Musical sophistication explains a good deal of cognitive performance. A cross-sectional study of musicians and non-musicians

Felipe Porflitt
Facultad de Educación, Pontificia Universidad Católica de Chile
felipe@uc.cl

Ricardo Rosas
Facultad de Ciencias Sociales, Pontificia Universidad Católica de Chile
rrosas@uc.cl

Abstract

Musical sophistication is a psychometric construct that can be measured both in people with musical training and without training. Through backgrounds related to musical activities in their lifetime, and other indicators referring to their current events, the person's musical sophistication can be estimated with a relatively high level of reliability (Cronbach's α =.78). In turn, few studies have covered the relationships between variables of this type and cognitive performance, leaving an area of research with little evidence. This study explores the relationship between musical sophistication and cognition, taking a sample of 35 musicians and 35 non-musicians (N=70). The objective was to determine to what extent musical sophistication explains cognitive performance. The Ollen Musical Sophistication Index (Ollen 2006) was used to measure this variable, and a battery of tests enabled the measurement of cognitive performance, which considered verbal and visual-spatial working memory, inhibition, flexibility, a go/no-go test, processing speed, fluid intelligence, and divided attention. Exploratory factor analysis was run, showing two factors for cognition variables. Then regression analyses were run for factors 1 and 2, and both collapsed. The results show that 6 out of 8 cognitive variables correlate positively with musical sophistication, explaining 30% of cognitive performance, after controlling for demographic variables.

Keywords: Musical Sophistication, Cognition, Non-musical Abilities, Music Performers, Adult Musicians.

Introduction

A variety of evidence shows that music strengthens the development of complex cognitive representations (Koelsch, Rohrmeier, Torrecuso & Jentschke 2013; Oeschslin et al. 2013; Oeschslin, Van De Ville, Lazeyras, Hauert & James 2013; Patel 2008), while other studies have shown improved cognitive performance in expert musicians, both in simple and complex aspects. These cognitive relations can be seen in near-transfer and far-transfer skills (Miendlarzewska & Trost 2014). Still, some contradictory evidence for the effect

Fecha de recepción: 29-11-2019 / Fecha de aceptación: 20-04-2020

size of these kinds of training is shown in a meta-analysis (Sala & Gobet 2017). It has been demonstrated that children who have received musical training have significant advantages in the cognitive performance of executive functions[1] (e.g., Jaschke, Honing & Scherder 2018; Moreno et al. 2011; Sachs, Kaplan, Der Sakissian, Alissa & Habibi 2017), as well as in other aspects of cognition such as intelligence (e.g., Doxey & Wright 1990; Schellenberg 2011), phoneme discrimination (Lamb & Gregory 1993), phonological awareness (e.g., Degé, Kubicek & Schwarzer 2011; Moreno et al. 2011), speech perception (Francois & Schön 2011), visual aspects of divided and selective attention (Rodrigues, Loureiro & Caramelli 2013), and even academic performance (e.g., Schellenberg 2006; Young, Cordes & Winner 2013). Other findings have shown that musically trained adults and older people have similar cognitive advantages to children with musical training in executive functions, compared with the people without this kind of practice (e.g., Bugos, Perlstein, McCrae, Brophy & Bedenbaugh 2007; Franklin, Moore, Jonides, Rattray & Moher 2008; Parbery-Clark, Skoe, Lam & Kraus 2009), particularly in tasks associated with working memory (Pallesen et al. 2010). But does cognitive performance vary according to the degree of musical sophistication?

Musical expertise has not been satisfactorily defined in the literature. There are definitions according to the extra-curricular training at school (e.g., Degé et al. 2011; Moreno & Farzan 2015), the musical interpretation of a particular instrument (e.g., Omahen 2009; Ramachandra, Meighan & Gradzki 2012), or experiments that only consider listening to music (e.g., Koelsch et al. 2013). These definitions always depend on the design of the research studies and have considered separating expert musicians from inexperienced ones, typically categorizing them as musicians or non-musicians. This lack of a common criterion or Gold Standard measurement in the area has generated a significant weakness in the state-of-the-art for this topic, starting in the 20th century and continuing in the 21st.

Given this background, Ollen (2006) designed the Ollen Musical Sophistication Index (OMSI). This measurement does not seek to define musical expertise, but rather discriminates the level of musical sophistication of the interviewees (musicians or not), using a questionnaire of ten items, with the following reliability: Cronbach's α =.78. The OMSI makes it possible to generate a scale of musical sophistication, according to the diverse musical backgrounds of the participants, considering the age of the individuals, the age of initiation of their musical activity, the number of years that they have received private classes in an instrument, the number of years of practice with their primary instrument, the current amount of time invested in playing an instrument or singing, if they have studied music at the university level, completed courses or degrees in music, their experience as musical composers, their attendance of concerts in the previous year, and their self-perception regarding professionalism in the discipline of music. Thus, the OMSI can determine the level of musical sophistication according to all the aforementioned factors, and deliver an indicator of musical sophistication on a scale of 1 to 1000. This kind of proposal comes from the paradigm that musical sophistication is not exclusive to music performers, but also appears in every human culture, where the participation of society members in several music activities is cross-sectional and is not necessarily linked to a music type, playing any musical instrument, or reading music notation. For example, listeners, DJs, fans, music producers, among others, have differences in the knowledge of music too (Müllensiefen, Gingras, Musil & Stewart 2014). In particular, this paradigm and scale (OMSI) allow us to expand some connections where literature had a

1. These are also called cognitive control or executive control (Miyake et al. 2000; Diamond 2013).

lack, comparing this kind of measurement in the population that plays and does not play any musical instrument.

The construction of this measurement was based on previous studies by the same author and validated by expert musicians (Ollen 2006). From a considerable number of initial indicators (38), this measurement collected the ten items listed before, which are the most relevant in a person's musical trajectory, according to previous research results with expert musicians (validation through experts). Another aspect to mention is that the OMSI offers a categorization of consistently sophisticated people in music and others who are not. This categorization is done according to the probability that a music expert would categorize a person, based on their musical background, as either "more musically sophisticated" or "less musically sophisticated". For example, if a participant scores 750 in the OMSI, the probability that an expert would categorize them as more sophisticated in music is =.75.

Unlike other tests used in the 20th century (e.g., Bentley 1966; Gordon 1989; Law & Zentner 2012; Seashore, Lewis & Saetveit 1960; Wallentin, Nielsen, Friis-Olivarius, Vuust & Vuust 2010; Wing 1962), the OMSI does not behaviorally measure musical ability, understood as playing a musical instrument or singing (Hallam & Prince 2003), or as the musical talent associated with playing an instrument (Levitin 2012). Nor does it measure musicality, typically associated with the emotional aspects that music can evoke (e.g., Gembris 1999; Revesz 1953). This characteristic of the OMSI is what allows it to measure the musical sophistication of musician and non-musician participants, i.e., people sophisticated in music (>500 points) or people non-sophisticated in music (<500 points), and in turn, discriminate within each of these groups on a scale of 500 points.

On the other hand, there is robust evidence showing improved cognitive processing in the population with music training (e.g., Bugos, Perlstein, McCrae, Brophy & Bedenbaugh 2007; Degé et al. 2011; Franklin et al. 2008; Moreno et al. 2011; Miendlarzewska & Trost 2014; Pallesen et al. 2010; Parbery-Clark et al. 2009; Zuk et al. 2014). In the case of Slevc, Davey, Buschkuehl, and Jaeggi (2016), there is a clear relationship between musical ability in auditory discrimination, the level of sophistication and musical ability, and the relationships of these variables with executive functions. Their study shows that the higher the musical ability, the better the performance in some variables, such as working memory in auditory and visual aspects. Similarly, Müllensiefen et al. (2014) propose that musical sophistication, observable through individual musical backgrounds (such as those measured by the OMSI), can show differences in the cognitive system of both musicians and non-musicians. Although there are precedents that show diverse relationships between these variables, few studies have investigated the associations of musical sophistication with cognitive performance, both in complex cognitive processes (e.g., executive functions or fluid intelligence), and in simpler ones (e.g., reaction time or speed processing).

Among the factors that benefit from musical training are executive functions, understood as the ability to control and regulate our thoughts and behaviors. It is a concept that is used in a general way to describe several sub-processes of human cognition (Miyake et al. 2000; Diamond 2013). Within these sub-processes, three have more critical relevance in one's lifetime: inhibition, working memory, and flexibility (Diamond 2013). Inhibition is understood as the ability to manage behaviors, thoughts, attention, and emotions, thereby canceling the individual's internal predispositions and the external predispositions from the environment (Diamond 2013). Working memory is understood as the ability to operate with several short-term mental representations, with a high component of storage and processing of the cognitive system. This ability allows decoding incoming information in an auditory channel, as well as in written systems or numerical symbolization (visual) in stages of learning (Baddeley & Hitch 2010; Hoffman, Gschwendner, Friese, Wiers & Schmitt 2008; Santa Cruz & Rosas 2017). Flexibility is understood as the ability to change problem-solving strategies in the face of new situations. It allows us to observe situations from more than one point of view, or get rid of previously conceived ideas (Diamond 2013). Added to this are other cognitive aspects associated with music training. Fluid intelligence is understood as the ability to perceive relationships between new stimuli, independent of a specific practice or instruction regarding these same stimuli (McGrew 1997). It is associated, in turn, with the resolution of problems in emergent situations (Cattell 1963). Processing speed is understood as the ability to perform simple cognitive tasks in a repetitive, fast, and fluid manner. It is a secondary skill compared to other aspects of cognition, although it has established itself as a good predictor of performance in complex cognitive tasks (McGrew 2005). Divided attention is understood as the ability to execute more than one task simultaneously (Hahn et al. 2008), dividing or rapidly changing the attentional focus (Parasuraman 1998). Few studies have analyzed the relation between divided attention and musical training. However, the areas of the nervous system associated with this ability are similar to those stimulated when hearing or interpreting music (e.g., Besson & Faïta 1995; Levitin 2006; Petsche, Lindner & Rappelsberger 1988; Pretto & James 2015; Riva, Cazzniga, Esposito & Bulgheroni 2013). As previously mentioned, all the cognitive aspects described here have been related to an improvement in performance in a population with musical training (musicians), compared to people who have not received this type of training (non-musicians).

The objective of this study is to determine how musical sophistication explains cognitive performance in a balanced sample of people with and without musical training. In this sense, the central hypothesis in the present study was to evaluate if musical sophistication impacts cognition. To carry this out, various indicators of cognitive performance were considered, such as verbal working memory, visual-spatial working memory, cognitive inhibition, a go/no-go test, cognitive flexibility, processing speed, fluid intelligence, and divided attention, and musical sophistication measured with the OMSI.

Method

Participants

To generate a balanced sample between musician and non-musician participants, we included 35 musical performers consistently sophisticated in music (musicians' group), and 35 not consistently sophisticated in music (non-musicians' group). All the sample was monolingual (Spanish speakers), separated for the results in the OMSI. The age average was 30.5 years old (*SD*=6.41). 32.9% of the participants were women. Initially, there was a larger sample, 35 non-musicians and 101 musicians. They had participated in two previous studies of the same research team, where musical sophistication was controlled. These previous studies considered contacting people through snowball sampling. The balance between musicians and non-musicians and snowball sampling prevented the balance between men and women because of the characteristics of the present study. Although the sample was not balanced between male and female, studies that report differences in cognitive performance do not analyze the variables included in the present study, or the same age range (e.g., Lauer, Yhang & Lourenco 2019). To select the 70 participants, we chose 35 people with a higher level of musical sophistication, and the other 35 with a lower level, to balance the sample between musicians and non-musicians. Thus, the musical sophistication level for the musicians' group was 921 (*SD*=80), and for the non-musicians' group it was 163 (*SD*=113), measured by the OMSI. The participants of the musicians' group were performers in several musical instruments such as piano, guitar, violin, flute, trumpet, singing, orchestral percussion, and drums, among others. The participants of the non-musicians group do not play any musical instrument.

The participants signed an informed consent form before the measurement, approved by the Research Ethics and Security Unit of Pontificia Universidad Católica de Chile, respecting national and international regulations for research in Social Sciences according to the Geneva agreement. The participants received no incentives of any kind (e.g., gifts, credits for a course, or money) to participate in the study.

Instruments

A translation to Spanish of OMSI was created, as it was Spanish speakers who measured this variable in the sample (see Appendix 1). The OMSI makes the formula presented on page 9 to calculate each value; Ollen (2006) proposes a sum, according to the weight of each of the answers given by the participants, calculated logarithmically. According to the author's data, a constant of -3.513 (logit) is used as a base, and the values presented in Table 1 for the participant's answers (sum).

Item	Sub-Item	Description	Logit Factor
1	-	Age	.027
2	-	Age at commencement of musical activity	-.026
3	-	Years of private lessons	-.076
4	-	Years of regular practice	.042
5		Current practice	
	a	Rarely practice	0
	b	About 1 hour per month	-.060
	c	About 1 hour per week	-.098
	d	About 15 minutes per day	-.301
	e	About 1 hour per day	-1.211
	f	More than 2 hours per day	-1.528
6	-	Enrolled in music courses (college or university)	N/A
7		Music coursework completed	
	a	None	-.423
	b	1 or 2 NON-major courses	.274
	c	3 or more NON-major courses	-.616

	d	Introductory music program for Bachelor's level work	.443
	e	1 year of full-time coursework in a Bachelor Music degree	.055
	f	2 years of full-time coursework in a Bachelor Music degree	2.801
	g	3+ years of full-time coursework in a Bachelor Music degree	.387
	h	Completion of a Bachelor of Music degree program	1.390
	i	One or more graduate-level music courses or degrees	3.050
8		Experience in music composition	
	a	Never composed music	0
	b	Composed bits and pieces, but never completed a composition	.516
	c	Composed one or more completed compositions, but not performed	1.071
	d	Composed music just in an educational environment	.875
	e	Composed music performed for local audience	.456
	f	Composed music performed for regional or national audience	-1.187
9		Concerts attended in the last 12 months	
	a	None	0
	b	1 to 4	1.839
	c	5 to 8	1.394
	d	9 to 12	1.713
	e	13 or more	1.610
10		Self-description as musician	
	a	Non-musician	0
	b	Music-loving non-musician	-.553
	c	Amateur musician	.328
	d	Serious amateur musician	1.589
	e	Semi-professional musician	1.460
	f	Professional musician	2.940

Table 1 / Ollen Musical Sophistication Index variables factors.

Since the interpretation based on logarithms can be confusing, a probability of prediction (*P*) is proposed through the following formula: $P = e^{Logit} / (1 + e^{Logit})$, where *e* = logarithmic natural base (approximately 2.718). As previously stated, if the result is higher than .50, the probability that an expert would categorize the participant as "more musically sophisticated" is more than 50%. This is why in the present study, the musicians' group has more than 500 points, and non-musicians have less than 500 points, far from the center. The scale from 1 to 1000 delivered by the survey is an expression of the prediction probability within that range. The survey is available online, in English, at the following link: http://marcs-survey.uws.edu.au/OMSI/index.php.

For cognitive variables, the following battery test was administered to measure the performance (Table 2).

Dependent Variable	Test	Test Type
Cognitive flexibility	Wisconsin Card Sorting Test	Form
Verbal working memory	Digit Span (WAIS-IV)	Form
Cognitive inhibition	Stroop Test	Form
Go/No-go	Cats & Dogs (YellowRed)	Tablet
Visual-spatial working memory	Binding (YellowRed)	Tablet
Divided attention	Divided attention (HAL2)	Tablet
Fluid intelligence	FIX (HAL2)	Tablet
Processing speed	Cats & Dogs (YellowRed)	Tablet

Table 2 / Battery test.

As was previously mentioned, a Spanish translated version of the OMSI test was administered to measure musical sophistication. However, the test showed similar reliability to the original psychometric data (original α =.78, present study α =.77).[2] On the other hand, there is another test measuring musical sophistication in the literature: The Goldsmith Musical Sophistication Index (Gold-MSI) (Müllensiefen et al. 2014). This test also shows high reliability (sub-scale 1=.80; sub-scale 2=.92)[2], but requires near to 40 minutes for the musical sophistication measure, and the OMSI just a couple of minutes. For the nature of the present study – that balances the sample between musicians and non-musicians –, OMSI was chosen over Gold-MSI to measure musical sophistication, because a) OMSI did not consider behavioral responses, b) Gold-MSI needs more time to reply to a similar variable to OMSI, c) Gold-MSI requires special conditions for the auditory stimuli, and d) auditory stimuli could affect the non-musicians' group in the case of the present study. Thus, we chose the OMSI because of the reasons previously mentioned, and because it is a continuous variable, which fits with our analytic plan for the regression models.

With regard to dependent variables, cognitive flexibility was measured with the Wisconsin Card Sorting Test (Grant & Berg 1948; Heaton 1981), an index that considered the variables of perseverative responses, perseverative errors, non-perseverative errors, completed categories, and learning to learn. Verbal working memory was measured with an index of the three conditions of Digit Span (forward, backward, and sequence), a sub-test of the Wechsler Adult Intelligence Scale (WAIS-IV; Wechsler, Rosas, Pizarro, & Tenorio 2013). Cognitive inhibition was measured with the Stroop Test, an index for its three conditions (words, colors, and words-colors interference), in 45 seconds (Golden 2007), considering that the sample has a typical development. Visual-spatial working memory was measured in a Tablet with Binding, a YellowRed sub-test, designed in the UC Development Centre of Inclusion Technologies (CEDETi UC) (Rosas, Espinoza & Garolera 2020). In this test, participants must remember drawings associated with numbers (T1), presented on a screen. Then, on a second screen (T2), the drawings appear in a different order, and the numbers are presented between distractors (other numbers). The participants must drag the number to the corresponding drawing. The test progressively increases the difficulty level and has a cut-off criterion when the participant makes three consecutive mistakes. Cats & Dogs, a YellowRed sub-test, was used to measure Go/No-go (CEDETi UC) (Rosas, Espinoza & Garolera 2020). This test is based on the Hearts & Flowers test (Wright & Diamond 2014), and the participants respond to the same paradigm. The three test conditions (congruent, incongruent, and random stimuli) were administered, although only the third condition (random stimuli) was considered for data analysis (33

2. Cronbach's Alpha.

items). Divided attention was measured with a sub-test of HAL2 (CEDETi UC) on a tablet (Rosas & Pizarro 2018). This test considers the resolution of two tasks simultaneously. The first task is to slide a finger up or down on one side of the tablet (left), as odd or even numbers appear (task 1). Simultaneously, the participant has to visually follow the trajectory of red circles in motion within an octagon (task 2), along with blue circles (distractors). After a few seconds, the red circles change to the color of the distractors (blue) and continue moving inside the octagon. Afterward, both tasks stop, and the circles are stopped on the screen. Once they are stopped, the participant must mark on the tablet the circles that were initially red. When the participants were able to do both tasks simultaneously and satisfactorily, this was considered a correct answer, i.e., there were no errors in swiping, and the circles were marked correctly. This test has 14 items. Fluid intelligence was measured with FIX, a sub-test of HAL2 (CEDETi UC) on a tablet (Rosas & Pizarro 2018). In this test, 2x2 matrices with different designs are presented, where the lower right space is always empty. Participants should select the answer they consider correct from a set of 5 alternatives (one correct, four distractors), choosing the piece that adequately completes the design. The test has ten items, and the gross value of each participant's correct answers was considered to generate the index. Processing speed was measured with Cats & Dogs (CEDETi UC) (Rosas, Espinoza & Garolera 2020). The sum of the response speed of the 33 items of the last test condition (random) was used, i.e., the sum of all responses from the moment the stimulus appears on the screen until the participants press with their finger. The time is recorded in milliseconds on the tablet. It is important to note that none of the tablet tests took into account auditory stimuli, considering the balanced sample of musicians and non-musicians, where the first group could have an advantage in auditory discrimination.

Measuring control variables

The age of the participants was recorded through a questionnaire. An index of a socio-economic level was generated considering the type of school they graduated from (3 levels), and the current educational level (4 levels) of the participants, given the relationship between education in Chile, socio-economic level, and cognitive performance (Rosas & Santa Cruz 2013). Laterality was measured by Edinburgh Handedness Inventory (Bryden 1977; Oldfield 1971) in Spanish, according to the findings of Nettle (2003), Powell, Kemp, and García-Finaña (2012), and Beratis, Ravabilas, Kyprianou, Papadimitriou, and Papageorgiou (2013), which show different performances for left-handed and right-handed people in terms of cognitive performance, in populations with and without musical training. Five participants were left-handed in the musicians' group, and two in the non-musicians' group. This variable (laterality) was controlled in all the data analyses.

Procedure

The tests were administered in 2018 in Chile, in the cities of Santiago, Punta Arenas, Frutillar, and Valparaíso. A single session was conducted with each participant, which lasted an average of 75 minutes. There were no noise or light distractors in the rooms during the measurements. Once the data was collected, it was analyzed with SPSS version 25. Normality and homoscedasticity were checked by Shapiro-Wilk and Levene tests, respectively. The variables that did not show normality and homoscedasticity were corrected by the Log10 transformation. Then we re-checked the transform variables, showing normality and homoscedasticity. After this process, a common transformation for all the variables was applied (except musical sophistication), in order to understand the cognitive performance on the same scale for all the factors (X1, 2, 3...*3+10).

Results

The following descriptive data show the cognitive measures and OMSI performance for musicians, non-musicians, and all the participants (Table 3).

Dependent variable	Musicians	Non-musicians	All participants
Verbal working memory	11.5(2.5)	7.16(1.9)	9.3(3.2)
Cognitive inhibition	10.8(3.2)	8.53(2.5)	9.7(3.0)
Go/No-go	11.3(2.5)	9.05(3.2)	10.2(3.1)
Processing speed	10.1(2.1)	11.7(3.5)	10.9(2.9)
Divided attention	10.5(1.6)	8.8(3.8)	9.6(2.9)
Fluid intelligence	10.6(3.4)	8.9(3.1)	9.8(3.3)
Cognitive flexibility	10.8(3.4)	9.3(3.2)	10(3.4)
Visual-spatial working memory	10.8(3.4)	9.3(3.2)	10(3.4)
Musical sophistication	921(80)	163(113)	542(393)

Mean (Standard deviation)

Table 3 / Descriptive data: cognitive variables and OMSI.

Verbal working memory was measured by the Digit Span Task; cognitive inhibition by the Stroop Test; Go/No-go test, processing speed, and visual-spatial working memory by YellowRed; divided attention and fluid intelligence by HAL2 Test; cognitive flexibility by the Wisconsin Card Sorting Test; and musical sophistication by Ollen Musical Sophistication Index. All the tests, sub-tests, and test types for cognitive variables are detailed in Table 2.

Sets of analysis of variance (ANCOVA) were run looking for significant differences between musicians and non-musicians, for the same variables mentioned in the descriptive data. Table 4 shows the results of this analysis.

Dependent variable	*gl*	*F*	*sig.*	ηp^2	*π*	*Reliability*
Verbal working memory	3	21.406	.000**	.49	.99	.97
Cognitive inhibition	4	3.997	.006*	.20	.89	.71
Go/No-go	4	2.586	.045*	.14	.70	.83
Processing speed	4	4.188	.004*	.21	.90	.83
Divided attention	4	2.707	.038*	.14	.72	.69
Fluid intelligence	4	3.346	.015*	.171	.82	.80
Cognitive flexibility	3	4.180	.009*	.16	.83	.91
Vis-spa. working memory	4	0.620	.650	.04	.19	.81
Musical sophistication	3	392.798	.000**	.95	.99	.77

**significant at α<.05, **significant at α< .001*

Notes: reliability was calculated by Cronbach's alpha. For cognitive flexibility, verbal working memory, and musical sophistication, age was not considered, because the tests assessed this variable previously.

Table 4 / ANCOVA controlling age, socioeconomic status and laterality.

The variable of processing speed was inverted, considering that the participants obtained a better performance at a lower value (fasters). All the variables show significant differences between musicians and non-musicians, except for visual-spatial working memory. These differences are significant at a 1% confidence interval for verbal working memory and musical sophistication. Subsequently, the correlations of musical sophistication with all dependent variables were analyzed (Table 5) to understand how musical sophistication was related to these cognitive measures.

Dependent variable	***r°***
Verbal working memory	.672**
Cognitive inhibition	.390**
Go/No-go	.380**
Processing speed	.290*
Divided attention	.320**
Fluid intelligence	.263*
Cognitive flexibility	.178
Visual-spatial working memory	.174
Musical sophistication	3

**significant at p<0.05, **significant at p<0.001.*

°Pearson bivariate correlations

Table 5 / Correlations between musical sophistication and dependent variables.

Significant correlations were observed between musical sophistication and all dependent variables, except cognitive flexibility and visual-spatial working memory.

To determine how many factors could reduce cognitive performance, an exploratory factor analysis was performed (EFA), with the variables that obtained significant correlations with musical sophistication. Given the exploratory nature of this study, in a first step, the analysis was run with a maximum-likelihood estimator with promax rotation. The correlation between the factors (2) was almost inexistent (=.05); thus, the maximum-likelihood estimator was used with varimax rotation, as suggested by Fabrigar, Wegener, MacCallum, and Strahan (1999) for this type of analysis with normal data distribution. In both cases (varimax and promax), the results show two factors, but varimax rotation was better for interpreting the data. Results in Table 6 are reported with varimax rotation, and show the two factors for cognitive performance.

Variable	**Factor 1**	**Factor 2**
Verbal working memory	.048	**.614**
Cognitive inhibition	.279	**.532**
Fluid intelligence	.272	**.547**
Divided attention	**.372**	.294
Processing speed	**.996**	.083
Go/No-go	**.504**	.324

Table 6 / Factor analysis with varimax rotation and maximum-likelihood estimator.

The data were re-calculated in two factors (sum) to execute two-step regression models for these factors. According to the control variables that can explain cognitive performance, in step 1 of each regression model, age, socio-economic level, and laterality were included. In step 2, musical sophistication was added to determine how much variance this variable explains to cognitive performance factors. Then, several regression analyses were run to understand how musical sophistication explains variance for factors 1 and 2 in musicians and non-musicians, and with all the participants. Table 7 shows the results of regression analyses.

Group/Factor	Step	Variables	β	ΔR^2	*gl*	t	sig.
Musicians Factor 1	1	Age	.069	.061	3	4.397	.590
		Socio-economic level	-.220				
		Laterality	-.089				
	2	Musical sophistication	-.088	.006	1	1.638	.661
Non-musicians Factor 1	1	Age	-.101	.114	3	5.813	.268
		Socio-economic level	-.245				
		Laterality	-.127				
	2	Musical sophistication	.313	.088	1	5.057	.074
Musicians Factor 2	1	Age	-.545	.297	3	4.727	.013*
		Socio-economic level	.017				
		Laterality	-.020				
	2	Musical sophistication	.027	.001	1	1.148	.875
Non-musicians Factor 2	1	Age	.147	.189	3	2.413	.079
		Socio-economic level	-.388				
		Laterality	-.201				
	2	Musical sophistication	.299	.081	1	1.735	.074
All participants Factor 1	1	Age	.275	.141	3	5.35	.018*
		Socio-economic level	-.219				
		Laterality	-.175				
	2	Musical sophistication	.571	.244	1	6.47	.000**
All participants Factor 2	1	Age	.065	.074	3	2.99	.165
		Socio-economic level	-.218				
		Laterality	-.146				
	2	Musical sophistication	.504	.190	1	4.10	.000**

**Significant at α <.05, **significant at α <.001*

Table 7 / Regression models for musicians and non-musicians. Factors 1 and 2.

Regression models show no significant changes in factor 1 for musicians and non-musicians. In factor 2 for non-musicians, the result is the same (no significant changes). Still, for musicians, there is some variance in the cognitive factor (ΔR^2=.297), explained by the control variables (sig.=.013). For collapsed data (musicians' and non-musicians' groups), in factor 1, the results show significant differences with control variables and musical sophistication, where the control variables explain 14.1% of the factor, and musical sophistication 24.4%. The case of factor 2 is different, where control variables do not explain significant differences (sig.=165), but on the contrary, musical sophistication shows substantial changes in ΔR^2=.190 (sig.=.000).

As musical sophistication shows significant changes with different r-squares in factors 1 and 2, to understand the relationship between all the sample (musicians and non-musicians) and cognitive performance in general, the last analysis was run, considering the total collapsed data (factor 1 + factor 2 = factor 3). The result is in the following table (8).

Variable		*B*	ΔR^2	*gl*	t	sig.
Step 1	Age	.202	.134	3	4.99	.023*
	Socio-economic level	-.190				
	Laterality	-.257				
Step 2	Musical sophistication	.634	.300	1	6.344	.000**

**Significant at α<.05, **significant at α<.001*

Table 8 / Regression model for all participants factor 3 (collapsed data)

Discussion

The relationships between musical training and cognitive performance have been widely explored, in most cases, through studies comparing people with and without musical training, according to different definitions of this training (typically playing a musical instrument), which depend on the research designs and the age range of the participants. The results tend to show that higher levels of musical sophistication are favorable for cognition performance. However, there is still a variety of contradictory evidence for some cognitive variables (simple and complex).

In this research, we chose to look at the relationship between musical sophistication and performance in executive functions (working memory, inhibition, and flexibility), processing speed, fluid intelligence, and divided attention. As we expected, musical sophistication correlated with a considerable number of cognitive aspects: verbal working memory, cognitive inhibition, go/no-go test, processing speed, fluid intelligence, and divided attention. A balanced sample of musicians and non-musicians was tested (N=70), responding to paradigms such as those proposed by Ollen (2006), Musil, Elnusauri, and Müllensiefen (2013), and Müllensiefen et al. (2014), which show that musical sophistication can be measured in both people with instrumental music training and those without this kind of training.

The test we used was the Ollen Musical Sophistication Index (translated), which, through a ten-item questionnaire, was able to satisfactorily discriminate these two types of populations (dichotomy) and then as a linear variable for the two groups (scale). As previously mentioned, the original data of the test showed a Cronbach's alpha =.78, and in our case, the instrument translated into Spanish showed similar reliability (=.77). The validation of this test in Spanish is not a topic of the present research but could contribute to the understanding of these kinds of variables in the literature.

The result for the EFA was two factors. One factor has verbal working memory, cognitive inhibition, and fluid intelligence (high-order cognitive processes). The second factor was composed of divided attention, processing speed, and go/no-go test. In both cases, musical sophistication explains variance, even controlling by age, socio-economic status, and laterality.

We believe that this study's main contribution is precisely this: musical sophistication explains more variance (and in a significant way) than other variables, which are typically associated with cognitive performance, executive functions, and other aspects of cognition. If we look at our data in detail, the regression analysis results show a significant variance explanation in the two factors. Whatever the explanation of variance may be, it is different between musicians and non-musicians. We believe that a possible reason for these results could be that the variance explained in the significant factor (2) for musicians is related to variables associated with verbal or listening components (specifically for verbal working memory and cognitive inhibition), because the tests used to measure the variables consider problem-solving through the phonological system.

Finally, the data from this study show that musical sophistication and cognitive performance are closely related. Musical sophistication explained 30% of the variance in cognitive performance in people who were consistently and not consistently sophisticated in music (musicians and non-musicians). This evidence agrees with the findings of Slevc et al. (2016), which state that musical ability explains part of some variables of cognitive performance, such as working memory, expanding the measurement paradigm of this type of variable to the entire population, and not only to people with musical training.

Conclusion

Musical sophistication is expandable to all populations and can be measured by analyzing people's engagement in activities related to the discipline in many other aspects, which do not necessarily correspond to playing a musical instrument. In turn, this sophistication has a clear relationship with cognitive performance, explaining an important part of its variance (30%). Even the typical control variables used in music studies explained less variance in the collapsed cognitive factor (13.4%) (i.e., laterality, age, and socio-economic status). Some aspects of executive functions were included in the analyses, as well as other cognitive aspects. Our findings suggest that, however small a person's musical sophistication is, this variable is relevant in their cognition.

References

Baddeley, Alan & Graham Hitch. 2010. "Working Memory". *Scholarpedia* 5 (2): 3015. doi:10.4249/scholarpedia.3015

Bentley, Arnold. 1966. *Bentley Measures of Musical Abilities*. London: Harrap.

Beratis, Ion, Andreas Ravabilas, Miltiades Kyprianou, George Papadimitriou & Charalabos Papageorgiou. 2013. "Investigation of the Link Between Higher Order Cognitive Functions and Handedness". *Journal of Clinical and Experimental Neuropsychology* 35 (4): 393-403. doi:10.1080/13803395.2013.778231.

Besson, Mireille & Frédérique Faïta. 1995. "An Event-Related Potencial (ERP) Study of Musical Expectancy: Comparison of Musicians with Nonmusicians". *Journal of Experimental Psychology: Human Perceptions and Performance* 21 (6): 1278-1296. doi:10.1037/0096-1523.21.6.1278.

Bryden, M. Philip. 1977. “Measuring Handedness with Questionnaries”. *Neuropsychologia* 15 (4): 617-624.

Bugos, Jennifer, William Perlstein, Christina McCrae, Timothy Brophy & Pervis Bedenbaugh. 2007. “The Effect of Individualized Piano Instruction on Executive Functions in Older Adults”. *Aging and Mental Health* 11 (4): 464-471. doi:10.1080/13607860601086504.

Cattel, Raymond. 1963. “Theory of Fluid and Crystallized Intelligence: A Critical Experiment”. *Journal of Educational Psychology* 54 (1): 1-22. doi:10.1037/h0046743.

Degé, Franziska, Claudia Kubicek & Gudrun Schwarzer. 2011. “Music Lessons and Intelligence: A Relation Mediated by Executive Functions”. *Music Perception* 29 (2): 195-201.

Diamond, Adele. 2013. “Executive Functions”. *Annual Review of Psychology* 64: 135. doi:10.1146/annurev-psych-113011-143750.

Doxey, Cynthia & Cheryl Wright. 1990. “An Exploratory Study of Children’s Music Ability”. *Early Chilhood Research Quartely* 5 (3): 425-440. doi:10.1016/0885-2006(90)90031-U.

Fabrigar, Leandre, Duane Wegener, Robert MacCallum & Erin Strahan. 1999. “Evaluating the Use of Exploratory Factor Analysis in Psychological Research”. *Psychological Methods* 4 (3): 272-299. doi:10.1037/1082-989X.4.3.272.

Francois, Clément & Daniele Schön. 2011. “Musical Expertise Boosts Implicit Learning of Both Musical and Linguistic Structures”. *Cerebral Cortex* 21 (10): 2357-2365. doi:10.1093/cercor/bhr022.

Franklin, Michael, Katherine Moore, John Jonides, Katie Rattray & Jeff Moher. 2008. “The Effects of Musical Training on Verbal Memory”. *Psychology of Music* 36: 353-365. doi:10.1177/0305735607086044.

Gembris, Heiner. 1999. “Historical Phases in the Definition of ‘Musicality’”. *Psychomusicology* 16: 17-25.

Golden, Charles. 2007. *Stroop Test de Colores y Palabras, Manual* (5ª ed.). Madrid: TEA Ediciones.

Gordon, Edwin. 1989. *Advanced Measures of Music Audition*. Chicago: Riverside Publishing Company.

Grant, David & Esta Berg. 1948. “A Behavioural Analysis of Degree of Reinforcement and Ease of Shifting to New Responses in a Weigel-type Card-sorting Problem”. *Journal of Experimental Psychology* 38: 404-411.

Heaton, Robert. 1981. *Wisconsin Card Sorting Test Manual*. Odessa (FL): Psychological Assessment Resource Inc.

Hahn, Britta, Frank Wolkenberg, Thomas Ross, Carol Myers, Stephen Heishman, Dan Stein, Pradeep Kurup & Elliot Stein. 2008. "Divided Versus Selective Attention: Evidence for Common Processing Mechanisms". *Brain Research* 1215: 137-146. doi:10.1016/j.brainres.2008.03.058.

Hallam, Susan & Vanessa Prince. 2003. "Conceptions of Musical Ability". *Research Studies in Music Education* 20: 2-22. doi:10.1177/1321103X030200010101.

Hoffman, Wilhem, Tobias Gschwendner, Malte Friese, Reinout Wiers & Manfred Schmitt. 2008. "Working Memory Capacity and Self-regulatory Behavior: Toward an Individual Differences Perspective on Behavior Determination by Automatic versus Controlled Processes". *Journal of Personality and Social Psychology* 95 (4): 962-977. doi:10.1037/a0012705.

Jaschke, Artur, Henkjan Honing & Erik Scherder. 2018. "Longitudinal Analysis of Music Education on Executive Functions in Primary School Children". *Frontiers in Neuroscience* 12 (103): doi:10.3389/fnins.2018.00103.

Koelsch, Stefan, Martin Rohrmeier, Renzo Torrecuso & Sebastian Jentschke. 2013. "Processing of Hierarchical Syntactic Structure in Music". *Proceedings of the National Academy of Sciences* 110 (38): 15443-8. doi:10.1073/pnas.1300272110.

Lamb, Susannah & Andrew Gregory. 1993. "The Relationship between Music and Reading in Beginning Readers". *Educational Psychology* 13 (1): 19-27. doi:10.1080/0144341930130103.

Lauer, Jillian, Eukyung Yhang & Stella Lourenco. (2019). "The Development of Gender Differences in Spatial Reasoning: A Meta-Analytic Review". *Psyhological Bulletin* 145 (6): doi:10.1037/bul0000191.

Law, Lily & Marcel Zentner. 2012. "Assessing Musical Abilities Objectively: Construction and Validation of the Profile of Music Perception Skills". *PLoS ONE* 7 (12): e52508. doi:10.1371/journal.pone.0052508.

Levitin, Daniel. 2006. *This is Your Brain on Music: The Science of a Human Obsession*. Dutton: Penguin.

_________. 2012. "What Does it Mean to be Musical?". *Neuron* 73: 635-637. doi:10.1016/j.neuron.2012.01.017.

McGrew, Kevin. 1997. "Analysis of the Major Intelligence Batteries According to a Proposed Comprehensive Gf-Gc Framework". In *Contemporary Intellectual Assessment: Theories, Tests, and Issues*, D. P. Flanagan, J. L. Genshaft & P. L. Harrison (Eds.), 151-179. New York: Guilford.

_________. 2005. "The Cattell-Horn-Carroll (CHC) Theory of Cognitive Abilities. Past, Present and Future". In *Contemporary Intellectual Assessment*. *Theories*, *Tests, and Issues*, D. P. Flanagan & P. L. Harrison (Eds.), 136-202. New York: Guilford Press.

Miendlarzewska, Ewa & Wiebke Trost. 2014. "How Musical Training Affects Cognitive Development: Rhythm, Reward and Other Modulating Variables". *Frontiers in Neuroscience* 7 (279): doi:10.3389/fnins.2013.00279.

Miyake, Akira, Naomi Friedman, Michael Emerson, Alexander Witziki, Amy Howerter & Tor Wager. 2000. "The Unity and Diversity of Executive Functions and Their Contributions to Complex 'Frontal Lobe' Tasks: A Latent Variable Analysis". *Cognitive Psychology* 41 (1): 49-100. doi:10.1006/cogp.1999.0734.

Moreno, Sylvain, Ellen Bialystok, Raluca Barac, E. Glenn Schellenberg, Nicholas Cepeda & Tom Chau. 2011. "Short-term Music Training Enhances Verbal Intelligence and Executive Function". *Psychological Science* 22: 1425-1433. doi:10.1177/0956797611416999.

Moreno, Sylvain & Faranak Farzan. 2015. "Music Training and Inhibitory Control: A Multidimensional Model". *Annals of the New York Academy of Sciences* 1337 (1): 147-152. doi:10.1111/nyas.12674.

Müllensiefen, Daniel, Bruno Gingras, Jason Musil & Lauren Stewart. 2014. "The Musicality of Non-Musicians: An Index for Assessing Musical Sophistication in the General Population". *PloS ONE* 9 (2): e89642. doi:10.1371/journal.pone.0089642.

Musil, Jason, Budr Elnusairi & Daniel Müllensiefen. 2013. "Perceptual Dimensions of Short Audio Clips and Corresponding Timbre Features. In Aramaki M., Barthet M., Kronland-Mrtinet R., Ystad, S. (Eds.). From Sounds to Music and Emotions. CMMR 2012". *Lecture Notes in Computer Science*: 7900. Springer, Berlin, Heidelberg. doi:10.1007/978-3-642-41248-6_12.

Nettle, Daniel. 2003. "Hand Laterality and Cognitive Ability: A Multiple Regression Approach". *Brain and Cognition* 52 (3): 390-398. doi:10.1016/S0278-2626(03)00187-8.

Oeschslin, Mathias, Céline Descloux, Alexandre Croquelois, Julien Chanal, Dimitri Van de Ville, Francois Lazeyras & Clara James. 2013. "Hippocampal Volumen Predicts Fluid Intelligence in Musically Trained People". *Hippocampus* 23: 552-558. doi:10.1002/hipo22120.

Oechslin, Mathias, Dimitri Van De Ville, Francois Lazeyras, Claude-Alain Hauert & Clara James. 2013. "Degree of Musical Expertise Modulates Higher Order Brain Functioning". *Cerebral Cortex* 23 (9): 2213-24. doi:10.1093/cercor/bhs206.

Omahen, David. 2009. "The 10.000-hour Rule and Residency Training". *Canadian Medical Association Journal* 180 (12): 1272. doi:10.1503/cmaj.090038.

Oldfield, Richard. 1971. "The Assessment and Analysis of Handedness: The Edinburgh Inventory". *Neuropsychologia* 9: 97-113.

Ollen, Joy. 2006. "A Criterion-related Validity Test of Selected Indicators of Musical Sophistication Using Expert Ratings". Electronic Thesis or Dissertation. Retrieved from https://etd.ohiolink.edu/.

Pallesen, Karen, Elvira Brattico, Christopher Bailey, Antti Korvenoja, Juha Koivisto, Albert Gjedde & Synnöve Carlson. 2010. "Cognitive Control in Auditory Working Memory is Enhanced in Musicians". *PLoS ONE* 5 (6): e11120. doi:10.1371/journal.pone.0011120.

Parasuraman, Raja. 1998. "The Attentive Brain: Issues and Prospects". In *The Attentive Brain*, Parasuraman, R. (Ed.), 3-15. Cambridge, Massachusetts: MIT Press.

Parbery-Clark, Alexandra, Erika Skoe, Carrie Lam & Nina Kraus. 2009. "Musician Enhancement for Speech-in-noise". *Ear and Hearing* 30: 653-661. doi:10.1097/AUD.0b013e3181b412e9.

Patel, Aniruddh. 2008. *Music, Language and the Brain*. Oxford: Oxford University Press.

Petschke, Hellmuth, Katherine Lindner & Peter Rappelsberger. 1988. "The EEG: An Adequate Method to Concretize Brain Process Elicited by Music". *Music Perception* 6: 133-160.

Powell, Joanne, Graham Kemp & Marta García-Finaña. 2012. "Association between Language and Spatial Laterality and Cognitive Ability: An fMRI Study". *NeuroImage* 59 (2): 1818-1829. doi:10.1016/j.neuroimage.2011.08.040.

Pretto, Michael & Clara James. 2015. "Principles of Parsimony: fMRI Correlates of Beat-Based Versus Duration-Based Sensorimotor Synchronization". *Psychomusicology* 25 (4): 380-391. doi:10.1037/pmu0000122.

Ramachandra, Vijayachandra, Colleen Meighan & Jillian Gradzki. 2012. "The Impact of Musical Training on the Phonological Memory and the Central Executive: A Brief Report". *North American Journal of Psychology* 14 (3): 541-548.

Revesz, Géza. 1953. *Introduction to the Psychology of Music*. London: Longmans.

Riva, Daria, Fabiana Cazzniga, Silvia Esposito & Sara Bulgheroni. 2013. "Executive Functions and Cerebellar Development in Children". *Applied Neuropsychology Child* 2 (2): doi:10.1080/21622965.2013.791092.

Rodrigues, Ana-Carolina, Maurício Loureiro & Paulo Caramelli. 2013. "Long-term Musical Training May Improve Different Forms of Visual Attention Ability". *Brain and Cognition* 82 (3): 229-235. doi: 10.1016/j.bandc.2013.04.009.

Rosas, Ricardo, María-Victoria Espinoza & Marion Garolera. 2020. "Evidencia intercultural de un test basado en Tablet para medir las funciones ejecutivas de niños entre 6 y 10 años: resultados preliminares". *CEDETi UC Papeles de Investigación 12*. Retrieved from the website of the Centro de Desarrollo de Tecnologías de Inclusión. Pontificia Universidad Católica de Chile.

Rosas, Ricardo & Marcelo Pizarro. 2018. "HAL2: Herramienta en formato Tablet para la evaluación de la propensión a la accidentabilidad". *CEDETi UC Papeles de Investigación 10*. Retrieved from the website of the Centro de Desarrollo de Tecnologías de Inclusión. Pontificia Universidad Católica de Chile.

Rosas, Ricardo y Catalina Santa Cruz. 2013. *Dime en qué colegio estudiaste y te diré qué CI tienes: radiografía al desigual acceso al capital cognitivo en Chile*. Santiago: Ediciones Universidad Católica de Chile.

Sachs, Matthew, Jonas Kaplan, Alissa Der Sakissian & Assal Habibi. 2017. "Increased Engagement of the Cognitive Control Network Associated with Music Training in Children During an fMRI Stroop Task". *PLoS ONE* 12 (10): e0187254 doi:10.1371/journal.pone.0187254.

Santa Cruz, Catalina y Ricardo Rosas. 2017. "Mapping of Executive Functions / Cartografía de las funciones ejecutivas". *Estudios de Psicología* 38 (2): 284-310. doi:10.1080/02109395.2017.1311459.

Schellenberg, E. Glenn. 2006. "Long-Term Positive Associations Between Music Lessons and IQ". *Journal of Educational Psychology* 98 (2): 457-468. doi:10.1037/0022-0663.98.2.457.

_________. 2011. "Examining the Association between Music Lessons and Intelligence". *British Journal of Psychology* 102 (3): 283. doi:10.1111/j.2044-8295.2010.02000.x.

Seashore, Carl, Don Lewis & Joseph Saetveit. 1960. *Seashore Measures of Musical Talent*. New York: The Psychological Corporation.

Slevc, Robert, Nicholas Davey, Martin Buschkuehl & Sussane Jaeggi. 2016. "Tuning the Mind: Exploring the Connections between Musical Ability and Executive Functions". *Cognition* 152 (1): 199-211. doi:10.1016/j.cognition.2016.03.017.

Wallentin, Mikkel, Andreas Nielsen, Morten Friis-Olivarius, Christian Vuust & Peter Vuust. 2010. "The Musical Ear Test, a New Reliable Test for Measuring Musical Competence". *Learning and Individual Differences* 20 (3): 188-196. doi:10.1016/j.lindif.2010.02.004.

Wechsler, David, Ricardo Rosas, Marcelo Pizarro & Marcela Tenorio. 2013. *WAIS-IV: Manual de administración y corrección*. Santiago: Pearson.

Wing, Herbert. 1962. *Wing Standardized Tests of Musical Intelligence*. Windsor: National Foundation for Educational Research.

Wright, Andy & Adele Diamond. 2014. "An Effect of Inhibitory Load in Children While Keeping Working Memory Load Constant". *Frontiers in Psychology* 5: 213. doi:10.3389/fpsyg.2014.00213.

Young, Laura, Sara Cordes & Ellen Winner. 2013. "Arts Involvement Predicts Academic Achievement only when the Child has a Musical Instrument". *Educational Psychology* 34 (7): doi:10.1080/01443410.2013.785477.

Zuk, Jennifer, Christopher Benjamin, Arnold Kenyon & Nadine Gaab. 2014. "Behavioral and Neural Correlates of Executive Functioning in Musicians and Non-musicians". *PLoS ONE* 9 (6): e99868.

Appendix 1: Ollen Musical Sophistication Index (OMSI) translation to Spanish

Bienvenido al Índice de Sofisticación Musical de Ollen (OMSI).

El Índice de Sofisticación Musical de Ollen (OMSI) es una herramienta para ayudar a los investigadores a clasificar a sus participantes en la investigación, arrojando un indicador de "consistentemente" o "no-consistentemente" sofisticado en música.

Para mayor información, diríjase a http://marcs-survey.uws.edu.au/OMSI/index.php, o escriba directamente un correo (ENG) a ollenj@douglas.bc.ca (Joy Ollen).

Esta versión fue traducida al español en orden a facilitar la comprensión de sus encabezados, y pensando en que su lengua materna es el español.

1) ¿Cuál es su edad actualmente? ______ (edad en años)

2) ¿A qué edad comenzó a tener actividad musical sostenida? La "actividad musical sostenida" está entendida como el comienzo de las clases de música regulares, o la práctica autodidacta por al menos tres años de dicha actividad. Si nunca tuvo actividad musical sostenida conteste con el valor "cero".

Edad en la que comenzó su actividad musical sostenida en años: ________

3) ¿Cuántos años de lecciones de música privada ha recibido en algún instrumento? Si es que recibió clases en más de un instrumento, incluyendo la voz, conteste pensando en el instrumento/voz con el que estuvo más tiempo. Si nunca recibió lecciones privadas de música conteste con "cero".

Años de clases de música que ha recibido: ________

4) ¿Durante cuántos años ha tenido una práctica diaria en algún instrumento o cantando? Aquí se define "práctica diaria" considerando que tocó o cantó entre cinco a siete días de la semana, y anualmente, entre diez a doce meses en el año. Si nunca practicó algún instrumento regularmente, o lo hizo por menos de diez meses al año, conteste con "cero".

Años de práctica en algún instrumento o canto: ________

5) ¿Actualmente, cuál de las siguientes categorías está más cerca de lo que usted practica en un instrumento o el canto? Cuente exclusivamente la práctica individual, no los ensayos grupales (marque con una cruz).

Rara vez canto o practico algún instrumento: _____
Alrededor de una hora al mes: _____
Alrededor de una hora a la semana: _____
Alrededor de quince minutos diarios: _____

Alrededor de una hora al día: _____
Mas de dos horas al día: _____

6) ¿Ha recibido clases de música en cursos de college, pregrado u otros en alguna institución de educación superior (instituto, universidad, otros)?

Sí: _____
No: _____ (Vaya a la pregunta 8)

7) (Si respondió afirmativamente). ¿Cuántos cursos de música en college, pregrado u otros completó en alguna institución de educación superior? En caso de que más de una categoría aplique, seleccione la más reciente.

Ningún curso completo: _____
Uno o dos cursos como apreciación musical o cantar en un coro: _____
Tres o más cursos como apreciación musical o cantar en un coro: _____
Un programa introductorio conducente a una licenciatura: _____
Un año de cursos de música con dedicación exclusiva en una licenciatura: _____
Dos años de cursos de música con dedicación exclusiva en una licenciatura: _____
Tres o más años de cursos de música con dedicación exclusiva en una licenciatura: _____
Licenciatura en música completa o equivalente (institutos por ejemplo): _____
Uno o más grados académicos en música completos: _____

8) ¿Cuál de las siguientes opciones lo describe mejor en su experiencia componiendo música?

Nunca he compuesto música: _____
He compuesto ritmos y fragmentos de música, pero nunca una pieza completa: _____
He compuesto una o más piezas completas, pero nunca las he tocado: _____
He compuesto piezas vinculadas a proyectos para clases, una o más de mis piezas se han ejecutado en público o grabado, siempre en un contexto educacional: _____
He compuesto piezas que han sido tocadas para audiencias locales: _____
He compuesto piezas que han sido tocadas o grabadas para audiencias a nivel regional o nacional (por ejemplo tocar en un ensamble, conciertos grandes, o grabaciones profesionales ampliamente distribuidas): _____

9) De lo que pueda recordar: ¿en cuántos conciertos ha estado los últimos doce meses como auditor? Esto considera conciertos pagados o gratuitos, de cualquier estilo musical. Por favor no incluya en esta cuenta la participación en actos religiosos.

Ninguno: _____
1 a 4: _____
5 a 8: _____
9 a 12: _____
13 o más: _____

10) ¿Qué título lo describe mejor?:

No-músico: _____
Amante de la música no-músico: _____
Músico amateur: _____
Músico amateur serio: _____
Músico semi-profesional: _____
Músico profesional: _____

R