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Instrumental Music Instruction and Executive Functions: A Cross-Sectional Study of Romanian Children (10-12 Years)

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by

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DEDICATION

This document is dedicated to my son David, my daughter Alicia, and my wife Nicoleta.

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ABSTRACT

The purpose of this study was to assess the differences in verbal fluency, verbal memory, and processing speed of children (age 10-12) enrolled in a Romanian vocational music school as compared to a group enrolled in vocational visual arts school, and a group enrolled in a regular public school. This is the first study to assess children enrolled in a music school in Romania. A total of 105 participants (43 males and 62 females) 10 to 12 years old (M = 11.13, SD = .34) competed the testing. There were 36 participants (15 males and 21 females) in the music group, 34 participants (12 males and 22 females) in the visual arts group, and 35 participants (16 males and 19 females) in the traditional education group. No significant differences were found in age, p = 0.873; gender, p = 0.682; parent education, p = 0.896; or household annual income, p =0 .968 among the groups. The full-scale IQ and the musical aptitude test scores were included in the analysis protocol as covariates, as the music group scored significantly higher on those two measures. The results of a multivariate analysis (MANCOVA) revealed a significant difference (p = .012) between groups, with music group demonstrating enhanced verbal memory performance. The results of this study indicate that instrumental music education may have a positive impact on cognitive functions in children (age 10-12).

CHAPTER ONE: INTRODUCTION

The learning process has been commonly perceived as essential for the development of a child. Learning is a necessity that provides an individual with various skills and abilities that are needed for existential needs, which range from simple communication to advancing the value of society. One of the most powerful statements of the importance of education was delivered by Chief Justice Earl Warren during the trial of Brown v. Board of Education (1954):

> "Today, education is perhaps the most important function of state and local governments. Compulsory school attendance laws and the great expenditures for education both demonstrate our recognition of the importance of education to our democratic society. It is required in the performance of our most basic public responsibilities, even service in the armed forces. It is the very foundation of good citizenship. Today it is a principal instrument in awakening the child to cultural values, in preparing him for later professional training, and in helping him to adjust normally to his environment. In these days, it is doubtful that any child may reasonably be expected to succeed in life if he is denied the opportunity of an education. Such an opportunity, where the state has undertaken to provide it, is a right which must be made available to all on equal terms." (p. 493)

Because the success is based on numerous variables, and is perceived differently from one individual to another, the extent to which education influences the outcome of success is incommensurable. However, the educational curricula include instruction and objectives that represent a set of values that are essential in the overall development of a

child. Therefore, it is fair to assume that education could provide a ramp for achievement and success.

Curriculum Hierarchy

Some subjects within the education curricula are perceived (arguably) as more important than others. While the importance of some subjects such mathematics is highly regarded, the cognitive benefits of others, such as music education, are sometimes overlooked by school administrators, representatives, and stakeholders. The reasons behind the existence of such hierarchy may be based on various theories that value some subjects more than others, and this epistemology has been in existence for thousands of years. For example, Plato (ca. 370 B.C.E./2000), ranked subjects linked to abstract reasoning such the philosophy, and the rendering of the absolute truths regardless of time and space such as mathematics, as most important. He believed that those subjects should not be accessible to all, but rather be reserved solely for the individuals fit to rule.

While physical science is a subject that is well regarded and receive great attention from school administrators today, it was not perceived as essential in one's education by Plato. He recognized the knowledge of trades as very important for the development of society; however, he considered these subjects of a lower status in comparison to mathematics and philosophy. Gutek (1988) argues that Plato's position in regard to physical science was determined by the fact that physical science was at its infancy stage, and Plato associated it with crafting and trading areas of study.

This epistemology that places mathematics at the top of the educational hierarchy has been maintained for over two thousand years, and arguably remains to be perceived as accurate today. According to Bleazby (2013), the contemporary educational methodologies still favor the

subjects that provide knowledge of absolute, indisputable truth, such as mathematics and physical science.

Bleazby (2015) provides a tentative example of traditional curriculum hierarchy as she ranks the subjects by tiers, with tier one as being the most prestigious and tier four as the least prestigious. According to her ranking, the mathematics and the physical sciences are in tier one. The applied science and mathematics subjects (e.g., biology, geography, and economics); traditional humanities and arts (e.g., ancient & medieval history, English, music, or theatre studies with a focus on theory and classics) are placed in second tier. The arts and humanities (e.g., social studies, civics, media studies and business studies) were placed in the third tier, while the vocational education, physical education, outdoor education, health, and technology subjects (e.g., woodwork) were classified as the tier four.

Surprisingly, music and theatre studies were included in the second tier, ahead of social studies which arguably receive more attention from school representatives, as it has been included in the standardized tests of various states in the United States (National Center for Education Statistics, 2018). Perhaps, the Australian educational system, of which Bleazby is part of, has a slightly different hierarchy of standards than the United States of America.

There is no clear explanation of why some hierarchical values of different subjects are still perceived today as they have been for millennia, and Bleazby (2015) argues that the traditional hierarchical ranking system limits the development of reasoning and restricts inclusivity. Perhaps, the quote: “Man who lives in a world of hazards is compelled to seek for security” (Dewey, 1930, p. 3) may express the human nature as we continuously seek for the unknown, and find the unequivocal truth as the ultimate, most important knowledge. Therefore, abstract, indubitable principles such as the ones found in mathematics, are being considered

absolute knowledge, deeming them superior to other knowledge based on esthetics, or concrete experience.

Dewey promoted the value of knowledge that was grounded and arose from the inquiry that is based on concrete experiences and social matters and integrates multi-disciplinary knowledge. According to him, all subjects have learning value; some provide knowledge, some help with the growth of certain abilities, while others may help with cognitive development.

Education for the Future

The presence of mathematics in curricula does not aim to ensure that all students become mathematicians (the society needs specialists of a wide variety), but because it is believed that studying mathematics will cognitively challenge the students, and this process will contribute to the learners' cognitive development. However, we are still in the process of learning how each subject improves the cognitive abilities. Therefore, there is much need for research that measures the association between various subjects and the overall cognitive development of a child. For example, the literature suggests that musical training contributes to various cognitive functions (Bugos et al., 2007; Bugos, 2010; Schellenberg, 2011; Degé et al., 2011).

Vidergor (2018) suggests dynamic curricula that are oriented towards future thinking, and focus on the acquirement of meaningful knowledge, development of skills, creativity, and higher thinking. Subject matter is very important; however, there are other aspects that need to be taken in consideration during the process of assessing the hierarchical scale, such as the individual's attributes, aptitudes, and preferences that may influence one's career path.

The technological innovation and continuous transformation had made a big impact on all aspects of life. The work market is a continuously changing environment, requiring the acquisition of new skills and knowledge. Many of the careers that are currently in high demand

did not exist just a few years ago. Frazee and Level (2018) anticipated that by 2030, 85% of jobs performed by the students enrolled in schools (in 2018) did not yet exist at that time. A study conducted in 2013 by a Federal Reserve researcher revealed that only 27 percent of college graduates obtain positions related to their degree program.

If most students find employment in professions that are unrelated to their specific degree, and many of these positions are unknown today, then what kind of training would ensure their professional success? What subjects should the curriculum include, and what would the hierarchy of such a curriculum look like? These questions cannot yet be answered, since no one can predict how the technological advancement, and other influences that will produce new requirements for skills and knowledge for the work force in the future might be. Therefore, a desired curricula should promote the development of well-rounded intellectual and support one's ability to adjust to a dynamic environment while remaining competent, and successful.

This suggests that the importance of a subject is not measured only by the near transfer, which reflects the skills, abilities, or knowledge accumulated directly from the subject matter, but also the subjects' far transfer potential, which reflects the skills and knowledge accumulated indirectly from the subject matter. The far transfer refers to the transfer of knowledge and skills to apparently unrelated contexts.

Executive Functions

Executive functions are interdependent high-level cognitive skills that include problem solving, inhibition, attention, working memory, task initiation, flexibility and complex planning used for a specific purpose, such as a goal-oriented behavior (Lezak et al., 2004). Since executive functions are associated to the academic performance (Blair & Razza, 2007), it is

paramount that we identify all the elements that may have a positive impact on executive functions, to support students' academic achievement.

Executive functions may predict the extent in which and individual can perform everyday tasks that include planning, inhibition, and flexibility. According to Cortés et al. (2019), executive functions are also a very good predictor of academic performance in children (6–12 years), with the greatest effect being on mathematics. Among all the components of executive function (inhibition, cognitive flexibility, planning, and working memory), working memory had the strongest effect on academic performance. Blair and Razza (2007), argue executive functions are better predictor of academic performance than intelligence and Gathercole et al. (2004) states that executive functions may predict the achievement in math and reading skills at all grade levels.

While measurements of cognitive executive functions do not fully correlate with the measurements of intelligence, the functions of the two cognitive domains overlap at times, and both domains received strong interest from researchers who observed the effect of music training on cognitive functions.

Musical Training and Cognitive Improvement

Music training requires the development of a multitude of cognitive and motor functions that often are employed at the same time. For example, most of the musical instruments require bimanual coordination, which promotes the development of fine and gross motor abilities. Musicians read music from a specific notation, which is a complex series of symbols and markings that provides detailed information on how each note is played on its own, or in relation with the other notes within the musical phrase. The practitioner must also constantly adjust for tuning, dynamics, and interpretation, based on personal preference, as well as synchronizing the

musical output with others, as music is played individually, or in small, or large groups. In many instances music training requires the memorization of lengthy pieces of music, which may allow for enhancing the ability of storing, retaining, and retrieving information. Since music performance contains highly complex skills, any of these musical acts may contribute to cognitive development.

Musical training may have an impact on various cognitive functions (Bugos et al., 2007; Bugos, 2010; Schellenberg, 2011; Degé et al., 2011). These findings are supported by research studies focused on the investigation of music education effect on various cognitive functions, in which musically trained participants outperformed non-musicians on standardized measures of executive functions.

Executive functions that may be improved by musical training are: processing speed (Bugos et al., 2007), memory (Degé et al., 2011), short-term memory (Tierney et al., 2008), verbal skills (Moreno et al., 2011b), verbal working memory (Franklin et al., 2008; Lee et al., 2007), verbal long-term memory (Franklin et al., 2008; Jakobson et al., 2008), non-verbal reasoning (Bergman-Nutley et al., 2011; Mackey et al., 2011), spatial abilities (Zafranas, 2004), visuo-spatial reasoning (Forgeard et al., 2008), visual memory (Jakobson et al., 2008), and fluid intelligence (Jaeggi et al., 2008).

The literature suggests that musical training may have a positive impact on working memory (Bergman-Nutley et al., 2011; Brehmer et al., 2012; Bugos et al., 2007), and there are indications that improvement of working memory derived from music training has positive impact on other cognitive abilities such as fluid intelligence (Klingberg et al., 2005; Jaeggi et al., 2008) or non-verbal reasoning (Bergman-Nutley et al., 2011; Mackey, Hill et al., 2011).

These findings are also supported by neuroimaging studies that used functional magnetic resonance imaging (fMRI) to examine the effects of music training on musicians' neural system (Hempel et al., 2004; Olesen et al., 2004; Jolles et al., 2010), and revealed an increased prefrontal and parietal activity (areas associated with working memory function) when participants were engaged in musical activity.

Music training was also associated with reading ability (Moreno et al., 2009), vocabulary (Forgeard et al., 2008), sequencing verbal information (Piro & Ortiz, 2009), detecting pitch violations in spoken language (Marques et al., 2007), decoding emotions conveyed by prosody in speech (Trimmer & Cuddy, 2008) auditory imagery tasks (Aleman et al., 2000), and auditory processing speed and frequency discrimination (Schellenberg & Moreno, 2010).

Since there is a multitude of skills that are required in leaning and performing music, we do not have conclusive evidence that pinpoint to all the specific elements of the musical training that may produce far transfer improvements in the cognitive functions. Therefore, more investigations are needed to evaluate specific domains of cognitive abilities, to better understand the far transfer effects of music training.

Significance

This study examined the effect of instrumental music training on cognitive functions in children enrolled in a vocational music school in Romania, as compared to a group enrolled in a visual arts vocational school, and a group enrolled in a regular public school. The music and art groups are comprised of students enrolled in schools that aim at forming professional musician and artists, therefore, the training regimen was rigorous and consisted of individual and group lessons, musical theory, and individual practice.

The results of this study provide evidence regarding the impact of instrumental music training on far transfer of executive functions in children (10-12 years). Data derived from this study may provide resources that can be used for designing curricula and advancing the effectiveness of education for children in this age group.

Purpose of the Study

The present study examined the far transfer of instrumental music training on the executive functions by observing the differences in cognitive performance between three groups of children (age 10-12) from Romania. The purpose of this study was to examine the association between instrumental musical training and various executive functions such as verbal fluency, verbal memory, and information processing.

Instrumental music performance requires a cumulus execution of complex skills as reading music notation, manipulating an instrument, fine adjustment in tuning, dynamics, synchronization, while making or following interpretative content. While playing in small or large groups, music playing requires synchronizing detailed aspects of music playing such as articulation, dynamics and adopting a common interpretative approach with other players or the conductor. The development of such skills may have a beneficial effect on individuals and may transfer to cognitive abilities such as verbal fluency, verbal fluency, and information processing.

Since the high complexity of cognitive engagement in instrumental music learning process, the researcher hypothesized that participants enrolled in the instrumental music education would outperform the visual arts group, as well as the traditional education group on the cognitive assessments. The researcher also hypothesized that the visual arts group would outperform the traditional education group, as visual arts learning process may also engage the learners in complex cognitive processes.

Main Research Question:

What is the association between instrumental music instruction and executive functions in children (10-12 years) when comparing a music group to a visual arts group, and a traditional education group?

The complexity of skills and abilities developed through the musical training may be associated with far transfer to cognitive abilities. Therefore, the underlying hypothesis was that musically trained participants would outperform the participants in the visual arts group, and traditional education group on standardized cognitive assessments.

Sub-Questions:

- What is the association between instrumental music instruction on long-term verbal memory in children (10-12 years) when comparing a music group to a visual arts group, and a traditional education group?
- What is the association between instrumental music instruction on the verbal fluency in children (10-12 years) when comparing a music group to a visual arts group, and a traditional education group?
- What is the association between instrumental music instruction and performance on information processing speed in children (10-12 years) when comparing a music group to a visual arts group, and a traditional education group?

Definitions of Terms:

- Long-term memory refers to the storage of information that can be recalled over a period of time, after the process of learning has stopped, and the attention has been diverted from that specific learning activity (Jeneson & Squire 2012, p. 15).

- Short-term memory refers to the load of information that can be retained in mind during direct observation or learning (Jeneson & Squire 2012, p. 15).
- Working memory refers to the capacity of storing information in mind while also performing a cognitive task such as reasoning, comprehension and learning (Baddeley, 2010, p. R136).
- Near transfer refers to the knowledge or skills acquired specific to the domain in which training has taken place (Laker, 1990).
- Far transfer refers to the gain of knowledge or skills that are not specific to the domain in which training has taken place (Laker, 1990).

CHAPTER TWO: LITERATURE REVIEW

The purpose of this chapter is to discuss the association between the executive functions and intelligence, and present a review the relevant literature, including studies that explored the effect of musical training on various cognitive functions such as verbal fluency, verbal memory, and information processing.

Executive Functions Versus Intelligence

While executive functions and intelligence may seem related, surprisingly there is a rather weak association between the intelligence and executive function. For example, a study in which adults were observed performed by Johnstone et al., (2000) show that executive functions were not correlated with the intelligence, and similar results were also found by Welsh et al. (1991), who observed children (6-12 years).

However, some executive functions have a stronger relation with intelligence than others. For example, Friedman and Miyake (2004) found that working memory correlates with intelligence, and other executive functions such as conceptual problem-solving (identify gaps, inconsistencies, contradictions, etc., in resolving a problem), cognitive efficiency (the ability to supply adequate mental performance for the completion of a given task), and language-related skills (refers to task performance that require listening, speaking, reading, and writing abilities) strongly correlate with intelligence (Seidenberg et al., 1983).

Additionally, Friedman et al. (2006), argued that specific tasks in working memory that focus on adding and deleting information (updating), are highly correlated with the abilities measured by select subtests of the WAIS Full-Scale intelligence, as well as the Ravens

Progressive Matrices. According to Ardila et al. (2000), fluency measures of the Wisconsin Card Sort Perseverative Errors correlated with Verbal and Full-Scale IQ, while Riccio et al. (1994), also revealed a correlation between the Wechsler Intelligence Scale for Children-Revised (WISC-R) and the Wisconsin Card Sorting Test (WCST) in children with attention deficit hyperactivity disorder age 9 to 11 years old.

On the other hand, Ardila et al., (2000), found weak relation between executive functions such as motor planning (the ability to mentally create a carry-out plan to accomplish a specific goal), and intelligence measures. According to Arffa (2007), there is little correlation between the intelligence and other cognitive domain performance such as simple motor tasks (gross motor abilities such as standing, walking, running, etc.), constructional (ability to build, assemble a structure unit), perceptual abilities (the ability to process sensory tasks, such as distinguish between different colors, sound pitches, etc.), inhibition (suppressing automatic responses), or shifting (shifting between subtasks).

Music Education and Working Memory, Attention, and Processing Speed

The effect of music training on the processing speed has been observed by Bugos and Mostafa (2011), who used the Paced Auditory Serial Addition Test (PASAT) in their study. For this study they recruited young adult participants enrolled in an undergraduate program, which included 14 musicians (mean age 19.3) and 16 non-musicians (mean age 19.4). The musicians enrolled had at least six years of musical training, practice for at least five hours per week, and could read music. The results of the one-way ANOVA revealed that musicians outperformed the non-musicians $F(1,28) = 9.9$, $p < 0.1$).

The authors argued that music instruction, through its nature of organized sound production, can develop higher ability in auditory processing speed. The results of the above

study show that musicians have superior information processing speed, as they were able to find better strategies for completing the task. Bugos and Mustafa (2011) also mentioned that musical training, including the sight reading, could enhance the cognitive abilities required in such a difficult test.

Music Education and Visual Search, Processing Speed, and Mental Flexibility

The Trail Making Test (TMT; Reitan & Wolfson, 1993) is one of the most used instruments of evaluation in the neuropsychology field (Rabin et al., 2005). The TMT provides information on visual search, scanning, speed of processing, mental flexibility, executive functioning (Tombaugh, 2004), set-shifting and working memory (Saarikivi et al., 2016).

There are two subtests of the TMT: Trial A and Trial B. On the Trial A, the participant is provided with a page that contains 25 numbers from 1 to 25, that appear randomly on the page. The participant is asked to connect those numbers by tracing a line from one number to another, in a sequential pattern from the lowest to the highest value. On the Trial B, the page contains numbers (from 1 to 13), and letters (from A to L). The participant is asked to connect them in a sequential pattern but in alternating order between the numbers and the letters (1-A-2-B-3-C, etc.)

The Trial B is a more difficult task than the Trial A, and it is considered to access other executive functions such as set-shifting and cognitive flexibility (Strauss et al., 2006; Salthouse, 2011). According to Reitan (1992) the completion of the TMT, accesses the participant's ability to recognize numbers and letters, visually scan the page to identify the next stimuli, and flexibility in combining the numeric and alphabetic series, while working under time constrictions.

So far, we do not have conclusive evidence regarding the potential of TMT in evaluation of the cognitive far transfer derived from musical training, as the literature provides mixed results. Saarikivi et al. (2016), who administered the part B of the TMT, found no differences between the musicians and non-musicians. On the other hand, Bugos, and Mostafa (2011) revealed that musicians completed the TMT significantly faster than non-musicians in both Trial A ($p = 0.02$) and Trial B ($p = 0.02$) subtests. Zuk et al. (2014) also found that musically trained children outperformed the controls in both, Trial A, and Trial B of the TMT ($p= 0.026$). Specific circumstances and limitations such as "task impurity problem" may influence the outcome of the results, therefore, further investigations with well-designed methodologies are necessary for the process of elucidating the far transfer effects of music training on cognitive functions.

Music Education and Verbal Fluency

Zuk et al. (2014), implemented the Delis-Kaplan Executive Function System for the evaluation of the verbal fluency including all three conditions of the subtest (letter fluency, category fluency, and category switching fluency) in a study that included two different experiments. One experiment examined the far transfer effects of musical training in children, and the other one observed those effects in adults.

The first experiment included 30 adult participants aged 18-35 years (M =24.8), which included one group of 15 musicians and one group of 15 non-musicians. The participants in the musicians' group were either professional musicians holding a degree in music, or students enrolled in a degree seeking music program, while the non-musicians' group had no musical training.

The child experiment included 27 children with 15 musicians and 12 non-musicians, 9-12 years (M =10.9). The participants in the musicians' group had taken private music lessons on a

musical instrument for a minimum of two years, started their training around age 5, and played music for an average of 5.2 years, while the participants in the non-musician group did not have music instruction outside their school's curriculum. Independent *t*-tests revealed that musicians outperformed the non-musicians on verbal fluency in both adults (p= 0.018) and children's (p= 0.016) groups.

Saarikivi et al. (2016) used the NEPSY-II test battery (Korkman et al., 2008), a revised edition of the NEPSY, *Developmental Neuropsychological Assessment* (Korkman et al., 1998) to examine the effect of music education on verbal fluency. The participants in the study were 90 children aged 9–15 years from southern Finland. The researchers compared a group of 43 musicians with a control group of 47 non-musicians. The participants in the musicians' group had begun their musical training around age seven and were enrolled in a school that provided music training including instrument lessons, and ensemble at the time of testing, while the participants enrolled in the control group had no musical training, but participated in adult supervised extracurricular activities such as sports. The authors did not find any statistical differences between the groups in verbal fluency abilities.

Janus et al. (2016) conducted a study in which they analyzed 57 children (4-6 years) who were assigned to either a music instruction group or a conversational French computer-based intervention for 2 hours per day for 20 days. The authors administered two testing sessions: pre- and post-training, and one of the administered tests was the category version of the verbal fluency test adapted from Strauss et al. (2006). For this test, the participants were given specific categories such as "fruits and vegetables" or "clothing", and were asked to produce as many words as possible from that category within 60 seconds. The final score was calculated by the mean number of correct words produced between the two categories. Both groups showed an

improvement in verbal fluency between the pre- and post-test sessions, and there were no significant differences between the two groups ($p = 0.17$).

However, Moreno et al. (2011), who used the same computer-based intervention that provided participants with treatment for 2 hours per day for 20 days, found that children enrolled in music training program outperformed the ones enrolled in a visual art program group on verbal intelligence. In this study, the authors analyzed the data from 64 children aged 4-6 years, with 32 participants receiving music and 32 participants receiving visual-art training. To evaluate the verbal ability, the authors administered the vocabulary subtest of the WPPSI-III (Wechsler, 2002), in which the participants were asked to explain the meaning of certain words (e.g., "What is a _____?" or "What does _____mean?"). The pre-test analysis revealed no differences between the two groups in verbal abilities ($p > .3$). However, the post training scores revealed that only the music group improved significantly ($p < .001$) in the verbal ability test.

The above studies revealed mixed results regarding the musical training effect on the verbal ability. While Zuk et al. (2014) reported that musicians' group outperformed the non-musicians on measurement of verbal ability, Saarikivi et al. (2016) did not find such effects. The main difference between the two studies is that they used different measurement tools. While Zuk et al. (2014) used the Delis-Kaplan Executive Function System, Saarikivi et al. (2016), utilized the NEPSY-II test battery.

We are not certain of how these two different measurement tools had impacted the results, but Saarikivi et al. (2016), argued that the results of their study might have been affected by "task impurity problem" (Burgess, 1997). The executive function measurement tools often require the involvement of more than just one executive function. Also, in order to manifest, the executive functions require the engagement of multitude of nonexecutive cognitive abilities,

which creates various background demands. Therefore, the results of the executive function measurements may carry a "task impurity problem", as they cannot be attributed solely to a specific executive function.

Another difference between the two studies is that the measurement tool used by Zuk et al. (2014) contained a switching fluency condition that was not implemented in the study conducted by Saarikivi et al. (2016). Perhaps, there is a possibility that musical training may have a positive impact on set-shifting ability in verbal fluency that produces significant results.

A very interesting detail that is worth mentioning is that Moreno et al. (2011), and Janus et al. (2016) reached contrasting results while using the same treatment. While Moreno et al. (2011) found that musically trained participants outperformed the ones trained in visual arts in verbal abilities, Janus et al. (2016) did not find differences between the musician and conversational groups. However, in the study conducted by Janus et al. (2016) both groups had made progress from the pre- to post-test, which may indicate that both programs (music instruction and computer-based intervention conversational French) might have a positive impact in producing far transfer cognitive effects in verbal abilities.

Music Education and Verbal Memory

Rey Auditory Verbal Learning Test (RAVLT) is one of the most used measurement tools for the evaluation of verbal memory through the auditory presentation. In this task, the participants will hear a series of 15 words (list A) at a rate of one approximately word per second. Then, they are asked to recall as many words as possible from the list. This process is repeated for a total of five trials (learning trials). After the fifth trial, the participants will hear a different set (list B) of 15 words (interfering list) and asked to recall these words, then, immediately after that, they are asked to recall the words from the first list (short-term memory).

After a 30-minute break, the participants are asked to recall the words from the list A(long-term memory).

Degé and Schwarzer (2017), investigated how the articulatory suppression, in which the participants were asked to add the word “the” between each recalled word (Richardson & Baddeley, 1975) might influence the scores of higher verbal memory abilities of musicians as compared to non-musician children (age 10-12). In this study, they compared a group of 19 musicians who were either involved in music lessons (average of 28.21 months) or had former music lessons (average of 28.21 months) to a group of 20 non-musicians. The authors used the Verbaler Lern- und Merkfähigkeitstest (VLMT) adapted by Helmstaedter et al. (2001), which is a German version of Rey Auditory Verbal Learning Test (RAVLT) for the assessment of verbal memory. The participants were tested with or without the articulatory on two sessions that took place on two consecutive days.

A MANOVA analysis of the test administered in normal conditions revealed that musicians outperformed the non-musicians group $F(4, 33) = 3.28$, $p = 0.02$. Separate ANOVAs revealed that musicians outperformed non-musicians on the immediate recall, $F(1, 36) = 4.29$, $p = 0.046$, but revealed no difference in learning score $F(1, 36) = 0.01$, $p = 0.94$. The musicians also outperformed the non-musicians by recalling more words $F(1, 36) = 5.76$, $p = 0.02$, and they forgot fewer words $F(1, 36) = 4.29$, $p = 0.04$, after interference. However, the results of the testing that included the articulatory suppression condition, revealed no group differences in any of the trials. There were no significant differences in immediate recall $F(1, 36) = 0.70$, $p = 0.40$, learning factor $F(1, 36) = 2.29$, $p = 0.14$, number of words recalled $F(1, 36) = 1.93$, $p = 0.17$, or number of words forgotten after the interference $F(1, 36) = 0.09$, $p = .77$. A MANOVA analysis revealed no group differences, $F(3, 34) = 1.65$, $p = 0.20$ on the suppression condition.

The findings of the Degé and Schwarzer's study revealed a similar trend in a young adult population through the study conducted by Franklin et al. (2008) who used the Rey Auditory Verbal Learning Test (RAVLT) to evaluate the differences in verbal memory between undergraduate musicians and non-musicians. In this study, musicians outperformed the non-musician on verbal memory. However, this advantage disappeared when a suppression condition was implemented.

Franklin et al. (2008) study had two phases; in the first phase they compared 12 musicians and 13 non-musicians while the second phase they observed 11 musicians and 9 non-musicians. The participants in the musicians group started their musical training at the age ten or younger, had received training for at least nine years, practiced at least 15 hours per week, were enrolled in an undergraduate or graduate music program, and had a sight-reading skill of four or more on a seven-point scale.

In the first phase of the study the RAVLT was implemented by following the normal procedure of the test. In the second phase the authors also implemented the articulatory suppression technique in which the participants were asked to add the word "the" between each word. The articulatory suppression technique prevented participants from accessing working memory for the rehearsal of verbal material, which allowed for a better assessment of the long-term memory abilities.

The results of this study revealed significant differences between musicians and non-musicians in the first phase, $t(24) = 3.17$, $p = 0.004$. However, these differences were not observed in the phase two of the experiment $t(19) = 1.19$, $p = 0.31$. The index of long-term memory of the RAVL delayed recall test show that musicians outperformed the non-musicians on the first phase $t(24) = 2.10$, $p = 0.04$ but not on the second phase $t(19) = 0.84$, $p = 0.41$.

Roden et al. (2012) evaluated the effects of a school-based instrumental training program of verbal memory in primary school children by administering the German adaptation of Rey's Auditory Verbal Learning Test adapted by Helmstaedter et al. (2001). They enrolled a total of 73 children (mean age = 7.73 years), from different parts of Germany in this study, with 25 children in the instrumental music instruction group, 25 children natural science group, and 23 children in the no treatment group. The children in the music program received 45 minutes of instruction weekly for a period of 18 months, and all participants were tested at three time points. The results of the study revealed that children enrolled in the music instruction group outperformed the ones enrolled in the natural science and no treatment control group. The repeated measures of ANCOVA revealed significance in time by group effects for verbal learning $F(3.63, 123.4) = 5.19$, $p = 0.001$, delayed recall $F(4, 136) = 3.17$, $p = 0.016$, and verbal recognition $F(3.05,103.56) = 2.72$, $p = 0.048$.

Ho et al. (2003) recruited 90 boys ages 6 to 15 (mean age = 10.66) from Raimondi College, from Hong Kong to examine the effect of music training on verbal memory. Half of the participants had musical training (1 to 5 years, with a mean of 2.6 years), and participated in ensembles such as band and orchestra. They played western musical instruments and received at least one hour of training per week. The other half of the enrolled participants were schoolmates with no musical training.

The verbal learning and memory abilities were evaluated with the HKLLT–Form One. The test prompts the participants with a series of 16 two-character Chinese words, and the participants are asked to recall as many words as possible in three learning trials. Then, two delayed recall trials are administrated after 10, and 30-minute delay, to better assess the verbal retention ability.

The results of the repeated measures of ANOVA revealed a significant main effect of group, $F(1, 88) = 25.93$, $p = 0.001$ for the first three learning trials in which the musicians outperformed non-musicians on the number of words recalled. The results of the repeated measures of ANOVA on the 10-min and 30-min delayed recall condition also revealed a significant main effect of group $F(1, 88) = 10.69$, $p = 0.01$, which indicates that musicians had a better verbal retention than controls.

To diminish the possibility of casual effect of music training on the verbal memory, the authors conducted a second experiment in which they traced and assessed the changes in verbal memory abilities of the participants involved in the first experiment. For the second experiment, the researchers assigned three groups; one group was comprised of 24 students who participated in the first experiment as musicians and continued their musical training throughout the second experiment. The second group was comprised of 9 participants who participated in the first experiment as musicians but discontinued their musical training and had no musical participation for at least nine months before the second experiment. The third group was comprised on 17 children who participated as non-musicians in the first experiment but started their musical training after their assessment. Since these participants only had musical training for a year before the second experiment, they were classified as beginners.

The results of one-way ANOVA at the baseline measurement revealed a significant difference in the verbal total learning score $F(2, 47) = 9.11$, $p = 0.01$. Univariate F test revealed that beginners group scored lower than the ones in the continued and discontinued training groups with no significance between the last two groups. The follow-up assessment one year later revealed no group differences $F(2, 47) = 2.33$ (p value not provided in the study) among groups.

The results of a *t*-test suggested that this outcome might be the result of significant improvement in verbal total learning score in the beginners' group as a result of one year of musical training, $t(16) = 3.47$, $p = 0.01$. The results show that continued training group also improved their performance significantly in their verbal learning ability $t(23) = 3.37$, $p = 0.01$. However, the verbal memory abilities of the participants in the discontinued training group did not change significantly after one year $t(8) = -1.35$ (as reported in the study). The results of the above studies support the hypothesis that musical training may have a positive effect on the verbal memory abilities.

In conclusion, music education has various impact on different cognitive domains the as the musical training require extensive cognitive involvement of many components of executive function such as sustained attention, cognitive flexibility, bimanual coordination, goal-oriented behavior, and working memory. While such training it may improve processing speed and verbal fluency, the literature review revealed that verbal memory and learning abilities might be most likely improved by musical training in young children, since all four studies reviewed who implemented measurements of verbal memory (Degé and Schwarzer 2017; Franklin et al., 2008; Ho et al., 2003; Roden et al., 2012) revealed that music groups outperformed the others on verbal memory and learning. Based on the literature review, the association between the development of musical abilities and cognitive improvement appears conceivable, and it is reasonably justified to assume the hypothesis that musical training may have a positive impact on the development of the executive functions.

CHAPTER THREE: METHODOLOGY

The purpose of the study was to examine the effects of instrumental music training on executive functions in children (10-12 years). This chapter explains the research design, the conceptual framework of the study, and the cognitive measurements administrated. Specifically, measures of verbal learning memory, verbal fluency, and processing speed were administered to three groups: a group enrolled in instrumental music training, a group enrolled in visual arts training, and a group enrolled in a regular public school.

Research Design

This study employed a cross-sectional research design, as the researcher assessed the cognitive differences between three distinctive groups of children that were already enrolled at one of three different schools. All the participants who met the criteria for enrollment were invited to participate, and all the individuals who volunteered to participate met the criteria for the enrollment.

For the present study the researcher recruited three groups of Romanian children (10-12 years) who have received either music training, visual arts training, or traditional education. The participants enrolled in the traditional education group did not receive any music education beside the regular music classes that all students enrolled in public schools in Romania receive.

While instrumental music instruction can still have beneficial impact on cognitive functions to all individuals regardless of their neurological health, it is possible that such conditions may influence the outcome of the results administered. Therefore, to control for this variable, the participants enrolled in this study were free from any learning disabilities, color

blindness, hearing conditions, and were all cognitively intact. This implies that participants were free of any neurological deficits, had not undergone any treatments for any neurological disorders, and were not taking any medications that may have influenced their cognitive functions at the time of testing. To assess this condition, the participants' parent completed a questionnaire in which they reported if the participant had any learning disabilities, color blindness, hearing deficit, or intake of medication that may impact their cognitive abilities. The questionnaire also included other demographic criteria such as child's gender and age, parent education, and annual household income.

The music group consisted of students enrolled in a vocation music school that provide music training as part of their curriculum. To control for internal validity, a group consisting of students enrolled in a vocational visual arts school that provides visual arts training was recruited. The traditional education group consisted of students enrolled in regular public school that received no special treatment aside from the general education that is consistent throughout Romania.

Since intelligence can affect cognitive performance, the researcher measured participants' intelligence quotient (IQ) by administering the 2-subtest form of the Wechsler Abbreviated Scale of Intelligence - Second Edition (WASI-II; Wechsler, 2011), which include the vocabulary, and matrix reasoning tests.

While there is no evidence of the association between the musical aptitude and cognitive performance, the researcher chose to include this variable in the analysis protocol as a precaution, because the admission at the music school is based on candidates' musical aptitude, and it was hypothesized that music group would outperform the other groups on this measure. Therefore, the researcher also decided to assess participants' musical aptitude by administering

the Advanced Measures of Music Audiation (AMMA) test. All the demographic variables that revealed significant differences were included as covariates in the analysis protocol. The procedures and methods of this study have been approved by the Institutional Review Board of the University of South Florida.

Conceptual Framework

Based on the literature findings, a conceptual framework that reflects the hypothesis of the musical training outcome was developed by the researcher of this study (see Figure 1). Music training fosters the development of skills such as learning a highly complex symbol system that allows the trainee to read music, as well as the auditory processing abilities. Music performance requires the learner to play in sync with others, or with an external stimulus such as metronome or the conductor's beat, which may contribute to their sensorimotor synchronization. Furthermore, musicians may improve their bimanual coordination abilities as most instruments are played with both hands at the same time, and Debaere et al. (2004) found bimanual coordination practice to produce neuroplasticity during the learning period.

The literature suggests that music education may contribute to the improvement of cognitive abilities (Moreno et al., 2011a; Schneider et al., 2002; Forgeard et al., 2008). The process of music training involves complex cognitive and motor functions that may influence the working memory, processing speed, auditory, sensorimotor, visuospatial abilities, short- and long-term memory through learning of musical pieces, attention control for extended periods, learning and deciphering musical symbols (Hanna-Pladdy, & Gajewski, 2012).

There are multiple aspects related to musical education that may have an effect on cognition. The music reading process involves visuo-spatial decoding and requires constant updating. Musical notation is a complex combination of symbols which often are deciphered at

very high speeds. Some instruments (e.g., piano, harp, etc.) employ two independent musical notation lines (one line for each hand), therefore requiring the musician to read two different sets of music notations at the same time.

According to Stewart et al. (2003), the ability to read music will trigger the automatic sensorimotor translation into motor responses, and Bergman et al. (2014), argues that learning musical notation may greatly contribute to the cognitive development. Meinz and Hambrick (2010) found a correlation between the sight reading and working memory (r = 0.300–0.400), and few studies that examined the brain activity during the music sight reading process, revealed occipitotemporal and parietal activations (Stewart et al., 2003; Bengtsson & Ullen, 2006).

Music learning requires complex mental involvement, which may promote neuroplasticity. This process can generate various cognitive benefits through differential brain organization (Koelsch et al., 2005; Fujioka et al., 2006; Jäncke, 2009; Moreno et al., 2011a). This outcome is especially evident if music training occurs during childhood (Pantev et al., 2003; Forgeard et al., 2008; Moreno et al., 2011b). Another factor that may influence the association between the musical training and cognitive development is that musical training requires musicians to allocate extended time in musical training and practice sessions, which may contribute to increasing the attention span (Schellenberg, 2006; Forgeard et al., 2008).

Multiple studies that observed the impact of music education on various cognitive functions revealed that participants involved in music education have certain cognitive advantages over control groups. Degé and Kerkovius (2018), suggest that music training can produce an improvement in verbal and visual memory, and Moussard et al. (2016) proposes that music practice may produce improvement in the inhibition and working memory, such as higher verbal recall, and phonemic fluency (Hanna-Pladdy & MacKay, 2011; Hanna-Pladdy &

Gajewski, 2012; Fauvel et al., 2014). Short-term music intervention can improve self-efficacy in older adults (Bugos et al., 2016), and can be used as an effective intervention in mitigation of the cognitive decline (Bugos, 2007).

According to the literature, the abilities developed through musical training may transfer into executive functions, such as information processing speed (Bugos & Mostafa 2011), verbal memory (Ho et al., 2003), and verbal fluency (Zuk et al., 2014). Hanna-Pladdy and Gajewski (2012) claimed that cognitive gains assimilated during the musical training period were sustainable over time, even in older adults who ceased their musical activity.

Participants

All participants enrolled in this study were enrolled in fifth grade at their school during the 2019-2020 school year. The total sample size recruited for this study was 105 participants (43 males and 62 females), with 36 participants (15 males and 21 females) enrolled in music group, 34 participants (12 males and 22 females) enrolled in the visual arts group, and 35 participants (16 males and 19 females) enrolled in traditional education group (see Table 1).

The participants enrolled in the music group were children (age 10-12) enrolled in a music school who received instrumental classical music training including private instrument lessons, music theory, ear training, solfege, and music notation training, as part of their normal education in those specific schools. The music curriculum includes participation in ensemble performances, and students were required to practice their instrument daily. The training regimen reflects the music schools' curriculum, which is approximately eight hours of music instruction per week. The primary instruments for which the participants received training were piano (13 participants), violin (11 participants), guitar (4 participants), percussion (2 participants), and one

participant for each of the following instruments: clarinet, French horn, bassoon, flute, harp, and pan flute.

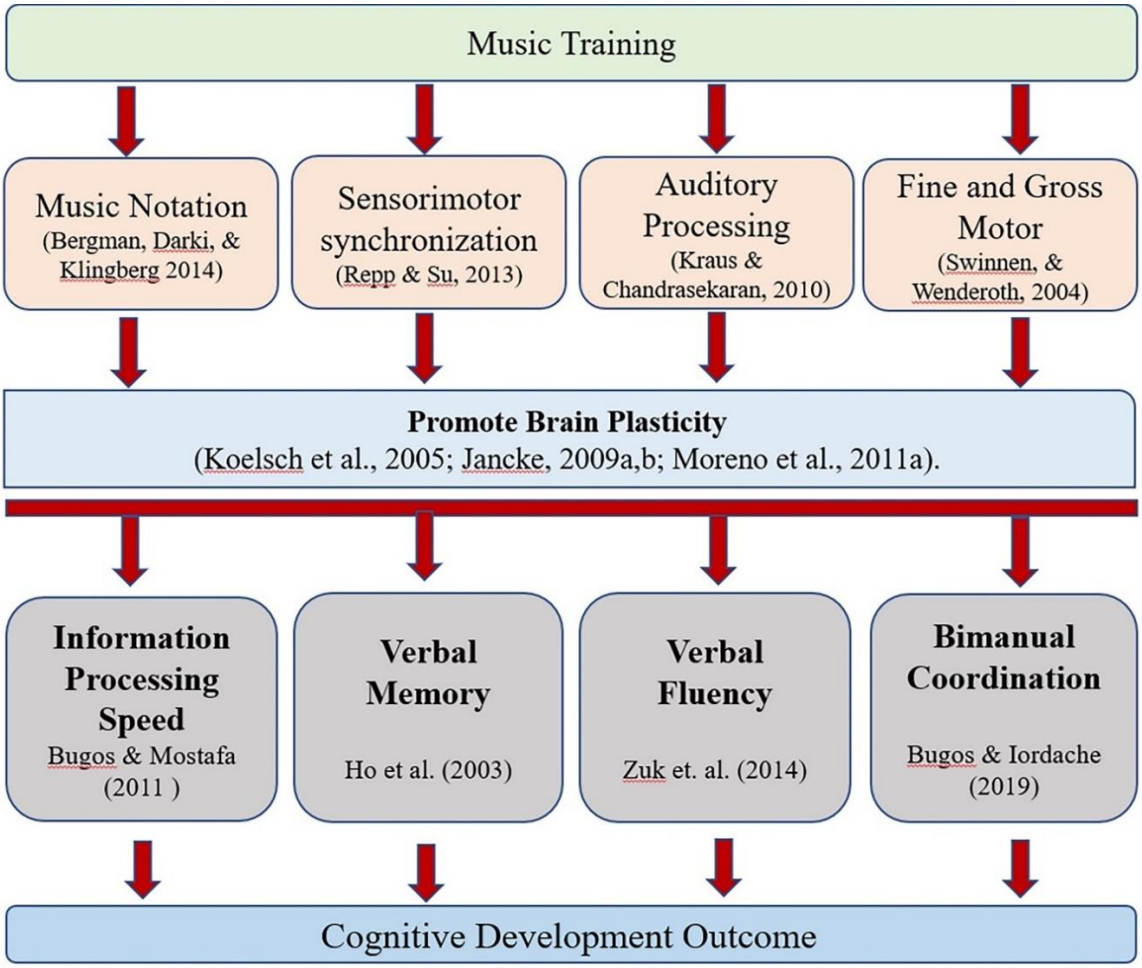

Figure 1. The conceptual framework of this study*

**This figure portrays the succession of cognitive changes derived from music education. The first stage shows the development of skills that are directly related to music training (music notation, sensorimotor synchronization, fine and gross motor development, and auditory processing). The development of these skills produces neuroplasticity (second stage), which fosters the far transfer improvement in various cognitive domains (stage three). The fourth stage reflects the outcome of the adjusted cognitive capacity of the music learner, after the music education effect.*

It is common at this music school that students seeking to play piano or violin start their training in the first grade, violoncello in the third grade, viola in fourth or fifth grade, and all woodwind, brass, and percussion in fifth grade. The reason for this procedure is based on the

generally perceived physical potential of a child, and the belief that playing a woodwind, brass, or percussion instrument at age of five or six would be too strenuous for the child. However, this is not a strict rule, and the school's administration accepts special circumstances in which students are enrolled earlier or later for a specific instrument. For example, a student who missed the application deadline for enrollment in fifth grade, may be admitted in the sixth grade if he or she possesses great musical aptitude. The school also allows students to switch from one instrument to another. For example, a student who started his or her training in piano or violin in the first grade may choose to switch to violoncello in third-grade, viola in fourth-grade, or a woodwind, brass, harp, or percussion instrument in fifth grade.

The participants enrolled in the music group played various instruments, which resulted in a difference in their music training onset. From the total of music participants 29 started their training in the 1st grade, one student in 2nd grade, one student in 4th grade, and five students in 5th grade.

Participants enrolled in the visual arts group were children (age 10-12) enrolled at a visual arts school. Those students participated in visual arts training that includes individual and group instruction in visual arts, according to their school's curriculum. These students received general education for four days a week, while one day was reserved for visual arts training, which include small group instruction in drawing and painting. The instructional time allocated to the art group, as well as instruction design (private and group instruction), was similar to the one received by music group, and both groups were required to devote individual practice after school, as both instructional programs aim for the full potential achievement. The visual arts group participants started their training in fifth grade. However, because the entrance exam is very competitive, it is common that students who aspire to attend this school start private

tutoring in drawing and painting one or two years prior applying for admission. Therefore, by the time the students are enrolled at this school, they already had one to two years of training in visual arts.

The participants enrolled in the traditional education group were children (age 10-12) enrolled in regular public school, who were matched for age with the visual arts and the music groups. These participants received no special training beside their regular instruction based on the established nation-wide curriculum. The recruitment was based on the participant willingness to voluntary participate in the study.

Training Environment

The music and the visual arts schools are vocational schools that enroll students regardless of their residence. The admission at these schools is based on an entry exam that evaluates candidates' aptitudes in either music or visual arts, and there are limited spots available for enrollment each year. These schools aim at preparing their students to become professional musicians or artists, who would either practice in their specific field upon school graduation, or further advance their academic training in the field, by enrolling in higher education.

Since the admission procedure is based only on students' aptitude, the academic achievement and residency are not taken into consideration as a criterion for admission. Therefore, the students enrolled at these schools could come from any socio-economic or academic achievement background. Both vocational schools are public schools that are fully supported by public funds, therefore, there are no tuition costs or fees for application, enrollment, or for attendance at these schools.

The music school from which the music group participants were recruited for this study is a public school that also employs a dual curriculum. There is one general education curriculum

that is followed by all public schools in Romania, and one music curriculum employed by this school. The school's mission is to prepare its students for a professional career in music or acting, and employs approximatively 170 teachers, from which 130 are music, or drama teachers. Many of these teachers are active professional performers from the highest musical institutions in Bucharest, and hold advanced degrees such as Masters' or Doctoral degrees in music. More than half of the professors that teach at the National University of Music from Bucharest are graduates of this music school, and many of its graduates perform on some of the most prestigious art institutions in the world.

The aptitude examination employed by the music school consists in the measurement of student's ability to vocally reproduce short melodic phrases of approximately four measures played on the piano and reproduce various rhythmical patterns by clapping or tapping. Also, candidates are asked to prepare in advance two songs from which the committee may choose to hear one, or both.

Music students also receive instruction in music theory including ear training and solfeggio, playing in musical ensembles, as well as being required to devote time for individual practice. Students enrolled in this school follow the school's music curriculum and are involved in music training approximately eight hours a week.

The vocational visual arts school is a public school that also employs a dual curriculum. First, the students enrolled in this school follow the same curriculum for general education as all other public schools in Romania. The second curriculum is based on visual arts instruction, which is designed to prepare the students for a professional career in visual arts. The visual arts curriculum includes courses in drawing, painting, and plastic arts, and these classes are thought

in small group classes of approximately ten students. The art classes represent one fifth of the total courses taught, and the instruction time is also approximately of eight hours per week.

As I mentioned before, the candidates are accepted based on their aptitudes, and the criteria for aptitudes test at the art school are based on two examinations: drawing and painting. It is worth to mention that the examination is performed live in front of a commission. For the drawing segment the candidates must draw in pencil on A4 paper a static nature, which includes two objects. For the painting segment, the candidates must use watercolor to create a composition that is chosen by the committee at the time of examination. The assessment criterion is based on composition's balance and chromatic harmony.

The middle school from which the traditional education group was recruited is a public school that enrolls students within a specific residential area. The schools' facilities include a festivities hall, two indoor sports venues, a computer lab, a library that contains over ten thousand volumes, and a dining hall. The school has its own dentist office, medical office, and a psycho-pedagogic office.

In Romania, all teachers, regardless of the subject taught, are compensated according to the teachers' pay scale, which is based on teachers' highest earned degree, experience in the field, as well as their rank, which is earned based on various tests that can be implemented at certain time points during the teachers' career. All three schools described above are tuition free public schools.

The recruitment for this study was based on the participant willingness to volunteer to participate in the study. All the students enrolled in this study were enrolled in fifth grade, therefore, all children were between 10-12 years old and were cognitively intact. All children involved in this study, as well as their parents signed an informed consent to participate.

Music Training Regimen

The music training received by the music group included various group and individual classes. All students received two private lesson a week on their major instrument, and during these lessons a piano accompanist is present in the room, so the student can practice his or her pieces along with the accompaniment.

The achievement goals are specifically tailored for each student, based on their individual potential. For example, individuals in the same grade level, playing the same instrument, may work on different repertoire, as the goal is to have students face constant challenges while aiming for achievable short- and long-term goals. Students also receive piano instruction once a week, as an auxiliary instrument.

Ensemble enrollment is based on student's playing ability, and all students are enrolled in either symphonic orchestra, choir, and/or various chamber ensembles. Rotation is used to ensure that all students experience performance in all orchestral chairs, as well as participation in various ensembles.

Students attend theory, solfeggio, and ear training class twice a week, and the school employs ten music teachers for this specific instruction. These classes consist of smaller groups in which students are enrolled based on their performance level. For example, students who started music in first grade are enrolled in different groups (advanced) then those who started music in fifth grade (beginners).

All students follow the music theory, solfeggio, and ear training book series by Motora-Ionescu and Visky (2016), which provides the curriculum from the first to the fifth grade. In the first grade, the students learn music notation of the notes within the central octave, and the names for the musical sounds are taught by their solfeggio names (do, re, mi, fa, sol, la, ti). Students

sing melodic solfeggio in the tonalities of C major and A minor while reading music notation. The music includes rhythmical values for sounds and rests of whole note, dotted half note, half note, quarter and the eight note. As students advance their knowledge and skills, towards the end of the school year, students are introduced to the natural, flat, and sharp alterations. However, these notes are not included in music reading and solfeggio yet.

In the second-grade students learn the intervals up to one octave, major and minor scales up to one alteration (F major, D minor, G major, and E minor), including the natural, harmonic, and melodic minor variants. They are introduced to new rhythm formulas such as the triplet, sixteen notes, and combination of eight and sixteen notes. Their solfeggio includes rhythm, and the length of the ear training (dictation) exercises are four to six measures, and within a range of a perfect fifth. Towards the end of the school year, students are working on individual compositions that include rhythmic formula of eight note followed by two sixteen notes.

In the third-grade students are working on solfege which include the time signature of 6/8, major and minor scales up to two alterations (D major, B minor, B flat major, and G minor), including the natural, harmonic, and melodic minor variants. Students also work on major and minor intervals, chord inversions, and functions of subdominant, dominant chords around tonic. Towards the end of the school year, students learn and practice the execution of the symmetric syncope on half time (eight note followed by quarter note, followed by eight note), and offbeat, singing multiple succession of eighth rest followed by eighth note.

In the fourth-grade students learn the major and minor scales up to three alterations (A major, F sharp minor, E flat major, and C minor), including the natural, harmonic, and melodic minor variants. They learn and practice the symmetric syncope on quarte time (sixteen note followed by eight note, followed by sixteen note) and practice offbeat singing, such as multiple

succession of sixteen rests followed by sixteen notes. The students enrolled in this music school are constantly involved in national and international competitions for ensembles, or individual participation.

Measures

The purpose of this section is to present the measurement tools implemented in this study, and the reasoning for using them. The researcher collected demographic data such as gender, age, parental education, and household income, as well as participants level in musical aptitude and intelligence. For the cognitive evaluations, the researcher implemented tests measuring the participants processing speed, verbal fluency, and verbal memory. The tests were administered in the same order for all participants, and the following is the order in which the tests were administered: Advanced Measures of Music Audiation (AMMA), Rey Auditory Verbal, Learning Test (RAVLT), WASSI-Matrix reasoning, WASSI-Vocabulary, Symbol Digit Modalities Test (SDMT), Trail Making Test (TMT), and D-KEFS-Verbal fluency.

Intelligence

Intelligence is a mental capacity that incorporates various cognitive abilities (Colom et al., 2010), therefore, it is possible that individuals with higher intelligence may score higher on various cognitive measures as compared to their counterparts who possess lower intelligence abilities. Since this study employed a cross-sectional model, the researcher of this present study had no control over the group distribution regarding the intelligence factor. Therefore, all participants were tested for intelligence quotient (IQ) and the IQ scores were included as a covariate in the analysis model, since the one-way ANOVA revealed statistical significance between the groups.

To establish the participants' intelligence level, the two-subtest form (Vocabulary and Matrix Reasoning tests) of Wechsler Abbreviated Scale of Intelligence - Second Edition (WASI-II; Wechsler, 2011) was administered.

The concurrent validity analysis revealed a high correlation between WASI-II and the original WASI, WISC-IV, and WAIS-IV ranging from r=.71 to r=.92, while the internal structure analysis of validity showed a strong interrelation among all subtests and composites. For the adult sample aged 17 to 90 years, the reliability coefficients ranged from r=.90 to r=.92. The authors of the measurement tool provided a thorough explanation and analysis of the reliability and validity estimates of the WASI-II, supported by detailed tables providing clear evidence to support their findings (Mccrimmon & Smith, 2012).

The Vocabulary test of Wechsler Abbreviated Scale of Intelligence test (WASI-II) requires the examinee to define each term from a series of unrelated words that are presented orally. Each answer is graded with two, one, or zero points. An answer that shows full understanding of the meaning of the word awards two points, and if the answer is correct but lacks in content, only one point is awarded for that item. If participant shows no understanding of the meaning of the word, that item is awarded zero points. The manual provides examples of possible answers and proper scoring. For example, for the question: "what is a bird?" the manual suggests the following scoring scale: an animal that can fly (two points), it flies (one point), it's pretty (zero points). The score for this task is represented by the total of correct answers. This subtest measures the word knowledge and verbal concept formation (Maccow, 2011).

The Matrix Reasoning task of Wechsler Abbreviated Scale of Intelligence test (WASI-II) is comprised of has 35 items and measures the fluid intelligence, broad visual intelligence, classification, and spatial ability (Maccow, 2011). For each item, the participants are presented

with a series of figures, with one of the figures being blank. The participant must choose one of the five possible choices provided on the same page, that may fit the blank figure. The score for this task is represented by the total of correct answers.

Musical Aptitude

The admission criterium for the music school is based on candidate's musical aptitude level therefore, it is expected that all students enrolled at this music school are musically gifted. To ensure a fair analysis between the groups, all participants' musical aptitude was measured, and this variable was included as a covariate in the analysis model, as the one-way ANOVA revealed statistical significance between the groups.

The Advanced Measures of Music Audiation (AMMA) is a music aptitude test that has been successfully implemented in the past to measure music aptitude level of (10 years old) children (Degé et al., 2011), and (10–12-year-old) children (Degé & Schwarzer, 2017). The test may be also used to assess the music performance achievement of music majors with approximately 67% of the variance in common (Schleuter,1993).

Gordon (1990) investigated the predictive validity of AMMA with music performance achievement with undergraduate and graduate music majors. The test was administered to 114 students, and eight months later, the participants were evaluated on the performance of an etude. The analysis of the correlation of AMMA Total scores (combined with rating scale) revealed a predictive validity coefficient of r=.82. Fullen's findings revealed that AMMA has the potential to assess secondary level students' achievement who scored at the ends of the score spectrum but is less accurate in predicting the achievement in music for all individual students (1993).

The AMMA test has two versions: a "paper and pencil", or a computer-based test consisting of 30 short musical items, with each item consisting of two short musical phrases.

These two phrases could be identical or slightly different, and the examinee must indicate if the musical patterns were perceived as identical or different. There are three possible answer choices (same, tonally different, or rhythmically different) for the paper and pencil version.

Finally, it is worth mentioning that computer version includes the fourth answer choice, in which the examinee must choose "N" (Not Sure) if the participant is not sure whether there is a difference between the patterns or not. The test comes with scoring templates that provides both tonal, as well as rhythmical scores for each individual participant, and these scores were combined for a total AMMA score.

While the patterns in each item may be identical or different from each other, there can only be one kind of difference, therefore, the difference can only be rhythmical or melodical, but not both. The participants are presented with this information during the instructions, before the test begins.

Verbal Fluency

To assess the cognitive differences in verbal fluency, the researcher of this present study administered the verbal fluency subtest from Delis-Kaplan Executive Function System (D-KEFS). D-KEFS is a standardized neuropsychological testing battery that evaluates the higher-level cognitive functions in both children and adults and can be administered to individuals between 8 and 89 years old (Delis et al., 2001).

The test-retest correlations revealed reliability coefficients r= .67 for letter fluency, r= .70 for category fluency, and for r=.65 the category switching (Fisher, 2006). The D-KEFS revealed moderate correlations tests with other cognitive tests (e.g., California Verbal Learning Test-II and Wisconsin Card Sorting Test). The validity findings from pilot studies with clinical populations show that D-KEFS tests have fair sensitivity in identifying numerous various types

of clinical groups (e.g., fetal alcohol exposure, schizophrenia, chronic alcoholism, Parkinson's disease, focal frontal lesions, etc.) from normal controls (Delis et al., 2001).

The verbal fluency task consists of three trials: letter fluency, category fluency, and category switching. For the letter fluency trial, the participants are presented with a letter (e.g., letter "b"), and are asked to provide as many words as possible that start with letter "b", except names of people, or places, or numbers within a 60 second time frame. For example, for the letter "b" they may say "boat", but not "Brandon".

The test administrator records all the answers at four intervals of 15 seconds. For example, the answers given within the first 15 seconds intervals are written in one box. When the 15 seconds period has passed, the administrator writes the answers in the second box, the process continues in the same manner for the third and the fourth segment. When the 60-second period is completed, the participant is presented with a new letter, and the same procedure is repeated for two more times, as the verbal fluency trial includes a total of three letters.

For the category fluency task, the participants are asked to say as many words as possible form a specific category (e.g., items of clothing). The administrator would record all the answers at 15 second intervals for a total of 60 seconds. Then, the participants are asked to switch to a different category (e.g., names of girls) and the same procedure is implemented. For these two tasks, the administrator records three different results: the correct words provided at each time segment, the repeated words, and the answers that did not meet the specific criterion for the task.

For the switching trial, the participants are asked to provide words from two categories in a specific order, by switching back and forth between two categories (e.g., vegetables and musical instruments). First, they would name a vegetable, then a musical instrument, then a vegetable again, and so on and so forth.

For this trial, the administrator scores the correct words provided at each time segment, as well as the correct switches between the two categories. For example, the series of words representing a "vegetable - musical instrument - musical instrument" reflects three correct items, but only one switch. The administrator also records the repeated words, and the answers that are not reflecting the two categories.

Verbal Learning and Memory

To assess the cognitive differences between the groups in verbal learning and memory, the researcher administered the Rey Auditory Verbal Learning Test (RAVLT). RAVLT assesses a wide range of cognitive functions such as: short-term auditory-verbal memory, rate of learning, learning strategies, retroactive, proactive interference, presence of confabulation of confusion in memory processes, retention of information, and differences between learning and information retrieval in individuals 7 to 89 years (Strauss et al., 2006).

The reliability for the RAVLT's scores ranged from r= .38 for the B list to r=.70 for the A list and the test-retest at one-year interval revealed a score of r=.55 (Tierney et al., 1994). The RAVT was compared with the California Test of Verbal Learning-Children Version, and the correlation between the two tests revealed score range of r=.50 to r=.65 (MacCartney-Filgnate & Vriezen, 1988).

For the administration of the test the examiner reads a set of 15 unrelated words at the pace of approximately one second interval, and the participants are asked to recall any, or all the words heard in no specific order. The same process is repeated for four more times, for of total of five trials. On the sixth trial, the examiner reads a different set of 15 words (interference list) and the participants are asked to recall any, or all the words from the new list. After this step, the participants are asked to remember the words from first list, then take a 30-minute break with no

other requirements or indication of further testing on this test. After the 30-minute break, the participants are asked to recall any, or all words from the first set of 15 words.

The first five trials represent the learning trials, the sixth trial (interference list) reflects the rate of learning, while the seventh trial provides a measurement on long term memory. Including the waiting period of 30 minutes, the test takes approximately 45 to 55 minutes to administer (Strauss et al., 2006).

Processing speed

To assess the processing speed differences derived from musical training between the groups, the researcher administered two measurements: the Symbol Digit Modalities Test (SDMT) and the Trail Making Test (TMT) of the Halstead-Reitan Neuropsychological Battery.

SDMT assesses working memory, attention, concentration and speed of information processing in both children aged 8+ and adults (Smith, 1982). The administration of the test requires a simple task in which the participants pair specific numbers with symbols by using a reference key, within a 90 second time period. The administration of the test takes approximately 5 minutes. Participants can provide written or spoken answers therefore, the test is appropriate for a very large segment of population, including culturally diverse, as well as individuals who don't speak English (Smith, 1982).

The SDMT manual reports a test-retest reliability coefficient of r=.76 in a healthy sample analysis. According to Benedict (2005), a two-week test-retest reliability analysis in multiple sclerosis (MS) patients revealed a score of r= .97. Morrow et al. (2010), investigated the test-retest reliability of SDMT in correlation with Multiple Sclerosis Neuropsychological Screening Questionnaire (MSNQ) and concluded that SDMT is reliable over multiple test-retest intervals with correlations ranged from r= .89 to r= .97.

According to Benedict et al. (2008), SDMT can discriminate between patients and controls on repeated administrations, and detects cognitive deterioration over time (Amato et al., 2010). Sonder et al. (2014) compared the SDMT with Paced Auditory Serial Addition Test (PASAT3) and found that SDMT is more reliable and stronger validity than PASAT3. López-Góngora et al. (2015) conducted a similar study in which they compared the SDMT with PASAT3 and they also found that SDMT has a better ability to detect cognitive impairment (CI) in MS patients then PASAT3.

The Trail Making Test (TMT) is a standalone measurement tool from the Halstead-Reitan Neuropsychological test battery that measures processing speed, and mental flexibility. This test has been used in the past for the evaluation of the impact of music on cognitive functions (Bugos, 2010; Groth-Marnat, et al., 2000; Reitan, 1993) and contains two parts (Part A and Part B).

TMT has a very high retest reliability with part A ranking between r=0.76 and r=0.89 and part B ranking between r=0.86 and r=0.94 (Wagner et al., 2011). The test evaluates sequencing, visual scanning ability, information processing speed, integration of visual and motor functions, and the ability to switch between different stimuli.

Part A of the test contains a paper with 25 circled numbers from 1 to 25. The participants were asked to draw lines from one circle to another starting with circle numbered “1” in an increasing sequential order and continue using this pattern until number “25”, which is also labeled as “End”.

Part B follows the same concept; however, this form contains circled numbers, as well as circled letters. The participants must connect the circles by drawing a line in an increasing sequential order by alternating between the numbers and letters. For example, the participant will

start with circle that includes number “1” it and go to the circle that includes the first letter “A”. Then connect to the number “2”, then letter “B” and continue using this pattern until the participant reaches a circle labeled “End”. When the examinee makes a mistake, the examiner asks the participant to go back to the last circle reached and continue until the task is completed.

The time to complete each part was recorded (in seconds) as the score. It is important to mention that smaller scores were considered being better than higher scores, since a smaller score indicated that participant completed the task faster. The instances in which the trajectory of the line was not initiated towards the designated circle was considered an error, and a frequency in which the errors occurred, was also recorded for each participant.

Procedure

A total of 105 children (age 10-12) were recruited from three different schools located in Bucharest, Romania (music school, a visual arts school, and a public middle school). The study was introduced to the participants’ parents at the end of the “back to school night” meeting by the researcher of the study, where the parents had to opportunity to learn about the details of the study, and all their questions were answered by the researcher.

All testing sessions were administered by one examiner who is the researcher of this present study, and all sessions were conducted at the participants’ school, outside of their instructional time. To examine the differences in cognitive performance among the three groups the individual tests scores were analyzed using statistical analysis software SPSS 25.

Ethics statement

The studies involving human participants were reviewed and approved by University of South Florida. The parents of the children recruited for the present study received and signed the informed consent and competed a demographic questionnaire. Therefore, as per IRB

requirements, the parents who signed the informed consent were enrolled in the study as inactive participants. The children also signed an informed consent and were enrolled in the study as participants.

Back translation

The official language of Romania is Romanian, therefore, to ensure that participants fully understood the instructions of how to perform during the testing sessions, the instructions of all the tests were back translated to Romanian. The test administrator is fluent in Romanian language and was able to answer all questions that participants had. The protocol of back translation requires a specific the step-by-step process (see Figure 2).

The back translation is the process in which a text is translated from the original language (English in this case) into the target language (Romanian in this case), then back to the original language. This protocol is used to ensure that no significant meaning has been lost during the translating process from the original to the target language.

The first translation must be done by two people that are fluent in both languages, compare and assess the two translations for differences in interpretation, and decide into one single translation that best reflects the content from the original text. Then, a different individual who is fluent in both languages translates it back in the original language. It is important that the individual who translates the text back to the original language is not involved in the study, as this may have an influence in how the translation is made. Then, the original text is reviewed and compared with the translated text and changes are made if necessary (Eremenco et al., 2004).

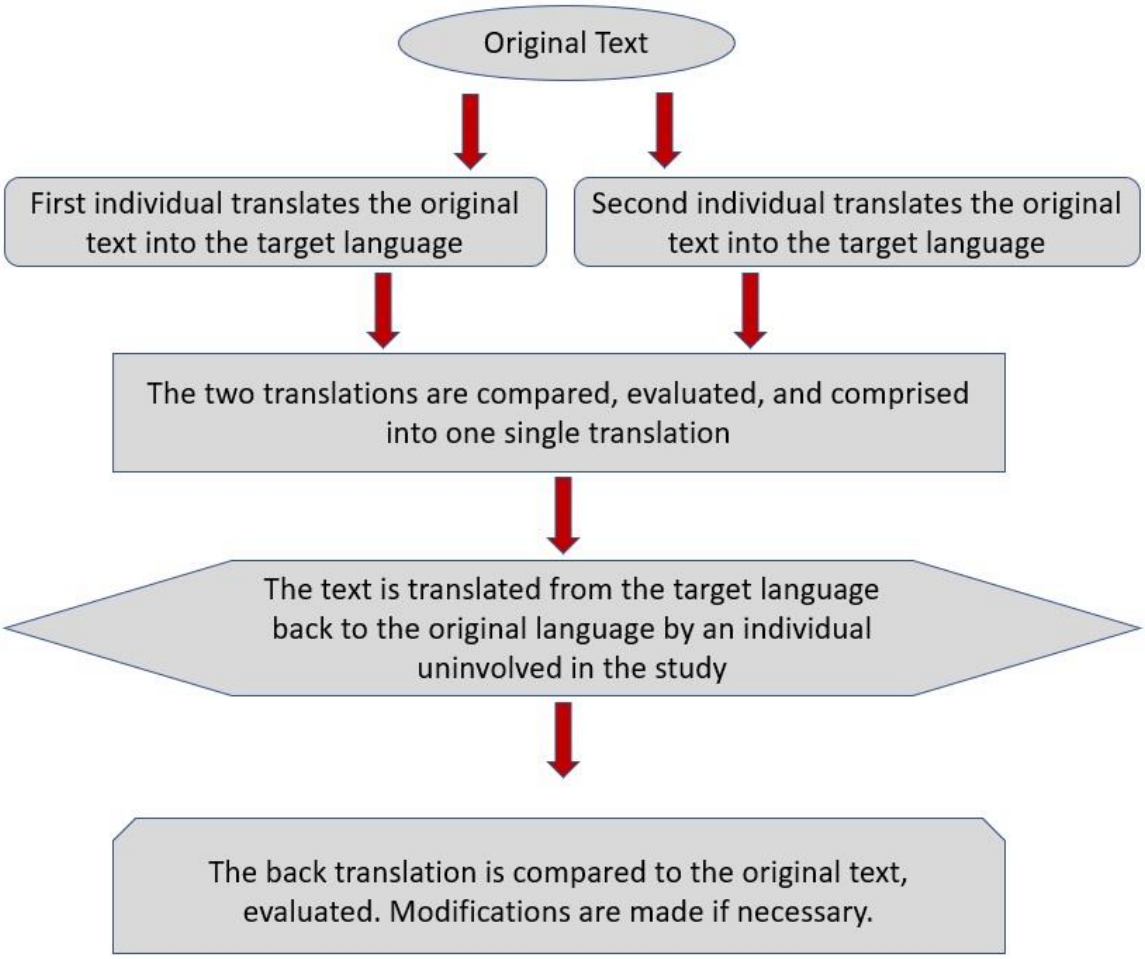

Figure 2. Back translation protocol*

**This figure portrays the step-by-step process of translation from the original language text to the target language, and back to the original language.*

The back translation has been previously used successfully with various cognitive tests in a study that assessed the neurocognitive functioning in a Romanian cohort of young adults with parenterally-acquired HIV-infection during childhood (Ene, et al., 2014).

CHAPTER FOUR: RESULTS

The purpose of this chapter is to present the analysis protocol of the present study, and report the results rendered by the statistical analysis. The results include the analysis of the primary demographic data such as age, gender, parental education, and household income, as well as baseline characteristics such as music aptitude and intelligence. The variables reflecting the cognitive abilities were analyzed by using the Multivariate Analysis of Covariance (MANCOVA), and exploratory analysis were conducted to observe the cognitive performance of all groups on each variable.

Data Analysis Protocol

This present study assessed the association between instrumental music instruction and executive functions in children (10-12 years). Since music requires high cognitive complexity, the underlying hypothesis is that the music group would outperform the visual arts group and the traditional education groups on the cognitive measurements administered. Since visual arts training also require extensive cognitive involvement, the underlying hypothesis is that the visual arts group will also outperform the traditional education group on the cognitive measurements. The independent variable in this study is the training, and the dependent variables are represented by the scores achieved through diverse measurements.

Demographic Analysis

First, a descriptive analysis of the demographic variables was conducted to report frequencies, and to determine if there was a statistically significant difference among the groups on the demographic variables, such as child's gender, child's age, parent education, and annual

household income. Second, ANOVAs were conducted to determine if there was a statistically significant difference among the groups on the two potential covariates, the intelligence and the musical aptitude. Differences between the groups indicated that it was necessary to include these variables as covariates in the multivariate model.

Multivariate Analysis of Covariance (MANCOVA)

Third, the data evaluating cognitive performance and student classification were analyzed using Multiple Analysis of Covariance (MANCOVA). MANCOVA requires (a) a single independent variable with two or more categorical and independent groups, (b) one or more covariates, and (c) multiple dependent variables that are measured at the interval or ratio level.

The dependent variables consist of scores, or composite scores of the cognitive measures administrated as follows: the Delta score of the TMT, the total correct score of SDMT, the combined scores of the letter fluency, category fluency, and category switching of the verbal fluency test of D-KEFS, and the combined scores of sixth and seventh trial of the verbal memory as measured by RAVLT.

While part A of the TMT measures participant's attention, rote memory and visual screening ability, trial B also measures the processing speed and is sensitive to executive functioning. The TMT's Delta score was achieved by subtracting the score of trial A from the score of part B. Subtracting the score of part A from the score of part B will reveal the executive function portion of the test, which is more relevant for this study.

The SDMT has only one score, which is represented by the number of correct answers, therefore, this score was used in the analysis model. The verbal fluency test of D-KEFS's letter fluency, category fluency, and category switching scores were combined into one composite score. The RAVLT has a total of seven trials; the first five trials represent the learning trials, the

sixth trial shows the rate of learning, while the seventh trial reflects the long-term memory. The scores of the sixth and the seventh trial are the most relevant for the present study, as they are indicative of the learning potential and the long-term memory. Therefore, the sixth and the seventh trials' scores were combined as one composite score.

MANCOVA determines whether mean differences among groups on a combination of dependent variables are likely to occur by chance (Huberty & Petoskey, 2000) while adjusting for covariates. By examining these theoretically related variables together rather than separately (as with multiple ANOVAs), a MANCOVA increases statistical power, and reduces the likelihood of Type I (rejecting a true null hypothesis) and Type II (failing to reject a false null hypothesis) errors (Keselman et al., 1998). This approach was selected for this study because there were three groups observed, their performance was compared across groups as measured on four cognitive tests, and two covariates were included.

To conduct a MANCOVA, the data must meet the following assumptions: (a) independence of observations, (b) homogeneity of variance, and (c) normality. Independence of observations suggests that there is no relationship between the observations in each group or between the groups. This assumption holds if the study does not consist of paired samples, repeated measures, or nested data structures. Homogeneity of variance assumes that the variance and covariance matrices are similar across groups. Box's M test was used to evaluate this assumption. The assumption of multivariate normality assumes that scores on the dependent variables are normally distributed across groups.

Finally, since the MANCOVA analysis yielded a statistically significant result, follow-up univariate *F* tests were run for each measure to determine whether there was a difference

between the means of all possible pairs of groups while adjusting the Alpha level to reduce the likelihood of Type I error for multiple tests.

Exploratory Analysis

To further analyze the cognitive performance across all three groups, statistical analysis was performed on each cognitive measures administered. The TMT has a total of three dependent variables which are reflected by the part A score, part B score, and the Delta score. A one-way ANOVA was conducted to find the differences between the three groups on each of the three dependent variables. The researcher collected data on the occurrences of errors that participants made during both trials of the test, and a frequency analysis on these occurrences was conducted as well.

The SDMT has one dependent variable, which is reflected by the number of correct answers. A one-way ANOVA was conducted to find the differences between the three groups. The researcher also collected data on the occurrences of errors that participants made during this test. These errors represent the number of times when the participant inputted a number that did not match the symbol which was associated with. A frequency analysis on these occurrences was conducted as well.

The D-KEFS verbal fluency test has a total of three dependent variables which are reflected by the letter fluency, category fluency, and category switching scores. A one-way ANOVA was conducted to find the differences between the three groups on each of the three dependent variables. The researcher also collected data on the two types of errors that some participants made during the three trials of the test. The first type of error occurred when a participant provided a word that did not fit the criteria required by the task. For example, when asked to name a vegetable, the participant provided the name of a fruit. The second type of an

error occurred when a participant provided an answer twice. This type of error was marked as repetition, and a frequency analysis on the occurrences of these two types of errors was conducted as well.

The RAVLT has a total of seven trials; the first five trials represent the learning trials, the sixth trial reflects the rate of learning, and the seventh trial provides a measurement on long-term memory. A one-way ANOVA was conducted to find the differences between the three groups on each of the of the trials. The researcher also collected data on the two types of errors. The first type of error occurred when a participant repeated a word (repetitions). The second type of an error occurred when a participant provided a word that did not exist on the list (errors). A frequency analysis on the occurrences of these two types of errors was conducted as well.

Demographics

General demographic data including gender, age, parent education and household income were collected for all participants. To control for potential group differences, measurements of intelligence and musical aptitude were also collected. A descriptive analysis of the general demographic variables is provided (see Table 1).

The majority of the participants in this study were 11 years old (M = 11.13, SD = .34). Approximately 59% of the students' parents had attended or graduated from post-secondary school, and a majority (80%) of the students' parents had an annual household income between $10,000 and $20,000. The minimum monthly salary in Romania is the equivalent of approximately 550 US dollars, while the medium salary is approximately 1000 US dollars. Therefore, the income range of participants' families fell into the middle-class category.

To determine if there was a statistically significant difference between the groups on the demographic variables, a one-way MANOVA was conducted for gender, age, parent education,

and annual income. The results revealed no significant differences among groups in age, p = 0.873; gender, p = 0.682; parent education, p = 0.896; or annual income, p = 0.968, as data analysis revealed similar demographic characteristics for all groups.

Table 1. Frequency distribution of demographic variables*

	Groups						Total	
	Music		Art		Traditional			
	n	%	*n*	%	*n*	%	*n*	%
Gender								
Male	15	41.7	12	35.3	16	45.7	43	41.0
Female	21	58.3	22	64.7	19	54.3	62	59.0
Age (in years)								
10	1	2.8	3	8.8	2	5.7	6	5.7
11	35	97.2	29	85.3	30	85.7	94	89.5
12	0	0.0	2	5.9	3	8.6	5	4.8
Parent education (in years)								
12 or fewer	15	41.7	13	38.2	15	42.9	43	41.0
13 to 16	9	25.0	8	23.5	10	28.6	27	25.7
17 or more	12	33.3	13	38.2	10	28.6	35	33.3
Household annual income (in $)								
Less than 10,000	3	8.3	7	20.6	3	8.6	13	12.4
10,000 – 20,000	32	88.9	23	67.6	29	82.9	84	80.0
20,000 – 30,000	0	0.0	2	5.9	3	8.6	5	4.8
30,000 – 40,000	1	2.8	2	5.9	0	0.0	3	2.9

**This table shows the differences in demographic values between the groups. The gender section shows the number of males and females and the percentage of each gender in each group. The age section shows the number of participants at each age segment and the percentage of each age segment in each group. The parent education section shows the number and the percentage of parents that competed their education at each education bracket in each group. The household annual income section shows the number of participants and the percentage of participants who fall in each income segment in each group.*

Baseline Characteristics of Music Aptitude and Intelligence

Since factors such as music aptitude and intelligence may impact performance on cognitive measures, potential group differences on these variables were evaluated and used as covariates in the analysis. A one-way ANOVA was used to evaluate potential differences between three groups.

Overall, there was a significant difference in estimated IQ among groups; $F(2,102) = 17.71$, $p < .001$. Post-hoc comparisons using the Tukey HSD test indicated that the mean score on the WASI-IQ for music students ($n = 36$, $M = 118.97$, $SD = 5.42$) was significantly higher than the art students ($n = 34$, $M = 111.29$, $SD = 9.18$) and traditional students ($n = 35$, $M = 106.46$, $SD = 11.31$). To control for the significance in IQ performance, this variable was selected to be included as a covariate in the multivariate analysis.

The results of a one-way ANOVA revealed a significant difference in musical aptitude among the groups; $F(2,102) = 9.66$, $p < .001$. Post-hoc comparisons using the Tukey HSD test indicated that the mean score for music students ($n = 36$, $M = 52.69$, $SD = 5.98$) was significantly higher than the art students ($n = 34$, $M = 47.32$, $SD = 4.63$) and traditional students ($n = 35$, $M = 47.86$, $SD = 6.21$). To control for the significance in musical aptitude, this variable was also included as a covariate in the multivariate analysis.

Assumptions of Normality

First, results of the Shapiro-Wilk test indicated that the assumption of normality is tenable for all variables and groups with two exceptions: music students on the SDMT ($W = .949$, $p < .001$) and art students on the RAVLT ($W = .959$, $p = .002$). Although the univariate distribution was non-normal in these cases, MANCOVA is robust to minor violations of the normality assumption (Nimon, 2012; Stevens, 2002).

Second, homogeneity of variance was examined with Box's M test to test the equality of the covariance matrices. Results revealed a Box's M value of 32.60, with a p value of = .059. This indicates that there were no significant differences between the covariance matrices.

Third, Levene's test of equality of error variances revealed significant p values for three of the dependent variables (SDMT = .203, RAVLT = .109, and D-KEFS = .659), and a

significant *p* value for one of the dependent variables (TMT-delta = .004). However, MANCOVA is robust to violations of the assumption, as long as the ratio of the largest and the smallest group size is less than 1.5. In this study the largest group had 36, while the smallest group had 34 participants, making the groups size similar.

Finally, independence of observations was achieved by testing mutually exclusive groups of students. This study did not include paired samples, repeated measures, or nested data; therefore, observations can be assumed to be independent of each other.

Descriptive Statistics for the Dependent Variables

Descriptive information about the psychometric measurements by student classification is provided bellow (see Table 2). The skewness and kurtosis values were close to 0 for the majority of the dependent variables across groups, with the exception of the SDMT for music students and the RAVLT for art students. Both measures demonstrated slight skewness and substantial kurtosis.

Table 2. Descriptive statistics for the dependent variables by group*

Measures	Music group (n = 36)			Art group (n = 34)			Traditional group (n = 35)		
	M	*Sk*	*Ku*	*M*	*Sk*	*Ku*	*M*	*Sk*	*Ku*
TMT- Delta	63.92	0.43	0.73	66.15	0.45	-0.09	76.11	0.02	-0.64
SDMT items correct	44.22	1.45	4.62	41.97	0.09	-0.52	41.00	0.26	-0.50
RAVLT composite score	18.97	-0.60	0.37	17.47	-1.12	1.88	14.77	0.76	-0.36
DKEFS composite score	40.81	0.15	-0.87	37.56	0.10	-0.57	36.89	-0.38	-0.43

**This table shows the skewness and kurtosis values by group.*

Multivariate Analysis (MANCOVA)

The main research question of this present study aimed at finding the association between instrumental music instruction and executive functions in children (age 10-12). A one-way multivariate analysis of covariance (MANCOVA) was conducted to test the hypothesis that

participants enrolled in the music group would outperform cognitively the visual arts and the traditional education groups.

The results of the analysis revealed a significant difference in means on the set of measures that was statistically significant as indicated by Wilks' lambda, $\Lambda = 0.820$, $F(8, 194) = 2.53$, $p = .012$, and a multivariate effect size of .095, as measured by the value of partial eta squared. This result indicates that the means of multiple dependent variables differ by student classification, therefore, the null hypothesis that there is no difference between the cognitive performance between the groups was rejected. Because the results were statistically significant, post-hoc tests were conducted.

TMT-Delta

A one-way ANOVA with an adjusted Alpha level of .0125 was conducted to explore differences across groups in mean scores on the TMT-Delta. The differences across groups were not statistically significant, $F(2,102) = 1.57$, $p = .214$. However, the traditional education group had a slightly higher mean score on this measure than the other groups (see Figure 3). The higher mean score indicates that participants in the traditional education group took longer time to complete the task, which indicates lower performance than the visual arts, and the music groups.

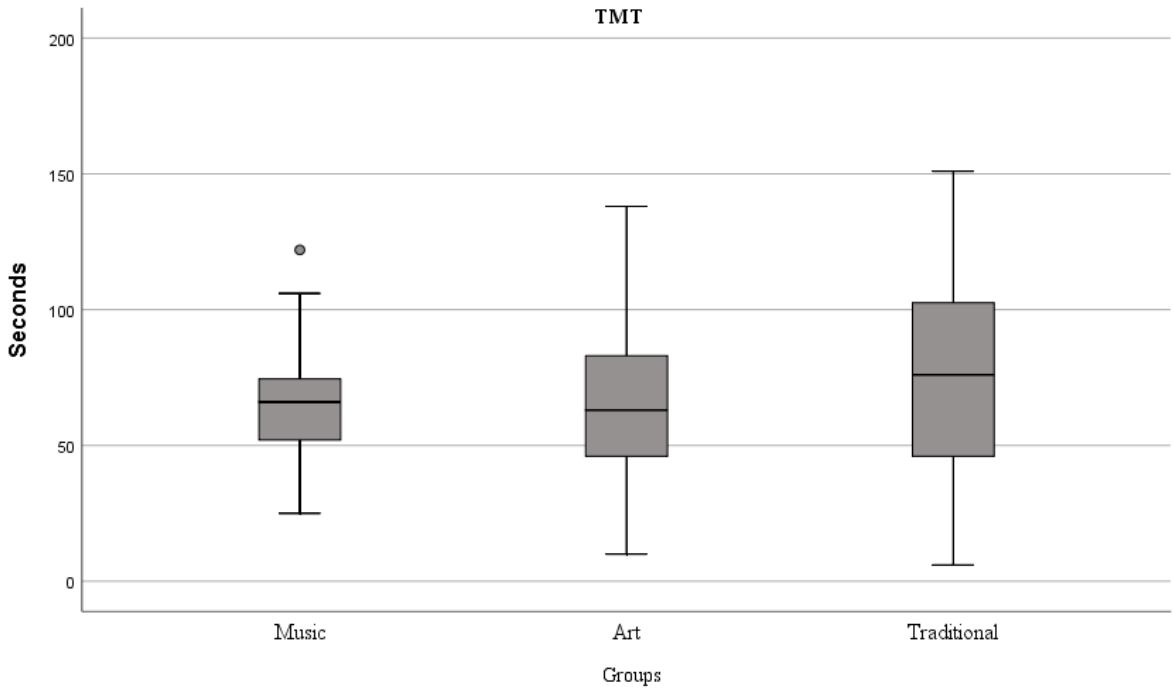

Figure 3. TMT results by group*

**This figure shows the group distribution of the TMT data*

SDMT

A one-way ANOVA with an adjusted Alpha level of .0125 was conducted to explore differences in mean scores on the SDMT across the groups. As shown in the boxplots (see Figure 4), the differences across groups were not statistically significant, $F(2,102) = 1.12$, $p = .330$. However, music students had a slightly higher mean score on this measure than the other groups

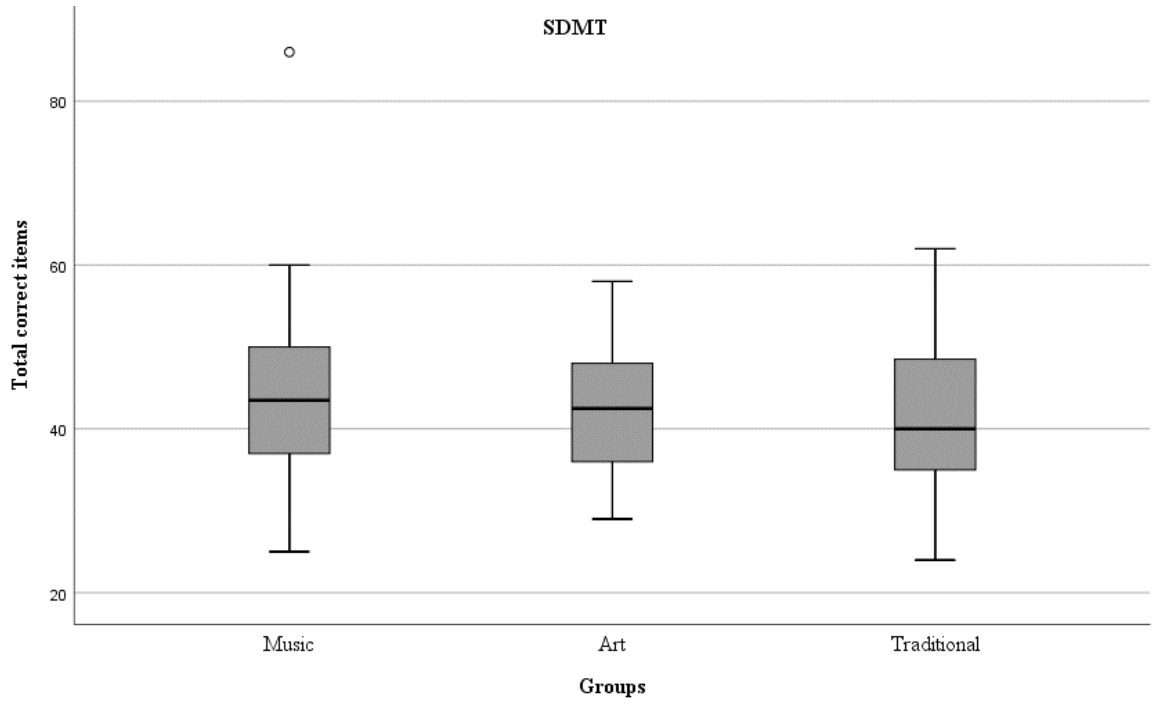

Figure 4. SDMT results by group*

**This figure shows the group distribution of the STMD data*

D-KEFS

A one-way ANOVA was conducted to explore differences across groups in mean scores on the D-KEFS. The differences across groups were also not statistically significant, $F(2, 102) = 2.17$, $p = .119$. However, music students had a slightly higher mean score on this measure than the other groups (see Figure 5).

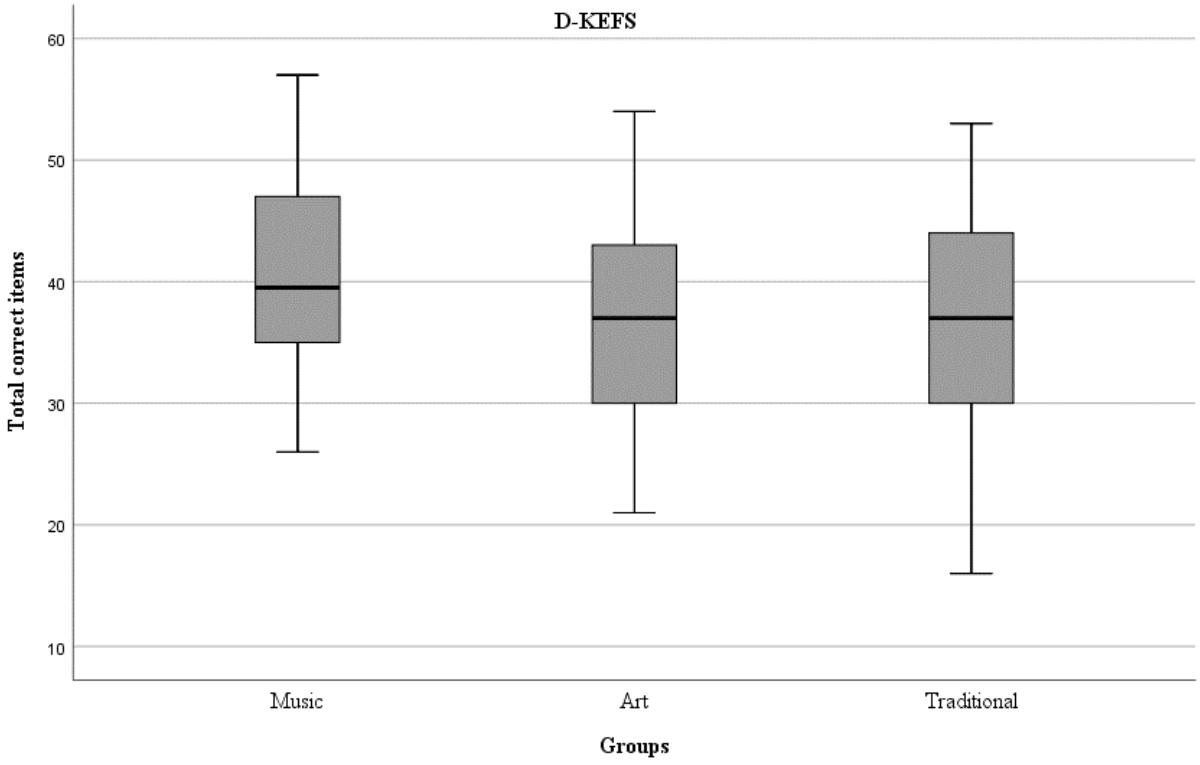

Figure 5. D-KEFS results by group*

**This figure shows the group distribution of the D-KEFS data*

RAVLT

A one-way ANOVA was conducted to explore differences across groups in mean scores on the RAVLT. The differences across groups were statistically significant, $F(2,102) = 11.73$, $p < .001$. The mean score on RAVLT for the music students ($M = 18.97$, $SD = 3.58$) was significantly different than the traditional students ($M = 14.77$, $SD = 2.88$) but not the art students ($M = 17.47$, $SD = 4.48$). However, the differences between the art students and traditional students were also significantly different (see Figure 6).

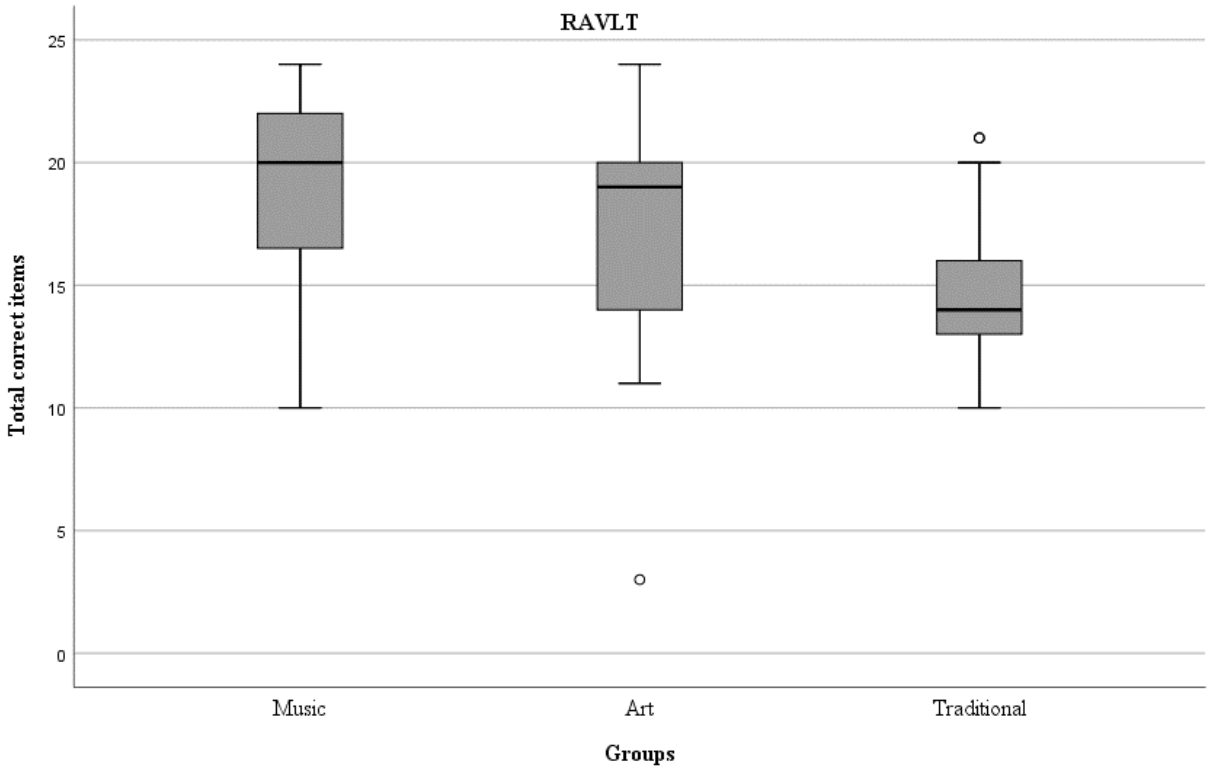

Figure 6. RAVLT results by group*

**This figure shows the group distribution of the RAVLT data*

Exploratory Analysis

To further assess the cognitive performance of the participants the researcher conducted one-way between-subjects ANOVAs on each trial of all the cognitive measures administered.

TMT

The results revealed no significant difference among the groups on the TMT-A; $F(2, 102) = 0.53$, $p = .889$, TMT-B; $F(2, 102) = 1.83$, $p = .165$, and TMT-Delta trials; $F(2, 102) = 1.56$, $p = .214$. Apart from recording the time taking to compete the task, TMT also recorded the number of instances in which a participant started to draw the line in an incorrect trajectory; these instances are logged as “errors”. The results revealed no significant difference on errors among

the groups on both TMT (part A and B). Descriptive statistics for TMT-Delta measure by group classification has been provided bellow (see Table 3).

Table 3. Descriptive Statistics for TMT measure by group classification*

	Music		Art		Traditional		
Measure	*M*	*SD*	*M*	*SD*	*M*	*SD*	*p* value
Part-A	57.14	17.60	56.15	21.90	58.46	20.05	.889
Part-B	121.06	27.05	122.29	31.89	134.57	38.31	.165
Errors-Delta	63.92	21.11	66.15	31.54	76.11	37.69	.214
Errors-A	.11	.39	.38	.85	.26	.70	.246
Errors-B	.56	1.53	.71	1.09	1.23	2.10	.197

**This table shows the means (M), standard deviation (SD), and the significance value (p) on all trials of TMT per each group.*

SDMT

No significant differences were found between the groups on the SDMT trial; $F(2, 102) = 1.12$, $p = .331$. SDMT also records the number of instances in which a participant inputed an incorrect digit for a symbol; these instances were logged as "errors". The results revealed no significant difference between the groups on SDMT error trial as well. Descriptive statistics for SDMT measure by group classification is provided bellow (see Table 4).

Table 4. Descriptive Statistics for SDMT measure by group classification*

	Music		Art		Traditional		
Measure	*M*	*SD*	*M*	*SD*	*M*	*SD*	*p* value
SDMT total correct	44.22	11.048	41.97	7.280	41.00	9.136	.331
SDMT-errors	.78	1.333	.56	.746	1.06	1.533	.259

**This table shows the means (M), standard deviation (SD), and the significance value (p) on all trials of SDMT per each group.*

D-KEFS

The analysis revealed no significant differences between the groups on the D-KEFS category fluency trial; $F(2, 102) = 1.61$, $p = .206$, letter fluency; $F(2, 102) = 8.72$, $p = .454$, category switching; $F(2, 102) = 1.09$, $p = .341$, and the category switching total correct switches; $F(2, 102) = 2.93$, $p = .058$.

Apart from recording the total correct responses within the time allotted, D-KEFS records two types of errors that participants might have produced. First, the number of instances in which a participant gave an incorrect answer, with those instances being logged as "errors". Secondly, when the participant replied with a word that was previously logged as a correct response, with those instances being logged as "repetitions".

The results revealed no significant difference on repetitions between the groups. However, there was a significant difference between the art group and the traditional education group on errors trial of the D-KEFS. The music group had a total of eight errors, the traditional education group had a total of 20 errors, while the art group completed the task with no errors. Descriptive statistics for D-KEFS measure by group classification is provided bellow (see Table 5).

Table 5. Descriptive Statistics for D-KEFS measure by group classification*

	Music		Art		Traditional		
Measure	*M*	*SD*	*M*	*SD*	*M*	*SD*	*p* value
Letter fluency - total correct	10.33	3.77	9.65	2.70	9.37	3.34	.454
Category fluency - total correct	13.69	3.56	12.44	3.55	12.37	3.38	.206
Category switching - total correct	9.14	1.53	8.65	2.04	8.51	2.03	.341
Category switching - total correct	7.64	1.47	6.82	1.86	6.63	2.19	.058
Total errors	.22	.72	.22	.000	.57	1.11	.010
Total repetitions	.33	.67	.24	.50	.54	.89	.185

**This table shows the means (M), standard deviation (SD), and the significance value (p) on all trials of D-KEFS per each group.*

RAVLT

The results revealed significant difference on the following trials of the RAVLT: The music group scored significantly higher than the traditional education group trial 2; $F(2, 102) = 5.44$, $p = .006$, trial 3; $F(2, 102) = 3.83$, $p = .025$, trial 5; $F(2, 102) = 4.50$, $p = .013$, and trial 7; $F(2, 102) = 8.03$, $p = .001$. On trial 6 the music group scored significantly higher than both the visual arts, and the traditional education groups; $F(2, 102) = 9.60$, $p < .001$. However, there were no differences between groups on trial 1; $F(2, 102) = 1.21$, $p = .302$, and trial 4; $F(2, 102) = 1.83$, $p = .165$.

Participants could have made two types of errors on the RAVLT. First, the number of instances in which a participant gave an incorrect answer. For example, on the seventh trial, participants are asked to recall words from the first list. Providing a word that was on the second list was recorded as an "error". Second type of error occurred when the participant repeated a word that was previously logged as correct; those instances were logged as "repetitions". None of those instances were counted towards the total correct items.

The results revealed no significant differences on repetitions between the groups ($p = .124$), but the music group performed with significantly fewer errors than the art group, but not the traditional education group on the RAVLT ($p = .020$). Descriptive statistics for RAVLT measure by group classification is provided bellow (see Table 6).

Table 6. Descriptive statistics for RAVLT measure by group classification*

	Music		Art		Traditional		
Measure	*M*	*SD*	*M*	*SD*	*M*	*SD*	*p* value
Trial 1 - total correct	7.11	1.58	6.97	1.94	6.51	1.50	.302
Trial 2 - total correct	10.11	1.81	9.47	1.95	8.71	1.56	.006
Trial 3 - total correct	10.83	2.13	10.68	2.30	9.51	2.10	.025
Trial 4 - total correct	11.83	2.06	11.35	2.30	10.94	1.41	.165
Trial 5 - total correct	12.58	1.88	12.06	1.90	11.31	1.54	.013
Trial 6 - total correct	7.50	1.66	6.06	1.92	5.60	2.11	.001
Trial 7 - total correct	11.47	2.90	11.41	3.23	9.17	1.91	.001
Errors	.19	.40	.97	1.46	.69	1.32	.020
Repetitions	.08	.36	.35	.69	.17	.568	.124

**This table shows the means (M), standard deviation (SD), and the significance value (p) on all trials of RAVLT per each group.*

This chapter provided the analysis protocol of the study which outlines all the steps taken to analyze the data collected, as well as the results rendered by statistical analysis including the demographic data. The main question was answered by implementing the Multivariate Analysis of Covariance (MANCOVA), and follow-up univariate *F* tests were used to answer the sub-questions of the present study.

CHAPTER FIVE: DISCUSSION

The purpose of this present study was to assess the association between the instrumental music education and the cognitive development in 10-12 years old children. The statistical analysis revealed that instrumental music education may be beneficial to cognitive development and suggests long-term memory enhancement in students who had instrumental music training. This chapter discusses the results of standardized cognitive measures in relation to the research questions of this study.

Overview of the Study

The aim of this study was to compare performance on measures of executive functions in musically trained children to children who received visual arts training and children who receive no special training. A total of 105 participants were recruited this study, and all the participants who agreed to participate in the study met the criteria of enrollment. The music group consisted of 36 participants, the visual arts group consisted of 34 participants, and the traditional education group consisted of 35 participants.

A battery of cognitive measurements was administered to all participants. Because the enrollment in the music school is based on a student's musical aptitude, all participants completed the AMMA to assess the musical aptitude of all participants. Since the results of the cognitive measures may be influenced by the participants' intelligence, all participants completed the 2-subtest form of the WASI-II.

The music group scored significantly higher on both, AMMA and WASI-II. To establish that differences in the cognitive results reflected the gains produced by the musical training, both

variables (composite scores of AMMA and the IQ scores derived from the two subtests of WASI-II) were included as covariates in the multivariate analysis of covariance (MANCOVA) as per analysis protocol. This analysis model controls for music aptitude and the IQ differences between the groups therefore, therefore, the rendered results revealed the differences derived from the participation in the instrumental music training. Results of multivariate analysis of covariance (MANCOVA) indicated that instrumental music training may enhance long-term verbal memory performance.

Strength of the Study

The study observed a large sample size (N=105) of participants with similar group distribution such as the visual arts group (n = 34), traditional education group (n = 35), and music group (n = 36). The researcher recruited children from Romania (age 10-12) that were enrolled in either vocational, or regular schools. Romania provides young children with the opportunity to enroll in vocational schools that provide excellent training for various learning opportunities such as music, visual arts, and sports. While these educational institutions focus on producing highly trained professionals, there are no research studies that can be identified at this time that observed the far transfer to cognitive abilities from music training in children from Romania. The present study is the first to consider the effect of these learning opportunities and examine the far transfer of instrumental music education to cognitive performance in this country.

Instrumental music education requires a substantial financial commitment, as there are expenses related to instrument acquisition and its maintenance, printed materials, online resources, and often private instruction. It is a common trend in the USA, that parents of children who take music lessons have the financial means to afford such expense. Therefore, many of the

music learners may have a socio-economic advantage as compared to children who are not involved in music learning. However, there were no differences in the socio-economic status, as well as age, and parents' education between the groups in the present study.

The quality of the musical training is especially important when assessing the far transfer from musical training to cognitive ability. For example, (1999) found no differences in cognitive performance between the music and the control group after three years of piano instruction. However, the musical training for Costa-Giomi's study consisted of one piano lessons of 30 minutes per week for the first two years, which increased to 45 minutes long during the third year of instruction. These lessons were provided at participants' schools during lunch recess or after school. Since participants were eating while learning piano during their lunch time, it is fair to assume limited engagement for most learners, and this training regimen may not have been rigorous enough to produce a measurable effect on cognitive performance.

An important strength of this study was the high quality of the instruction provided by the vocational schools in Romania. Both, the music, and the visual art program from which the participants were enrolled aim for excellence, include individual and group education, as well as practical and theoretical instruction for approximately eight hours a week. Also, it is important to mention that the training at these schools was provided by highly trained, certified professionals.

Results Overview

The purpose of this section is to discuss the results rendered by the statistical analysis in regards to the association between the instrumental education and cognitive ability, as well as the participants' performance on the processing speed, verbal fluency, and verbal memory tasks.

Association Between Instrumental Music Education and Cognition

The research questions of this study focused on examining the association between instrumental music instruction and executive functions in children, and it was hypothesized that participants enrolled in music training would outperform the visual arts and the traditional education groups on the battery of assessments. The hypothesis of music group performing superiorly was based on the cognitive demands of the instrumental education, and the enhanced transfer to verbal memory performance may be attributed to the complex cognitive processes during the learning process and instrumental skill development.

These cognitive processes are, but not limited to the deciphering of a highly complex symbol construct, synchronization with a beat, a conductor, or other players, bimanual coordination, instrument manipulation, as well as continuous adjustments to dynamics, and creative interpretation. Many of these processes must be executed at the same time, and the practician needs to make collective adjustments while playing in group with very subtle cues from other performers or the conductor. As the learners advance their skills, the music becomes progressively more challenging and increasing in length, requiring longer time of focusing on the task. Therefore, the skills developed from the instrumental music training may transfer into cognitive development.

On the other hand, visual arts training also requires extensive cognitive involvement, especially the development of visual memory, which is specific to painting and drawing. The results of this study revealed that visual art group also outperformed the traditional education group on the cognitive assessments which confirms the underlaying hypothesis.

Results of the multivariate analysis revealed that music group scored higher than the visual arts, and the traditional education groups on all trials of all administered tests, and the

results of this study are aligned with other studies (Bugos et al., 2007; Bugos, 2010; Schellenberg, 2011; or Degé et al., 2011), who found that music training enhances areas of executive functioning in young children.

Processing speed. The TMT and the SDMT were administered to assess the association between the instrumental music instruction and processing speed in children (10-12 years). While music and visual art groups scored consistently higher than the traditional education group on all trials, the differences were not statistically significant.

The results of this study are consistent with Bialystok and Depape (2009) who observed young adults 18 to 35 years old and Virtala et al. (2014) who observed young adults 19 to 34 years. Bialystok and Depape (2009) analysis revealed $p = 1.74$ on the TMT-A and $F < 1$ on the TMT-B, while Virtala et al. (2014) revealed $p > .10$ on both TMT trials, therefore, both studies found nonsignificant differences between musicians and non-musicians.

While differences found in this study were not statistically significant, the results of TMT and SDMT indicate that both music and visual arts training might have a positive impact on processing speed, as these groups consistently performed better than traditional education group in all trials of these measurements. Perhaps more research is needed to further clarify the association between the instrumental music instruction and processing speed.

Verbal fluency. The D-KEFS verbal fluency test was administered to the participants in this study to assess the association between the instrumental music instruction and the verbal fluency. The music group scored higher in all four categories (Letter Fluency, Category Fluency, total correct items in the Category Switching, as well as the total correct switches in the Category Switching) than both visual arts, and the traditional education groups. However, the differences did not reach statistical significance.

While some research studies found that musicians outperformed non-musicians (Zuk et al., 2014) or visual arts group (Moreno et al., 2011b) in verbal fluency measurements, others found no differences between music training and French learning group (Janus et al., 2016) or music and a control group (Saarikivi et al., 2016). The results of the present study align with the findings of Zuk et al. (2014) and Saarikivi et al. (2016).

Verbal memory. The RAVLT was administered to the participants of this study to assess the association between the instrumental music instruction and long-term verbal memory. The music and visual arts groups scored significantly higher on the verbal memory task than the traditional education group, with the music group having the highest scores. This may indicate that both music, as well as visual arts may have a positive impact on verbal memory.

The findings of this study, as well as other studies (Franklin el. al., 2008; Degé & Schwarzer, 2017; Roden et al., 2012; Ho et al. (2003)) indicate that music training may improve verbal memory. These findings do not come as a surprise, since music learners often memorize lengthy pieces of music that include a great deal of information, which is not limited to performing all notes that are to be played, but also information regarding dynamics, expressive content, tempos, etc.

Future Research

While statistical significance was not found on all the cognitive domains tested, there was a clear trend in which music group scored higher than visual arts and traditional education groups. However, it is worth mentioning that visual arts group also scored consistently higher than the traditional education group. This shows that music is not the only program that may improve cognitive performance.

The development of cognitive abilities occurs over time and with constant practice and skill development (Gioia et al., 2002; Meltzer, 2007). Therefore, to further elucidate the association between the instrumental music training and cognitive development, more research is needed.

Limitations

Results of this study indicate that music training may have a positive effect on cognitive ability, especially in verbal memory in young children (age 10-12). However, this present study employed a cross-sectional research design in which the participants were already enrolled in their specific groups before the testing took place. Therefore, with no opportunity for randomized group assignment, it is uncertain whether the music training produced the enhancement in verbal memory, or the children who were enrolled in the music program happened to have better abilities in verbal long-term memory.

The participants in the music group were enrolled in a vocational school that admits students based on their musical aptitudes. As expected, the music group scored higher on the musical aptitude test than both, visual arts, and the traditional education group. While there is no evidence that individuals with strong musical aptitude possess superior cognitive potential, the researcher used the results of this variable as a covariate in the analyses. The IQ variable was also used as a covariate, as the music group scored higher than both, visual arts, and the traditional education group. The multivariate analysis of covariance (MANCOVA) is designed to minimalizes the effects of significant differences in demographic variables; however, the analysis may not predict exactly how the participants may have scored if there were no such differences in intelligence and musical aptitude.

While both, music and the visual arts group received similar training regarding time on task, group, individual instruction, as well as individual assignments, the training regimen did not match exactly, as each school followed their own curriculum. There is also difference in training length between the participants of the music group, as 29 of the 36 participants in the music group started the training in their first grade, one began music training in the second grade, one in fourth grade, and five in fifth grade. Also, while the visual arts school starts the enrollment in the fifth-grade, students usually start private training in visual arts for one to two years before enrollment, as the acceptance at this school is very competitive.

The participants in the present study were asked to complete multiple cognitive measurements. They were very excited and seemed fully engaged at the beginning of the testing session; however, the administrator of the tests observed a decline in the participants' enthusiasm and cognitive engagement as participants kept working on the tests, and they struggle to stay focused on task towards the end of the session. Therefore, it is possible that last cognitive measurements administered (TMT and Verbal Fluency subtest of DKEFS) may not reflect the full cognitive potential of the participants. However, all tests were administered in the same order for all participants, therefore they all faced the same challenges.

Implications

This study has a cross-sectional design that assessed the effect of music on cognitive development. Because the researcher aimed at finding the impact of instrumental music instruction on cognitive abilities, the analysis protocol was designed to be sensitive to the group classification. The age segment of the participants was chosen to fall between 10 to 12 years old, because many of the schools in the United States implement the instrumental music training at this age.

While learning music is a highly rewarding activity that justifies the dedication of energy and time associated with the training, it is also important to understand how music learning may have a far-transfer effect that might improve the executive functions, as well as identifying the cognitive domains that are most likely to be improved.

However, while the literature suggests that music education may enhance cognitive development, it is necessary to point out that music education varies greatly from school to school, based on genre of the music learned, but most evidently by the instrument learned. The differences found in various music learning methodologies will transfer in various degree of far transfer to cognitive development.

For example, playing a piano involves bimanual coordination, as the player is often required to play different parts with each hand, while playing the trombone only requires playing with one hand, while the other hand holds the instrument. Individual personality and motivation may also have an impact on how music education may influence cognitive development.

Patel (2011) discusses the OPERA hypothesis, which aims at explaining the process in which musical training is conducive to adaptive neural plasticity. According to this theory, the adaptive neuroplasticity takes place in speech-processing networks of the brain when five essential conditions are met: overlap (overlapping of the brain networks that involve both, music and speech), emotion (music engages strong emotive content), repetition (musical activity engages the speech processing network repeatedly), and attention (focused attention engages the speech processing network during musical involvement). Therefore, it there may be different far transfer effects from music education derived by the various specifics such as instrument (or voice), musical genre, motivation, personality, as well as the teaching methodology implemented.

This present study presents few special strengths: the participants enrolled in the music group were attending a school that provides a comprehensive music training which includes two individual instrument lessons per week, two music theory classes per week, group practice in various ensemble settings, as well as required individual practice. The instrument teachers do not follow a strict curriculum, but rather custom design the instruction for each student individually, so the progress reflects learners' full potential. The placement in theory classes and ensembles are also based on the students' performance level, to ensure they progress according to their potential. Many of the students enrolled at this school participate in national and international competitions and aspire to become professional musicians. One specific aspect about this music program is that students receive separate training in music theory, solfege, and dictation. Another strength of this study is reflected by the fact that this population that has not been observed so far, and it is important to observe how various population involved in music training perform cognitively when compared with non-musicians.

Understanding how music education impacts children's cognitive functions is necessary for developing curricula that calls for students' involvement in instrumental music education. The results of this study suggest that instrumental music education may have a positive effect on executive functions in young children, especially in long-term verbal memory.

Teachers and parents could make informed decisions on involving students in instrumental music program, as the results of this study indicate that instrumental music learning may enhance the cognitive abilities in processing speed, verbal fluence, with the strongest impact on verbal memory and learning. Therefore, the results of this study could be influential to adopting, implementing, or supporting the music programs in schools, and may contribute to the sustainability of music education as an important subject to be thought in schools.

Future Research Considerations

This present study revealed the superior cognitive performance of children enrolled in a music program. However, because the design of this study is cross-sectional, additional experimental studies are needed to further assess the far transfer effects of music education on executive functions in young children. A randomized controlled trial would eliminate the assumption that individuals who enroll in instrumental music programs may have superior cognitive abilities, as compared who individuals who chose not to enroll in such activity, often viewed as an extracurricular pursuit. It is also interesting to learn how different specifics of musical education such as the different instruments or voice, musical genre, individual personality, or the teaching methodology may influence the cognitive development.

This study focused on observing the differences in verbal memory, verbal fluency, and processing speed between children enrolled in music training and traditional education and visual arts groups. However, there may be other cognitive domains that may benefit from music education, such as inhibition and planning. Therefore, future research is necessary to examine performance in these cognitive domains between musicians and non-musicians.

To ensure a fair evaluation when assessing the impact of music education on cognitive ability, it is important that music training programs include rigorous training programs that are taught by highly trained instructors, and include training in music notation, ear training, solfege, playing the instrument individually, as well as in groups, in order to facilitate strong musicianship skills.

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APPENDICES

Appendix A: Institutional Review Board Approval

UNIVERSITY OF SOUTH FLORIDA
USF RESEARCH & INNOVATION

RESEARCH INTEGRITY & COMPLIANCE
Institutional Review Boards, FWA No. 00001669
12901 Bruce B. Downs Blvd, MDC35, Tampa, FL 33612-4799
(813) 974-5638 FAX (813) 974-7091

8/2/2019

Adrian Iordache
School of Music
612 S Glen Ave
Tampa, FL 33609

RE: **Expedited Approval for Initial Review**
IRB#: Pro00041362
Title: The Effects of Music Instruction on Cognitive Executive Functions in School Age Children

Study Approval Date: 8/2/2019

Dear Mr. Iordache:

On 8/2/2019, the Institutional Review Board (IRB) reviewed and **APPROVED** the above application and all documents contained within, including those outlined below. **Please note this study is approved under the 2018 version of 45 CFR 46 and you will be asked to confirm ongoing research annually in place of a full Continuing Review. Amendments and Reportable Events must still be submitted per USF HRPP policy.**

Approved Item(s):

Protocol Document(s):

Protocol, Version #1, 07 26 2019.docx

Consent/Assent Document(s)*:

Combined Parental Perm. & Parent, Version #1, 08 02 2019.docx.pdf
SB Assent Form with optional child signature line 08 02 2019.docx.pdf

*Please use only the official IRB stamped informed consent/assent document(s) found under the "Attachments" tab. Please note, these consent/assent documents are valid until the consent document is amended and approved.

Appendix A: Continued

Please submit an amendment prior to data collection to include the translated assent/consent documents in the application. These should both be uploaded in section 7.2.1 and the current assent form should be removed from section 6.3a.3, since it is not a verbal assent.

It was the determination of the IRB that your study qualified for expedited review which includes activities that: (1) present no more than minimal risk to human subjects, and (2) involve only procedures listed in one or more of the categories outlined below. The IRB may review research through the expedited review procedure authorized by 45 CFR 46.110 and 21 CFR 56.110. The research proposed in this study is categorized under the following expedited review category:

(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

This research involving children as participants was approved under 45 CFR 46.404: Research not involving greater than minimal risk to children is presented. Permission of one parent is sufficient and assent is required of all children.

As the principal investigator of this study, it is your responsibility to conduct this study in accordance with IRB policies and procedures and as approved by the IRB. Any changes to the approved research must be submitted to the IRB via an Amendment for review and approval. Additionally, all unanticipated problems must be reported to the USF IRB within five (5) business days.

We appreciate your dedication to the ethical conduct of human subjects research at the University of South Florida and your continued commitment to human research protections. If you have any questions regarding this matter, please call 813-974-5638.

Sincerely,

Melissa Sloan, PhD, Vice Chairperson
USF Institutional Review Board

Appendix B: Parental Permission Form in English

USF
UNIVERSITY OF
SOUTH FLORIDA

Consent to Participate in Research and Parental Permission for my Child to Participate in Research

Information for parents to consider before agreeing to participate and allowing your child to participate in this research study

Title: The Effects of Music Instruction on Executive Functions in Young Children age 10-12 years.

Pro#00041362

Overview: The following information is being presented to help you and your child decide whether you would like to be a part of a research study. The sections in this Overview provide the basic information about the study. More detailed information may be provided in the remainder of the document.

Study Staff: This study is being led by *Adrian Iordache* who is a *PhD Candidate* at/in *University of South Florida.* This person is called the Principal Investigator. *He* is being guided in this research by *Dr. Jennifer Bugos*. Other approved research staff may act on behalf of the Principal Investigator.

Study Details: This study is being conducted at vocational schools with music, visual arts training, as well as regular schools in Bucharest, Romania, and is supported/sponsored by *USF-Music department.* You will be asked to complete a confidential preliminary questionnaire.

There will be a total of three testing sessions that will last up to two hours each.

Participants: You are being asked to take part, and to allow your child to take part because *you are the parent of a child that is between the age of nine and eighteen, who doesn't have any neurological disorders and have no prior private music of dance training. We want to see how music and dance training helps people improve learning, memory, and ability to use both hands at the same time.*

Voluntary Participation: Your and your child's participation is voluntary. You and your child do not have to participate and may stop your participation at any time. There will be no penalties or loss of benefits or opportunities if you and your child do not participate or decide to stop once you start.
Alternatives to participating in the study include: *The alternative is to not participate in this research study*

Your decision to participate or not to participate will not affect your job status, employment record, employee evaluations, or advancement opportunities.

Benefits, Compensation, and Risk: You and/or your child *will not* be compensated for your participation. This research is considered minimal risk. Minimal risk means that study risks are the same as the risks you face in daily life.

Appendix B: Continued

Confidentiality: Even if we publish the findings from this study, we will keep you and your child's study information private and confidential. Anyone with the authority to look at you and your child's records must keep them confidential.

Why are you & your child being asked to take part?

The literature suggests that music training may improve memory, learning potential. We want to see how music training has a positive impact on memory and learning potential in comparison to visual arts training, or a control group.

Study Procedures:

Only your child will participate in testing in this study. The parent will only participate by completing a questionnaire.

If you and your child take part in this study, you and your child will be asked to:

Attend the classes of the school that he or she is enrolled at and follow the specific curriculum of their school (music school, visual arts school, or regular public schools).
Your child should complete the three testing sessions that will last up to two hours each.
During the test, the child will be asked to compare a short melody that may or may not be the same and indicate if it was the same or not. Your child may also be asked choose an image that best fits into a pattern of images, define certain words, follow a succession on numbers or numbers and letters, memorize and recall words, trace a succession of numbers or numbers and letters, and substitutes a number for randomized geometric figures

Your child will have to stay after the regular school hours to take the test. However, your child may choose to end the session at any time if not comfortable completing the session.
I will solicit the help of the teachers, as well as the parents to identify the best times to schedule the testing sessions.

There will be three testing sessions and your child will be asked to complete the following tests:

1. Delis-Kaplan Executive Function System (D-KEFS)- your child will be asked to produce as many words as possible from a specified category.
2. Advanced Measures of Music Audiation AMMA- your child will be listening to two musical phrases, and confirm if they were the same or different
3. Trail Making Test, - your child will be asked to follow with a pencil line a sequence of numbers or numbers and letters
4. Wechsler Abbreviated Scale of Intelligence - Second Edition (WASI-II) In the Vocabulary task your child will define words that are presented to you. In the Matrix Reasoning task, you will observe an incomplete matrix and selects the response option that completes the matrix.
5. Symbol Digit Modalities Test (SDMT) your child will substitute a number for randomized presentations of geometric figures
6. RAVL test – your child will be asked to recall from memory a certain number of words

Appendix B: Continued

Total Number of Participants
350 individuals will take part in this study (117 child participants and 233 parents)

Alternatives / Voluntary Participation / Withdrawal
You and your child do not have to participate in this research study.
You and your child should only take part in this study if you want to volunteer. You or your child should not feel that there is any pressure to take part in the study. You and your child are free to participate in this research or withdraw at any time. There will be no penalty or loss of benefits you and your child are entitled to receive if you stop taking part in this study.

Benefits
You and your child will receive no benefit(s) by participating in this study.

Risks or Discomfort
This research is considered to be of a minimal risk. That means that the risks associated with this study are the same as what you face every day. There are no known additional risks to those who take part in this study.

Compensation
You and your child will receive no payment or other compensation for taking part in this study. There will be no cost associated with participation in this study.

Privacy and Confidentiality
We will do our best to keep you and your child's records private and confidential. We cannot guarantee absolute confidentiality. You or your child's personal information may be disclosed if required by law. Certain people may need to see you or your child's study records. These individuals include:

- The research team, including the Principal Investigator, study coordinator, other research staff.
- Certain government and university people who need to know more about the study. For example, individuals who provide oversight on this study may need to look at your records. This is done to make sure that we are doing the study in the right way. They also need to make sure that we are protecting your rights and your safety.
- Any agency of the federal, state, or local government that regulates this research. This includes the Department of Health and Human Services (DHHS) and the Office for Human Research Protection (OHRP).
- The USF Institutional Review Board (IRB) and its related staff who have oversight responsibilities for this study, and staff in USF Research Integrity and Compliance.

Appendix B: Continued

Your identifiers might be removed from your private records or your samples. Your information or samples could be used and/or distributed to another investigator for future research studies without additional consent from you or your Legally Authorized Representative.

We may publish what we learn from this study. If we do, we will not include you or your child's name. We will not publish anything that would let people know who you are.

Data collected for this research will be stored at the USF- Music Building, located at the University of South Florida in the United States.

The following information may be used and disclosed to others:

- Your research records

Your personal information collected for this research will be kept as long as it is needed to conduct this research. Once your participation in the research is over, your information will be stored in accordance with applicable policies and regulations. Your permission to use your personal data will not expire unless you withdraw it in writing. You may withdraw or take away your permission to use and disclose your information at any time. You do this by sending written notice to the Principal Investigator at the following address:

3755 USF Holly Drive, MUS 101, Tampa, FL 33620

While we are conducting the research study, we cannot let you see or copy the research information we have about you. After the research is completed, you have a right to see the information about you, as allowed by USF policies.

If you have concerns about the use or storage of your personal information, you have a right to lodge a complaint with the data supervisory authority in your country.

You can get the answers to your questions, concerns, or complaints.

If you have any questions, concerns or complaints about this study, call *Adrian Iordache* at *(813) 618 2491*. If you have questions about your rights, complaints, or issues as a person taking part in this study, call the USF IRB at (813) 974-5638 or contact by email at RSCH-IRB@usf.edu

Appendix B: Continued

Consent to Participate and Parental Permission for My Child to Participate in this Research Study

I freely give my consent take part and to let my child take part in this study. I understand that by signing this form I am agreeing to take part and to let my child take part in research. I have received a copy of this form to take with me.

_____ _____

Signature of Adult Participant/Parent of Child Taking Part in Stud Date

_____

Printed Name of Adult Participant Taking Part in Study

_____

Printed Name of the Child Taking Part in Study

Statement of Person Obtaining Informed Consent

I have carefully explained to the person taking part in the study what he or she can expect from their participation. I confirm that this research participant speaks the language that was used to explain this research and is receiving an informed consent form in their primary language. This research participant has provided legally effective informed consent.

_____ _____

Signature of Person Obtaining Informed Consent Date

_____ _____

Printed Name of Person Obtaining Informed Consent Date

Appendix C: Parental Permission Form in Romanian

USF
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Consimțământ de participare la cercetare și permisiunea părinților pentru copilul lor de a participa la cercetare

Informații pe care părinții trebuie să le ia în considerare înainte de a fi de acord să participe și să permită copilului dvs. să participe la acest proiect de cercetare

Titlul studiului de cercetare: Efectele educatiei muzicale asupra funcțiilor executive cognitive la copii intr-e 10 si 12 ani.

Pro#00041362

Prezentare generală: Următoarele informații sunt prezentate pentru a vă ajuta pe dvs. și copilul dvs. să decideți dacă doriți să faceți parte din acest proiect de cercetare. Secțiunile din această prezentare generală oferă informații de bază despre proiect. Informații mai detaliate pot fi furnizate în restul documentului.

Personalul proiectului: Acest proiect este condus de Adrian Iordache, care este doctorand la University of South Florida, SUA. Această persoană este numită cercetatorul principal. El este ghidat în această cercetare de Dr. Jennifer Bugos. Alți membri ai personalului de cercetare aprobat pot acționa în numele cercetatorului principal.
Detalii despre proiect: Acest proiect se desfășoară in școli de muzică, scoli de arte plastice și școli publice din București, România, și este susținut/sponsorizat de departamentul sectiei de Muzică al USF. Vi se va cere să completați un chestionar preliminar confidențial.
Vor fi un număr de trei sesiuni de testare care vor dura până la două ore fiecare.

Participanți: vi se cere să luați parte și să permiteți copilului dvs. să ia parte, deoarece sunteți părintele unui copil cu vârsta cuprinsă între nouă și optsprezece ani, care nu are tulburări neurologice și nu are lectii de muzică privată sau lectii de dans. Vrem să vedem cum formarea muzicii și dansului ajută oamenii să îmbunătățească învățarea, memoria și coordonarea ambelor mâini în același timp.

Participarea voluntară: Participarea dvs. și a copilului dvs. este voluntară. Dv. și copilul dvs. nu trebuie să participați in acest proiect, și vă veti putea retrage participarea în orice moment. Nu vor exista penalități sau pierderi de beneficii sau oportunități dacă dvs. și copilul dvs. decideti sa nu participate, sau decideți sa renuntati la participare odată ce începeți aceasta participare.
Printre alternativele de participare la proiect se numără: Alternativa este de a nu participa la acest proiect de cercetare
Decizia dvs. de a participa sau de a nu participa nu vă va afecta statutul, registrul de angajare, evaluările angajaților sau posibilitățile de avansare.

Appendix C: Continued

Beneficii, compensații și riscuri: dvs. și/sau copilul dvs. nu veți fi compensați pentru participarea dvs. in acest proiect. Această cercetare este considerată un risc minim. Riscul minim înseamnă că riscurile de proiect sunt aceleași cu riscurile cu care te confrunți în viața de zi cu zi.

Confidențialitate: Chiar dacă publicăm rezultatele acestui proiect, vă vom păstra informațiile despre proiect și copilul dvs. private și confidențiale. Oricine are autoritate in acest proiect să acceseze înregistrările copilului dvs. are obligatia să le păstreze confidențial.

De ce vi se cere să participați și copilul dvs.?
Literatura de specialitate sugerează că educatia muzicală poate îmbunătăți memoria, si potențialul de învățare. In acest proiect de cercetare, vrem să vedem cum educatia muzicala va ajută memoria și potențialul de învățare în comparație cu educatia de arte plastice sau un grup de control.

Procedurile proiectului:
Doar copilul dvs. va participa la testarea acestui proiect. Părintele va participa doar completând un chestionar.
Datorita faptului ca dvs. și copilul dvs. luați parte la acest proiect, vi se va cere:

Copilul dvs. ar trebui să participe la cursurile școlii la care este înscris și să urmeze programa specifică a școlii (școala de muzică, școala de arte plasticesau școlile normale publice).

Copilul dvs. ar trebui să finalizeze cele trei sesiuni de testare care vor dura până la două ore fiecare.
În timpul testului, copilului i se va cere să compare doua melodii scurte si sa indice daca cele doua melodii sunt identice sau diffeereite. De asemenea, copilului dumneavoastră i se poate cere aleaga o imagine care se potrivește cel mai bine într-un model de imagini, definiți anumite cuvinte, urmați o succesiune de numere sau cifre și litere, memorați și reamintiți cuvinte, urmăriți o succesiune de numere sau cifre și litere și înlocuiți un număr cu figuri geometrice aleatorii

Copilul dvs. va trebui să stea după orele școlare obișnuite pentru a face testul. Cu toate acestea, copilul dvs. poate alege să încheie sesiunea în orice moment, dacă nu este confortabil cu încheierea sesiunii.
Voi solicita ajutorul profesorilor, precum și al părinților pentru a identifica cea mai buna zi si ora pentru a programa sesiunile de testare.

Vor fi trei sesiuni de testare unde li se va cere să finalize următoarele teste:

1. Delis-Kaplan Executive Function System (D-KEFS) – copilului dv. v-a primi o categorie (cum ar fi „legume") și v-a trebui produca cât mai multe cuvinte din acea categorie.

2. Măsuri avansate de audiere muzicală AMMA - copilului dv. v-a asculta două fraze muzicale și v-a confirma dacă acestea sunt aceleași sau diferite

Appendix C: Continued

3. Trail Making Test, - copilului dv. v-a urmața cu creionul o secvență de numere sau numere și litere

4. Simbol Digit Modalities Test (SDMT) copilului dv. v-a înlocui un număr pentru prezentări aleatorii de figuri geometrice

5. Wechsler Abbreviated Scale of Intelligence - Ediția a II-a (WASI-II) copilului dv. v-a defini cuvinte care ii vor fi sunt prezentate.

6. Testul Matrix Reasoning, copilului dv. v-a observa o matrice incompletă și trebuie sa selecteze opțiunea de răspuns care completează matricea.

Numărul total de participanți
350 de persoane vor participa la acest proiect (117 copii participanți și 233 părinți)

Alternative / participare voluntară / retragere
Atat dvs. cat și copilul dvs. nu aveti obligatia să participați la acest proiect de cercetare.

Atat dvs. și copilul dvs. participați la acest proiect doar dacă doriți să faceți voluntariat. Dvs. sau copilul dvs. nu trebuie să simțiți că există vreo presiune pentru a lua parte la proiect. Dvs și copilul dvs. sunteți liberi să participați la această cercetare sau să vă retrageți în orice moment. Nu va exista nicio penalitate sau pierdere de beneficii pe care dvs și copilul dvs. aveți dreptul să le primiți dacă încetați să participați la acest proiect.

Beneficii
Dvs și copilul dvs. nu veți primi niciun beneficiu (beneficii) participând la acest proiect.

Riscuri sau discomfort
Această cercetare este considerată a fi un risc minim. Asta înseamnă că riscurile asociate acestui proiect sunt aceleași cu cele cu care va confruntați în fiecare zi. Nu se cunosc riscuri suplimentare pentru cei care participă la acest proiect.

Compensare
Dvs și copilul dvs. nu veți primi nicio plată sau altă compensație pentru participarea la acest proiect

Costuri
Nu va exista niciun cost asociat cu participarea la acest proiect.

Confidențialitate și confidențialitate
Vom face tot posibilul pentru a vă păstra înregistrările private și confidențiale ale copilului dumneavoastră, dar nu putem garanta confidențialitatea absolută. Informațiile personale ale dvs. sau ale copilului dvs. pot fi dezvăluite dacă legea prevede acest lucru. Este posibil ca anumiți oameni să fie nevoiți să vă vadă în registrul de proiect al copilului dvs. Aceste persoane includ:

• Echipa de cercetare, incluzând cercetatorul principal, coordonatorul proiectlui, sau alte cadre de

Appendix C: Continued

cercetare.
• Anumiți oameni guvernamentali și universitari care trebuie să știe mai multe despre proiect. De exemplu, persoanele care oferă supraveghere cu privire la acest proiect ar putea fi necesar să se uite la înregistrările dvs. Acest lucru este făcut pentru a ne asigura că facem proiectul în mod corect. De asemenea, trebuie să se asigure că vă protejăm drepturile și siguranța.
• Orice agenție a guvernului federal, de stat, sau local care reglementează această cercetare. Aceasta include Departamentul pentru Sănătate și Servicii Umane (DHHS) și Oficiul pentru Protecția Cercetării Umane (OHRP).
• Consiliul de revizuire instituțională (IRF) al USF și personalul său aferent, care au responsabilități de supraveghere pentru acest proiect, precum și personal în domeniul integrității și conformității cercetării USF.

Identificatorii dvs. ar putea fi eliminați din înregistrările private sau din eșantioanele dvs. Informațiile sau eșantioanele dvs. ar putea fi utilizate și / sau distribuite unui alt cercetator pentru studii viitoare de cercetare fără consimțământ suplimentar din partea dvs. sau a reprezentantului dumneavoastră legal.

Este posibil să publicăm ceea ce învățăm din acest proiect. Dacă o facem, nu vom include numele dvs. sau numele copilului dumneavoastră. Nu vom publica nimic care ar permite oamenilor să știe cine sunteți.

Datele colectate pentru această cercetare vor fi stocate la clădirea muzicală USF, situată la Universitatea din South Florida, în Statele Unite.

Următoarele informații pot fi utilizate și dezvăluite altora:
• Fișele dvs. de cercetare

Informațiile dvs. personale colectate pentru această cercetare vor fi păstrate atât timp cât este necesar pentru a efectua această cercetare. După terminarea participării la cercetare, informațiile dvs. vor fi stocate în conformitate cu politicile și reglementările aplicabile. Permisiunea dvs. de a folosi datele dvs. personale nu va expira decât dacă o retrageți în scris. Puteți retrage sau retrage permisiunea dvs. de a utiliza și de a dezvălui informațiile dvs. în orice moment. Faceți acest lucru trimițând o notificare scrisă către cercetatorul principal la următoarea adresă:

3755 USF Holly Drive, MUS 101, Tampa, FL 33620

În timp ce realizăm proiectul de cercetare, nu vă putem lăsa să vedeți sau să copiați informațiile de cercetare pe care le avem despre dumneavoastră. După finalizarea cercetării, aveți dreptul de a vedea informațiile despre dvs., asa cum sunt permise de politicile USF.

Dacă aveți probleme cu privire la utilizarea sau stocarea informațiilor dvs. personale, aveți dreptul de a depune o plângere la autoritatea de supraveghere a datelor din țara dvs.

Puteți obține răspunsurile la întrebările, preocupările sau reclamațiile dvs.

Appendix C: Continued

Dacă aveți întrebări, îngrijorări sau reclamații cu privire la acest proiect, sunați la Adrian Iordache la (813) 618 2491. Dacă aveți întrebări despre drepturile, reclamațiile sau problemele dvs. în calitate de persoană care participă la acest proiect, sunați la IRF USF la (813) 974-5638 sau contactați prin e-mail la RSCH-IRB@usf.edu

Consimțământul de participare și permisiunea părinților pentru copilul meu să participe la acest proiect de cercetare

Îmi dau liber consimțământul să ia parte și să-mi las copilul să ia parte la acest proiect. Am înțeles că, prin semnarea acestui formular, sunt de acord să iau parte și să las copilul meu să ia parte la cercetare. Am primit o copie a acestui formular pentru a lua cu mine.

_____ _____

Semnatura participantului adult (părintele copilului care ia parte la proiect) Data

_____

Numele participantului **adult** care ia parte la proiect

_____

Numele **copilului** care ia parte la acest proiect

Declarația persoanei care obține consimțământul informat

I-am explicat cu atenție persoanei care participă la proiect la ce se poate aștepta de la participarea lor. Confirm că acest participant la cercetare vorbește limba folosită pentru a explica această cercetare și primește un formular de consimțământ informat în limba lor nativa. Acest participant la cercetare a oferit consimțământul informat legal eficient.

_____ _____

Semnătura persoanei care obține consimțământul informat Data

_____

Numele persoanei care obține consimțământul informat

Appendix D: Assent of Children to Participate in Research Form in English

USF
UNIVERSITY OF
SOUTH FLORIDA

Assent of Children to Participate in Research

Pro # 00041362

Title of study: The Effects of Music Instruction on Executive Functions in Young Children age 10-12 years.

Why am I being asked to take part in this research?
You are being asked to take part in a research study about the impact of music on cognitive functions. You are being asked to take part in this research study because you have the appropriate age required for this study and are enrolled in one of the specific schools observed by this study. If you take part in this study, you will be one of about 350 people at this site.

Who is doing this study?
The person in charge of this study is Adrian Iordache. He is being guided in this research by Jennifer Bugos PhD. However, other research staff may be involved and can act on behalf of the person in charge.

What is the purpose of this study?
By doing this study, we hope to learn the effects of music training on cognitive functions.

Where is the study going to take place and how long will it last?
The study will take place at your school. You will be asked to participate in three visits which will take about two hours each. The total amount of time you will be asked to volunteer for this study is six hours over the next ten months.

What will you be asked to do?
You will be asked to complete six different tests that are game-like. You do not have to prepare for these tests."

You should comply with the specific training provided in the school that you are enrolled at and complete the three testing sessions.
You will be taking the following tests:

Appendix D: Continued

1. Delis-Kaplan Executive Function System (D-KEFS)- you will be asked to produce as many words as possible from a specified category.
2. Advanced Measures of Music Audiation AMMA- you will be listening to two musical phrases, and confirm if they were the same or different
3. Trail Making Test, - follow with a pencil line a sequence of numbers or numbers and letters
4. Wechsler Abbreviated Scale of Intelligence - Second Edition (WASI-II) In the Vocabulary task you will define words that are presented to you. In the Matrix Reasoning task, you will observe an incomplete matrix and selects the response option that completes the matrix.
5. Symbol Digit Modalities Test (SDMT) you will substitute a number for randomized presentations of geometric figures
6. RAVL test – you will be asked to recall from memory a certain number of words

You will receive instructions on how to complete each test. You may ask any clarifying questions. There is no need for preparation of these tests.

The three testing sessions implemented in this study are optional, and the data resulted from these will be used for research analysis. The class activities are part of the participants' normal education and this information will not be used for research.

What things might happen if you participate?
To the best of our knowledge, your participation in this study will not harm you.

Is there benefit to me for participating?
You will not receive any benefits from taking part in this research study.

What other choices do I have if I do not participate?
You do not have to participate in this research study.

Do I have to take part in this study?
You should talk with your parents or guardian and others about taking part in this research study. If you do not want to take part in the study, that is your decision. You should take part in this study because you want to volunteer.

Appendix D: Continued

Will I receive any compensation for taking part in this study?
You will not receive any compensation for taking part in this study.

Who will see the information about me?
Your information will be added to the information from other people taking part in the study so no one will know who you are.

Can I change my mind and quit?
If you decide to take part in the study, you still have the right to change your mind later. No one will think badly of you if you decide to stop participating. Also, the people who are running this study may need for you to stop. If this happens, they will tell you when to stop and why.

What if I have questions?
You can ask questions about this study at any time. You can talk with your parents, guardian or other adults about this study. You can talk with the person who is asking you to volunteer by calling Adrian Iordache, tel. (813 618 2491). If you think of other questions later, you can ask them. If you have questions about your rights as a research participant you can also call the USF IRB at (813) 974-5638 or contact by email at RSCH-IRB@usf.edu.

Assent to Participate

I understand what the person conducting this study is asking me to do. I have thought about this and agree to take part in this study. I have been given a copy of this form.

_____ _____
Name of person agreeing to take part in the study Date

Signature of child agreeing to take part in the study: _____

_____ _____
Printed name & Signature of person providing Information (assent) to subject Date

Appendix E: Assent of Children to Participate in Research Form in Romanian

Consimțământul copiilor minori pentru a participa la cercetare

Pro # 00041362

Titlul studiului de cercetare: Efectele educatiei muzicale asupra funcțiilor executive cognitive la copii intr-e 10 si 12 ani.

De ce mi se cere să iau parte la această cercetare?
Vi se cere să participați la un studiu de cercetare despre impactul muzicii asupra funcțiilor cognitive. Vi se cere să luați parte la acest studiu de cercetare, deoarece aveți vârsta adecvată necesară pentru acest studiu și sunteți înscris într-una dintre școlile specifice observate de acest studiu. Dacă participați la acest studiu, veți face parte din aproximativ 350 de persoane la aceasta locatie.

Cine face acest studiu?
Responsabilul acestui studiu este Adrian Iordache. El este ghidat în această cercetare de către doctorul Jennifer Bugos. Cu toate acestea, si alte personae pot fi implicate in personalul de cercetare, care poat acționa în numele persoanei responsabile.

Care este scopul acestui studiu?
Prin acest studiu, sperăm să aflăm efectele educatiei muzicale asupra funcțiilor cognitive.

Unde va avea loc studiul și cât va dura?
Studiul va avea loc la scoala de care apartii. Vi se va cere să participați la trei vizite care vor dura aproximativ două ore fiecare. Perioada totală de timp pentru care vi se va cere să faceți voluntariat pentru acest studiu este de șase ore în următoarele zece luni.

Ce vi se va cere să faceți?
Vi se va solicita să finalizați șase teste diferite, asemănătoare unui joc.Nu trebuie să vă pregătiți pentru aceste teste.
• Trebuie să respectați pregătirea specifică oferită în școala la care sunteți înscris și să finalizați cele trei sesiuni de testare.
• Vei face urmatoarele teste:

Appendix E: Continued

1. Delis-Kaplan Executive Function System (D-KEFS) - vi se va prezenta o categorie (cum ar fi „legume") și veți produce cât mai multe cuvinte din acea categorie.

2. Măsuri avansate de audiere muzicală AMMA - veți asculta două fraze muzicale și veți confirma dacă acestea sunt aceleași sau diferite

3. Trail Making Test, - urmați cu creionul o secvență de numere sau numere și litere

4. Simbol Digit Modalities Test (SDMT) veți înlocui un număr pentru prezentări aleatorii de figuri geometrice

5. Wechsler Abbreviated Scale of Intelligence - Ediția a II-a (WASI-II) Veți fi solicitati sa definiti cuvinte care vă sunt prezentate vizual și oral.

6. Testul Matrix Reasoning, veți observa o matrice incompletă și selectați opțiunea de răspuns care completează matricea.

Veți primi instrucțiuni despre cum puteți finaliza fiecare test. Puteți pune întrebări de clarificare. Nu este necesară pregătirea pentru teste.

Cele trei sesiuni de testare implementate în acest studiu sunt opționale, iar datele rezultate din acestea vor fi utilizate pentru analiza cercetării. Activitățile din clasă fac parte din educația normală a participanților și aceste informații nu vor fi utilizate pentru cercetare.

Ce lucruri s-ar putea întâmpla dacă participați?
În conformitate cu cunoștințele noastre, participarea dvs. la acest studiu nu vă va fi dăunatoare in nici un fel.

Există avantaje pentru mine pentru participare?
Nu veți primi niciun beneficiu din partea participării la acest studiu de cercetare.

Ce alte opțiuni am dacă nu particip?
Să nu participați la acest studiu de cercetare.

Trebuie să iau parte la acest studiu?
Ar trebui să discutați cu părinții sau cu tutorele și cu alții despre participarea la acest studiu de cercetare. Dacă nu doriți să participați la studiu, aceasta este decizia dvs. Ar trebui să participați la acest studiu pentru că doriți să faceți voluntariat.

Voi primi compensații pentru participarea la acest studiu?
Nu veți primi nicio compensație pentru participarea la acest studiu.

Cine va vedea informațiile despre mine?
Informațiile dvs. vor fi adăugate la informațiile de la alte persoane care participă la studiu, astfel încât nimeni nu va ști cine sunteți.

Appendix E: Continued

Pot să mă răzgândesc și să renunț?
Dacă decideți să participați la studiu, aveți totuși dreptul să vă răzgândiți mai târziu. Nimeni nu se va gândi rău la tine dacă decizi să nu mai participi. De asemenea, este posibil ca persoanele care efectuează acest studiu să vă oprească. Dacă se întâmplă acest lucru, ei îți vor spune când să te oprești și de ce.

Ce se întâmplă dacă am întrebări?
Puteți pune întrebări despre acest studiu în orice moment. Puteți discuta cu părinții, tutorele sau alți adulți despre acest studiu. Puteți discuta cu persoana care vă cere să faceți voluntariat, sunând pe Adrian Iordache, tel. (813) 618 2491. Dacă te gândești la alte întrebări mai târziu, le poți pune. Dacă aveți întrebări cu privire la drepturile dvs. în calitate de participant la cercetare, puteți, de asemenea, puteti suna la USF IRB la (813) 974-5638 sau contactați prin e-mail la RSCH-IRB@usf.edu.

Acordul de participare

Înțeleg ce îmi cere persoana care efectuează acest studiu. M-am gândit la acest lucru și sunt de acord să iau parte la acest studiu. Am primit o copie a acestui formular.

_____ _____
Numele persoanei care a acceptat să ia parte la studiu Date

Semnătura copilului care acceptă să ia parte la studiu: _____

_____ _____
Numele tipărit și semnătura persoanei care furnizează Informații (consimțământ) la subiect Data

Appendix F: Letter of Support Romanian Ministry of Education

MINISTERUL EDUCAȚIEI NAȚIONALE
INSPECTORATUL ȘCOLAR AL MUNICIPIULUI BUCUREȘTI
romania2019.eu
Președinția României la Consiliul Uniunii Europene

Nr. 15397 / 10.07.2019

CĂTRE
SCHOOL OF MUSIC – COLLEGE OF THE ARTS
UNIVERSITY OF SOUTH FLORIDA – Research Study Pro#00041362
4202 E. Fowler Avenue, MUS101, Tampa, FL 33620-7350
Phone: (813) 974-2311 Fax: (813) 974-8721

În atenția,
Domnului Adrian IORDACHE
iordache@mail.usf.edu

Urmare a solicitării dumneavoastră înregistrată la Inspectoratul Școlar al Municipiului București – România cu nr. 15397/05.07.2019, vă comunicăm că, susținem demersurile domnului Adrian Iordache, privind realizarea unui studiu necesar finalizării lucrării de doctorat.

Considerăm că, în acest context curricular complex, efectuarea acestui studiu internațional privind efectul educatiei muzicale în dezvoltarea cognitiva a copiilor poate reprezenta o oportunitate, întrucât va permite atât o evaluare a stadiului competențelor cognitive existente și formate în acest moment, cât și oferirea unor informații care să permită dezvoltarea strategiilor educaționale, în domeniu, pe termen mediu și lung.

Având în vedere că deținem facilitățile necesare pentru efectuarea acestui studiu, sustinem acest proiect si il consideram adecvat pentru elevii înscriși în unitățile de învățământ preuniversitar mai jos menționate:

1. **Colegiul Național de Muzică "George Enescu", sector 1, București, România;**
2. **Colegiul Național de Arte "Dinu Lipatti", sector 4, București, România;**
3. **Liceul de Coregrafie "Floria Capsali", sector 4, București, România;**
4. **Liceul Teoretic „Decebal", sector 3, București, România;**
5. **Școala Gimnazială Nr. 84, sector 3, București, România.**

INSPECTOR ȘCOLAR GENERAL
Ioana Mihaela Neacșu

INSPECTOR ȘCOLAR PENTRU DEZVOLTAREA RESURSEI UMANE
Mihaela ROȘCA

Str. Icoanei nr. 19, Sector 2, 020451, București
Tel: +40 (0)21 211 84 85
Fax: +40 (0)21 210 48 51
www.ismb.edu.ro

Appendix G: Letter of Support Romanian Ministry of Education II

MINISTERUL EDUCAȚIEI NAȚIONALE

INSPECTORATUL ȘCOLAR AL MUNICIPIULUI BUCUREȘTI

Nr. 24666 / 25.10.2019

CĂTRE
SCHOOL OF MUSIC – COLLEGE OF THE ARTS
UNIVERSITY OF SOUTH FLORIDA – Research Study Pro#00041362
4202 E. Fowler Avenue, MUS101, Tampa, FL 33620-7350
Phone: (813) 974-2311 Fax: (813) 974-8721

În atenția,
Domnului Adrian IORDACHE
iordache@mail.usf.edu

Urmare a solicitării dumneavoastră înregistrată la Inspectoratul Școlar al Municipiului București – România cu nr. 24666/24.10.2019, vă comunicăm că, susținem demersurile domnului **Adrian Iordache**, privind realizarea unui studiu necesar finalizării lucrării de doctorat.

Considerăm că, în acest context curricular complex, efectuarea acestui studiu internațional privind efectul educatiei muzicale în dezvoltarea cognitiva a copiilor poate reprezenta o oportunitate, întrucât va permite atât o evaluare a stadiului competențelor cognitive existente și formate în acest moment, cât și oferirea unor informații care să permită dezvoltarea strategiilor educaționale, în domeniu, pe termen mediu și lung.

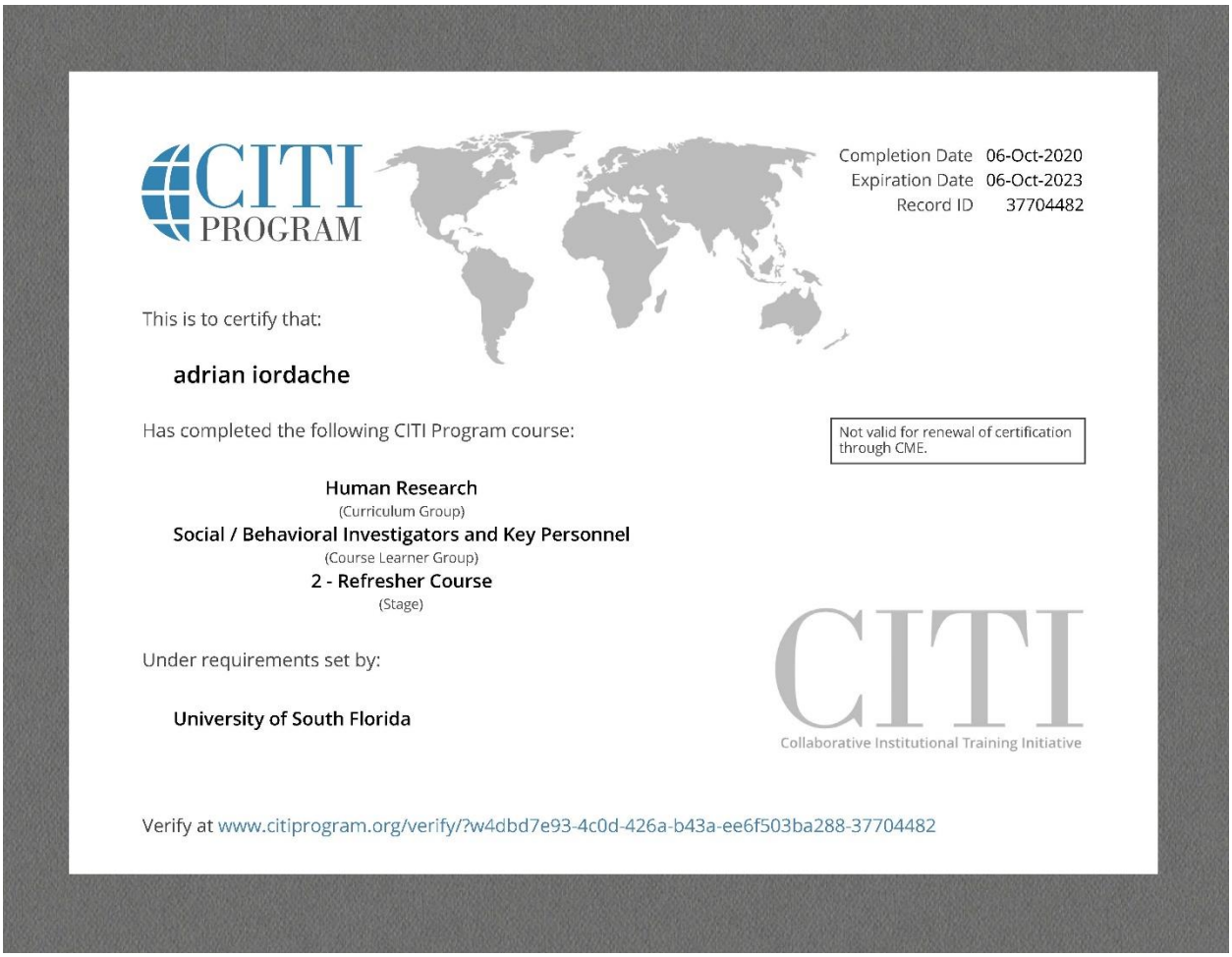
Având în vedere că deținem facilitățile necesare pentru efectuarea acestui studiu, **sustinem** acest proiect si il consideram adecvat pentru elevii înscriși în cadrul **Liceului de Arte Plastice "Nicolae Tonitza", sector 1, București, România.**

INSPECTOR ȘCOLAR GENERAL
Ioana Mihaela Neacșu

INSPECTOR ȘCOLAR PENTRU DEZVOLTAREA RESURSEI UMANE
Mihaela ROȘCA

Str. Icoanei nr. 19, Sector 2, 020451, București
Tel: +40 (0)21 211 84 85
Fax: +40 (0)21 210 48 51
www.ismb.edu.ro

Appendix H: Certification Human Research Key Personal



CITI PROGRAM

Completion Date 06-Oct-2020
Expiration Date 06-Oct-2023
Record ID 37704482

This is to certify that:

adrian iordache

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

Human Research
(Curriculum Group)
Social / Behavioral Investigators and Key Personnel
(Course Learner Group)
2 - Refresher Course
(Stage)

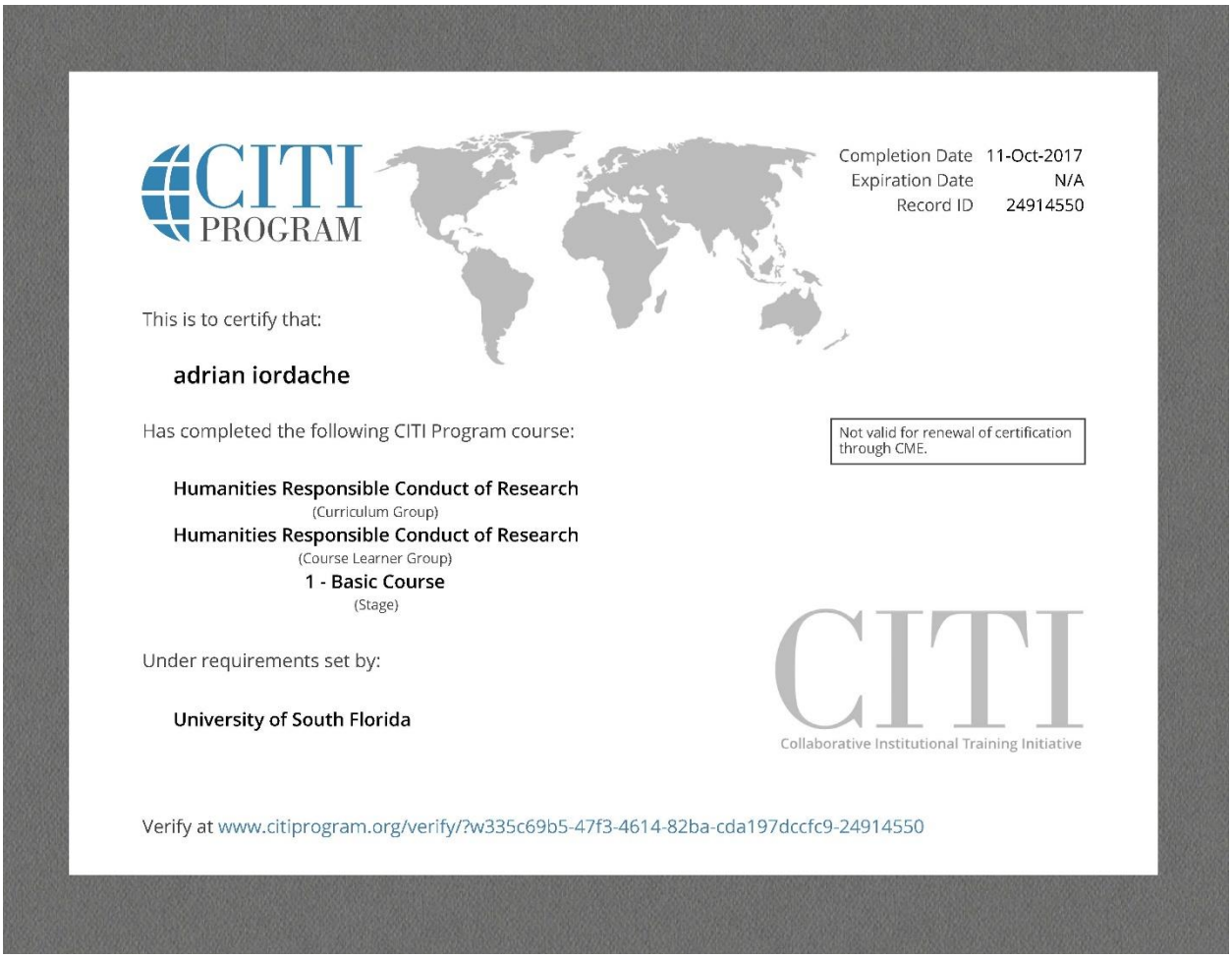
Under requirements set by:

University of South Florida

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w4dbd7e93-4c0d-426a-b43a-ee6f503ba288-37704482

Appendix E: Certification Humanities Responsible Conduct of Research



CITI PROGRAM

Completion Date 11-Oct-2017
Expiration Date N/A
Record ID 24914550

This is to certify that:

adrian iordache

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

Humanities Responsible Conduct of Research
(Curriculum Group)
Humanities Responsible Conduct of Research
(Course Learner Group)
1 - Basic Course
(Stage)

Under requirements set by:

University of South Florida

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w335c69b5-47f3-4614-82ba-cda197dccfc9-24914550