

Creativity level of students in the course of collaborative flute jamming

Nível de criatividade dos alunos no curso de improvisação colaborativa de flauta

Yang Li¹



Department of Music and Dance, Heilongjiang Preschool Education College,
Mudanjiang, China
yangli338@yahoo.com, 237510158@qq.com

Abstract: The direct impact of jamming on human creative thinking has been little studied. Within the framework of the study, the effect of collaborative playing on the level of creativity of students (for example, playing the flute) has been investigated. The key objective of the research is to determine a correlation between the level of creativity of students and their experience of jamming in groups based on pre- and post-tests. A hypothesis that there is a connection between creative thinking and the process of jamming has been put forward. A total of 260 respondents were divided into control and experimental groups (130 people each). The control group played exclusively classical pieces of music based on musical notation while the experimental group was engaged in collaborative jamming. In the course of the research, the students took a creativity test (developed for the purpose of the study) in the first, second, and third weeks of the experiment. As a result, six datasets were obtained; these were checked for obedience to the normal distribution with the help of the Shapiro-Wilk test and analyzed with the help of the two-sample t-test for independent variables. Based on the results of the 21-day experiment, the experimental group demonstrated much higher

¹ Yang Li - PhD, Associate Professor of the Department of Music and Dance, Heilongjiang Preschool Education College, Mudanjiang, China. Research interests: music, flute jamming, flute, jamming, classical pieces of music, music and psychology, and creativity. Yang Li, associate professor and postgraduate tutor. Research Field: Music Curriculum and Teaching Theory, Flute Performance and Teaching. Projects: 1. National Education Science Project "Research on Teachers Knowledge Sharing Factors and Support System", 2. Heilongjiang Art Science Planning Project "Research on the Inheritance and Development of Music of Hezhe Nationality in Heilongjiang from the Perspective of Life", 3. Heilongjiang Art Science Planning Project "The Spread of Soviet Music Theory in China in the New China Period". Monographs: 1. "Flute Performance and Practical Innovation", 2. "Basic Music Theory", 3. "Music Appreciation". Papers: Published more than 20 academic papers among which representative articles: "Teaching Strategies of Combining Music Teaching Method in Colleges and Films with Appreciation of Film and Television Music", "Current problems of the technology of the sound on flute", "Formation of a systemic worldview of the modern flute player" and so on.

levels of creativity in the second and third weeks (the mean scores were 7.82 and 8.74, respectively) compared to the control group (4.62 and 4.64, respectively). The results in the first week were almost identical. Thus, an alternative hypothesis that there is a correlation between an increase in creative thinking and the process of jamming through the example of playing the flute was accepted. Students from the experimental group rated the jamming process extremely positively. In particular, they reported that these practices improve mood and musical skills, and also make it much more effective to learn collaborative play. It is important to note that during the selection of respondents and dividing them into groups, most students wanted to join the experimental group, which indicates an increased interest of students in jamming. The results obtained can be useful in the field of psychology and musicology and serve as an argument for the introduction of jam sessions into the curriculum of higher educational institutions.

Keywords: Creativity. Flute. Jam sessions. Jamming. Music.

Resumo: O impacto direto da interferência no pensamento criativo humano tem sido pouco estudado. No âmbito do estudo, investigou-se o efeito da performance colaborativa no nível de criatividade dos alunos (por exemplo, tocar flauta). O principal objetivo da pesquisa é determinar uma correlação entre o nível de criatividade dos alunos e sua experiência de improvisar em grupos com base em pré e pós-testes. A hipótese de que existe uma conexão entre o pensamento criativo e o processo de improvisação foi levantada. Um total de 260 entrevistados foram divididos em grupos de controle e experimental (130 pessoas cada). O grupo de controle tocou exclusivamente músicas clássicas baseadas em notação musical enquanto o grupo experimental estava envolvido em improvisações colaborativas. No decorrer da pesquisa, os alunos fizeram um teste de criatividade (desenvolvido para o propósito do estudo) na primeira, segunda e terceira semanas do experimento. Como resultado, seis conjuntos de dados foram obtidos; estas foram verificadas quanto à obediência à distribuição normal com o auxílio do teste de Shapiro-Wilk e analisadas com o auxílio do teste t de duas amostras para variáveis independentes. Com base nos resultados

do experimento de 21 dias, o grupo experimental demonstrou níveis muito mais altos de criatividade na segunda e terceira semanas (as pontuações médias foram 7,82 e 8,74, respectivamente) em comparação com o grupo controle (4,62 e 4,64, respectivamente). Os resultados na primeira semana foram quase idênticos. Assim, foi aceita uma hipótese alternativa de que existe uma correlação entre o aumento do pensamento criativo e o processo de improvisação através do exemplo de tocar flauta. Os alunos do grupo experimental avaliaram o processo de interferência de forma extremamente positiva. Em particular, eles relataram que essas práticas melhoram o humor e as habilidades musicais, e também tornam muito mais eficaz o aprendizado de performances colaborativas. É importante notar que durante a seleção dos respondentes e a divisão dos mesmos em grupos, a maioria dos alunos desejava ingressar no grupo experimental, o que indica um aumento do interesse dos alunos em jam. Os resultados obtidos podem ser úteis no campo da psicologia e da musicologia e servir de argumento para a introdução de jam sessions no currículo das instituições de ensino superior.

Palavras-chave: Criatividade. Flauta. Sessões de improviso. Interferência. Música.

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Introduction

Interdisciplinary research on creativity at the nexus of music and psychology is a fairly popular fast-growing branch of science (CARNOVALINI and RODÀ, 2020; SNODGRASS, 2016; SUNARTO, 2020). Forming the modern parameters of creative skills development is the object of a large number of studies, among which only a small part indicates the adaptability of flute jamming.

The direct impact of jam sessions on the level of creativity has been little studied, which is the reason for this study; however, a similar topic is considered in the works of BAYRAK (2017) and EBERHARDT (2016). The study of ARKIN *et al.* (2019) found a positive correlation between improvisation and creative thinking. In particular, it was noted that despite the negative relationship between the level of creativity and gray matter volume in the right inferior temporal gyrus and bilateral hippocampus, musical improvisation has a positive effect on the gray matter volume in regions associated with the formation of memory, perceptual categorization, and sensory integration. Similar results were obtained in the study of SOWDEN *et al.* (2015). Although the study focused exclusively on dance practices, it also considered a correlation between improvisation and creativity. In the course of the research, based on the “toy” method and Torrance Tests of Creative Thinking, it was revealed that children who improvised during the experiment demonstrated a higher level of creativity than those who performed choreographed dances.

Research on playing the flute is fairly common. A lot of information is found in the studies of BURNS (2019), EDMISTON (2016), JOSHI and KIRAN (2020). Thus, BURNS (2019) notes that this musical instrument is one of the most common and effective in the context of medical music therapy. While JOSHI and KIRAN (2020) describe playing the flute as an effective means of coping with stress in the busy learning environment of technical students. For example, DOUGHTY and LAGERQVIST (2016) carry out a historical analysis of the South American flute. Street music and

its demographic variation across regions were investigated with the help of sensory analysis, interviews and observations. As part of the research of RIIKONEN (2017), the flute of Saariaho was studied. It was summarized that this type of flute requires a special approach that involves whisper and lip position.

The improvisation process has been discussed in a large number of studies based on different approaches (for example, in the study of HART and DI BLASI (2015), and HIRJI (2015)). Thus, the study of WALTON *et al.* (2018) examines the impact of jamming on various collaborative aspects. This research relies on the analysis of music recordings with the use of mathematical methods. In the study of BIASUTTI (2017), a qualitative narrative analysis of the theses put forward was used.

BELITSKI and HERZIG (2018) conducted a theoretical study of collective creativity and improvisation and described a model for managing organizational innovation. In the study of HERZIG and BAKER (2014), the process of jamming was investigated based on historical narratives, interviews and testing. Thus, the key factors are self-awareness, the competence of participants, their theoretical and practical knowledge in the field of improvisation, the ability to cooperate, the distribution of the roles of leaders and assistants, and a constant assessment of one's own skills.

The research of RITTER and FERGUSON (2017) examines the influence of different music on human creativity. The results showed that the respondents who completed creativity tasks while listening to music that made them feel positive performed better than those who took the test in silence. However, this effect did not affect convergent creativity. A similar study was also carried out by HE *et al.* (2017). It examined the effect of passive listening to music on the creative thinking of respondents. Based on the Test for Creative Thinking - Drawing Production and the Affect Grid, it was found that the results of testing do not depend on valence while arousal largely correlates with the level of creative thinking. Also, GUAN (2021) revealed that students who regularly listen to classical music have a higher level of creativity than students who

listen to classical music once or twice a week. However, in the course of the study, it was found that listening to classical music can lead to the loss of self-control and a sense of reality. Similar studies have also been carried out by CORAZZA and AGNOLI (2016), and KRATUS (2017).

Based on the literature analysis, the interest in using the principles of jamming in the context of developing students' creativity is insufficiently formed in the trend of related manuscripts. On the other hand, a large number of researchers have noted the significant potential of the flow of jamming as an element of improving the effectiveness of the learning process. As a result, the purpose of the study is to test the hypothesis that there is a correlation between an increase in the level of creative thinking and participation in jam sessions through the example of playing the flute based on pre- and post-tests. The results showed that the experimental group participating in jamming achieved better results in the creative thinking test than the control group, which was exclusively engaged in the reproduction of classical music with the help of musical notation.

Materials and methods

Pre-selection of respondents

Within the framework of this study, the respondents were selected to obtain homogeneous results that can be statistically analyzed. At the initial stage of the experiment, 278 students from various universities in China (Beijing, Shanghai and Wuhan universities, Tsinghua University and Fudan University) took part. To linearize the sample of respondents, only first-year students of these schools who could play the flute were selected. This approach is convenient as it narrows the circle of respondents and makes it possible to produce approximately identical results when playing different pieces (thus, the selected pieces were of relatively the same difficulty for all respondents).

All respondents were required to play short pieces of flute music of medium complexity to confirm their level of playing. However, all respondents, as expected, successfully coped with the task (the assessment was carried out by the teachers of the universities mentioned above).

In the course of the study, 9 students dropped out of the experiment for various reasons that did not require any explanation (going away from the city, family problems, etc.)

It is important to note that none of the respondents had participated in jam sessions before. This factor could have greatly affected the accuracy of the results obtained as according to the hypothesis being tested, the respondents with experience in jamming could have had much better indicators of creativity than other respondents.

It should be highlighted that in this case the progress of students has a minor effect on the course of the experiment as the music pieces played were not difficult enough to cause difficulties for students during the performance. Gender, social and financial status were not considered either.

During the study, 10 irrelevant results were obtained (the scores were very low). These data were not considered as the total number of responses greatly exceeds the number of the irrelevant ones.

Research methodology

The main research methodology involved questioning students (based on a questionnaire developed for the purpose of the study) in the course of jam sessions or performing classical works in order to assess a change in the level of their critical thinking.

The respondents were divided into the control and experimental groups of 130 people each. In turn, each group was divided into 10 subgroups (26 people each) for convenience.

Lessons (in this case, a lesson is a 45-minute performance of classical pieces (Appendix 2) for the control group and improvisation for the experimental group) were held five times a week. Thus, a total of 15 lessons were conducted in the course of the three-week experiment. At the beginning of the first week (pre-test), as well as at the end of the second and third weeks (post-test), the students were surveyed to assess their level of creativity (Appendix 1). The time limit for the questionnaire was 10 minutes.

At the end of the study, all responses were checked and summarized by the teachers of the same universities in China for a period of 10 days.

It is important to note that the respondents were asked not to improvise on their own during the experiment as this factor could have affected the uniformity of the results obtained.

Statistical research methods

In this research, the main tool for testing the hypothesis under study was the two-sample t-test for independent variables.

It is necessary to check the possibility of using the Student's t-test as a research method for this statistic. The main requirements for the conformity of the sample for the application of the Student's criterion: the sample sizes correspond to $n = 9$ with the requirement of 8. The compared samples must meet the requirements of a normal distribution. In this study, the Shapiro-Wilk test is used to check the compliance of samples with the normality criterion.

The value of the Shapiro-Wilk criterion is determined according to the following formula:

$$W = \frac{1}{s^2} [\sum_{i=1}^n a_{n-i+1} (x_{n-i+1} - x_i)]^2 \quad (1)$$

s^2 is a variance of the sample, a_{n-i+1} is the differences of values tabular coefficients, x is a certain sample value, i is variable index, n is sample size.

The hypothesis about the correspondence of the sample to the normal distribution should be accepted if the value obtained in formula (1) is not greater than the tabular value. In the opposite case, an alternative hypothesis should be accepted, which assumes the distribution of values in the sample under study in accordance with other criteria.

The critical value within this sample for the Shapiro-Wilk test is calculated as follows:

$$W_{cr} = \frac{(-0.0113 \cdot n^4 + 1.656 \cdot n^3 - 91.88 \cdot n^2 + 2408.6 \cdot n + 67608)}{100000} \quad (2)$$

where n represents a sample size.

As in most cases for the empirically obtained data, the critical values of the Shapiro-Wilk criterion were chosen in accordance with the significance level $\alpha = 0.05$. According to the calculation, at $n = 9$ for this sample, the critical value obtained was 0.15.

The study of the compared samples was carried out using a two-sample Student's t-test for independent variables according to the formula below:

$$t = \frac{\bar{x}_i - \bar{x}_j}{s^2} \quad (3)$$

\bar{x}_i and \bar{x}_j are sample means, s^2 is pooled sample variance, calculated by the formula $s^2 = \sqrt{\frac{s_i^2 + s_j^2}{n}}$ where s_i^2 and s_j^2 are variance of individual samples, and n is sample size.

An alternative hypothesis about the presence of a significant difference between the studied samples is confirmed when the values of the criterion are lower than those obtained empirically. Otherwise, the null hypothesis of the absence of significant differences between the samples is accepted. As a result of statistical studies, it was found that the critical value of the Student's criterion is 2.31.

Ethical issues

Within the framework of this study, a number of ethical issues that could affect the accuracy of the results were eliminated. First of all, the questionnaire was checked and confirmed by specialists in the field of psychology and psychiatry (Shanghai and Beijing universities). In addition, all student questionnaires were anonymized as the teachers could know the respondents, which could theoretically lead to the falsification of the results obtained.

The respondents and examiners were not interested in obtaining a particular research result.

The participation in the experiment was voluntary and was not encouraged or punished.

Research limitations

The main limitation of the study was the small number of questions in the questionnaire. This factor affects the reliability of the results as the accuracy of the Student's t-test directly depends on the number of values in the sample. However, the sample size 9, which is a sufficient condition for the applicability of the criterion.

Also, the number of respondents plays an important role in the accuracy of the results. The more respondents, the more accurate results can be obtained. However, it should be noted that a fairly large number of participants took part in the study.

Also, it is important that the concept of creativity is subjective and rather difficult to assess. Therefore, it is also worth focusing on this problem.

Results

Within the framework of the study, three pairs of samples of 9 respondents each were obtained.

Table 1 and Table 2 show the results of the survey of the control group. Column 1 contains the numbers of questions in the questionnaire. Columns 2, 3, and 4 show the results obtained at the beginning of the first and at the end of the second and third weeks, respectively.

Table 1 - The data obtained in the course of testing the control group

Control group			
n	First week	Second week	Third week
1	4.87	4.71	4.83
2	4.89	4.86	4.81
3	4.35	4.47	4.73
4	4.57	4.85	4.47
5	4.12	4.37	4.9
6	4.44	4.55	4.47
7	4.91	4.83	4.44
8	4.47	4.42	4.74
9	4.48	4.49	4.39

It can be seen that in the first, second and third weeks, the lowest results are 4.12 points for question 5, 4.37 for question 5 and 4.44 for question 7 while the highest ones are 4.91 points for question 7, 4.86 for question 2 and 4.83 points for question 1, respectively. Thus, in this case, there is hardly any correlation between the results obtained and the question number.

Table 2 - The data obtained in the course of testing the experimental group

Experimental group			
n	First week	Second week	Third week
1	4.52	7.92	8.88
2	4.58	7.78	8.56
3	4.72	7.73	8.62
4	4.77	7.67	8.59
5	4.69	7.98	8.92
6	4.77	7.99	8.81
7	4.52	7.62	8.66
8	4.81	7.78	8.82
9	4.29	7.92	8.78

In this case, in the first week, the lowest and highest results are 4.29 points for question 9 and 4.81 question 8; in the second

week, these are 7.62 points for question 7 and 7.98 for question 5, and in the third week, the indicators are 8.56 points for question 2 and 8.92 for question 5, respectively. In this case, the correlation between the value and the question number was not found either.

Table 3 - Data obtained by analyzing the samples with the help of the Student's t-test.

Values	Student's t-test		
	First week	Second week	Third week
t_{emp}	0.06	2.73	3.36
t_{cr}	2.31		

Table 3 shows the results of testing the hypothesis under study with the help of the Student's t-test. Column 1 contains the empirical and critical values of the Student's t-test. Columns 2, 3, and 4 show the results of comparing the obtained pairs of samples (the control and experimental groups) in the first, second, and third weeks, respectively.

It can be seen that in the first week, the empirical value of the Student's t-test does not exceed the tabular one, which indicates the acceptance of the null hypothesis (no correlation). In other words, before the start of the experiment, the participants were under equal conditions regardless of the group. In the second and third weeks, the value of the Student's t-test exceeds the tabular one, which indicates the acceptance of the alternative hypothesis that there is a correlation between the participation in jam sessions and a change in the level of critical thinking.

Table 4 - Examination of the control group sample using the Shapiro-Wilk test

Values	Shapiro-Wilk test		
	Control group		
	First week	Second week	Third week
<x>	4.57	4.62	4.64

s_i^2	0.07	0.04	0.04
W_{emp}	0.21	0.31	0.19
W_{cr}	0.15		

Table 5 - Examination of the experimental group sample using the Shapiro-Wilk test

Values	Shapiro-Wilk test		
	Experimental group		
	First week	Second week	Third week
$\langle x \rangle$	4.63	7.82	8.74
s_i^2	0.03	0.02	0.02
W_{emp}	0.22	0.21	0.18
W_{cr}	0.15		

Tables 4 and 5 show the results of the analysis of the samples with the help of the Shapiro-Wilk test. This method confirms the obedience of the samples to the normal distribution and is required for the application of the Student's t-test.

Column 1 contains the values of the arithmetic mean of samples, root-mean-square deviation, as well as the empirical and critical values of the Shapiro-Wilk test. It can be seen that in the first week, the means of the control and experimental groups are almost identical while in the second and third weeks of the experiment, the indicators of the experimental group are much higher. This fact suggests that despite the equal conditions ensured at the beginning of the experiment, in the middle and at the end of the study, the respondents from the experimental group demonstrated much better results.

Due to the fact that in all cases the empirical value of the Shapiro-Wilk test exceeds the tabular one, the samples obey the normal distribution.

Thus, it can be summarized that there is a correlation between participation in jam sessions and an increase in the level of creative thinking. In addition, the mean values of the samples show that this trend is most noticeable in the second week while the changes after the third week are minor (compared to the second week). However, it is important to note that the mean values of the control group have also slightly increased. Nevertheless, the changes are so small that they can be ignored (Student's t-test showed no significant differences in the results regardless of the time of testing). The results obtained indicate that long-term jam sessions (one week or more) contribute to the development of creative thinking. However, the main trends show that over time, the effect of improvisation practices diminishes. However, it remains fairly strong.

The main issue of this study is the impact of jamming in the long term. In addition, there is another issue related to the longevity of this influence. To investigate this problem, it is possible to further increase the duration of the experiment, as well as to conduct testing not only in the course of the experiment but also after its completion in a certain period time.

The results obtained are useful from the point of view of modern pedagogy in the field of music as they confirm the beneficial effect of jam sessions on creative thinking. In addition, the research pattern can serve as a basis for further research in this area.

Discussion

Despite a fairly large number of studies devoted to jamming and creativity in music (TURCHET and BARTHET, 2018), the impact of jamming on creative thinking has been poorly studied. Thus, TURCHET and BARTHET (2018) investigated a creative connection between performers and the audience with the help of special equipment. The results showed that gestures and screenshot notifications can serve as a means of creative communication.

Thus, in an online study of FALK *et al.* (2021), 27 jam session arrangers from 12 different countries were interviewed. Within the framework of this research, factors such as the level of risk and novelty, as well as combinational creativity and creativity constraints were investigated. The results showed that jamming develops not only creative thinking, as it was revealed in our study, but also increases the level of critical thinking, as well as contributes to the improvement of communication and collaboration skills. The findings of this study help to better understand how jam session arrangers can contribute to unlocking the creative potential of jamming participants. The study of HERZIG (2020) examines the collaborative efforts of a number of musicians to create jam sessions, describes new approaches to teaching jamming, as well as the main factors ensuring the efficiency of a jam session. These factors include the competence of individual participants, improvisation abilities, skills of democratic cooperation in a group, as well as mutual support and mentoring. RITTER and FERGUSON (2017) examined the effect of passive listening to classical music of various types on creative thinking. By testing such parameters as silence control condition, divergent and convergent creativity, it was found that “happy” (that is, positive) music has the greatest effect on the creativity of respondents. An experiment involving the control and experimental groups showed that the respondents solving creativity tasks in silence demonstrated worse results compared to those solving tasks while listening to positive music. However, it should be noted that this music did not have any effect on convergent creativity. Thus, this study is an argument for the introduction of positive classical music into the curriculum of higher educational institutions.

The study of VERNEERT *et al.* (2021) examined the impact of music rehearsals on various aspects of the well-being and life of homeless people (positive emotion, engagement, social relationships, meaning, accomplishment and the interactive dimensions of collective free improvisations). A change in collaborative creativity was also considered. The results showed

that collaborative creativity does increase over time in the course of music rehearsals. SAWYER (2006) also considers collaborative music production and reproduction. In particular, the processes of improvisation, collaboration and emergence are studied. By analyzing and summarizing the results of previous studies, it has been revealed that over time musicians begin to demonstrate a high level of synchronization without the help of a conductor. In addition, situations in which the musicians began to improvise in an attempt to eliminate the mistakes of other performers in the group, which led to the successful completion of the reproduction of the piece, have been described .

Also, the study of ŁUCZNIK *et al.* (2021) considers improvisation in collaborative dance performances. The results showed that dancers successfully improvise in complex group dances and come up with original and appropriate movements. However, it is important to note that the level of creativity is much higher in solo dance performances compared to the group ones. The work of PINHEIRO (2011) provides an exhaustive description of the process of creativity in jam sessions of the jazz genre. The research has shown that there are many factors that affect the success of a jam session. In particular, this is a place where they are played as it greatly affects the acoustic characteristics of the instruments. The connection between the musicians and the audience, as well as the connection between the musicians also play an important role. It should be noted that musical experience is essential.

Conclusions

Within the framework of this research, the hypothesis that there is a correlation between an increase in the level of creativity and the process of flute jamming was investigated. The experiment involved 3 stages with the participation of the control and experimental groups on the basis of the pre- and post-tests. The results showed that at the beginning of the first week, the students from the control and experimental groups had the same

level of creativity, which indicates the purity of the experiment and the possibility of further research on this issue. It should be noted that the respondents were tested based on a specially created and approved by specialists questionnaire consisting of 9 questions. At the end of the second and third weeks, it was found that in the control group, the level of creativity did not change – there were hardly any changes in the mean values of the samples (4.57, 4.62, and 4.64 points) – while in the experimental group, the means significantly increased and amounted to 4.63, 7.82 and 8.74 points. However, to confirm the hypothesis under study, we had to verify that the differences in the sample means are considerable. For this purpose, the analysis based on the two-sample t-test for independent variables was carried out – the pairs of samples of different groups were compared at the same testing time. The analysis showed that in the first week there was no difference between the test results of the control and experimental groups as the empirical value of the Student's t-test did not exceed the tabular one. At the end of the second and third weeks of the experiment, the results of the questionnaire differed significantly as the empirical values of the Student's criterion exceeded the tabular one. A statistically significant test result was 0.05 (as for any experimentally obtained data) and the sample size was 9. It should be noted that in order to apply the Student's t-test, all samples were preliminarily checked for compliance with the normal distribution with the help of the Shapiro-Wilk test. The results obtained can be useful in the field of pedagogy and serve as an argument for the introduction of jam sessions into the curriculum of higher educational institutions.

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Appendix 1

1. Think of 3 synonyms to "funny"
2. Think of 2 synonyms to "pride"
3. Think of 3 antonyms to "funny"
4. Think of 2 antonyms to "beauty"
5. Write 3 animals that start with "b"
6. Write 6 adjectives that start with "d"
7. Write 6 nouns that start with "f"
8. Write 4 countries with warm climate
9. Write 4 names that start with "t"

Appendix 2

1. Chamber Music (Honegger)
2. Flute Concerto (Reinecke)
3. Concertino for Flute (Chaminade)

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