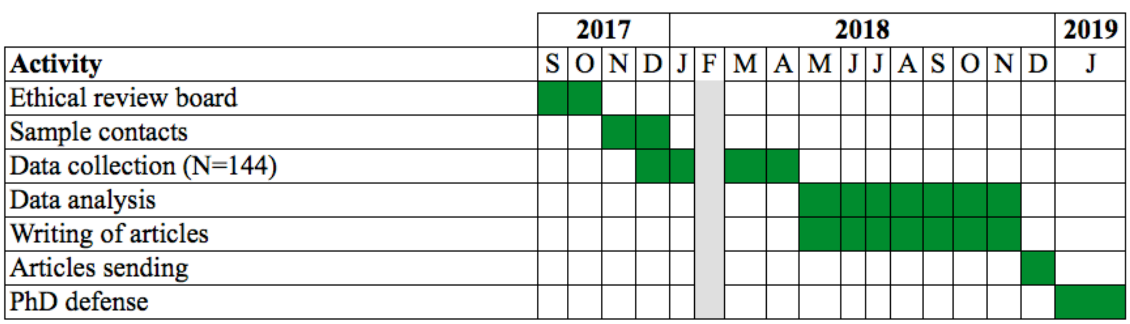
H4) Step 1: A medium-low SSS sub-cluster and medium-high SSS (dichotomy) will be generated for all groups.

Step 2: ANOVA's and ANCOVA's for each dependent variable and each control variable, taking into account the SES grouped dichotomously as a control variable.

Work Plan

- Ethical review board
- Initial sample contact
- Data collection
- Data analysis
- Writing of articles

Diagram 5: Chronogram



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