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Music Expertise and Gender Differences in Verbal and Visual Divergent Thinking. A Behavioral Study

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ABSTRACT
Research on creativity is a field of great relevance since it studies our capacity to create, the root of all innovation and problem solving. Some factors, like personality, motivation and artistic knowledge, are known to influence creativity. The aim of this study was to investigate the influence of music expertise and gender on creativity and the interaction between these factors. One hundred and fifty-eight participants, aged between 18 and 50, were involved in the study. Eighty-seven of them were musicians (56 male and 31 female) and 71 non-musicians (30 male and 41 female). To evaluate creativity, two tasks, one verbal and one visual, were used, each lasting 2 minutes. Fluency, Flexibility, Originality, Elaboration, and General Creativity were the creative domains under evaluation. The results showed statistically significant differences in music expertise and, to a lesser extent, in gender, especially in the verbal task. Music expertise had a positive impact on creative performance, and women were found to be more creative in the verbal domain than men. This research extends previous work on the influence of biological and environmental factors on creativity.

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Introduction

Human creativity is the root of extraordinary achievements in the artistic and scientific fields (McPherson & Limb, 2013), and it is a remarkable capacity which produces original ideas and generates new and novel solutions to real-life problems (Runco & Pritzker, 2011). It allows individuals and groups to adapt flexibly to changing circumstances, manage complex social relationships as well as survive and succeed through social, technological, and medical innovations (Baas, De Dreu, & Nijstad, 2015).

Research has shown that creativity is the result of several cognitive processes, including divergent and flexible thinking, the use of associative hierarchies, and convergent and persistent thinking (Baas, De Dreu, & Nijstad, 2011). The forms mostly used when assessing creative potential are the divergent thinking tasks, which tries to evaluate people's ability to produce many alternative, different and original ideas to a particular problem (Guilford, Christensen, Merrifield, & Wilson, 1978; Runco & Acar, 2012; Torrance, 1966). The creative process is determined by four dimensions: fluency (i.e., the ability to find several solutions to a problem), flexibility (i.e., the ability to produce solutions from different categories, or to switch between different modes of thinking), originality (i.e., the aptitude to solve problems differently from the usual way as well as the novelty of the resulting product) and elaboration (i.e., the ability to provide additional details per idea) (Torrance, 1966). To assess creativity, two task are generally used: The Alternative Uses Task (Wallach & Kogan, 1965) and the Torrance Test of Creative Thinking (Torrance, 1966).

Creativity and gender differences

Empirical investigations of creativity routinely seek to identify the variables that have an impact on creative performance (Ward, 2007). In this sense, individual differences in creativity are modulated by several factors such as intelligence, personality (Batey & Furnham, 2006; Batey, Furnham, & Safiullina, 2010; Folley & Park, 2005), and gender (Abraham et al., 2013), among others. Regarding gender differences, this line of research is hindered by the inconsistent results of behavioral studies (Abraham et al., 2013; Baer & Kaufman, 2008). Research in this area has identified few behavioral differences between men and women (Abraham,

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2016; Kapoor, 2019). For example, Baer and Kaufman (2008) suggested that women showed higher levels of creativity than men in verbal tests, such as searching for alternative uses of an object. Another study indicated that women were more fluent and productive on the Guilford verbal test (Shimonaka & Nakazato, 2007). However, some researchers did not find significant differences in gender in some creative tasks (Abraham et al., 2013; Charyton & Snelbecker, 2007; Pagnani, 2011). Interestingly, the same studies that did not find significant differences at the behavioral level did find differences at the neural level, this may suggest men and women employ different strategies but reach similar results (Abraham et al., 2013; Razumnikova, 2004; Ryman et al., 2014; Takeuchi et al., 2017).

Creativity and music expertise

Not only biological, but also environmental factors are able to modulate creativity. According to the far transfer concept, which indicates the transferred effects from one deliberate practice to a nonspecific cognitive domain (Kleinmintz, 2017), some research has focused on how different artistic abilities, such as dance, theater, and music affect cognition (Demarin, Bedeković, Puretić, & Pašić, 2016; Kleinmintz, 2017). Music and music expertise have been associated with an increase in creativity (Kleinmintz, Goldstein, Mayseless, Abecasis, & Shamay-Tsoory, 2014; Limb & Braun, 2008). Musicians have neuroanatomical and functional differences from people without formal musical knowledge. These differences are a product of their music expertise (Li et al., 2017), and they can have an impact on non-music related cognitive abilities, such as memory (Diaz Abrahan, Shifres, & Justel, 2019, 2020a, 2020b; Groussard et al., 2012; Herholz & Zatorre, 2012), language and mathematics (Seung, Kyong, Woo, Lee, & Lee, 2005), as well as creativity (Gibson, Folley, & Park, 2009).

Few studies have investigated the differences between musicians and non-musicians in the creativity domain. A research study developed by Gibson et al. (2009) examined the creative performance in divergent- and convergent-thinking tasks between a group of highly trained musicians and a group with no musical background. The results indicated that musicians presented greater divergent thinking scores than non-musicians. In addition, by evaluating a specific musical activity, Kleinmintz et al. (2014) compared musicians with improvisation expertise, musicians that were not used to improvising, and non-musicians. The results of this study indicated that musicians who improvised presented a significantly higher performance than musicians who did not improvise and non-musicians, with no differences between the last two groups. These data are in agreement with the study by Benedek, Borovnjak, Neubauer, and Kruse-Weber (2014), who investigated the differences between jazz, classical, and folk musicians and found that jazz musicians had better creative performance, and the authors attributed the differences to the jazz musicians′ daily contact with musical improvisation. In line with these findings, Sovansky, Wieth, Francis, and Mcllhagga (2016) suggested that improving creativity depends on the interaction between years of music expertise and participation in creative aspects of music, like improvising, arranging, and composing.

The current study

Therefore, the aims of this work were to extend previous research on the possible influence of biological and environmental factors on creativity and to inquire into gender-related creative performance. Specifically, the following points were investigated (1) the effect of music expertise and gender on divergent thinking, by means of two creative tasks, one visual and another one verbal; and (2) the possible interaction between these two factors (gender and music expertise) and its synergic effect on creativity. It was hypothesized that musicians would perform better at creative tasks than non-musicians. However, in light of the controversial results concerning gender differences found in previous work, no predictions were made regarding gender.

Method

Participants

One hundred and fifty-eight volunteers aged between 18 and 50 (*M*: 28.4, *SD*: .6) participated in this study. Eighty-seven of them were musicians (56 men and 33 women) and seventy-one had no musical background (30 men and 41 women). None of them reported history of neurological or psychiatric illness, and none were taking medication when the study was performed. Participation was voluntary, and participants were recruited from educational institutes, bands and musical ensembles.

The sample of musicians was divided into two groups: one for participants with five to ten years of music expertise and another for participants with more than ten years of musical expertise. The creative performance of these two groups was evaluated and compared. No significant differences were found between the groups (5–10 vs more than 10) in visual (Flexibility p = .627, Elaboration p = .934, Fluency p = .142, Originality p = .438) or verbal (Flexibility

$p = .876$, Elaboration $p = .371$, Fluency $p = .957$, Originality $p = .648$) measures of creativity. Since no significant differences were found, the sample was pooled into a single group. Therefore, subjects with five or more years of music expertise (formal and informal education) were considered musicians, according to previous research (Brown, Martinez, & Parsons, 2006; Diaz Abrahan & Justel, 2019a; Diaz Abrahan et al., 2019, 2020a; Justel & Rubinstein, 2013).

The final number per group was as follows: 56 male musicians (MM), 31 female musicians (FM), 30 male non-musicians (MNM), and 41 female non-musician (FNM). All participants signed an informed consent before the beginning of the study, where the anonymity and confidentiality of the data were assured, in compliance with the Helsinki Declaration, Convention of the Council of Europe on Human Rights and Biomedicine.

Procedure and materials

Participants were always tested in groups, and after they signed the informed consent, they completed socio-demographic and music questionnaires. After that, the creative tasks were administered in random order. The total duration of the study was half an hour in a single run.

Questionnaires

Participants completed a socio-demographic questionnaire (age, sex, and years of academic education) and a musical background questionnaire (years of formal and informal music education, instrument specialization, whether they were currently playing the instruments, and age at which they initiated their music education).

Creative visual task. Subset of torrance test (circle)

Each participant used a sheet with a matrix of 15 circles and a pencil. They were instructed to make as many sketches/drawings as they could on the matrix for 2 minutes. The instructions were *"Draw a picture for each circle of the matrix. The circle must be included in your drawing. Do not make abstract drawings or combine circles with each other. You have 2 minutes to complete this task."* Each drawing was meant to be as unique as possible, and the participants were asked to give a title to each drawing.

Creative verbal task. The alternate uses task

Each participant used a blank sheet and a pencil. They were asked to list as many alternative uses as possible for an object (shoe) within a period of 2 minutes. The instructions were *"Write all possible uses for a shoe. You have 2 minutes to complete this task"*.

The scoring of both creative tasks (visual and verbal) was done after the participants handed in all the samples, in order to identify the most original and elaborate ideas. The scoring included the number of categories and the number of ideas involving a change in perspective (Flexibility), the number of ideas with additional details (Elaboration), the number of responses (Fluency), and the number of statistical infrequencies of the responses among a group of peers (Originality) (Guilford et al., 1978; Torrance, 1974). External evaluators scored each of the creativity variables on a 5-point scale. The final mean of the four variables determined the General Creativity score. In order to estimate the inter-rate reliability, the correlation between evaluators was analyzed. The results showed a high level of agreement $r(158) = .981$, $p < .001$.

Results

Socio-demographic and music information

The data from three participants were discarded from the visual task and those from 12 participants were discarded from the verbal task because they had not followed the instructions. For the visual task, the performance of 49 male musicians (MM), 28 female musicians (FM), 30 male non-musicians (MNM), and 37 female non-musicians (FNM) was analyzed. For the verbal task, the performance of 56 male musicians (MM), 29 female musicians (FM), 31 male non-musicians (MNM), and 37 female non-musicians (FNM) was analyzed. Table 1 shows the means and standard deviations of age, years of academic education, years of music education, and age at which the participants initiated their music education.

All the musicians were musically active at the time of the study. Their instrument specializations included strings (66.6%), winds (14.9%), percussion (12.7%), and voice training (5.7%). There were no differences in gender for the number of years devoted to music training, $p > .05$.

To examine the relationship between the creativity and musical background variables mentioned above, Pearson's correlation analyses were conducted. No

Table 1. Socio-demographic and musical information.

	Age		Years of academic education		Years of musical education		Age of beginning of musical education	
Group	Means	SD	Means	SD	Means	SD	Means	SD
Male Musicians	28.72	2.34	16.26	0.42	10.14	0.91	12.42	1.16
Female Musicians	28.78	1.16	17.37	0.78	12.74	1.02	10.72	0.33
Male Non-Musicians	26.97	1.40	14.84	0.27	0.90	0.23	15.50	0.13
Female Non-Musicians	31.96	2.17	15.71	0.70	1.38	0.28	25.33	1.39

Years of musical education include formal and informal education. SD: Standard deviation.

significant correlation was found between the creativity variables (Flexibility, Elaboration, Fluency, Originality and General Creativity for both visual and verbal tasks) and musical background data (years of music education and age at which the participants initiated music education; $p > .5$).

Finally, to evaluate the possible impact of years of academic education in creativity, a univariate ANOVA was run with Gender and Expertise as factors and Years of Academic Education as the dependent variable. No significant differences were found for Gender $F(1, 62) = .95$, $p = .332$, $\eta^2p = .015$, Expertise $F(1, 62) = 2.32$, $p = .1.33$, $\eta^2p = .036$ or the interaction Gender x Expertise $F(1, 162) = .013$, $p = .911$, $\eta^2p = .001$.

Visual creativity

In the Subset of Torrance Test, the participants made as many drawings as possible inside a matrix of 15 circles for 2 minutes. Figure 1 illustrates the visual creativity performance. Flexibility, Elaboration, Fluency, Originality, and General Creativity were independently analyzed via univariate analysis of variance (ANOVA) with Gender (male vs. female) and Expertise (musicians vs. non-musicians) as the between-factors. *Post hoc* least-significant difference (LSD) comparisons were conducted to analyze significant main effects and interactions. The partial Eta square (η^2p) was used to estimate effect size. The alpha value was set at .05, and the software SPSS Statistics 17.0.2 was used to compute descriptive and inferential statistics.

Regarding general creativity, the ANOVA indicated a main effect of Expertise $F(1, 144) = 4.356$, $p = .039$, $\eta^2p = .39$, the *Post hoc* analyses revealed that musicians were more creative than non-musicians. In addition, a significant effect was found in the interaction Expertise x Gender $F(1, 144) = 6.736$, $p = .010$, $\eta^2p = .028$. The *Post hoc* test indicated that female musicians were more creative than male musicians (Figure 2); also *Post hoc* indicated that female musicians were more creative than female non-musicians, with no differences between male musicians and non-musicians. No significant differences were found between the groups for the Flexibility, Elaboration, Fluency, and Originality variables, $p > .05$. Table 2 presents the means and standard deviations for the visual variables.

Verbal creativity

In the Alternate Uses Task, each participant wrote a list of as many alternative uses as possible for a shoe, within a period of 2 minutes. Their performances were compared for each creative variable through a univariate ANOVA, with Expertise and Gender as the main factors.

Table 3 presents the means and standard deviations for the verbal variables. In Flexibility, the univariate ANOVA indicated a main effect of Expertise $F(1, 148) = 7.833$, $p = .006$, $\eta^2p = .50$, and Gender $F(1, 148) = 3.983$, $p = .048$, $\eta^2p = .26$. The *post hoc* test showed that musicians were more flexible than non-musicians, and that women were more flexible than men. No significant differences in the interaction Expertise x Gender were found $F(1, 148) = 2.19$, $p = .148$, $\eta^2p = .014$, nevertheless we run the *Post hoc* test and they indicated that female musicians were more

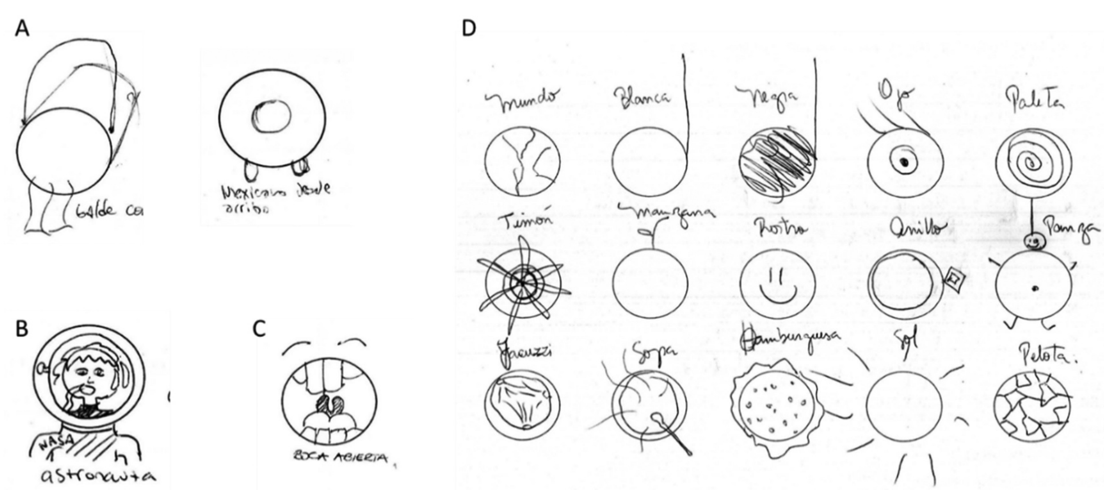

Figure 1. Examples of visual creativity. A. Flexibility (change in perspective: a bucket seen from one side and a Mexican seen from above). B. Elaboration (an astronaut). C. Originality (an open mouth). D. Fluency (only two participants out of 158 completed the entire matrix).

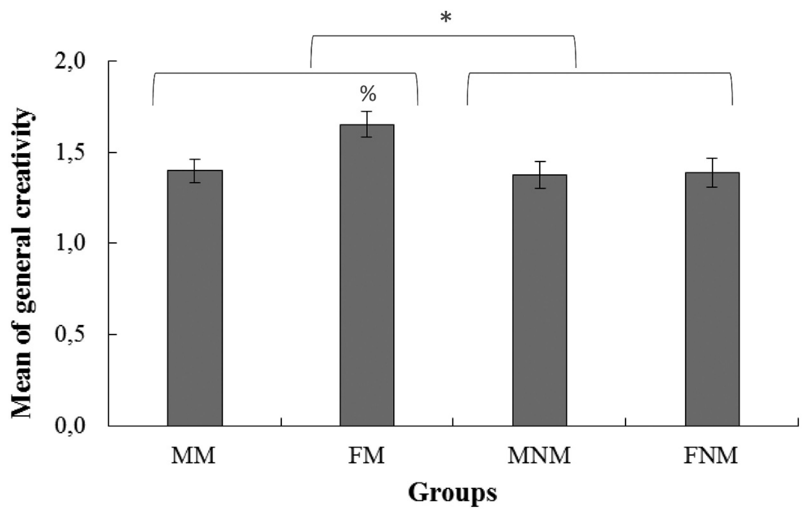

Figure 2. General visual creativity. Mean of Flexibility, Elaboration, Fluency, and Originality combined, for each group. MM: male musicians, FM: female musicians, MNM: male non-musicians, FNM: female non-musicians. *$p < .05$: Indicates expertise effect (musicians > non-musicians). % $p < .05$: Indicates interaction effect (Female musicians > Male musicians and Female non-musicians). Vertical lines represent standard errors of the mean.

Table 2. Means and standard deviations for the variables of visual creativity.

	Flexibility		Elaboration		Fluency		Originality		General Creativity	
Group	Means	SD	Means	SD	Means	SD	Means	SD	Means	SD
Male Musicians	1.69	0.08	1.00	0.16	2.29	0.15	0.59	0.12	1.40	0.06
Female Musicians	1.96	0.12	1.43	0.20	2.44	0.15	0.75	0.16	1.65	0.07
Male Non-Musicians	1.67	0.09	1.07	0.19	2.26	0.15	0.63	0.11	1.38	0.07
Female Non-Musicians	1.78	0.11	1.14	0.16	2.12	0.13	0.43	0.10	1.39	0.08

SD: Standard deviation.

Table 3. Means and standard deviations for the variables of verbal creativity.

	Flexibility		Elaboration		Fluency		Originality		General Creativity	
Group	Means	SD	Means	SD	Means	SD	Means	SD	Means	SD
Male Musicians	1.55	0.05	0.91	0.16	1.78	0.10	0.52	0.10	4.76	0.26
Female Musicians	1.82	0.09	1.03	0.25	2.10	0.13	0.67	0.12	5.62	0.31
Male Non-Musicians	1.48	0.09	0.42	0.11	1.74	0.11	0.45	0.11	4.10	0.26
Female Non-Musicians	1.50	0.08	0.74	0.18	1.73	0.09	0.31	0.08	4.29	0.28

SD: Standard deviation.

flexible than male musicians ($p = .017$), without differences in the non-musicians group ($p = .771$); also they indicated that female musicians were more flexible than female non-musicians ($p = .006$), without differences between men ($p = .364$). An example of flexible idea was "*To use as a phone in a performance*" (categories: animals, actions, and objects).

For Fluency, the univariate ANOVA indicated a trend in Expertise $F(1, 148) = 3.878$, $p = .051$, $\eta^2 p = .26$, the *Post hoc* test showed that musicians were more fluent than non-musicians. No significant differences in the interaction Expertise x Gender $F(1, 148) = 2.09$, $p = .150$, $\eta^2 p = .014$ or the Gender factor $F(1, 148) = 1.31$, $p = .253$, $\eta^2 p = .009$ were found. *Post hoc* test indicated that regarding the interaction there were no significant differences between female musicians and male musicians $p = .062$; or female non-musicians vs male non-musicians $p = .836$; or male musicians vs male non-musicians $p = .758$; however female musicians were more fluent than female non-musicians $p = .026$. The largest number of ideas generated was fifteen (only one participant).

The univariate ANOVA for Elaboration revealed a main effect of Expertise $F(1, 148) = 4.707$, $p = .032$, $\eta^2 p = .31$, the *Post hoc* test showed that musicians generated more elaborate ideas than non-musicians. No significant differences in the interaction Expertise x Gender $F(1, 148) = 2.99$, $p = .585$, $\eta^2 p = .002$ or the Gender Factor $F(1, 148) = 1.93$, $p = .167$, $\eta^2 p = .013$ were found. *Post hoc* test indicated that regarding the interaction there were no significant differences between female musicians vs male musicians $p = .542$; or female non-musicians vs male non-musicians $p = .183$; or female musicians vs female non-musicians $p = .285$, however male musicians had more elaborate ideas than male non-musicians $p = .049$. One example of an elaborate idea was "*To smell it and note if your feet, or those of the person who wore the shoe, have an ugly smell*".

For Originality, the ANOVA indicated a main effect of Expertise $F(1, 148) = 3.973$, $p = .048$, $\eta^2p = .26$, the *Post hoc* test showed that musicians generated more original ideas than non-musicians. No significant differences in the interaction Expertise x Gender $F(1, 148) = 2.19$, $p = .148$, $\eta^2p = .014$ or the Gender factor $F(1, 148) = .0001$, $p = .994$, $\eta^2p = .0001$ were found (see Figure 3 for a representation of the verbal variables). *Post hoc* test for the interaction indicated non-significant effects between female musicians and male musicians $p = .291$; or female non-musicians vs male non-musicians $p = .319$; or male musicians vs male non-musicians $p = .730$, however the *Post hoc* test indicated that female musicians had more original ideas than female non-musicians $p = .024$. One example of an original idea was "*To disassemble it and create a new type of shoe with its materials*".

Finally, the univariate ANOVA for General Creativity indicated a main effect of Expertise $F(1, 148) = 13.202$, $p < .001$, $\eta^2p = .82$, and a trend for Gender $F(1, 148) = 3.8523$, $p = .052$, $\eta^2p = .28$, the *post hoc* test showed that musicians were more creative than non-musicians, and women more creative than men. No significant differences in the interaction Expertise x Gender were found $F(1, 148) = 1.25$, $p = .264$, $\eta^2p = .008$, the *Post hoc* test indicated that female musicians had a higher score than male musicians, $p = .034$, and female non-musicians $p = .002$; while male non-musicians and female non-musicians were statistically similar $p = .629$, besides male musicians were statistically similar to male non-musicians $p = .08$ (Figure 4).

Discussion

The aim that guided the present study was to investigate the effect of music expertise and gender on the creative performance of a group of adults, through two divergent thinking tasks within the visual and verbal modalities. The interaction between the factors was also analyzed

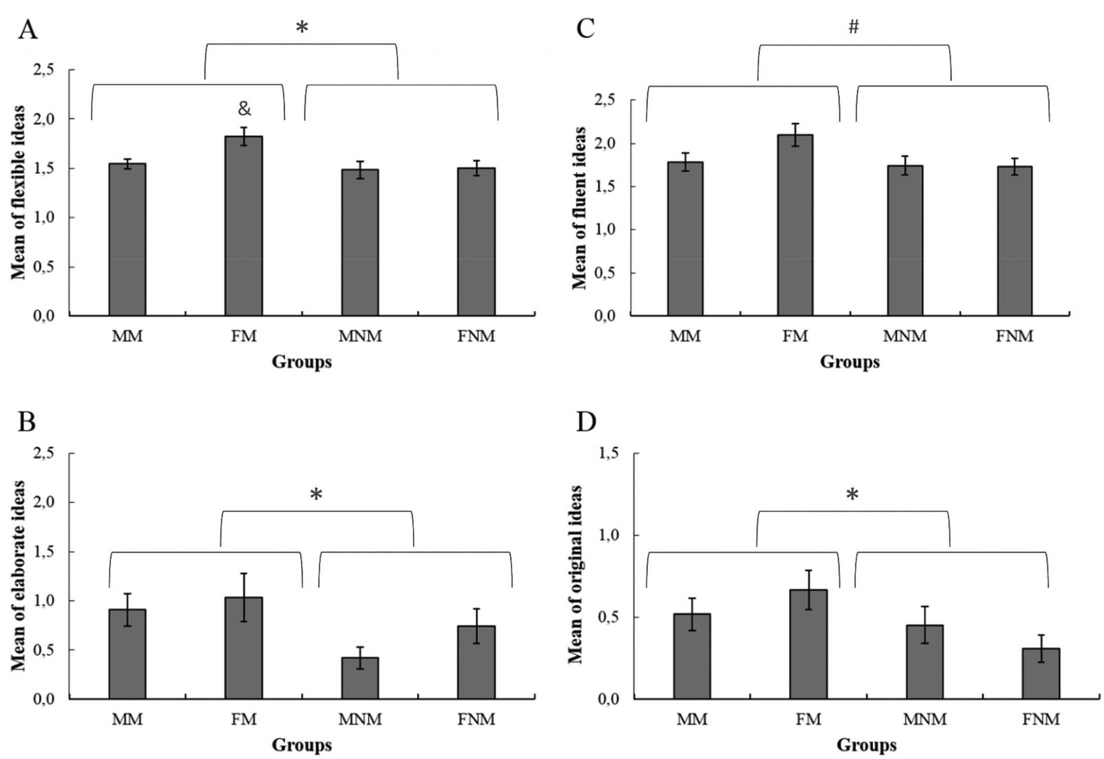

Figure 3. Verbal creativity. (A) Verbal Flexibility; (B) Verbal Elaboration; (C) Verbal Fluency; (D) Verbal Originality. MM: male musicians, FM: female musicians, MNM: male non-musicians, FNM: female non-musicians. $*p < .05$: Indicates expertise effect (musicians > non-musicians). & $p = .048$: Indicates gender effect (women > men). $\#p = .062$: Indicates an expertise trend effect (musicians > non-musicians). Vertical lines represent standard errors of the mean.

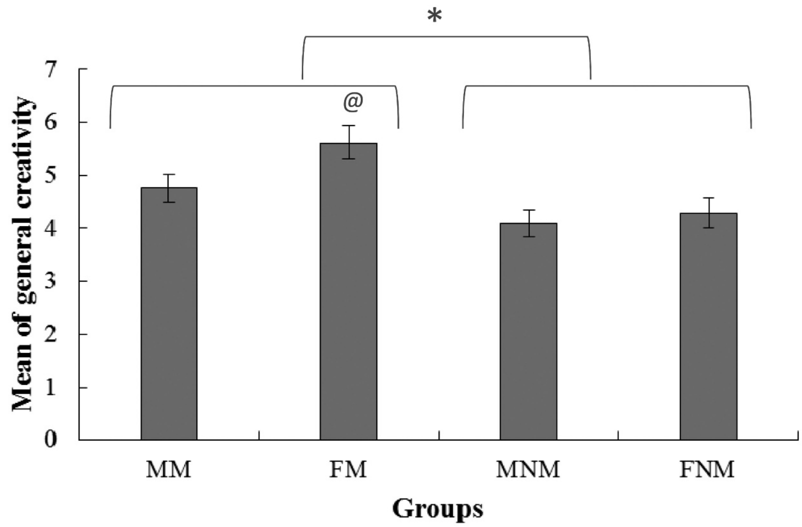

Figure 4. General Verbal Creativity. Mean between Flexibility, Elaboration, Fluency, and Originality for each group. MM: male musicians, FM: female musicians, MNM: male non-musicians, FNM: female non-musicians. *p = .039: Indicates expertise effect (musicians > non-musicians). @ p = .052: Indicates a trend for gender (female > male). Vertical lines represent standard errors of the mean.

when male and female musicians were compared with male and female non-musicians.

In line with the predictions made, the results obtained suggest that music expertise had an impact on creative performance, especially in the verbal domain. On the other hand, only one difference by gender was found in the verbal task.

Regarding gender, women had more flexible ideas in the verbal domain, than men, and although the main effects or interactions were not statistically significant, subsequent comparisons of some verbal performance follow a similar pattern (fluency and originality). This result is consistent with the study conducted by Baer and Kaufman (2008), who suggested that women have higher levels of creativity than men in the verbal domain. Previous studies are controversial on this topic, especially in behavioral studies (Abraham et al., 2013; Baer & Kaufman, 2008; Charyton & Snelbecker, 2007; Pagnani, 2011). Some studies indicate that women perform at a higher level than men in most language skills, as shown by their verbal fluency (Hyde, 2005), speech articulation, grammar skills, and the use of more complex and longer sentences, while men tend to outperform women in visual and spatial tasks (Kimura, 1983; Weiss, Kemmler, Deisenhammer, Fleischhacker, & Delazer, 2003). In this case, the differences between men and women were not due to biological aspects *per se* but could be attributed to social-cultural and environmental factors (Abraham et al., 2013; Runco, Cramond, & Pagnani, 2010), in this case music learning. The results obtained do not make it possible to clarify whether music expertise causes gender differences in creativity or whether it affects creativity only in women. Further research, in particular longitudinal and experimental studies, is needed to shed light on these issues.

On the other hand, brain research related to gender differences is stronger and more conclusive than behavioral research, and it indicates that women differ from men in cerebral areas associated with the visual and verbal domains (Abraham et al., 2013; Razumnikova, 2004; Ryman et al., 2014; Takeuchi et al., 2017). For example, a study conducted by Abraham et al. (2013) found no gender differences at the behavioral level but significant differences in brain areas related to semantic cognition, learning, and decision making, specifically higher activity in women. A possible explanation for the divergences between the neural and behavioral levels is that women and men employ different processing strategies to solve creative tasks and that these strategies could reflect at the neural but not at the behavioral level (Haier, Jung, Yeo, Head, & Alkire, 2005; Martín-Brufau & Corbalán, 2016). Also, this difference between behavioral and brain studies could implicate that there is a need to implement other behavioral evaluations that could reveal the different strategies employed by women and men.

The strongest result of this study was the differences found in music expertise, namely that musicians were more creative than non-musicians in all variables of verbal creativity and in the general score of visual creativity. These results are in line with previous investigations, which indicate that music learning impacts on creative ability (Gibson et al., 2009; Kleinmintz et al., 2014). At a behavioral level, several investigations have shown that music learning has a positive influence on verbal tasks, such as memory (Chan, Ho, & Cheung, 1998; Franklin et al., 2008; Ho, Cheung, & Chan, 2003; Jakobson, Lewycky, Kilgour, & Stoesz, 2008) and language (Schlaug et al., 2005). Besides, at a neural level, previous studies have shown that the interaction between cerebral hemispheres is critical when performing creative, divergent-thinking tasks (Carlsson, Wendt, & Risberg, 2000; Katz, 1986), which could explain the differences found in the performance of people who have musical knowledge. Extensive music training involves the reorganization of cortical structures and their functioning (Elbert, Pantev, Wienbruch, Rockstroh, & Taub, 1995), including a reduction in hemispheric asymmetry and an increase in interhemispheric interactions (Patston, Kirk, Rolfe, Corballis, & Tippett, 2007; Schlaug, Jäncke, Huang, Staiger, & Steinmetz, 1995). Therefore, music expertise may affect the organization of the brain and result in a cognitive system that is predisposed to divergent thinking. To reach more accurate conclusions in future investigations, it will be necessary to perform studies with neuroimaging support.

Limitations and future research

This study had limitations that need to be addressed in future research. An important distinction considered in the literature is the differences that can be found in the style of musical specialization, that is, expertise in classical, jazz, or folk music, among others (Benedek et al., 2014; Kleinmintz et al., 2014), or the type of participation in creative aspects of music, like improvising, arranging, and composing (Sovansky et al., 2016). The questionnaire about musical background did not inquire into these points, which is a limitation of the design, which could have differentiated between the musicians by musical specialization or experience in improvisation, but this limitation is a source of motivation to design future studies with this goal.

In addition, it would be interesting to conduct studies with different populations and investigate the effect of music expertise on creativity throughout human development. A possible design could compare creative performance across different age groups (children, adolescents, young and older adults) to address the development of creativity.

Another limitation concerns the many factors that could affect music expertise, so the differences in creative performance could have been due to a variety of factors. For instance, intelligence or personality could affect expertise and, therefore, the results obtained could be attributed to these variables (for a review literature, Diaz Abrahan & Justel, 2019b). Because years of academic education are related to IQ (Colom, Abad, Garcıa, & Juan-Espinosa, 2002; Kaufman, Kaufman, Liu, & Johnson, 2009) we are controlling this variable to a certain extent. However, future research could use a personality test, an IQ or premorbid intelligence test to control these variables.

Finally, our design allowed a limited time to perform the creativity tasks (two minutes). This point could be reconsidered in the future by extending the time allowance or eliminating the time limit for the creative performance.

Conclusion

The development of creativity has beneficial effects on musicians, dancers, visual artists, among others, but the advantages go well beyond the artistic field since creativity allows people to adapt flexibly to changing circumstances, solve conflicts through innovative and productive solutions, adapt precisely to one´s environment (Baas et al., 2015). Therefore, it is important to study the set of cognitive functions that regulates creativity and the different factors that could modulate it. Musical activities are accessible to the whole community, and they have been shown to have positive effects on the cognitive functions required daily, such as the ability to solve problems in everyday life. For this reason, the ongoing research is essential as it contributes to the body of knowledge and practices used for designing evidence-based activities for health and educational promotion.

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VDA and NJ contributed to the conception and design of the studies. VDA conducted the studies. VDA, LS and NJ contributed to data analysis. VDA wrote the first draft of the manuscript. VDA, LS, FS and NJ reviewed and edited the manuscript and approved the final version of the manuscript." NJ supervised the study.

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