The Effects of Virtual Reality on Music Performance Anxiety Among University-Level Music Majors

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Abstract

This study examined the effect of a virtual reality intervention on the symptoms of music performance anxiety among university-level music majors. During the two sessions, subjects (N=12) reported anxiety levels and symptoms before and after performing a short piece or excerpt. I measured treatment (n=6) and control (n=6) groups' heart rates prior to performance. The treatment group received a 5-minute virtual reality session before going on stage. During the session, I submerged subjects into a natural environment of their choice, after which I measured their heart rates again. The data showed a significant decrease in self-reported levels of anxiety for the treatment group. The treatment group also experienced decreased symptoms of anxiety in all categories, and heart rate measurements significantly decreased after the virtual reality session. Control group subjects showed no difference in heart rate measurements, self-reported anxiety levels, and symptoms experienced during the two sessions. Findings of this study indicate that virtual reality does alleviate symptoms associated with music performance anxiety and results in an improved performance experience.

Keywords: performance anxiety, virtual reality, music, anxiety, music performance

Review of Literature

The start of the 21st century marked a rapid increase in research that focused on the symptoms of performance anxiety, specifically related to music performance, and ways to address these symptoms. A recent survey (Osório, Burin, Nirenberg, & Barbar, 2017) showed that 40% of the classically trained participants suffered from music performance anxiety (MPA). These musicians also indicated that MPA interferes with their ability to perform at a level which is satisfactory to both them and their audiences. Most of the existing literature on MPA, as opposed to just performance anxiety in general, dates from 2010 onward. These studies highlight symptoms associated with MPA, the possible causes for these symptoms, and the many ways in which these symptoms can manifest. In addition to discussing MPA, the authors also provide possible solutions and suggestions for further studies on this topic.

There are many possible factors that can cause a person to feel anxious while performing. A fear of failure is often the major cause behind any kind of performance anxiety (Lazarus & Abramovitz, 2004). People are afraid of making mistakes in front of others and the disastrous aftermath they assume would follow as a result. Osório et al. (2017) supported this argument and added that internal factors are the most frequent triggers for MPA. These internal factors can include concerns about judgement from others and self-imposed pressure.

External factors can also play a role in the manifestation of music performance anxiety. Perdomo-Guevara (2014) stated that culture is an external element that can lead to feelings of anxiety during performance. Those from various cultures have different approaches to performance, and the type of performance plays a large role in whether or not symptoms of MPA occur.

Professional musicians perform under highly stressful situations. The feedback from these performances can influence future job opportunities and monetary income (Wells, Outhired, Heathers, Quintana, & Kemp, 2012). Conversely, informal music-making creates a

more comfortable space, and MPA symptoms are less common (Perdomo-Guevara, 2014). Schneider and Chesky (2011) confirmed these tenets in their exploration of the relationship between social support and performance anxiety. Music majors experienced much higher levels of MPA during performances as opposed to non-music majors.

Although each person experiences MPA in their own unique way, there are some common symptoms associated with MPA. MPA symptoms can be divided into behavioral and mental categories (Zakaria, Musib, & Shariff, 2013). Behavioral symptoms are those associated with anxiety, such as shivering and stiff muscles. Hyperventilation is also a major complaint for classical music students and can lead to negative feelings during performances (Studer, Danuser, Hildebrandt, Arial, & Gomez, 2010). Wells et al. (2012) highlighted other physiological symptoms of MPA, including a raised heart rate and a dry mouth. These symptoms can heavily impact performance ability, especially for wind players who need a certain amount of moisture to play comfortably.

Mental symptoms refer to the subjective emotions that the individual experiences because of anxiety. The act, and sometimes even just the idea, of performance stimulate these feelings (Zakaria et al., 2013). Wells et al. (2012) added that a decrease in concentration can be linked to MPA. The Kenny Music Performance Anxiety Inventory can be used to measure MPA (Barbar, Crippa, & Osório, 2014). The Kenny Music Performance Anxiety Inventory supports the work of Rodebaugh and Chambless (2004) as it showed a strong link between performance anxiety symptoms and that of social anxiety.

A common trend in recent research regarding the treatment of MPA focuses on using cognitive-behavioral therapy. In a cognitive approach, the thoughts and beliefs of a person are considered as the basis for their anxiety. These cognitions are then identified and used to determine how they influence anxiety levels (Rodebaugh, & Chambless, 2004). Hoffmann and Hanrahan's (2012) study focused on using short-term mental skills to learn to deal with

MPA, whereas Lazarus and Abramovitz (2004) worked on more long-term mental adjustments in their subjects. The authors agreed that cognitive-behavioral therapy is a cost-effective treatment option for performance anxiety. MPA often reflects a contextual misalliance, which is why reordering the mind addresses it (Lazarus & Abramovitz, 2004). Each treatment should, however, be specific to the patient, as there is no one-size-fits-all approach to treating performance anxiety.

Rodebaugh and Chambless (2004) also used cognitive therapy to treat performance anxiety. They suggested treating performance anxiety as you would a social phobia, otherwise known as social anxiety, as they share many similar characteristics. Cognitive behavioral therapy has often proved to be an effective tool to alleviate symptoms of MPA (Brugués, 2011; Hoffman & Hanrahan, 2012; Lazarus & Abramovitz, 2004; Rodebaugh & Chambless, 2004). Brugués (2011) noted, however, that this conclusion is drawn from a limited amount of research and that further research is necessary to determine whether this is really the case.

There are a few studies that employ more practical treatment courses in the hope of addressing certain physical symptoms associated with MPA. Osório et al. (2017) listed breathing and increased practice, but these were self-administered treatments and showed average results in decreasing MPA symptoms. Studer et al. (2010) named hyperventilation as one of the symptoms of MPA that can interfere with a performance. They suggested deep-breathing exercises as a possible solution, and although the study determined that these symptoms manifested more strongly prior to performance, they did not test whether they influence the performer physically or to what extent if they did. Wells et al. (2012) did include physiological symptoms and their data showed that deep breathing exercises managed to slow down the performer's heart rate prior to going on stage.

There is a strong tendency toward using breathing as a way to reduce symptoms of anxiety related to music performance. Zakaria et al. (2013) were of the few authors to explore other treatment options. They used prayer for the method of relaxation and found that more practical solutions such as more practice time and increased performance opportunities reduced anxiety during a performance. Stern, Khalsa, and Hofmann (2012) investigated another practical solution to performance anxiety: They studied the effects that yoga could have on MPA. The results showed that anxiety decreased when the yoga treatment was implemented. They obtained these data through questionnaires, however, and did not measure physical changes.

Owing to its recent rise in both popularity and affordability, virtual reality technology has become a hot topic in research ranging from medicine to journalism. This trend has begun to emerge in music education. Orman (2004) studied the effect of virtual reality graded exposure on performance anxiety levels in conductors. In 2016, Orman expanded this idea to study its impact on novice wind band conductors. A 2017 study by the same author explored the possibility of an augmented immersive virtual reality learning environment for conductors (Orman, Price, & Russel, 2017). Virtual reality has also been used to decrease symptoms of anxiety.

A study by Kim et al. (2017) used VRT as a possible treatment option for patients with social anxiety disorder. When one considers this study in relation to that of Rodebaugh and Chambless (2004), it raises the question of whether or not this can be transferred to MPA. One of the first studies to investigate the impact that VRT has on MPA was done in 2016 by Bissonnette, Dubé, Provencher, and Sala. The purpose of this study was to determine whether virtual reality exposure training can be used to treat MPA. The study focused on recreating the performance environment through the VRT and used these simulations as a way to desensitize the performers. Despite the data showing decreased anxiety as the study

progressed, the authors could not argued with certainty that it was as a direct result of the use of VRT. Performers reported that they did not feel the same level of anxiety during the VRT exposure sessions and thus could not fully experience MPA as they would for a real performance. This study raised some important questions on the role of VRT in relation to music performance and the effects that it could have on MPA. One such question was, Can virtual reality technology can be used to alleviate symptoms of music performance anxiety (Bissonnette et al., 2016)?

According to Brugués (2011), MPA affects musicians and performers regardless of their age, gender, instrument, experience, and level of preparation. Studies that approached MPA through a cognitive-behavioral lens often tended to produce results that were not as reliable. These types of studies face many challenges and shortcomings in that the line between correlation and causation often becomes blurred. Most of the studies included in this review suggest that further research should be done in this area, yet they do not specify where the focus should be. In this study, I shift the focus toward a more practical approach aimed at reducing the physical symptoms of MPA. Perhaps if the physical symptoms were less irksome, then the mental symptoms would subside as well.

The purpose of this study is to determine the effects of virtual reality technology on symptoms associated with music performance anxiety among university-level music majors. Can virtual reality technology be used to alleviate symptoms of performance anxiety in university-level music majors? The findings of this study will provide musicians and music educators with a tool for treating MPA in the form of a cost-effective and accessible device that can form an integral part of any performing musician's preperformance routine.

Method

Participants

Twelve undergraduate and graduate music majors (7 men, 5 women, M_{age} = 20.6 years, SD = 1.03, age range = 19–23 years) attending a large Northeastern university were participants in this project. I took a convenience sample from the university's different instrumental ensembles, visiting a rehearsal of each ensemble and inviting students to volunteer to participate in the study. Volunteers read and signed an informed consent form prior to any participation in the research. The resulting participant group consisted of a variety of instrumentalists, not including percussionists, vocalists, and conductors, whom I randomly assigned to either the control group (n_1 = 6) or the treatment group (n_2 = 6).

Materials

Setting. The performances for both sessions took place on a large stage in the university's performing arts center. The participants were required to enter the stage from the back, as they would in a performance. The other participants, the assistants, and the investigator sat in the audience during the performances. The audience members were instructed to clap as the performer came onstage as well as after the performance.

Self-reported measures. During the first session, I administered self-reflection questionnaires pre- and postperformance to test the participant's level of anxiety. These questionnaires asked participants to rate their level of anxiety and to indicate the different symptoms they were experiencing. During the second session, the control group completed the same pre- and postperformance questionnaires as in the first session. The treatment group completed the same preperformance questionnaire but were given a postperformance questionnaire that asked additional questions regarding their virtual reality experiencse.

Equipment. I used an Apple Watch (Series 3) to measure participants' heart rates. This device has a built-in heart rate monitor, and it was fastened on the participant's left wrist

before they went on stage. The Samsung Gear VR 2017 (SM-R324) was the virtual reality headset used in the second session. This headset works with a smartphone: I used a Samsung Galaxy S8. A pair of Samsung earphones provided the audio accompaniment to the visual stimuli.

Visual stimuli. The application that was used to provide visual stimuli for the virtual reality session was Guided Meditation VR (Cubicle Ninjas, 2016). The participants in the treatment group could select from three different environment settings for their virtual reality session: a beach, a meadow, and a desert. These environmental settings have accompanying sound effects similar to the real environments.

Procedures

A quasiexperimental, pretest–posttest control group design was used. The study consisted of two randomly assigned groups in which one group received the virtual reality treatment and the other group did not. Participants were involved with this study for two consecutive weeks. There was one session per week and the sessions were exactly a week apart. Each session lasted roughly an hour. The first session consisted of the pretest where both groups performed the same procedures. During the second session, the participants were randomly sorted into the treatment group and the control group.

Session 1. Participants completed the preperformance questionnaire, performed a short piece or an excerpt of a piece, and completed the postperformance questionnaire. I took the participants' heart rates just before they went on stage to perform. The participants formed part of the audience when they were not performing.

Session 2. The control group completed the preperformance questionnaire, performed on stage, and then completed the postperformance questionnaire. I measured the participants' heart rates right before they went on stage. The treatment group also completed the preperformance questionnaire, but before going on stage to perform, they received a 5-minute

virtual reality session in the backstage area. Once backstage, the participants in the treatment group received a brief introduction to the virtual reality technology and were told to notify the investigator if they felt any discomfort or negative effects such as those listed in the consent form. Each participant could choose their own visual stimuli from three different options. After they chose their stimuli, they were seated in a chair and the virtual reality headset was placed on their head. I set up the participant's chosen setting so the participant did not need to know how the device works. I measured the treatment group participants' heart rates before and after the virtual reality session. After performing, the treatment group completed a different postperformance questionnaire.

Results

I analyzed the data for this study using both between-groups and within-groups measures. Separately, I analyzed the sessions, then compared them to determine significant differences.

Session 1

The participants all followed the same procedures during this session, thus I analyzed the resulting data as one set (see Table 1). I conducted a paired-samples t-test to compare participants' self-reported anxiety levels pre- and postperformance. There was no significant difference between the scores for preperformance and postperformance conditions, $t(11) = 2.03$, $p = 0.07$. Results of the Pearson Correlation Test indicated that there was no significant association between self-reported levels of anxiety and heart rate measurements, $r(22) = 0.12$, $p < 0.001$. The participants' levels of preparedness did not have a statistically significant correlation to their anxiety levels, although the results of the Pearson Correlation Test showed a negative relationship between these variables, $r(11) = -0.48$, $p < 0.001$. The most common symptoms that participants experienced preperformance were increased heart rates (83.3%)

and sweatiness (58.3%). During the performance, participants experienced increased heart

rates (100%), increased sweatiness (50%), and shortness of breath (41.7%).

Table 1

Statistical Outcomes for Session 1

Variable	Anxiety preperformance	Anxiety postperformance	Heart rate (bpm)[a]
M	7.3	8.25	105.42
Mdn	8	9	102.5
Mode	9	10	-
Range	8	6	29
S^2	6.24	3.84	74.99
SD	2.5	1.96	8.66

[a]bpm = beats per minute

Session 2

Participants were randomly assigned to a control group and a treatment group. Table 2

illustrates the differences between the outcomes for the control group and the treatment group

during the second session. The results of a paired-samples *t*-test show that there was no

statistically significant difference between the self-reported anxiety levels for preperformance

and postperformance of the control group, $t(5) = 1.94$, $p = 0.11$. The differences in the

treatment group's self-reported anxiety levels between the preperformance and

postperformance were statistically significant, $t(5) = 4.67$, $p = 0.0055$. There was, however,

no statistically significant difference between the preperformance anxiety scores of the

control group and the treatment group, $t(10) = 0.14$, $p = 0.89$. Participants' levels of

preparedness varied between sessions, and despite there being a positive correlation between

participants' levels of preparation for the second session and their anxiety levels, this finding is statistically insignificant, $r(11) = 0.37$, $p < 0.001$.

The symptoms of anxiety the participants experienced during the second session were not very different from the first session. The most common symptom was increased heart rate (91.67%) along with increased sweatiness (66.67%). During the second performance, participants in the control group experienced much of the same symptoms as during the first session's performance. The majority (83.33%) of control group participants experienced increased heart rate and increased sweatiness (66.66%). The treatment group experienced decreased symptoms in all categories (see Table 3). I conducted a paired t-test to compare heart rate measurements for the control group and the treatment group. The preperformance heart rate measurements between these two groups were not significantly different, $t(10) = 0.69$, $p = -0.51$.

Table 2

Statistical outcomes for Session 2

| | Anxiety | | | | Heartrate (bpm)[a] | | |
| | Preperformance | | Postperformance | | | | |
Statistic	Control	Treatment	Control	Treatment	Control	Before VR	After VR
M	7.83	8	8.17	4.33	104	107.17	88.3
Mdn	8	9	8	4.5	102.5	104	87
Mode	8	-	7.8	-	-	-	-
Range	5	5	3	6	20	22	24
S^2	2.97	5.6	1.37	4.67	56.52	71.77	65.87
SD	1.72	2.37	1.17	2.16	7.48	8.47	8.12

[a]bpm = beats per minute.

Table 3

Number of Participants Experiencing the Different Symptoms of Anxiety

| | Session 1 | | Session 2 | | |
| | | | | Postperformance | |
Variable	Pre-performance	Post-performance	Pre-performance	Control	Treatment
Sweatiness	7	6	8	4	2
Shortness of Breath	3	5	3	2	1
Increased Heart rate	10	12	11	5	2
Nervous tics	4	5	5	1	0
Dry mouth	2	3	1	3	0
Decreased focus	5	4	4	1	0
Nausea	1	1	0	0	0

Analysis of the Effect of Virtual Reality

The first statistically significant finding regarding the effects of the virtual reality intervention is the difference between the participants' self-reported pre- and postperformance anxiety levels, $t(5) = 4.67$, $p = 0.0055$. Participants who had received the virtual reality treatment reported lower levels of anxiety during the performance. There was also an extremely statistically significant decrease in participants' heart rate measurements from preperformance to postperformance, $t(5) = 7.07$, $p < 0.001$.

Participants in the control group did not experience any serious adverse effects during the virtual reality session. One participant noted some discomfort during use, and another commented on the difference in lighting between the performance hall and the virtual reality scenario. The majority of the treatment group participants (66.6%) reported that they felt less anxious immediately after the virtual reality session and that it ultimately improved their performance experience (see Table 3 for a detailed illustration of symptoms experienced during the two sessions). The remaining participants (33.33%) felt that it had no effect on their anxiety and thus had no effect on their performance experience.

Discussion

Findings from this study indicated that virtual reality alleviated symptoms associated with music performance anxiety in this small sample of university-level music majors. Data indicated that subjects who received the 5-minute virtual reality treatment prior to performance, rated their anxiety as significantly lower than those who had not received the intervention. Subjects were asked to indicate their level of preparation for the performances, as this could have influenced their experience of anxiety. Interestingly, subjects' level of preparation had no significant influence on whether or not they felt anxious and the degree to which they experienced these symptoms. Subjects all followed the same protocol, except for the addition of the virtual reality intervention. One could, therefore, assume that it was the addition of the virtual reality that led to the decrease in anxiety for the treatment group.

At the onset of this study, I thought the performance environment might not be authentic enough to stimulate feelings of anxiety effectively. This, however, turned out not to be a problem as subjects experienced increased levels of anxiety along with other symptoms. In a similar study, Orman (2004) also found that even though the subjects knew the performance situation was fabricated, they still responded to it in ways that were like the real situation. Despite the success of the setting and the procedures of this study, the sampling

method could prove to be a threat to internal validity. Initially, the targeted sample pool was a studio class from one of the university's practical lecturers. This would have allowed me more control over the type of subjects that participated in the study. Eventually, however, I recruited a random sample; many subjects dropped out during the process. The lack of compensation and the time commitment resulted in fewer participants than I had hoped for. Future research can use students from a specific class or studio to ensure that they participate for the duration of the study.

An interesting finding was that there was no correlation between self-reported levels of anxiety and heart rate measurements. This could have been because all the subjects experienced high heart rates prior to performance, even if they did not consider themselves to be anxious. The high heart rate measurements could also have been caused by excitement or having rushed to reach the performance venue on time. An increased heart rate, even if not related to anxiety, is still not ideal state for performance. This is especially true for wind players that rely on their breathing to perform effectively. Considering the virtual reality session was effective in slowing down participants' heart rates before they performed, it could be used for exactly that purpose, regardless of the performer's level of anxiety. For educators and performers alike, this could provide the solution to a more enjoyable performance experience.

During the second session, subjects in the treatment group experienced a decrease in all the measured symptoms. These symptoms are the most commonly reported symptoms of anxiety and their decrease points toward an overall decrease in anxiety. This does not mean, however, that they are not still feeling anxious. As Lazarus and Abramovitz (2004) pointed out, the fear of failure and embarrassment are still internal factors that contribute to anxiety. The decrease in physical symptoms that were a result of the virtual reality session did, however, result in an improved performance experience for the subjects in this study.

For the virtual reality aspect of this study, there were no negative reactions to the equipment used, and subjects found the experience quite pleasing. Some subjects did comment that they initially had to get used to having the device on their head, but that it only took a moment to adjust. The timing of the virtual reality session was set to 5 minutes to prevent overuse of the technology, which can lead to some negative side effects. This time could possibly be adjusted to suit the needs of the performer or to include more time for relaxation and breathing. Future research in virtual reality can investigate the optimal time for virtual reality sessions that aim to reduce anxiety. The application that was used for the virtual reality scenes was effective. Future research can include different programs or environments. It could be interesting to develop a program where musicians or users could design their own environment that fits their specific needs. Researchers could focus on determining whether this is technologically possible and whether or not these sessions should consist of only visual stimuli or a combination of aural and visual stimuli.

Results from this experimental study indicate that virtual reality may be useful in alleviating symptoms associated with music performance anxiety among university-level music majors. Considering the recent increase in both affordability and accessibility of this technology, virtual reality may be a viable and affordable tool for musicians who experience anxiety before or during their performances. This intervention is not only applicable to adult performers. Brugués (2011) argued that music performance anxiety affects musicians regardless of age, and many young musicians could be affected by anxiety to such an extent that they stop making music altogether. It is the responsibility of music educators and fellow musicians to prevent this from happening. This study presents a possible solution to the problem. Future research should investigate the topic further and with a larger sample, in the hopes of creating a more enjoyable music-making experience for everyone.

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