SCHOLARLY REVIEW

Memory Retention in Classical Music: Exploring Strategies Through Examining Physiology, Repetition, and Participant Anecdotes

By Qing Peng Liu

Author Biography

Qing Peng (Jerry) is currently a senior in Lord Byng Secondary School, located in Vancouver, Canada. In his free time, he likes to play chamber music and golf with his friends. Qing Peng is passionate about classical music, and plays the violin, viola, and piano. He has won numerous musical competitions on both a local and international level and has had experience in professional orchestras. In his spare time he also volunteers and performs for senior homes as an executive at the Youth Musician and Artist Association. Qing Peng also volunteers to tutor at Schoolhouse.world, where he is certified in both Advanced Placement subjects like Biology, Chemistry, Calculus and the SAT.

Abstract

This study will explore memory and the effects of repetition in the context of classical music performance. Specifically, the study will review the role repetition has in memory related functions such as retaining and recalling information in the context of classical music performance. This is done through drawing responses from the participants of a survey and through a literary review of relevant materials. Through the participants' responses and studies related to memory retrieval in general and in music performance, it is evident that repetition can be highly beneficial for memory retainment and performance anxiety. This is crucial in understanding the role of repetition in memory and can lead to better results in music education and therapy. The study integrates both qualitative and quantitative findings to demonstrate the effectiveness of repetition-based practicing on memory in a musical context. By addressing both the physiological and psychological aspects of classical music performance, this study aims to provide insights into effective practice strategies in minimizing performance anxiety and its associated health risks.

Keywords: Music Performance, Performance Anxiety, Repetition, Music Therapy, Memory, Learning, Physiology, Neuroscience, Mental Health, Classical Music

Introduction

Memory plays a vital role in many of one's daily functions but it is absolutely essential in disciplines such as performance art or specifically, classical music performance. In the discipline of classical music, traditions are an important part of performances. Such traditions include the memorization of works in public performances, which can vary in length. Such works could be of considerable length but also contain densely packed information and nuances in the music, such as dynamics, tempo, rhythm, tone, speed, pitch and even articulation (Dymnikowa et al., 2020). While such nuances are not unique to the discipline of classical music performance, they are expected to be followed rigidly according to the general stylistic understanding of the work and also by what the composer of the work explicitly marks onto the music. This makes the memory aspect of classical music performances more difficult and more saturated with information than music performances in other disciplines such as Jazz or Popular music, where there is much more freedom in interpretation or even improvisation. Such performers could create a unique piece of music by themselves in the moment rather than relying on memory (Dymnikowa et al., 2020). Classical music is a unique discipline that requires more control and adherence to a set of established traditions, which can, however, often be more reliant on one's memory functions in order to accurately produce an acceptable performance.

Repetition is a key component of memorization and essential for classical music performances.

According to Hintzman & Block (1971), repetition of a memory creates and strengthens memory traces, per the Multiple Trace Theory, where different variations of the same memory, called "traces" are created each time one tries to actively recall a specific memory. The retrieval of a memory with multiple traces is often easier and can be quickly recalled, making it crucial for classical music performances, which requires almost immediate recall in order to have a successful and continuous performance.

Musician specific memory

In order to obtain direct and primary empirical evidence, this study employs the use of a survey with respondents at a high level of proficiency in their classical instruments or even at a professional level. Miller (1956), reveals that the majority of people in the general population have a score of seven in the digit span test, meaning they are able to recall seven consecutive digits during testing conditions with a standard deviation of plus or minus two. However, the digit spans of musicians tend to be higher (Talamini 2017) as with other memory related tasks.

According to Talamini (2017), 29 different studies and 53 memory related tasks musicians perform better in long-term memory, short-term memory, and working memory related tasks than non-musicians. In particular, musicians seem to perform better in tonal memory related tasks, a logical result given that musicians regularly deal with the process of memorizing and working with different tones in music. However, in order to understand how long-term memory works –which is especially relevant to music performance– it is important to review the effects of memory on a cellular level involving neurons in the brain.

Physiology

Long-term potentiation (LTP), is an important process that provides some of the physiological basis of memory retention and recall. LTP is the strengthening and enhancement of the synapses, which are connections between two neurons, as the two neurons are activated at the same time. When a presynaptic neuron that sends signals, and a postsynaptic neuron that receives signals are activated at the same time, it strengthens the synapses (Morris 2003). Glutamate, a neurotransmitter, is released through this process and binds to a receptor on the postsynaptic neuron, allowing calcium ions to flow to the postsynaptic neuron. Over time, this repeated binding leads to changes to the structure of the synapse and leads to the growth of dendritic spines, which are small protrusions on the neuron that receives signals (Morris 2003).

Long-term depression (LTD) on the other hand, works to counteract the effects of LTP and occurs when a synapse is not stimulated frequently. However, this also means that in the absence of LTP and the repeated stimulation of synapses, synaptic connections tend to weaken or even disappear over time, contributing and explaining the concept of memory loss at a physiological level. According to Ito (1989), LTD serves as a crucial role for the brain to eliminate and weaken synaptic connections that are no longer needed to facilitate synaptic plasticity and prevent overcrowding.

Synaptic plasticity, the concept in which both LTP and LTD falls under, is the ability of synapses to strengthen and weaken over time. Calcium-calmodulin-dependent protein kinase II (CaMKII), which is activated by calcium ions located in the synapses themselves, is a key protein in facilitating synaptic plasticity, phosphorylating or altering the structure of various synaptic proteins (Yasuda et al. 2022). CaMKII usually activates and enhances synapses, therefore making it a key factor in LTP, converting short-term memories into long-term memories and strengthening synaptic connections. On the other hand, Appelbaum et al. (2022) asserts that some alterations in synaptic plasticity and synaptic signaling can cause a myriad of mental health disorders including depression and schizophrenia. Appelbaum et al. (2022) discusses that various disruptors exist and that they can alter the structure and functions of synapses through processes such as increased cortisol production or decreased Brain-Derived Neurotrophic Factor (BNDF) production. Among such disruptors is stress, which increases cortisol levels but decreases BDNF production, thus reducing synaptic plasticity. As mentioned earlier, all of these physiological results of stress have been linked to mental health disorders. Many alterations, including dysfunctional CaMKII signaling can also lead to disorders such as schizophrenia (Yasuda et al. 2022).

Together, the processes of both LTP and LTD explain the concept of memory retainment and recall at a physiological and cellular level. Memories strengthen through frequent recall, and use through LTP. However, they will likely deteriorate after a continuous period of being untouched, much like how muscles atrophy after an extended period of immobility.Therefore, it is vital that classical musicians regularly refresh and engage in the repetition of music in order to solidify their memories of the music in order to prevent accidents during a performance.

Repetition

Repetition is an important process in order to acquire and more importantly, maintain any memory. According to Cunningham (1984), the effects of repetition can even be apparent in the context of short term memory. Participants in a memory related task have shown increased recall when both the presentation and testing aspect of the task is repeated while participants showed almost no improvement in recall in the absence of testing while only being presented the information repeatedly. This highlights that practice, and recalling the information, significantly improves one's memory but that mere repeated exposure to stimuli does not have the same effect. This idea can be applied to musicians in the field of classical music as in order to successfully memorize a musical work at a performance ready state, one must practice and repeatedly play through the music. Listening to a recording or being exposed to the work regularly is not sufficient in itself in order to accurately recall or perform the piece, although it can help solidify it in the presence of constant practice or repetition.

McDermott & Chan (2006), asserts that erroneous recollections, or in other words, mistakes in recall, often occur less frequently for younger adults in the presence of repeated exposure and recall, specifically for pragmatic inferences. However, this finding could also relate to the fact that people with better memory facilities, typically younger people, tend to have improved memory and reduced mistakes in recollection with repetition. In classical music, younger soloists often perform very frequently as compared to older musicians. If repetition has an effect in reducing mistakes or memory lapses in the younger population, it might partially explain the fact that soloists who hold more concerts and have a more extensive repertoire are typically younger. Memory lapses and mistakes in recall, while technically unavoidable, are extremely rare at a high skill level especially at the level of experience and skill a typical soloist has, which can be partially explained by the fact that repetition and time spent on practicing reduces such mishaps drastically.

Memory Lapses and Musical Performance

Memory lapses can be a disastrous accident in a classical music performance setting, as it disrupts the continuous flow of a work and can be very noticeable to audience members. Mishra (2010), found that errors in memory and recollection of a work tends to occur in more difficult, or less structured or organized passages, as perceived and marked by the musicians themselves. Furthermore, when instructed to memorize and perform a short work immediately, the fewest errors occurred during the first and last passages of the piece. These findings suggest that the memorization of pieces of music is a complex process and are influenced by many factors. However, by recognizing these factors, musicians can use strategies during practice and repetition to better and more efficiently commit certain works into memory and prepare them for performance. For instance, many musicians repeat and rehearse certain sections perceived as technically challenging or unusual many more times than other areas that are less complex.

According to Osborne & Franklin (2002), Music Performance Anxiety or described as MPA, has a strong correlation with other social phobias. This is reasonable given that classical music performances often occur in the attendance of many audience members and therefore could be stressful and anxiety inducing experience, especially for individuals who may already have an underlying social phobia. Furthermore, performance anxiety can have a significant negative impact on cognitive processes during performance and can affect the quality of their playing (Kenny & Osborne 2006). In addition, this effect is especially prevalent among younger performers, who may engage in negative self-talk or worry about the potential consequences, exacerbating their anxiety. Anxiety in general, including MPA, can often have negative implications on one's mental and physical well being, particularly if it occurs regularly, including musculoskeletal, gastrointestinal, or even a generalized anxiety disorder. This may be why many musicians, especially younger and less experienced performers, may experience discomfort in the stomach area right before a performance. Various strategies are capable of mitigating MPA, such as extensive preparation or even positive visualization of the result of an upcoming performance. Kenny & Osborne (2006) also emphasizes the importance for educators and parents to identify signs of performance anxiety and urges them to provide adequate support for young performers experiencing MPA. The effects of MPA are not only applicable to young performers. According to Kenny et al. (2016), MPA can be a career ending issue in the long-term, even for experienced musicians and performers. Since MPA is often muscle tension inducing, it exacerbates injuries which can sometimes be impossible to recover from.

However, according to Zhang et al. (2018), the underlying cause of anxiety, unlike fear, is often very difficult to identify. Furthermore, Zhang et al. (2018) proposes that specific cognitive processes affected by anxiety could be better identified in future research. Despite the lack of knowledge in this aspect of anxiety, it is proven that anxiety in general has a negative impact on both performance and one's general health.

Performance anxiety is a prevalent issue among musicians, especially those with less experience, but could be identified and addressed through various strategies and a general understanding or support by mentors and those around them. Such strategies may also often include repetition-based practicing and preparation before performing, which this study aims to analyze for effectiveness through assessing performance outcomes.

Methodology

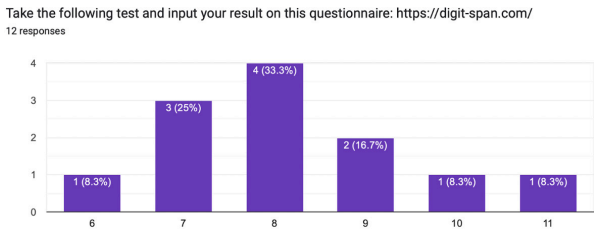
A survey with mostly open ended questions was sent to accomplished young musicians in order to gather some independent data and personal insights into the research being presented. Most of the respondents were close acquaintances, so their qualifications were clear to the author. It included students at music Pre-Colleges and music performance majors, who have extensive experience in the subject matter, but snowball sampling was also used, where these respondents were prompted to help recruit additional participants. A total of 12 participants between the ages of 15 and 19 participated in the survey. The participants were selected based on convenience sampling and no personally identifiable information was collected to maintain the privacy of the respondents. Participants were given a link to a Google Forms through email to be completed at their

convenience within a specific timeframe of 2 weeks. Participants were also individually informed of the purpose of the study and assured their anonymity electronically before they were redirected to the survey. The survey included mostly open ended questions and a short answer question asking for their score on the forward digit span test provided through a link to an external webpage. Open-ended questions were used to mainly gather qualitative and subjective information and anecdotes to add more depth and context in this study. Quantitative data, such as those obtained by the digit span test, were gathered from the 12 participants and analyzed. However, several limitations of the survey such as a small sample size and selection through convenience sampling makes it not generalizable to a larger population. The survey's self reported data may also be subjected to social desirability bias.

Results

When presented with the first question of "How long does it take for you to properly learn and memorize a standard concerto that is around 30 minutes long?", the responses of the participants vary by a very large amount. Participants entered a time period varying from a mere 2 weeks to upwards of 6 months, indicating a large variation in the memory capacities of the respondents and the difference in their abilities to store and recall a large amount of data such as long classical work or the standard concerto listed in the question. The number of definite but varied responses demonstrate that the respondents are fairly confident in their ability to estimate time. The high variability also suggests that the respondents had high confidence and openness in their responses. Furthermore, this variance in their ability in memory is further supported by the following quantitative results from taking the forward digit span test:

Table 1. Participant Results on Forward Digit Span Test



The bar graph illustrates the distribution of forward digit span scores among the 12 participants. The x-axis represents the forward digit span scores, measured as the maximum number of digits correctly recalled, and the y-axis shows the number of participants who achieved each score.

The participant's responses range from 6 digits to 11 digits. This is a staggering difference in memory capacity that is illustrated by the responses to the first question asked. With an average of 7 and a standard deviation of 2 according to Miller (1956), the highest score is more than 2 standard deviations above the lowest reported score of 6 and exactly 2 standard deviations from the average score of 7 from the general population as reported by Miller. Digit span scores in the general population usually follow a normal distribution, clustering around an average value with relatively equal numbers of individuals scoring above and below the mean. However, the scores in this survey of musicians appear to deviate from this pattern, exhibiting a right-skewed distribution. A greater proportion of participants achieved high scores, with fewer scoring below the average. This suggests that musicians may possess enhanced working memory capacity, potentially due to their training, which has been linked to improved cognitive functions.

When prompted, most participants reach a consensus on the fact that certain sections require more concentration and practice than other sections and that by practicing these sections, they also are less likely to make memory related mistakes during a live performance.

The majority of participants in the survey have also expressed that they have had experiences with memory lapses and shared some strategies in order to recover. These are often repetitive actions or improvisations designed to hide the memory lapse from the audience while buying time for them to recover and recall the following sections.

Furthermore, when asked about how long a 30 minute work could be retained for in their memories without performing, the participants' responses vary by a large amount. The majority of participants claim that a few months were the limit, but

interestingly, several of the participants who answered a few months to a year claimed that by listening to it regularly, even without practicing, they could retain memory of the work for upwards of a year.

Discussion

When the 12 participants of the survey were asked to self-report the result they had gotten from the digital span test that was attached to the survey, they reported a range of results from a 6 to a 11. While this is a significant range, the average was calculated and found out to be 8.17 after rounding. This is significantly higher than the average of 7 and the highest reported score from the survey, and 11 is two standard deviations above the established average (Miller 1956). This shows that musicians with a high level of proficiency, who can memorize and perform long works will also be likely to have a stronger working memory than someone from the general population, even in the context of short-term memory. Although no cause-and-effect relationship can be directly established between music education and general working memory based on these results alone, these results suggest a high degree of correlation between working memory and exposure to tasks requiring intensive memorization, in this case classical music performance.

Since the overwhelming majority of participants agree that certain sections need more practice than other passages, the responses seem to support the conclusions of earlier papers like those of Mishra (2010), which asserts that difficult and complex sections are areas where the most mistakes in recollection occur during a performance. The participant's responses showcase some strategies that musicians use to mitigate this phenomenon, indicating that practicing and repetition could be structured and optimized in many cases. However, participants' strategies seemed to be highly individualized and varied, indicating a high degree of personalization in their strategies and showing that it may be not possible to find a universal strategy to optimize the memorization of classical works and in doing so, mitigating MPA. However, from both the responses and the examination of previous studies, it can be generalized that constant revision over long periods of time through listening or spending a short amount of time practicing the work can help preserve its memory for much longer. This constant stimulation of certain neural connections can help maintain one's memories by facilitating LTP and help commit musical works to memory more efficiently, without dedicating extensive hours to single practice sessions. This strategy can be used to effectively supplement one's regular practice, supporting memory retention and potentially reducing MPA.

Conclusion

Music performance in a classical context is a complex process that involves a high degree of memorization. While repetition is likely the most significant factor in order for one to successfully recall a large scale work in a performance, a variety of other factors such as anxiety and a person's innate memory aptitude can play a crucial role in how one memorizes the long information dense works in classical music. Anxiety, while often overlooked, can have a serious impact on not only one's quality in music but also on personal health. Adequate support and even treatment may be needed in severe cases of music performance anxiety or MPA. In the context of career performers and musicians, excess stress can induce tension, leading to injuries over time. Such injuries can be career-ending and impact the livelihood of these musicians. Regardless, repetition plays a crucial role in memory due to the need to activate old memories in order to initiate LTP to counteract the deteriorating effects on memory of LTD. However, the medium in which repetition could be achieved could vary greatly, not solely depending on dedicated practice. Strategies such as regular exposure to a piece of music by listening through any mode can similarly maintain memory connections without the physical strain of dedicated practice.

References

Appelbaum, L. G., Shenasa, M. A., Stolz, L., & Daskalakis, Z. (2022). Synaptic plasticity and mental health: methods, challenges and opportunities. Neuropsychopharmacology, 48(1), 113–120. https://doi.org/10.1038/s41386-022-01370-w

Cunningham, T. F., Healy, A. F., & Williams, D. M. (1984). Effects of repetition on short-term retention of order information. Journal of Experimental Psychology: Learning, Memory, and Cognition, 10(4), 575–597. https://doi.org/10.1037/0278-7393.10.4.575

Dymnikowa, M., Ogorodnikova, E. A., & Petrushin, V. I. (2020). Biological specifics of musical performing memory: Essence for musical performance efficiency. Asian Journal of Humanities and Social Studies, 8(2), 20-45.

Hintzman, D. L. (2009). How does repetition affect memory? Evidence from judgments of recency. Memory & Cognition, 38(1), 102–115. https://doi.org/10.3758/mc.38.1.102

Hintzman, D. L., & Block, R. A. (1971). Repetition and memory: Evidence for a multiple-trace hypothesis. Journal of Experimental Psychology, 88(3), 297–306. https://doi.org/10.1037/h0030907

Ito, M. (1989). Long-term depression. Annual Review of Neuroscience, 12(1), 85-102. https://doi.org/10.1146/annurev.ne.12.030189.000505

Kenny, D. T., & Osborne, M. S. (2006). Music performance anxiety: New insights from young musicians. Advances in cognitive psychology, 2(2-3), 103-112.

Kenny, D.T., & Ackermann, B. (2016). Optimizing physical and psychological health in performing musicians.

Mishra, J. (2010). Effects of structure and serial position on memory errors in musical performance. Psychology of Music, 38(4), 447–461. https://doi.org/10.1177/0305735609351919

McDermott, K. B., & Chan, J. C. K. (2006). Effects of repetition on memory for pragmatic inferences. Memory & Cognition, 34(6), 1273–1284. https://doi.org/10.3758/bf03193271

Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. Psychological Review, 63(2), 81–97. https://doi.org/10.1037/h0043158

Morris, R. G. M. (2003). Long-term potentiation and memory. Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences, 358(1432), 643–647. https://doi.org/10.1098/rstb.2002.1230

Osborne, M. S., & Franklin, J. (2002). Cognitive processes in music performance anxiety. Australian Journal of Psychology, 54(2), 86–93. https://doi.org/10.1080/00049530210001706543

Talamini, F., Altoè, G., Carretti, B., & Grassi, M. (2017). Musicians have better memory than nonmusicians: A meta-analysis. PLOS ONE, 12(10), e0186773. https://doi.org/10.1371/journal.pone.0186773

Yasuda, R., Hayashi, Y., & Hell, J. W. (2022). CaMKII: a central molecular organizer of synaptic plasticity, learning and memory. Nature Reviews. Neuroscience, 23(11), 666–682. https://doi.org/10.1038/s41583-022-00624-2

Zhang, S., Woodman, T., & Roberts, R. (2018, December 20). Anxiety and Fear in Sport and Performance. Oxford Research Encyclopedia of Psychology. Retrieved 18 Oct. 2024, from https://oxfordre.com/psychology/view/10.1093/acrefore/9780190236557.001.0001/acrefore-9780190236557-e-162.