2017

Sensory Gating, Focus of Attention, and the Practice of String Repertoire: A Study of Visual Stimulus Reduction

Amber Svetik

THE FLORIDA STATE UNIVERSITY

COLLEGE OF MUSIC

SENSORY GATING, FOCUS OF ATTENTION, AND THE PRACTICE OF STRING REPERTOIRE: A STUDY OF VISUAL STIMULUS REDUCTION

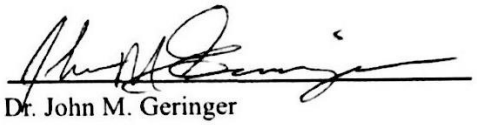
By

AMBER SVETIK

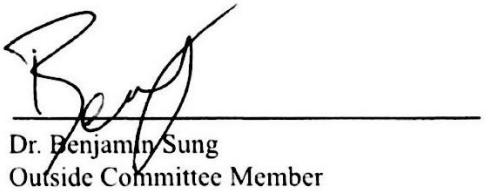
A Thesis submitted to the
Department of Music Education
in partial fulfillment of the requirements for graduation with
Honors in the Major

Degree Awarded:
Spring, 2018

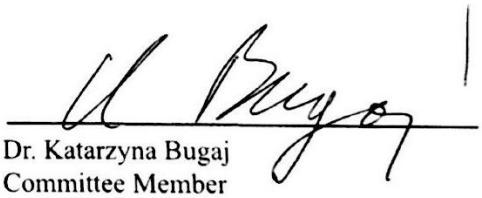
The members of the Defense Committee approve the thesis of Amber Svetik defended on November 30, 2017.



Dr. John M. Geringer
Thesis Director



Dr. Benjamin Sung
Outside Committee Member



Dr. Katarzyna Bugaj
Committee Member

Abstract

Musicians spend multiple hours practicing on a daily basis in the pursuit of successful performances. Efficient practicing, therefore, is of utmost priority to the training of successful musicians. Pedagogues and educators alike have designed strategies for effective practice, but few have included the use of the sensory stimulus reduction and its effects on performance. This study compares participants practicing from memory and participants practicing with reduced visual stimuli to participants practicing as they regularly would on a daily basis. Improvement of treatment groups was measured by intonation accuracy and presence of expression. Although there was not a significant difference in overall intonation and expression, of the seven notes analyzed, three notes at the beginning of the excerpt, B5, E6, and E4, showed significantly improved intonation for the reduced visual stimulus treatment group. Discussion suggests future replication of this study for a heterogeneous participant group (i.e. viola, cello, and bass), and how the results of the present study may influence instructional techniques of music educators.

Introduction

Throughout the course of a musician's lifetime countless daily hours are dedicated to practicing. Efficient use of this time, therefore, is at the forefront of being a successful musician. The definition of efficient practice is elusive, although confronted by professional musicians and music educators alike throughout their career. Practice techniques are primarily designed to improve upon an upcoming performance, and often, such techniques include the isolation of a passage, technique, or musical quality (Wulf & Mornell, 2008). The employment of isolation, however, can be further applied to sensory input. This study is intended to examine the effects of sensory stimuli reduction during the practice of music, specifically violin repertoire, and facilitate a further understanding of focus of attention in teaching efficient practice strategies.

The discrimination among sensory stimulus is done naturally in a neurological phenomenon termed sensory gating (Jones, L., Hills, Dick, Jones, S., & Bright, 2016). When multiple senses are active at once, the focus of attention can be applied to a single or combination of senses by filtering out peripheral or unnecessary stimuli. Sensory gating affects the ability to direct attention to specific qualities of any sensory experience and may affect the creativity of responses to such stimuli. While this ability seems necessary to the practicing of music, it has yet to be systematically applied to the field.

Research surrounding sensory gating and auditory evoked potentials shows that musicians, or those who make constant auditory discriminations, have a heightened ability in this regard (Kizkin, Karlidag, Ozcan, Ozisik, 2006). There is also evidence showing the ability to gate sensory input is reduced under conditions of fear or anxiety (i.e. performance) (Kurayama et al, 2009). Further researchers suggest the implementation of gated practice techniques could benefit the development of aural skills and even musical creativity (Jaeho et al., 2011; Zabelina,

O'Leary, Pornpattananangkul, Nusslock, & Beeman, 2015). The effect of the magnitude of sensory involvement during gated practice techniques is a variable as well (Ermutlu, Demiralp, & Karamürsel, 2007).

Review of Literature

How does an understanding of music learning and cognition contribute to the design of effective practice methods? Ericsson, Krampe, and Tesch-Römer, (1993) noted that effective practice is defined by the deliberate use of practice time in preparation of a performance. Although time is an important consideration in improving the skill set of a musician, the deliberate intentions made within that practice time appears necessary to an effective practice strategy (Williamon & Valentine, 2000; Duke, Simmons, and Cash, 2009). It was also observed that planned practice affects more than efficient use of time, but also aids in fewer temporal disruptions of skill acquisition in performance (Drake & Palmer, 2000). However, in consideration of how one must practice, the string player should also consider what constitutes a successful performance.

Factors outside of sound quality, such as stage presence, gesture, and musical presentation have been found to play an important role in success in performance (Davidson, 1994). Williamon (1999) observed the perceived benefits of performing music from memory. His study of 86 participants (50 musicians and 36 non-musicians) revealed that listening to and watching the performance from memory was superior in comparison to playing from a score. Results indicated superiority of memorized performance in both overall context as well as specific qualities of the performance such as technical proficiency and communicative ability. Thus, it appears that musicians should consider incorporating playing from memory into their

practice objectives. However, what if an emphasis on memory was placed prior to detailed practicing for musical qualities such as intonation, tone, and expression?

A revision of Bloom's Taxonomy theory of Cognitive Development states that memory is at the foundation of learning (Anderson & Krathwohl, 2001). In order to further understand, build, and create, one must first remember the information to be expanded upon. The research of McPherson, Bailey & Sinclair (1997) showed connections between primary skills in music and noted that memory is a cardinal component between playing by ear and sight reading, and re-creative (rehearsed) and creative (improvisatory) performance. Researchers have shown that practicing music from memory does not independently eliminate technical errors such as intonation or rhythm (Dakon, 2013; Palmer & Drake, 2000). Musicians memorize material as they hear it. However, the removal of notation from practice and the concurrent reduction of visual stimuli may suggest a more effective ability to detect errors as a result of a shift of focus of attention to more isolated aural processing (See Duke, Cash, & Allen, 2011).

A disadvantage to practicing from memory is that the initial memorization of material is time consuming (Williamon & Valentine, 2000; Imreh & Chaffin, 1997). If practicing from memory is to be a more efficient method of practicing, the process of memorizing music material should happen quickly and with no learned technical errors. Fortunately, methods have been identified that aid the ability to memorize musical material throughout practice. A study of observed practice showed that the ability level of the musician positively correlated with more segmentation of practicing on a basis of musical structure (Williamon & Valentine, 2002). It was also noted that the increased amount of structural based practice correlated with the more successful performances.

Furthermore, it commonly understood among the musician community that memory is complex and difficult. Music blogs and journals such as The Bulletproof Musician and The Strad, publish numerous "memory hacks" to aid the everyday musician in avoiding one of the most feared performance difficulties - memory slips. Piano pedagogue Jenny MacMillian (2004) contributed her thoughts on the best practices of successful memory in performance with a list of ten objectives, the first being to begin memorizing immediately. Memorizing music as a foundational learning objective appears to suggest that the performer's visual sensory capacity can be better put to use in ways other than viewing notation. However, is it the removal of notation itself or instead the reduction of visual stimuli that may benefit our performances?

Little research has been conducted regarding specific effects of stimulus reduction on effective practice. The purpose of this study is to explore possible outcomes of limited visual stimuli in practice of string repertoire. Three conditions of practice were compared: Control (Regular) practice, practice from memory, and practice of reduced visual stimuli. The effects of the three practice conditions were assessed for both technical and musical criteria: intonation and expressivity.

Method

Participants

Participants were violin performance majors and principals of the Florida State University College of Music enrolled in Fall 2017 semester. Twenty-four volunteers from any year of undergraduate study were eligible to participate. Sample groups were representative of the College of Music in terms of gender, year of study, and violin studio.

Procedure

This study compared possible effects of two specific practice procedures to a control (regular) practice session. Effects of regular practice, practice from memory, and practice with reduced visual stimuli were assessed by analyzing both intonation and expressivity of violin performances. Eight violinists were assigned randomly to each of the three practice groups (N = 24). Two practice and two record intervals occurred for each participant. Each practice interval was 10 minutes in duration and immediately followed by a recording session. During the first practice interval, all participants tuned to a standard tuning tone (A = 440 Hz) and were asked to practice with no changes to their typical practice techniques and routine. During the second practice interval, participants practiced according to their respective group assignment. The regular practice group was instructed to practice with no changes to their typical routine. The memory test group was instructed to practice from memory and had partial time access to notation. The reduced visual stimuli test group practiced with the excerpt displayed on a backlit device with the room otherwise dark so that participants only saw the notation.

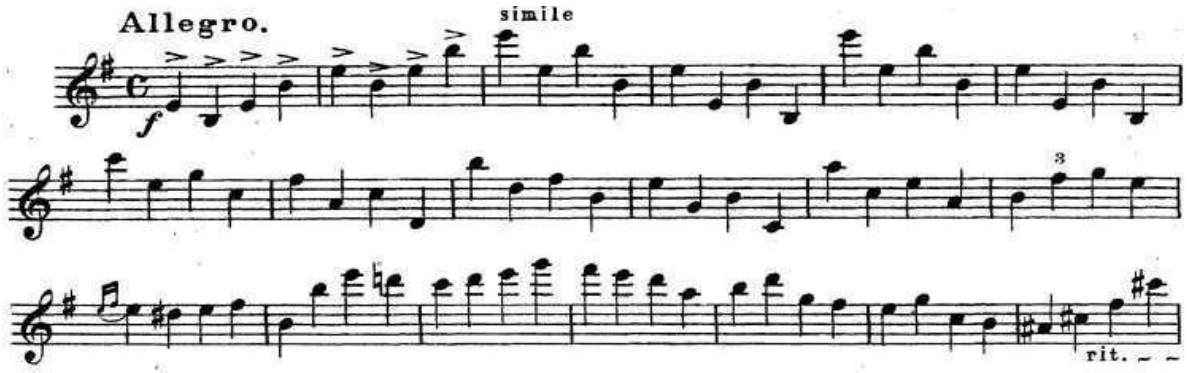
This study was designed to ensure that practice time and all variables other than the treatment are the same for each participant. Scheduling occurred in 10 minute intervals with the complete study taking 30 minutes to complete. Participants began in a proctored room (Preliminary Room) and given a questionnaire. The questionnaire asked for gender identification, age, and year of degree study, degree type, years of private lessons on violin, and a short description of typical practice routines. Immediately following, participants were led to a separate room (Room 1) for the first practice interval (which is identical for all three groups). Next, participants were led to the recording room (Recording Room) where five minutes was allotted for a tuning check and their first recording of the excerpt. They were then led to the

second practice interval room (Room 2) where they practiced according to the assigned condition (regular practice, visual stimuli reduced, or memorized). Finally, the participant was led back to the Recording Room (Rec) where five minutes was allotted to again record the excerpt. I was the proctor for all components of the procedure.

Materials

The selected passage was uniform for each participant and chosen from canonic solo violin repertoire. Displayed in Figure 1 below is the chosen excerpt, solo mm. 5-13 of Fritz Kreisler's "Praeludium and Allegro," for violin and piano. This excerpt features technical challenges such as shifting, large intervals, perfect intervals, and accidentals.

Figure 1: Kreisler, mm. 5 – beat 1 of mm.13.



Analysis

Intonation accuracy of the participants' recordings was analyzed by Praat, a computer software package frequently used in the scientific analysis of speech and music (Boersma & Weenink, 2017). The following sample of notes from the above excerpt were analyzed for pitch accuracy: B5, E6, E4, B3, D4, C4, and A5.

The presence and amount of musical expression was judged by a panel of three doctoral music education students, each with principal study in string instruments and at least three years

of teaching experience. They rated each recording on a 9-point scale from low to high expressivity referencing a rubric provided to align defining measures of expression. Judges were blind to participants' practice condition. The ratings were independent, and their scores averaged to provide data for analysis. Judges' ratings were analyzed for reliability.

Results

Musical Expression

The panel of expert judges rated the 24 posttest performances on a 9-point scale from very low (1) to very high expressivity (9). The reliability of the three independent judges was acceptable; Kendall's Concordance Coefficient (W) was .703. A one-way analysis of variance using the judges' mean ratings indicated no significant difference between treatment conditions in judged musical expression ($F(2, 21) < 1$, $p > .50$. The mean ratings were similar across the treatment groups (approximately 4.25, with relatively large standard deviations, 1.75).

Intonation

I measured the average cent deviation of seven notes in both the performance following the initial practice session (pretest) and the performance subsequent to the treatments (posttest). I used absolute deviation scores relative to A-440 Hz with an equal-temperament standard. Intonation data were analyzed with a three-way mixed model analysis of variance, with one between subjects factor (the three treatment conditions), and two within subjects factors (the two performance tests and the seven notes selected for analysis). There was not an overall treatment main effect, ($F(2, 19) = 1.45$, $p > .20$. Mean deviation scores were lowest for the memory group ($M = 7.35$, $SE = 1.35$), followed by the reduced visual group ($M = 9.80$, $SE = 1.35$) and the control ($M = 10.34$, $SE = 1.26$). There was not a significant difference between the first and

second performances in intonation, ($F(1, 19) = 1.86$, $p > .15$, nor an interaction between test and treatment conditions.

There was a significant difference between the seven notes analyzed, ($F(6, 114) = 6.95$, $p < .001$. Table 1 shows the means for each of the seven notes. The most deviation away from equal temperament was shown for E_6, and the least for D_4 (most players used the open D-string for this note). Additionally, however, there was a significant interaction between the notes and treatment conditions, ($F(12, 114) = 2.11$, $p < .05$. Figure 2 shows the note deviation scores for the pre- and post-treatment performances.

Table 1

Mean Cent Deviation for the Seven Notes Analyzed

Notes	Mean	Standard Error	95% Confidence Intervals	
			Lower	Upper
B_5	9.09	1.52	5.90	12.27
E_6	15.02	2.04	10.75	19.29
E_4	7.88	1.24	5.29	10.46
B_3	9.20	1.23	6.62	11.78
D_4‡	3.70	0.64	2.36	5.04
C_4	11.71	1.37	8.84	14.57
A_5	7.54	1.74	3.89	11.19

‡ Most players used open string

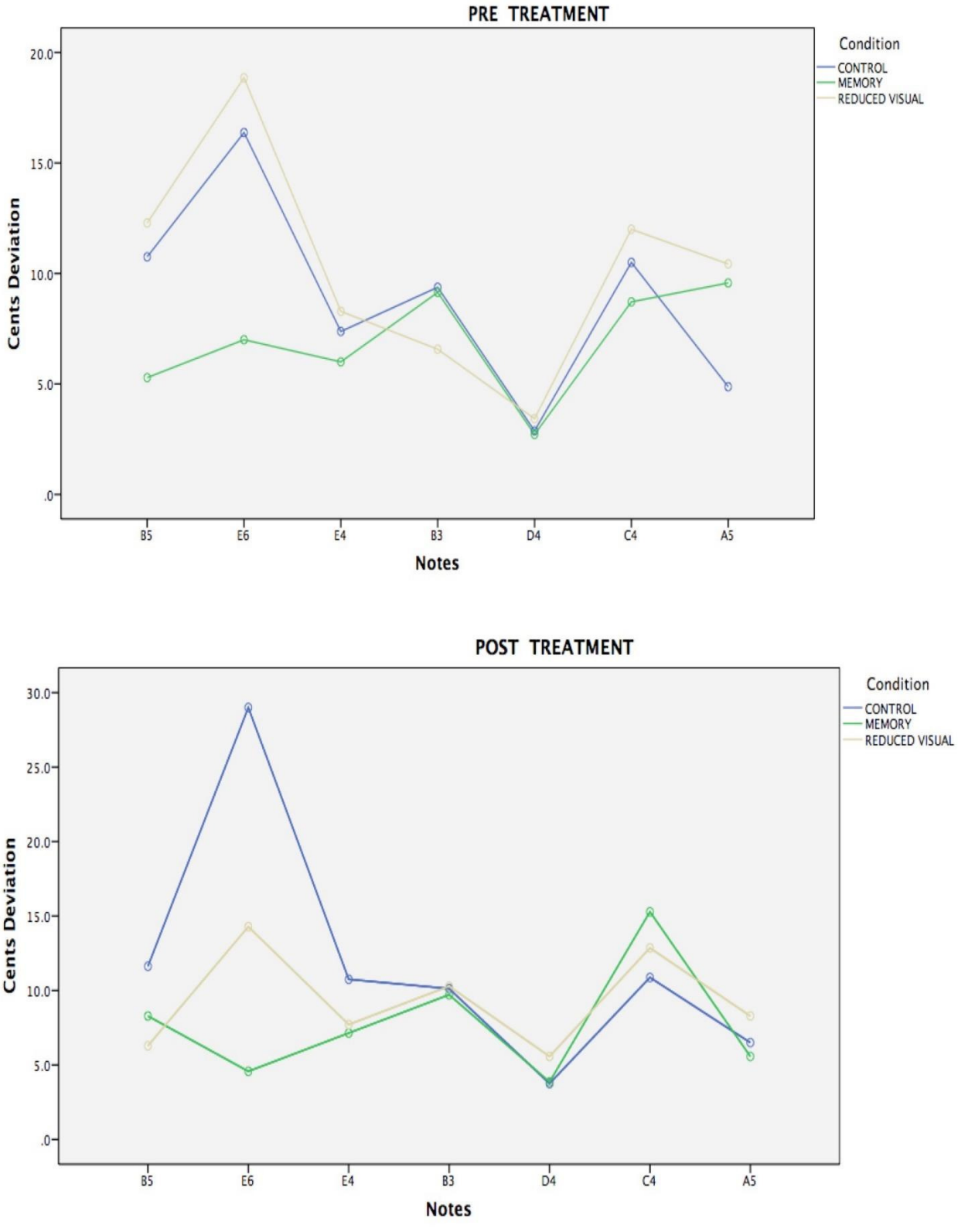


Figure 2a and 2b. Pre- and Post-Treatment Means for the Seven Notes Analyzed

The Figure shows little difference between the pre-treatment performance (2a) and the post-treatment performance (2b) across notes 4 – 7. However, for the first three notes, intonation performance changed from pretest to posttest. Because visual inspection of Figure 1 evidenced possible differences between groups notably in the first three notes, a subsequent analysis was conducted using only those pitches (B_5, E_6, E_4). There was a significant difference between the notes $F\ (2, 42) = 7.89$, $p < .01$. Mean cent deviations were higher when performing the E_6 (15.46 cents) than either the E_4 ($M = 7.81$ cents) or B_5 ($M = 8.94$ cents). There was a significant difference between the conditions, $F\ (2, 21) = 7.04$, $p < .01$, however, there was an interaction between treatment conditions and the two performance tests, $F\ (2, 21) = 5.87$, $p < .01$. As can be seen in the Figure, the control group performance of the E_6 on the posttest ($M = 29$ cents) was worse than on the pre-treatment test ($M = 16$ cents). The reduced visual group showed improvement across notes from pre- to posttest (from 14 cents to 9 cents), while the memory group performance was similar for both tests.

Discussion

At the conclusion of the study I recognized that many participants could be categorized by the way they practiced. Responses to the question on the pre-study survey "In a few words or phrases, briefly describe your typical daily practice strategies" often followed a pattern that could described by the following; deliberate (specific continuous sequence), diagnose and remediate (i.e. when X problem occurs I do Y), random (multiple practice strategies for many problems), or a combination of these categories. Data analysis did not include matching the responses to this question to the dependent measures, but doing so would possibly reveal a correlation between improvement and practice type.

The natural evolution of this research would be to replicate this study for a heterogeneous group. The inclusion of viola, cello, and bass would reveal whether or not the results from the present study would transfer to other instruments of the same family. The choice of excerpt for the heterogeneous participant group would need to be just as familiar as the Kreisler excerpt was to violinists. In choosing an excerpt for violin, viola, cello, bass, I would look to canonic orchestra repertoire that includes a melody played by every instrument within the work.

The dependent measure of expression in the post test recordings was similar among all three test groups. Research shows that performing from memory is not only preferred by audiences, but also results in increased presence of expression (Williamon, 1999). However, increased expression was not supported by the results of this study. In reflection of observing the procedure and the required task the participants were asked to complete, it was often a challenge to practice the excerpt in the allotted time without the added component of performing from memory. It is likely that the increase of expression would be measured more accurately if the participants had more time to improve, perhaps even a longitudinal design.

The results of this study indicate that the practice environment may affect performance quality. Performance venues are often available before the scheduled performance (e.g. recitals, studio rooms, orchestra), but in certain circumstances, they are not (e.g. auditions, competitions, recording sound rooms). In the position of the latter, practice performing in different environments than the typical place of practice is valuable in that the performer can rehearse and predict a certain amount of variability. Many aspects of playing are affected when changing environments including auditory, visual, and kinesthetic sensory input. For instance, practicing in the dark could be an effective practice strategy by relying independently on the muscle movements in technique acquisition opposed to the combination of kinesthetic and visual

stimulus. An example of this would be when a performer enters a stage with very different lighting than the typical practice environments, the results of this study suggest that there would be a higher chance of success in intonation and note accuracy because the diminished presence of or removal of light has already been experienced.

From the perspective of a music educator, the most successful students are often those that practice most effectively. The rehearsal of ensembles is highly reliant on the amount and quality of students' preparation, and so arguably, the best use of class time would be spent instructing students how to practice. However, this required time ratio of spoken instruction to playing in rehearsal is not realistic in that experienced educators spend less than 20 percent of rehearsal time in non-playing activities such as breaks, spoken instruction, and dismissal (Goolsby, 1996). The teaching of effective practice will not be feasible holistically within rehearsal time, so another avenue must be explored.

References

Anderson, L. W., & Krathwohl, D. R. (Eds.). (2001). A taxonomy for learning, teaching and *assessing: A revision of Bloom's taxonomy of educational objectives.* New York: Longman.

Boersma, Paul & Weenink, David (2017). Praat: doing phonetics by computer [Computer program]. Version 6.0.36, retrieved 11 November 2017 from http://www.praat.org/

Dakon, J. M. (2013). A descriptive examination of aural and visual practice strategies exhibited by beginning-level string students when memorizing music material. String Research Journal, 4, 37-53.

Davidson, J. (1994). Which areas of a pianist's body convey information about expressive intention to an audience? Journal of Human Movement Studies, 26, 279-301.

Drake, C., & Palmer, C. (2000). Skill acquisition in music performance: Relations between planning and temporal control. Cognition, 74(1), 1-32.

Duke, R. A., Cash, C. D., & Allen, S. E. (2011). Focus of attention affects performance of motor skills in music. Journal of Research in Music Education, 59(1), 44-55.

Duke, R. A., Simmons, A. L., & Cash, C. D. (2009). It's not how much; it's how: Characteristics of practice behavior and retention of performance skills. Journal of Research in Music Education, 56(4), 310-321.

Ericsson, K. A., Krampe, R. T., & Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. Psychological Review, 100(3), 363-406.

Ermutlu, M. N., Demiralp, T., & Karamürsel, S. (2007). The effects of interstimulus interval on sensory gating and on preattentive auditory memory in the oddball paradigm. Neuroscience Letters, 412(1), 1-5.

Goolsby, T. W. (1996). Time use in instrumental rehearsals: A comparison of experienced, novice, and student teachers. Journal of Research in Music Education, 44(4), 286-303.

Imreh, R. & Chaffrin. G. (1997). "Pulling teeth and torture": Musical memory and problem solving. Thinking & Reasoning, 3(4), 315-336.

Jaeho, S., Miae, O., June Sic, K., Seung-Hyun, J., Sun Il, K., & Chun Kee, C. (2011). Discrimination of timbre in early auditory responses of the human brain. Plos ONE, 6(9), 1-10.

Jones, J. D. (2006). The effects of music training and selective attention on working memory during bimodal processing of auditory and visual stimuli (Unpublished doctoral dissertation). Florida State University, Tallahassee.

Jones, L., Hills, P., Dick, K., Jones, S., & Bright, P. (2016). Cognitive mechanisms associated with auditory sensory gating. Brain and Cognition, 102, 33-45.

Jongsma, M. L. A., Eichele, T., Quian Quiroga, R., Jenks, K. M., Desain, P. W. M., & Honing, H. J. (2005). Expectancy effects on omission evoked potentials in musicians and non-musicians. Psychophysiology, 42(2), 191-201.

Kizkin, S., Karlidag, R., Ozcan, C., & Ozisik, H. I. (2006). Reduced P50 auditory sensory gating response in professional musicians. Brain and Cognition, 61(3), 249-254.

Kurayama, T., Nakazawa, K., Matsuzawa, D., Yoshida, S., Nanbu, M., Suto, C., & Shimizu, E. (2009). Alterations of auditory P50 suppression in human fear conditioning and extinction. Biological Psychiatry, 65(6), 495-502.

Lijffijt, M., Lane, S. D., Meier, S. L., Boutros, N. N., Burroughs, S., Steinberg, J. L., & Swann, A. C. (2009). P50, N100, and P200 sensory gating: Relationships with behavioral inhibition, attention, and working memory. Psychophysiology, 46(5), 1059-1068.

Macmillan, J. (2004). Successful memorizing. Piano Professional (September), 6-8.

McPherson, G. E., Bailey, M., & Sinclair, K. E. (1997). Path analysis of a theoretical model to describe the relationship among five types of musical performance. Journal of Research in Music Education, 45(1), 103-129.

Mears, R. P., Boutros, N. N., & Cromwell, H. C. (2009). Reduction of prelimbic inhibitory gating of auditory evoked potentials after fear conditioning. Behavioral Neuroscience, 123(2), 315-327.

Salzberg, R. S. (1980). The effects of visual stimulus and instruction on intonation accuracy of string instrumentalists. Psychology of Music, 8(2), 42-49.

Schulkind, M. D. (2009). Is memory for music special. Annals of the New York Academy of Sciences, 1169(1), 216-224.

Sörqvist, P., Stenfelt, S., Rönnberg, J., Avdelningen för bygg- energi- och miljöteknik, Akademin för teknik och miljö, & Högskolan i Gävle. (2012). Working memory capacity and Visual–Verbal cognitive load modulate Auditory–Sensory gating in the brainstem: Toward a unified view of attention. Journal of Cognitive Neuroscience, 24(11), 2147-2154.

Williamon, A. (1999). The value of performing from memory. Psychology of Music, 27(1), 84-95.

Williamon, A., & Valentine, E. (2000). Quantity and quality of musical practice as predictors of performance quality. British Journal of Psychology, 91(3), 353-376.

Williamon, A., & Valentine, E. (2002). The role of retrieval structures in memorizing music. Cognitive Psychology, 44(1), 1-32.

Wulf, G., & Mornell, A. (2008). Insights about practice from the perspective of motor learning: A review. Music Perform Res, 2, 1-25.

Zabelina, D., O'Leary, D., Pornpattananangkul, N., Nusslock, R., & Beeman, M. (2015). Creativity and sensory gating indexed by the P50: Selective versus leaky sensory gating in divergent thinkers and creative achievers. Neuropsychologia, 69, 77-84.