THE PEER-LED TEAM LEARNING INTERNATIONAL SOCIETY
PROCEEDINGS OF THE INAUGURAL CONFERENCE
MAY 17-19, 2012
NEW YORK CITY COLLEGE OF TECHNOLOGY OF
THE CITY UNIVERSITY OF NEW YORK
BROOKLYN, NY 11201-2983

Classical Music Stimulates Community College Students' Perception and Engagement during Chemistry Laboratories

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Abstract

Exposure to classical music has been shown to enhance brain functions such as abstraction, mathematical ability and spatial reasoning. However, previous studies have focused on students attending chemistry lectures at four-year institutions. Limited insight exists on the connection between classical music and the levels of perception and engagement among community college students during chemistry laboratories. This study exposes community college students, working in teams integrated by members from highly diverse backgrounds, to selected classical music compositions as they perform chemistry experiments. Our preliminary results suggest that following such exposure, there is a general enhancement of perception among students (measured by test scores of experiments and surveys), which facilitates the accomplishment of the experimental goals and reinforces the understanding of the underlying chemistry concepts. It is also observed that despite the high diversity among team members, abilities related to effective peer leadership and student interactions are also stimulated.

Introduction

Classical music has been reported to enhance brain activities such as spatial task performance and learning (Rauscher, et al, 1993, Jausovec, et al, 2006). A widely documented case of such stimulatory effect, involves the "Mozart Effect," in which Mozart's Sonata K. 448 has been reported to enhance spatial rotation skills and reasoning (Jausovec, et al, 2005) in addition to visual activities (Jausovec, et al, 2004). The stimulatory response has been documented using various methods such as electroencephalographic (EEG) analysis that incorporated induced event-related desynchronization/synchronization (ERD/ERS), coherence (ERCoh) (Jausovec, et al, 2003), and approximated entropy (ApEn) methods (Jausovec, et al, 2006). These approaches revealed that individuals that were exposed to this Mozart's composition displayed less complex EEG patterns and more alpha band synchronization than individuals who remained in a silence condition (Jausovec, et al, 2003, Jausovec, et al, 2005, Jausovec, et al, 2006). The synchronization of EEG alpha activity is considered as indicative of neuronal responses which are associated with active internal brain processing and creative thinking (Benedek, et al, 2011). A stimulatory effect on sensorial and brain visual activity was also documented using the Tanaka B-type intelligence test and optical topography (Suda, et al, 2008). These methods revealed a dramatic enhancement in spatial-temporal reasoning through neuronal activation in the dorsolateral prefrontal cortex and the occipital cortex in individuals who were exposed to the musical condition compared to subjects who remained in a silence condition. Other studies have also suggested that listening to Mozart's music increases the activity of specific brain areas facilitating the selection and "binding" together of pertinent aspects of sensory stimulus into a perceived whole concept (Jausovec, et al, 2005). Other classical music compositions such as Brahms' Hungarian dance No. 5 (Jausovec, et al, 2006), Haydn's

symphony (no. 94) (Jausovec, et al, 2003) and Beethoven's Fur Elise (Suda, et al, 2008) have also been correlated, although with lower stimulatory effects than Mozart's Sonata K442, to the enhancement on spatial reasoning activities.

Despite the numerous publications on the stimulatory effect of classical music on spatial capacities and brain activities linked to performance and learning, many of these studies have been conducted on individuals within non academic backgrounds (Suda, et al, 2008, or limited to four-year academic institutions (Last, 2009). This study aims to explore the potential stimulatory effect of a selection of classical music compositions in community college students performing a chemistry laboratory course. Our preliminary findings emerge form a student population that is particularly diverse in background. In this initial phase, we rely on grades obtained in a common test across various semesters; laboratory reports scores in which the listening condition was applied or not; and a survey of student's opinion on the potential stimulatory effect of classical music on their engagement and perception as they perform chemistry experiments. We also conducted observations on the student's ability to focus on the experimental tasks, to understand underlying chemical concepts, to harmonize their diverse backgrounds and to establish effective peer-leadership skills.

Methodology

During the first phase of this study, various classical music compositions were selected with the aim of creating an atmosphere of serenity prior to the performance of experiments (Table I). Students were exposed to two listening periods. The first listening period of approximately five minutes was aimed at acclimatizing the students to a state of relaxation after the explanation of the experiment and prior to its execution. This first listening exposure also served to control any interference by psychological arousal (Rauscher, et al, 1993). A second listening period of 10-15 minutes followed, as students executed their experiments. The second listening condition aimed at creating serenity during this stage of higher practical and intellectual execution.

Classical music was played via smart classroom technology, through ten different experiments, each conducted once a week, meeting at the same time period. Approximately 22 students were divided in five groups of 3-4 students. Prior to the beginning of the study, the instructor inquired from his students if they agree on music being played as they conducted their experiments as well as on the volume. All students agreed. Groups were established in such a way that ethnic diversity was preserved. Each group had one student with demonstrated leadership skills. As the experiments were conducted, the instructor carefully observed student interactions. In addition, the instructor analyzed the types of questions that students posed following exposure to classical music in comparison to the typical questions from students not exposed to classical music. The instructor also considered the average time that each group employed to finish each experiment. At the end of the laboratory course, an exam was administered which covered material from each of the ten experiments in which classical music was played. Results were compared to a different group of students who conducted the same ten experiments in absence of the listening experience. In addition, a survey was administered with carefully designed questions aiming at determining various factors such as any previous exposure to classical music prior to the course, knowledge of a classical instrument, general attitudes towards empirical chemistry before and after the listening periods and knowledge of the underlying chemical principles associated with each experiment.

A second phase of this study is being initiated, in which groups of students will be exposed to five laboratory experiments with and without the listening condition. At the end of each laboratory session a short quiz will be administered. A survey will also be provided at the end of the laboratory course.

Table I.

Selection of classical music compositions that were played during two listening periods aimed at inducing different conditional responses.

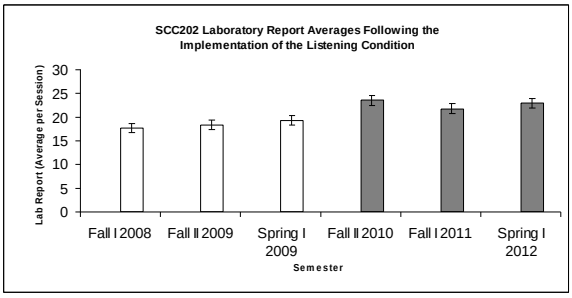
Composition	**Listening Period**	Aim
Claire de lune – C. Debussy Air – J.S. Bach	First	Relaxation and Control for Arousal
Suits 1-3 for Cello – J.S. Bach, Sonata for two pianos K 448 – W.A. Mozart, Concierto de Aranjuez – J. Rodrigo, Bolero – M. Ravel, The Four Seasons – A. Vivaldi, Piano Concerto No. 5 – L. van Beethoven (by student request), La Music Notturna Delle Strade Di Madrid No. 6, Op. - L. Boccherini, Nabucco – G. Verdi, Water Music, Suite II, Allegro Maestoso – G.F. Handel	Second	Enhancement of Perception and Engagement

Discussion

Impact of classical music on laboratory evaluations

The grades of laboratory evaluations including laboratory reports and final laboratory exams for the course during various academic semesters were averaged. A tendency is evident in which higher grades are obtained for these criteria in semesters in which the listening condition was applied (Fall II - 2010, Fall I - 2011 and Spring I - 2012) compared to previous semesters in which no classical music was played during the laboratory sessions (Fall I – 2008, Fall II – 2009 and Spring I – 2009). The increase in the average grades following the listening condition is 38% for laboratory reports and 19% for laboratory exams (Figure 1 A-B). The same laboratory exam was administered through all semesters. During the second phase of this investigation, the experimental group of students will be exposed to classical music every other laboratory session and a short quiz will be administered following the execution of the experiment in presence and absence of the listening condition.

A



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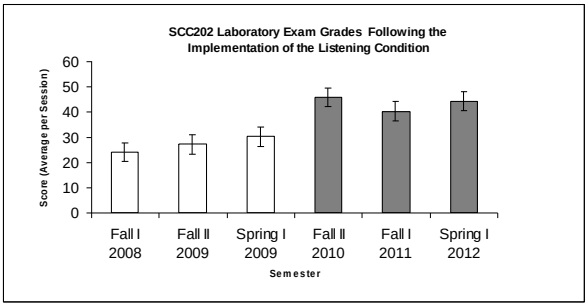
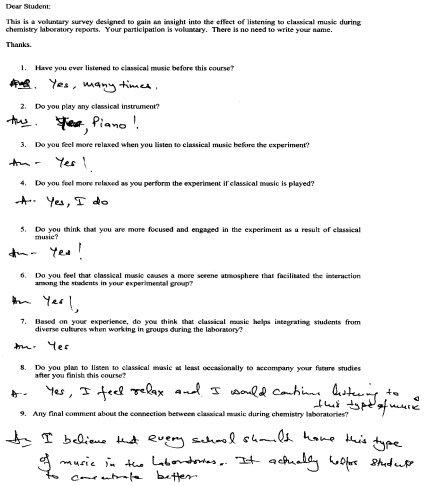


Figures 1 A-B: A; Laboratory report averages for students in the course through various semesters. Academic semesters in which classical music was not utilized are shown as white bars, whereas semesters in which classical music was played in laboratories are indicated as gray bars. One standard deviation is shown. B; Averages for final exams for the same course from semesters in which classical music was not used (white bars) and semesters in which classical music were utilized (gray bars). Although in each semester the student population corresponded to different sections, they received the same final laboratory exam. One standard deviation is also shown.

A



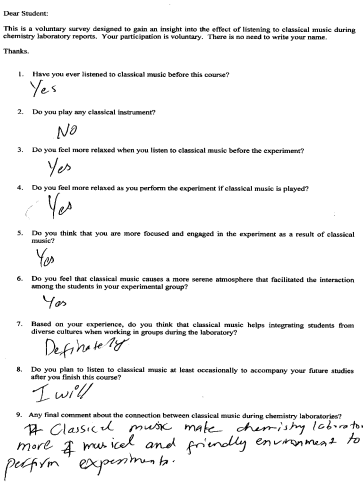
Dear Student:

This is a voluntary survey designed to gain an insight into the effect of listening to classical music during chemistry laboratory reports. Your participation is voluntary. There is no need to write your name.

Thanks.

1. Have you ever listened to classical music before this course?
Yes, many times.
2. Do you play any classical instrument?
Yes, Piano !.
3. Do you feel more relaxed when you listen to classical music before the experiment?
Yes !
4. Do you feel more relaxed as you perform the experiment if classical music is played?
Yes, I do
5. Do you think that you are more focused and engaged in the experiment as a result of classical music?
Yes !
6. Do you feel that classical music causes a more serene atmosphere that facilitated the interaction among the students in your experimental group?
Yes !,
7. Based on your experience, do you think that classical music helps integrating students from diverse cultures when working in groups during the laboratory?
Yes
8. Do you plan to listen to classical music at least occasionally to accompany your future studies after you finish this course?
Yes, I feel relax and I would continue listening to this type of music
9. Any final comment about the connection between classical music during chemistry laboratories?
I believe that every school should have this type of music in the laboratories. It actually helps students to concentrate better.

B



Dear Student:

This is a voluntary survey designed to gain an insight into the effect of listening to classical music during chemistry laboratory reports. Your participation is voluntary. There is no need to write your name.

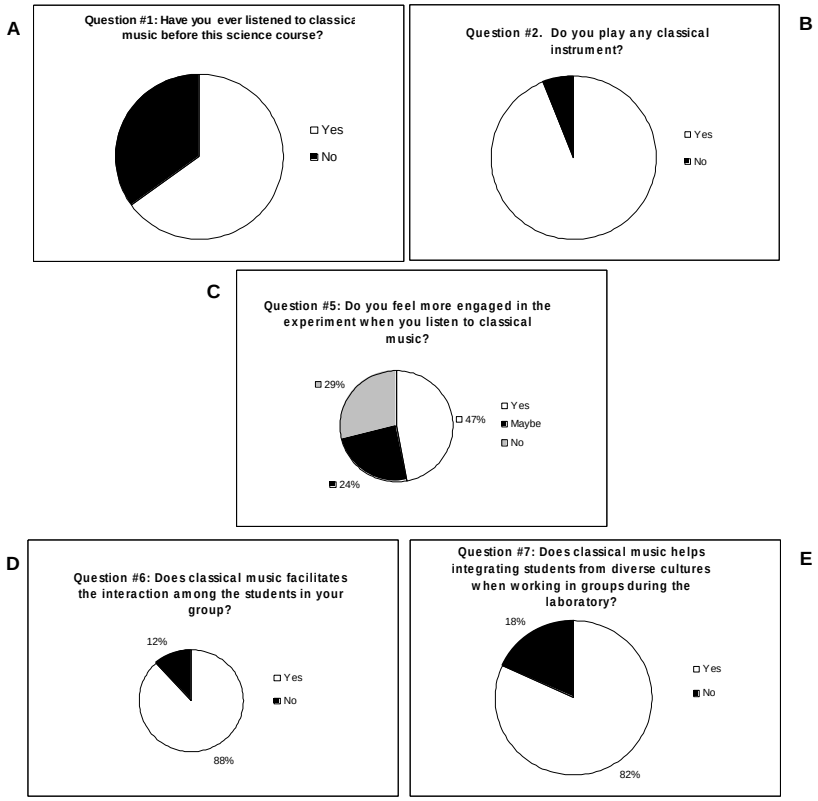
Thanks.

1. Have you ever listened to classical music before this course?
Yes
2. Do you play any classical instrument?
No
3. Do you feel more relaxed when you listen to classical music before the experiment?
Yes
4. Do you feel more relaxed as you perform the experiment if classical music is played?
Yes
5. Do you think that you are more focused and engaged in the experiment as a result of classical music?
Yes
6. Do you feel that classical music causes a more serene atmosphere that facilitated the interaction among the students in your experimental group?
Yes
7. Based on your experience, do you think that classical music helps integrating students from diverse cultures when working in groups during the laboratory?
Definately Yes
8. Do you plan to listen to classical music at least occasionally to accompany your future studies after you finish this course?
I will
9. Any final comment about the connection between classical music during chemistry laboratories?
Classical music make chemistry laboratories more a musical and friendly environment to perform experiments.

Figures 2 A-B: A; Student survey on the connection between classical music and performance in chemistry laboratories. Panel A shows a sample of the responses from a student with formal education in a classical instrument. B; Responses from a student without formal knowledge of a classical instrument. In general, similar responses are obtained for all students.

<u>Surveying students on the effect of classical music on their performance</u>

At the end of an academic semester, a nine-question survey was administered to one group of students in order to assess their opinion on the effect of the exposure to classical music on their performance. The survey (Figure 2) included questions aiming at determining the level of exposure and knowledge of students to classical music prior to the course, and their opinion on the effect of the listening stimulus on various factors such as stress levels, relaxation, ability to focus, engagement in the experiment, ability to interact with classmates from diverse cultures. Results indicated that their general exposure to classical music was moderate (Figure 2 A-B and Figure 3 A-B), while most students understood that classical music helped them to focus on the experiment and to engage the chemical concepts (Figure 3 C). A majority of students also indicated that classical music also helped facilitate their interaction with other student peers from diverse cultures within their groups (Figure 3 D-E). Finally, most students plan to continue accompanying their studies with classical music in the future, and some suggested the use of classical music during chemistry laboratories as a standard institutional practice. Student responses were in general similar regardless of the degree of knowledge of classical music prior to exposure during the chemistry laboratory.



Figures 3 A-E. Results for some questions from a survey on the students' perspective on the use of classical music in the chemistry laboratory. Seventeen students volunteered to participate in this survey

Preliminary Results

Our preliminary findings suggest that students exposed to selected compositions of classical music as they perform a chemistry laboratory experiment show improved scores in laboratory evaluations that include reports and a common final examination. We believe that different classical compositions can stimulate different aspects of performance as students execute the experiments. The improved performance may be attributed to the induction of a more serene state linked to higher perception and engagement. This tendency is supported by responses in a student survey that questioned their opinion on the listening condition and various aspects of their performance. It was also observed that classical music facilitates the interaction of students from diverse ethnic backgrounds. Future projections of this study aim at investigating additional aspects of performance in presence and absence of the musical stimulus, optimizing the time of exposure of the listening experience, providing a short quiz after each experiment, and further testing the underlying chemistry concepts that are related to each experiment.

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Cite this paper as: Rivera-Torres, I. (2012). Classical music stimulates community college students' perception and engagement during chemistry laboratories. *Conference Proceedings of the Peer-Led Team Learning International Society,* May 17-19, 2012, New York City College of Technology of the City University of New York, www.pltlis.org; ISSN 2329-2113.