Sponsoring Committee: Professor Marilyn Nonken, Chairperson
Professor Susan Koff

A DELIBERATE PRACTICE LOOP FOR MUSIC PERFORMANCE TRAINING

Sean Millman

Program in Percussion Studies
Department of Music and Performing Arts Professions

Submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy in the
Steinhardt School of Culture, Education, and Human Development
New York University
2021

ABSTRACT

A loop construct designed as an aid for targeted deliberate practice is introduced which incorporates findings from the science of expertise, motor skill acquisition, and sport psychology. In suggesting a consolidated and systematic process, the loop draws conceptually on the work of Anders Ericsson in the understanding of expert performance, the OPTIMAL theory of Gabriele Wulf and Rebecca Lewthwaite, the PETTLEP model of motor learning from Paul Holmes and David Collins, and Don Greene's application of sport psychology to music training. This research interacts with similar issues as in popular writings by authors including Timothy Gallwey, Geoff Colvin, Charles Duhigg, and Malcolm Gladwell.

The loop elements consist of motivation, mental representations, pre-performance routines, feedback, and practice targeting. Cross-interaction between disciplines informs and strengthens each element in a cycle of improvement supported by interdisciplinary research. In practice, the loop may inform actionable uses for musicians, including visualization, self-recording, mock auditions/performances, and archiving musical progress. After the components of the loop are introduced in a general manner, three domain-specific example applications are suggested, which illustrate how the loop elements apply to highly specialized music training.

This loop may guide performers toward processes offering them greater levels of efficiency in practice, increasing rate of improvement in both competitive and noncompetitive musical pursuits. The construct is designed for continual repetition, mirroring and enhancing practice over a long period of time. Each instance of applying the loop's elements feeds more data and skill improvement into the next, for increasing awareness of the highest priority elements for improvement. This construct offers a model for enhanced practice efficiency, and a structure and vocabulary for describing and understanding effective practice.

CHAPTER 1: INTRODUCTION

1.1 Overview

Deliberate practice is the most relevant and controllable factor in performance achievement. There has been growing interest in expert performance from musicians since Anders Ericsson's landmark 1993 study demonstrating the value of deliberate practice in achieving expert level performance, a common marker for the beginning of the modern science of expertise.[1] Impressive evidence suggests that the acquisition of expert performance skills may be attributed more to deliberate practice, along with lifestyle and environmental factors, than innate talent, and that deliberate practice becomes increasingly controllable as an individual progresses in age and skill.[2] My research builds on the expert performance discourse and Ericsson's work. The mental side of elite performance is represented by the sport psychology field. The work of Don Greene, performance psychologist for Olympians and classical musicians, is foundational to my application of sport psychology for this research.

The need to train one's body to correctly perform task-specific motions in context and in real time is a common foundation of training shared by musicians and those in many other domains, particularly sports. Because of this similarity, popular publications applying successful improvement techniques in other domains have been helpful for many musicians.[3]

---

[1] Anders Ericsson, Ralf T. Krampe, and Clemens Tesch-Römer, "The Role of Deliberate Practice in the Acquisition of Expert Performance," *Psychological Review* 100, no. 3 (1993): 363-406.

[2] Anders Ericsson, "Deliberate Practice and the Modifiability of the Body and Mind: Toward a Science of the Structure and Acquisition of Expert and Elite Performance," *International Journal of Sport Psychology* 38 (2007): 4–34.

Friedrich Platz, Reinhard Kopiez, Andreas C. Lehmann and Anna Wolf, "The Influence of Deliberate Practice on Musical Achievement: A Meta-Analysis," *Frontiers in Psychology* 5: no. 646 (2014): 1-13.

Geoff Colvin, *Talent Is Overrated: What Really Separates World-Class Performers from Everybody Else* (New York: Penguin, 2011).

[3] See Appendix A for a list of books regarding these issues commonly used and cited by performing musicians.

Misconceptions exist about central realities of music training, particularly around ideas like innate talent, effective means of creating what is colloquially and incorrectly known as muscle memory, and the "10,000 Hour Rule," an overly simplistic and reductive construct from Malcolm Gladwell's book *Outliers* representing a flawed understanding of Ericsson's research.

My work seeks to expose and rectify these misconceptions and elevate the discussion of peak performance strategies for musicians through examination of the research literature, to offer musicians a research-backed process of long-term improvement. A core premise of my study is that domain-general concepts can transfer between activities, while domain-specific concepts cannot. Two unrelated domains may have entirely different specific tasks and skills required, though the means of acquiring and improving those tasks will share similarities. This research will identify foundational concepts shown to be effective in multiple domains, and then outline specific musical processes based on them. I aim to distill elements from diverse research to actionable steps to create a process of improvement for music performance training. This dissertation's contribution is not in new empirical research or understanding of any particular issue, but in aggregating existing research from disparate domains toward a new process of practice able to be applied by musicians in any subfield.

1.2 Research Questions

During my percussion training at the University of Florida, I began to recognize foundational similarities between training methods of college athletes and college musicians. Continued examination led me to see that these commonalities existed in many other domains, including business and military applications. I began to question why athletes and their coaches operated so differently from the teachers and students in the music programs I had seen and of which I had been a part. On completion of this research, it became clear to me that my

contribution is not in presenting any new scientific finding or previously-undiscovered fact, but in drawing together various existing threads of research in a concise, understandable, and actionable way for musicians. Many of these threads have been fully embraced by the vast majority of practitioners in non-music domains; it is my hope that the music field will embrace these tenets in a similarly widespread way. The following questions guided this research:

Primary Research Question:

> How can the discourse of expert performance, performance psychology, and motor learning inform an effective process of deliberate practice for music performance improvement?

Research Sub-Questions:

1. What are domain-general elements of effective deliberate practice?
2. How can these elements be used in domain-specific ways for performing musicians?
3. How can a process of improvement for music performance be concisely expressed?

I answer the primary question by examining the overlapping elements of expert performance, motor learning, and sport psychology and how they support each other. Recognizing domain-general elements of deliberate practice is addressed in Chapter 2, and I present the case for logical consistency through agreement from separate fields. I determine what commonalities of training ubiquitously lead to improvement over time across disparate disciplines. Chapter 2 functions as a wide-angle lens, aggregating existing knowledge about deliberate practice across domains into a unified and inter-related concept aiming to answer "what are domain-general elements of effective deliberate practice?" Subsequent chapters narrow this focus first onto musicians broadly, and then narrow again toward example applications combining my percussion expertise with the body of research for examples of application.

Chapters 3 and 4 jointly seek to answer the second question about domain-specific applications, as the loop's elements are examined in relationship to the specifics of music training. Chapter 2's recognition and organization of factors known to be effective for improvement undergirds these applications, in a similar way to sport science research supporting physical training methods for athletes. Chapter 3 answers "how can these elements be used in domain-specific ways for performing musicians" by focusing on issues such as lesson effectiveness, mental states, and practice/performance analysis. I present a model of domain-specific usage of the loop concepts within music performance applications at this stage. At the most narrow and focused point of this research, Chapter 4 demonstrates even more specific application through three example scenarios (orchestral timpani, marimba soloist) toward disparate percussion subfields, demonstrating specific actionable steps. These examples are highly domain-specific and function both as recommendations for percussionists in those subfields, and as models for musicians at large to mimic in applying deliberate practice to their own work.

"How can a process of improvement for music performance be concisely expressed" is answered by the deliberate practice loop as a unified means of representing the elements and their relationships to each other. Chapter 5 includes a second version of the graphic that is more complete in its representation of the intertwined relationships between loop elements; this deeper version of the construct is designed to shed light on the depth and complexity of the loop, in contrast with the simpler version aiming to represent the loop at a glance. The explorations of potential application toward percussion subfields in Chapter 4 also serve to answer this subquestion, as they operationalize for practical use. These explorations are not designed to be prescriptive but rather illustrative.

1.3 Need for Study

While there is engagement with these issues among professional musicians, much of it is merely shallow engagement without the necessary depth. This is understandable as world-class players and teachers have spent their careers studying composers, styles, and technique rather than the latest publishing in psychology journals. The professional field's combination of widespread interest in peak performance techniques without correspondingly widespread formal training in them results in opportunities for innocent misapplication through misunderstanding. Percussionist Colin Hill and clarinetist Christine Carter both represent performers with completed research asking pertinent questions, but applied in incomplete ways; Carter's examination of interleaved practice schedules does not address scenarios in which they are counterproductive, and Hill's application of Ericsson's expert performance concepts are based on misunderstood conclusions. As interest in mental strategies for peak performance like visualization and mindfulness has gained momentum in recent years, musicians may find themselves taking advice from dubious sources or spending precious resources on books, courses, or lessons with little return on investment.

Daniel Levitin uses the work of Ericsson to claim that 10,000 practice hours are necessary to achieve mastery in any field, referencing music composition, performance, chess, and basketball.[4] Charles Duhigg examines the role of habit loops in deliberate practice for improvement in a similarly broad list of fields.[5] Recent publications popularizing this research include Gladwell's *Outliers* and Geoff Colvin's *Talent is Overrated*.[6] Ericsson himself

[4] Daniel J. Levitin, *This is Your Brain on Music: The Science of a Human Obsession,* (New York, NY: Dutton, 2006), 197.
[5] Charles Duhigg, *The Power of Habit: Why We Do What We Do in Life and Business* (New York: Random House, 2012).
[6] Malcolm Gladwell, *Outliers: The Story of Success* (New York: Little, Brown, and Co., 2008).

contributed to the popular literature on expert performance with *Peak*, presenting his body of research for the lay reader.[7] Timothy Gallwey's *The Inner Game of Tennis* and eventual spin-off *The Inner Game of Music* are mainstays of music performance discussion, and the career and publications of Noa Kageyama further show the interest in performance psychology.[8] Kageyama's popular "Bulletproof Musician" website and blog tends to center around issues of sport psychology, but often includes topics from related fields.

There is a need to engage with these topics in a scholarly manner. Many of those responsible for bringing these concepts to the public audience are authors publicizing research for public consumption rather than the researchers themselves, resulting in a disconnect between the actual study and the claims made to the public. The most egregious example of this issue is the misuse of Ericsson's work and 1993 study into creating the "10,000 Hour Rule" by Malcolm Gladwell. This brought the research into the public eye, but did so at the expense of nuance and fact. While they have been considered useful by many musicians, these concepts must be engaged in a research-based way targeted for performing musicians to clarify what the research actually supports, and what has been added or exaggerated for simplification, entertainment, or sales purposes.

Geoff Colvin, *Talent Is Overrated: What Really Separates World-Class Performers from Everybody Else* (New York: Penguin, 2011).

[7] Anders Ericsson and Robert Pool, *Peak: Secrets from the New Science of Expertise* (New York: Houghton Mifflin, 2016).

[8] Timothy Gallwey, *The Inner Game of Tennis: The Classic Guide to the Mental Side of Peak Performance* (New York: Random House, 2010).

Timothy Gallwey and Barry Green, *The Inner Game of Music* (New York: Random House, 1986).

Noa Kageyama, "Pre-Performance Routines: How Consistent Do They Need to Be?" *The Bulletproof Musician,* January 15, 2017, accessed May 25, 2021, www.bulletproofmusician.com/pre-performance-routines-consistent-need/

In contrast to the above books and online sources, lawyer and organizational behavior specialist Angela Mouton links Gallwey's work to research in music performance, athletics, and business with emphasis on coaching relationships and sport psychology, suggesting future research areas regarding mindset, conditions conducive to mental health, the coach-player relationship, and organizational culture.[9] Elevating and supporting the discussion around deliberate practice, audition preparation, and process of improvement will provide a framework from which to construct practice processes. This will assist working professionals, players on the orchestral audition circuit, college teachers, and music educators in streamlining methods for optimal use of time and resources.

The demand from musicians for peak performance strategies, practice methods, and performance psychology is demonstrated through statements from established players, up-and-coming scholar-performers, and a broader audience of students and hobbyists. Tenured players with International Conference of Symphony and Opera Musicians (ICSOM) orchestras and lesser-known musicians alike have written about the need for musicians to be exposed to mental training. Metropolitan Opera Oboe and English Horn player Pedro Diaz expresses the music performance field's demand for the kind of performance psychology training once provided by Don Greene at the Juilliard School.[10] The claim that collegiate music training is lacking in preparing players for high-stakes performances is supported by the existence of resources targeted for professional musicians who have completed their education and entered the workforce, yet feel unprepared to train for highly competitive auditions.

---

[9] Angela Mouton, "Performance Coaching in Sport, Music, and Business: From Gallwey to Grant, and the Promise of Positive Psychology," *International Coaching Psychology Review* 11 no. 2 (2016): 129-141.

[10] Dominique Bellon, "Application of Sport Psychology to Music Performance: A Study Based on a Review of Sport Psychology Literature and Selected Interviews with Professional Musicians," (DMA Diss., Arizona State University, 2006): 146.

Philadelphia Orchestra Principal Horn Jennifer Montone published a plan for audition preparation. [11] Her plan includes self-recording, visualization, and the centering technique taught by Greene, with a duality of focus between performance improvement and preparing for the audition moment itself. Her performance improvement recommendations tend toward technique and musicality, using recordings, and the practice time limitations inherent to brass performance. Montone's plan for the audition itself include visualization practice, creating an "on stage, between excerpts plan" and including that process in each practice run; she specifically mentions the mitigation of negativity for this process.

Despite currently not holding a performance position as prestigious as Diaz or Montone, Christopher Rose supports their thoughts on the necessity for performance psychology in music training. In 2011, Rose published a manual for taking orchestral auditions on string bass, focused primarily on practical issues of orchestral auditions with substantial examination of performance ideas for bass excerpts as well. Very little of his work speaks to non-playing preparation or specific practice planning, with the major thrust of the dissertation being the orchestral audition process and how best to prepare for it. Yet Rose represents a view toward the common insufficiencies of music training toward the non-artistic elements of a music career, stating:

> Even with an exhaustive education, students are often unprepared, or at least unaware of what they must do to find, and win a job in the professional orchestra industry. This subject matter seems to have been relegated to the venues of trade

[11] Jennifer Montone, "Sample Audition Preparation Plan," Accessed May 25, 2021, https://www.jenmontone.com/practice-tips

journals, magazines, and conferences, rarely finding a place in the curriculum of major universities.[12]

An expanding body of popular literature surrounds expertise acquisition, sport psychology, and the management of teams. This body of work is targeted toward the layperson and includes some works that are based in scientific research and some whose foundations are more anecdotal. A selection of books representative of this body of work is listed in Appendix A, beginning in 1974 with *The Inner Game of Tennis*. The relevant books listed include three before Ericsson's 1993 study and three in the decade following it, followed by a dramatic increase in publishing beginning in 2005. Ericsson's *Peak* was published in 2016, in part to correct some of the misconceptions about his work propagated in the public consciousness by Gladwell and other unscientific authors and journalists.

Since graduate-level study in music performance frequently does not include significant research requirements or training in understanding peer-reviewed writing in favor of a performance-first approach, many highly skilled and successful professional players lack the framework with which to understand the research in these fields. Thus when students or professional performers begin to take interest in issues like performance psychology or motor learning, they are often not equipped or interested to locate the publications on their own. In this way, highly-effective professionals can be vulnerable to writers and clinicians who misapply this research in incomplete ways.

Carter and Hill both represent scholarly engagement by performing musicians with elements of the expert performance discourse for application to musicians. Carter's work is

[12] Christopher Rose, "An Orchestra Audition Preparation Handbook for Bass Players," (DMA Diss., Arizona State University, 2011): 1.

around an effect to be examined in detail later in this research; Hill's applied Ericsson's concept of tracking amassed deliberate practice hours to prominent professional percussionists. Each of them operate based on solid peer-reviewed research, however each of them also represent somewhat narrow views of their area with an apparent lack of context.

Carter has become perhaps the most vocal advocate for interleaved practice, publishing both peer-reviewed work into the phenomenon as well as live clinics and online articles touting its potential benefits.[13] Carter's work in this area is an example of concepts under the umbrella of expertise science being applied toward music training in a limited way; her writing and clinics seem to be focused on this single issue and often present it as an easy-to-implement strategy for greater efficiency and retention in practice. Unfortunately, as examined in my literature review, the effect is inconsistent in its appearance and not fully understood in its function.

Hill applied the science of lifetime expert performance acquisition to an interview study of 36 professional percussionists including orchestral players, soloists, college professors, and marching percussion instructors.[14] Hill's research relied on Gladwell's flawed interpretation of Ericsson's work, focusing on the so-called "10,000-Hour Rule." Hill's study perpetuated an unhelpful myth for future generations of musicians, but had notable conclusions, including that most of the elite players he interviewed reached the arbitrary 10,000-hour threshold between age

[13] Christine Carter, "Why the Progress You Make in the Practice Room Seems to Disappear Overnight – Part 1," Bulletproof Musician, October 12, 2013, accessed May 25, 2021, https://bulletproofmusician.com/why-the-progress-in-the-practice-room-seems-to-disappear-overnight/.
Christine Carter, "Why the Progress You Make in the Practice Room Seems to Disappear Overnight – Part 2," Bulletproof Musician, July 19, 2020, accessed May 25, 2021, https://bulletproofmusician.com/why-the-progress-you-make-in-the-practice-room-seems-to-disappear-overnight-part-2/.
Christine Carter and Jessica Grahn, "Optimizing Music Learning: Exploring How Blocked and Interleaved Practice Schedules Affect Advanced Performance," *Frontiers in Psychology* 7 no. 1251.
[14] Colin Hill, "The 10,000-hour Threshold: Interviews with Successful Percussionists," (PhD diss., University of Kentucky, 2013).

21 and 22, suggesting the potential for a critical window of expertise acquisition.

1.4 Limitations

My research engages heavily with the concept of mental representations. Ericsson used this concept to refer to the performer's cognitive construction of a successful or ideal performance, commonly referred to with the imprecise term "visualization." In the present context, this term and category refer to a performer's mental understanding of an ideal performance. Other types of mental representations like memories, associations, or schemas are not included in this discussion; my research does not include the discourse of schematic learning or cognitive psychology as related to these kinds of areas. Any formal study or theory of biomechanics is outside the scope of this work; biomechanics as a field are integral to the domain-specific applications of deliberate practice, but not relevant for the largely domain-general focus of this document of introducing the loop itself. Common music preparation activities like score study are not included in my mental representation discussion. This discussion of mental representations is targeted toward a performer's understanding of what it looks, sounds, and feels like to execute their task. Semantic, linguistic, and semiotic uses of the term are not included in its use for the purposes of this research, nor are issues of behavioral psychology. This research is targeted toward the improvement of the individual. Group and team concepts, organizational culture, and work environment are beyond the scope of the present study.

My aim is to create a theory, and an associated model for practice, based on existing published studies. I do not claim to present new data points or add to the research discourses of expert performance, motor learning, sport psychology, or any other field. This research is a targeted application of existing data toward music performance; my contribution is in

organization and cross-applications. I do not include empirical study or quantitative research; my conclusion in Chapter 5 suggests potential avenues for this type of study in the future.

1.5 Definitions

Deliberate Practice is a term associated with Anders Ericsson, including activities specially designed for improvement in real-time performance of a skill, whether motor or otherwise. The concept is offered as an explanation for the difference between the performance of experts and non-experts. Implementation requires repetition over a long period of time, informed decisions about chosen methods, and a process of evaluation.

Domain-specific refers to knowledge, concepts, or skills applicable only in a narrowly defined field or activity. This concept is primarily associated with the chunking research and chess studies of the mid-20th century, around the human brain's ability to simplify complex sets of data for easier retrieval. The defining element is that a skill is not useful or relevant outside of its home domain.

Domain-general, in contrast to domain-specific, refers to knowledge, concepts, or skills applicable across a variety of fields or activities. The idea is functionally opposite from domain-specific in that domain-general concepts are not constrained by their home domain, and often don't have a home domain from which they originated.

Expert Performance is real-time execution of a skill or activity at a demonstrably high level in a developed and well-understood field. The term is associated with the work of Ericsson et al, and requires a highly-developed field with measurable performance differences between experts and non-experts in order to be recognizable.

A *Mental Representation* can be understood as a combination of memory and imagination in a performer's mind's eye, functioning as an internal multisensory recording of the ideal execution currently conceivable by the individual. The representation can be used as a model toward which to strive in deliberate practice. This cognitive creation is supported by the performer's foundation of domain-specific knowledge, as improvement in perception and execution will continually enhance this construct and raise the perceived standard, motivating additional improvement. This document uses the term as defined here in relation to the work of Ericsson and the larger expert performance discourse.

A *Motor Performance* is a singular act of a physical motion. One performance can be analyzed or understood individually and on its own merits, with or without context of previous performances, lessons, or feedback.

Motor Learning (or *Motor Skill Acquisition*) is a field of cognitive and development research that seeks to understand how humans achieve and improve function in tasks involving physical movements. The process of improvement at a skill over time is differentiated from motor performance through a focus on improvement of ability over time. The term can fundamentally refer to both the science of studying motor skill acquisition, and the process itself. Motor learning over time is made up of many single motor performances, which taken together create a context and pattern that represents a performer's trajectory over time.

The *OODA* (Observe, Orient, Decide, and Act) loop is a decision-making process codified by US Air Force Colonel John Boyd in his seminal presentation *Patterns of Conflict* in the late 1970s.[15]

[15] John Boyd, "Patterns of Conflict," edited by Chuck Spinney, Chet Richards, and Ginger Richards, 2007, accessed May 25, 2021, http://www.projectwhitehorse.com/pdfs/boyd/patterns%20of%20conflict.pdf.
John Boyd, "Patterns of Conflict," YouTube recording of live presentation with visual aids added, accessed May 25, 2021, https://www.youtube.com/watch?v=9iiQlBaGJQA&list=PL4pmLxkc7CTcuklIpD0UThT7Y_K09oxXe&index=1.

The process begins with data collection and interpretation, before moving to determining options and executing. A central theme of Boyd's work is that if a competitor can move through the stages of their loop with greater speed than their opponent, the opponent will be acting on outdated information and operate at a disadvantage. This process functioned as inspiration and a model for the deliberate practice loop I present.

OPTIMAL (Optimizing Performance Through Intrinsic Motivation and Attention for Learning) is the title of the unified motor learning theory proposed in 2016 by Gabriele Wulf and Rebecca Lewthwaite.[16] The model functioned to bring together several threads of motor learning research that had yet to be integrated to each other; it presents motivational and attentional factors as key drivers enhancing the learning and retention of motor function.

PETTLEP (Physical, Environment, Task, Timing, Learning, Emotion, and Perspective) is a model of motor learning proposed by Holmes and Collins in 2001.[17] These seven elements function as a de facto checklist for elements to be included in a visualization used to improve performance.

Sport Psychology as a discipline seeks to help athletes and other performers optimize their mindset for optimal performance, removing interference detrimental to effective execution.

1.6 Literature Review

The context for my research includes the fields of expert performance, motor learning, and sport psychology. While some motivating works were examined previously, those below

[16] Gabriele Wulf and Rebecca Lewthwaite, "Optimizing Performance Through Intrinsic Motivation and Attention for Learning: The OPTIMAL Theory of Motor Learning," *Psychonomic Bulletin & Review* 23 no. 5 (2016): 1382-1414.
[17] Paul Holmes and David Collins, "The PETTLEP Approach to Motor Imagery: A Functional Equivalence Model for Sport Psychologists," *Journal of Applied Sport Psychology,* 13 no. 1 (2001): 60-83.

represent the domain-general discourses providing the backdrop for my deliberate practice loop. This section is organized by examining each of the three fields, and placing them into historical context.

1.6a Expert Performance

This field explores what sets high-achieving performers apart from others in their domains. Early study examined perception in chess, notably the work of Adriaan de Groot in the 1960s followed by William Chase and Herbert Simon in the 1970s. These researchers discovered and codified the concept of domain-specific knowledge by realizing that elite chess players were no more effective at remembering the positions of random, impossible chess boards than novices, in comparison to their expert-level memory of scenarios possible within real games.[18] This concept became known as chunking, and forms the beginning of what would come to be called mental representations. John Sloboda's 1976 study applied this line of research toward musical memory, demonstrating that trained musicians had greater recall than non-musicians when presented with notated pitches.[19]

The expert performance discourse today relies largely on the work of Ericsson and his colleagues, juxtaposed with voices including psychology professors David Hambrick and Brooke Macnamara at Michigan State and Case Western Reserve respectively, who represent a competing view of the acquisition of expert level performance.[20] Ericsson argues against the role

---

[18] Adriaan De Groot, *Thought and Choice in Chess*, The Hague: Mouton, 1965.
William Chase and Herbert Simon, "Perception in Chess," *Cognitive Psychology* 4 (1973): 55-81.

[19] John Sloboda, "Visual Perception of Musical Notation," *Quarterly Journal of Experimental Psychology* 28 (1976): 1-16.

[20] K. Anders Ericsson, "Deliberate Practice and the Modifiability of the Body and Mind: Toward a Science of the Structure and Acquisition of Expert and Elite Performance," *International Journal of Sport Psychology* 38 (2007): 4–34.
Brooke Macnamara, David Moreau, and David Hambrick, "The Relationship Between Deliberate Practice and Performance in Sports," *Perspectives on Psychological Science* 11 no. 3 (2016): 333- 350.

of innate talent, emphasizing what he terms deliberate practice.[21] The origin of this line of research is his 1993 Berlin experiment discovering that violin students who had amassed more practice hours over their lifetimes were superior to their peers.[22] This study also noted that merely playing the instrument was not enough; deliberate practice included only those activities that were planned and designed for specific improvement through mitigation of weaknesses.

Macnamara and others disagree with Ericsson, posing counterarguments that deliberate practice is an insufficient or uncompelling answer to the question of elite performers; the May 2016 issue of *Perspectives on Psychological Science* featured this debate.[23] A 2014 meta-analysis examined the data of 13 studies to determine the relationship between long-term deliberate practice and expert performance acquisition on a larger scale; deliberate practice was seen as a core factor.[24] Recent years have seen a renewed public debate about these issues, as the disagreement between the Ericsson and Macnamara camps has increasingly moved into the space of journalism. Macnamara et al. attempted to replicate Ericsson's 1993 study and claimed that results were not repeatable, while Ericsson found that attempt to largely concur with the 1993

[21] K. Anders Ericsson and Jerad Moxley, "The Expert Performance Approach and Deliberate Practice: Some Potential Implications for Studying Creative Performance in Organizations," in *The Handbook of Organizational Creativity*, edited by Michael Mumford, (London: Academic Press, 2012): 141-167.
[22] Ericsson, "The Role of Deliberate Practice in the Acquisition of Expert Performance," 363-406.
[23] Brooke Macnamara, David Hambrick, and David Moreau, "How Important is Deliberate Practice? Reply to Ericcson (2016)," *Perspectives on Psychological Science* 11 no. 3 (2016): 355-358.
David Hambrick, Frederick Oswald, Erik Altmann, Elizabeth Meinz, Fernand Gobet, and Guillermo Campitelli, "Deliberate Practice: Is That All it Takes to Become an Expert?" *Intelligence* 45 (2014): 40.
Brooke Macnamara, David Hambrick, and Frederick Oswald, "Deliberate Practice and Performance in Music, Games, Sports, Education, and Professions: a Meta-Analysis," *Psychological Science* 25 no. 8 (2014): 1615.
[24] Friedrich Platz, Reinhard Kopiez, Andreas C. Lehmann and Anna Wolf, "The Influence of Deliberate Practice on Musical Achievement: A Meta-Analysis," *Frontiers in Psychology* 5: no. 646 (2014): 1-13.

study.[25] These disagreements were widely covered by prominent news organizations.[26] A 2009 article focused on memorization for solo cellists cited Ericsson et al's work on chunking memory processes via a case study, and examined many elements of the subject's process that are related to the issues included in the present dissertation.[27] Macanamara's 2014 publication disputing Ericsson's conclusions was likewise covered in the mainstream press.[28]

This science of expertise seeks to understand what accounts for exemplary performers across various domains. In contrast to the motor learning and sport psychology fields, expert performance tends to be more focused on career-spanning lifestyle elements measured over years and decades, with emphasis on sustainability, drive, and efficiency instead of domain-specific techniques.

---

[25] Brooke Macnamara and Megha Maitra, "The Role of Deliberate Practice in Expert Performance: Revisiting Ericsson, Krampe & Tesch-Römer (1993)," *Royal Society Open Science* 6 (2019): 1-19.
Anders Ericsson, "Towards a Science of the Acquisition of Expert Performance in Sports: Clarifying the Differences Between Deliberate Practice and Other Types of Practice," *Journal of Sports Sciences* 32 no. 2 (2020): 159-176.
[26] Karl Smith, "No One Wins Gold for Practicing the Most," *Scientific American*, August 5, 2016, https://www.scientificamerican.com/article/no-one-wins-gold-for-practicing-the-most/.
Jason Shen, "The Complete Guide to Deliberate Practice," *Medium*, May 31, 2017, https://medium.com/better-humans/the-complete-guide-to-deliberate-practice-3a70319be3af.
Ivan De Luce, "Malcolm Gladwell's Famous 10,000 Hour Rule for Mastering a Skill Isn't Holding Up in New Research," *Business Insider* August 21, 2019. https://www.businessinsider.com/malcolm-gladwell-anders-ericsson-10000-hour-rule-isnt-replicating-2019-8.
Ian Sample, "Blow to 10,000-Hour Rule as Study Finds Practice Doesn't Always Make Perfect," *The Guardian* August 21, 2019, https://www.theguardian.com/science/2019/aug/21/practice-does-not-always-make-perfect-violinists-10000-hour-rule.
Jason Daley, "Practice Will Make You Better, but Maybe Not the Best." *Smithsonian Magazine*, August 22, 2019, https://www.smithsonianmag.com/smart-news/practice-will-make-you-better-maybe-not-best-180972961/.
Ivan De Luce, "Why Malcolm Gladwell's 10,000 Hour Rule Doesn't Actually Hold Up," *Money*, August 30, 2019, https://money.com/10000-hour-rule-is-wrong/.
[27] Roger Chaffin, Tania Lisboa, Topher Logan, and Kristen Begosh, "Preparing for Memorized Cello Performance: The Role of Performance Cues," *Psychology of Music* 38 no. 1 (2009): 3-30.
[28] Benedict Carey, "How Do You Get to Carnegie Hall? Talent," *New York Times*, July 14, 2014, https://www.nytimes.com/2014/07/15/science/which-matters-more-talent-or-practice.html.
Valerie Strauss, "Actually, Practice Doesn't Always Make Perfect – New Study," *Washington Post*, July 25, 2014, https://www.washingtonpost.com/news/answer-sheet/wp/2014/07/25/actually-practice-doesnt-always-make-perfect-new-study/.

1.6b Motor Learning

Motor learning as a research field studies how humans gain or improve the ability to move in domain-specific ways. Motor learning research examines how performers train their minds and bodies to execute physical motions, known as motor skills. This offshoot of psychology research often includes studies done in the domain of sports, in which real-time motor skills are both crucial to effective performance and easily measurable for learner progress. Research into the acquisition and learning of motor skills is traced back to the end of the 19th century with inquiry into practice plateaus and the relationships between physical practice and feedback information.[29] The subsequent history of the discourse is covered in Newell's 1991 review of subfields. The then-current state of the discourse noted that there was no single overarching theory of motor learning, listing the issues such a theory would need to address: what is actually learned during practice, a debate between representation-led practice and subconscious trail-and-error practice, and the role of information as it affects the learner.[30]

This study was referring to what Ericsson would later call the "mental representation," and noted the closed-loop theory associated with Adams that broke it down into a "memory trace" version that chose and started the motor skill, and a "perceptual trace" version that encoded the skill in its most correct form.[31] Advances in representation lead to realization that shifting conditions of the learning environment affects motor learning in a positive way.[32] This preceded a line of research around variety of focus in practice, surrounding a dichotomy between

[29] Jack Adams, "Historical Review and Appraisal of Research on the Learning, Retention, and Transfer of Human Motor Skills," *Psychological Bulletin* 101 No. 1 (1987): 41-74.
[30] Karl M. Newell, "Motor Skill Acquisition." *Annual Review of Psychology* 42 (1991): 213-237.
[31] Ibid., 219.
Jack A. Adams, "A Closed-Loop Theory of Motor Learning." *Journal of Motor Behavior* 3 (1971): 111-150.
[32] Richard A. Schmidt, "A Schema Theory of Discrete Motor Skill Learning." *Psychology Review* 82 (1975): 225-260.

"blocked" practice marked by continual repetition of one skill before moving to the next, as opposed to "random," "variable," or "interleaved" practice that intersperses practice of multiple skills between each other.

Contextual interference (CI) is a phenomenon suggesting that changing the context of motor performances can enhance improvement.[33] Introducing interference or distraction during learning or practicing of a skill lowers performance during practice, but improves retention. The counter-intuitive nature of this effect can lead to confusion, as interference is presented as detrimental to performance in Gallwey's equation of performance = potential minus interference. Both the CI discourse and Gallwey are referring to the same thing by the term interference, simply meaning anything that interferes with the performer rendering their best possible performance. The difference is that Gallwey seeks to minimize it at the moment of execution when it matters in competition or live performance before an audience, while the CI effect seeks to intentionally introduce interference in the learning process. The two benefits of using interference in learning are greater performance on retention because the learner's mind was forced to work harder in practice, and greater tolerance of interference in performance situations due increased exposure to it and experience managing its effects.

This effect is notoriously inconsistent in its appearance; Newell writes that "the early evidence for the benefits of variable practice on the transfer of motor skill was not strong. Some schema studies also tended to confound the manipulation of variability of practice with

[33] Jadeera Cheong, Brendan Lay, and Rizal Razman, "Investigating the Contextual Interference Effect Using Combination Sports Skills in Open and Closed Skill Environments," *Journal of Sports Science and Medicine* 15 (2016): 167.
Craig Wrisberg, *Sport Skill Instruction for Coaches*, (Champaign, IL: Human Kinetics, 2007): 87-92.

differences in the similarity between acquisition and transfer task criteria."[34] It was hypothesized in 1983 that the effect was underpinned by a memory operation, and that interfered practice made individual motor performances the basis for a new memory of the skill itself.[35] Contemporaneously, it was found that the "curious paradox" of interfered practice helped the learner to develop a schema for the skill.[36]

Studies examining the effect's usefulness and possible ways to actionably use it have had difficulty reproducing results and explaining the difference between scenarios in which the core contextual interference idea – lessened effectiveness during practice, greater performance on retention – appeared and those in which it did not.[37] A 2012 study of basketball free throws that sought to test an "especial skill" effect – one in which a performer loses significant skill with only slight deviation from the skill as learned – was unable to produce a CI effect as a related variable.[38] A 2019 study holds that CI-backed practice is effective in a novel situation, while non-CI or blocked practice is more beneficial for trained performers.[39]

Wulf and Lewthwaite offered the OPTIMAL (Optimizing Performance Through Intrinsic Motivation and Learning) theory in 2016 partially to fill the role of a unified motor learning

[34] Karl M. Newell, "Motor Skill Acquisition," *Annual Review of Psychology* 42 (1991): 222.
Karl M. Newell, "Skill Learning," *Human Skills* ed. D.H. Holding (New York: Wiley, 1981): 203-226.
[35] John Shea and Susan Zimny, "Context Effects in Memory and Learning Movement Information," *Advances in Psychology* 12 (1983): 361.
[36] Timothy Lee and Richard Magill, "The Locus of Contextual Interference in Motor-Skill Acquisition," *Journal of Experimental Psychology* 9 No. 4 (1983): 730-746.
[37] Jadeera Cheong, Brendan Lay, and Rizal Razman, "Investigating the Contextual Interference Effect Using Combination Sports Skills in Open and Closed Skill Environments," *Journal of Sports Science and Medicine* 15 (2016): 167-175.
Hamidreza Taheri, Davoud Fazeli, and Sogand Poureghbali, "The Effect of Variability of Practice at Execution Redundancy Level in Skilled and Novice Basketball Players," *Perceptual and Motor Skills* 124 No. 2 (2017): 491-501.
[38] Gavin Breslin, Nicola J. Hodges, Andrew Steenson, Mark Williams, "Constant or variable practice: Recreating the especial skill effect," *Acta Psychologica* 140 (2012): 154-157.
[39] Stanisław H. Czy˙z, Martin Zvona˘r, Zbigniew Borysiuk, Ji˘rí Nykodým, and Piotr Ole´sniewicz, "Gaze Behavior in Basketball Free Throws Developed in Constant and Variable Practice," *International Journal of Environmental Research and Public Health* 16 no. 3875 (2019).

theory, recognized in 1991 as missing by Newell. This theory draws together research threads within the motor learning discourse, inviting application to various domains.[40] Several related studies have built upon and supported the OPTIMAL theory.[41] A major element of that theory is that learner choice and positive expectations, jointly categorized as motivational factors, have a significant effect on the rate at which motor learning occurs.[42] Another finding is that performers benefit from placing their mental focus on an object or point other than their own body. This line of research has also demonstrated the cumulative positive value of autonomy, expectations, and external focus.[43]

The overall motor learning field studies human acquisition of specialized movements associated with skill in disparate domains. The majority of studies have been conducted in athletic domains, largely because of the ease of measuring success in many sports applications. The field's conclusions illuminate human learning processes in general because they transfer across domains. This research is about training for execution; conceptual understanding and decisions about what needs to be performed are domain-specific concepts that need to be layered over motor learning ideas.

---

[40] Gabriele Wulf and Rebecca Lewthwaite, "Optimizing Performance Through Intrinsic Motivation and Attention for Learning: The OPTIMAL Theory of Motor Learning," *Psychonomic Bulletin & Review* 23 no. 5 (2016): 1382-1414.
[41] Saeed Ghorbani, "Motivational Effects of Enhancing Expectancies and Autonomy for Motor Learning: An Examination of the OPTIMAL Theory," *The Journal of General Psychology* 146 no. 1 (2019): 79-92
Saeed Ghorbani and Andreas Bund, "Motivational Effects of Enhanced Expectancies for Motor Learning in Individuals With High and Low Self-Efficacy," *Perceptual and Motor Skills* 127 No. 1 (2020): 263-274.
Thomas Simpson, Lorcan Cronin, Paul Ellison, Evelyn Carnegie, and David Marchant, "A Test of OPTIMAL Theory on Young Adolescents' Standing Long Jump Performance and Motivation," *Human Movement Science* 72 (2020).
Brad McKay and Diane Ste-Marie, "Autonomy Support and Reduced Feedback Frequency have Trivial Effects on Learning and Performance of a Golf Putting Task," *Human Movement Science* 71 (2020).
[42] Gabriele Wulf, Takehiro Iwatsuki, Brittney Machin, Jessica Kellogg, Clint Copeland, and Rebecca Lewthwaite, "Lassoing Skill Through Learner Choice," *Journal of Motor Behavior* 0 no. 0 (2017): 1-8.
[43] Gabriele Wulf, Rebecca Lewthwaite, Priscila Cardozo and Suzete Chiviacowsky, "Triple Play: Additive Contributions of Enhanced Expectancies, Autonomy Support, and External Attentional Focus to Motor Learning," *The Quarterly Journal of Experimental Psychology* (2017): 1-9.

1.6c Sport and Performance Psychology

Sport psychology in the United States can be traced to Coleman Griffith in the 1920s and 30s.[44] Griffith was hired by P.K. Wrigley to work with the Chicago Cubs in 1938 in an experiment that failed because of manager Charlie Grimm's noncooperation. Breaking from the conventional wisdom of Major League Baseball (MLB) at the time preferencing players perceived to have superior instincts and inherent feel for the game, Griffith believed that other than physical characteristics, innate talent was irrelevant to baseball skill – predating Ericsson's work demonstrating this concept by half a century.

This collaboration with the Cubs also demonstrated another element that has come to be integral to sport psychology in interpersonal dynamics, as Griffith's work in the MLB was marked as much or more by statements about how "the members of a team can come to work better as a unit" and "learning how to interact more effectively on a personal level."[45] Griffith also stated that contrary to conventional MLB wisdom at the time, "a better practice regimen would enable players to achieve better performance, closer to the actual physical limits of their bodies."[46] Despite being forgotten and re-discovered by sport psychology, Griffith arrived at a chunking-related finding decades before the chess studies of Adriaan de Groot as he "used the result of an interview held with Harold 'Red' Grange during the 1924 Michigan-Illinois game to illustrate that successful athletes had the capacity to effectively react to stimuli without assistance from the conscious."[47]

[44] Walter Kroll and Guy Lewis, "America's First Sport Psychologist," *Quest* 13 no. 1 (1970): 1-4.
[45] Christopher Green, "Psychology Strikes Out," *History of Psychology* 6 no. 3 (September 2003): 273.
[46] Ibid., 274.
[47] Walter Kroll and Guy Lewis, "America's First Sport Psychologist," *Quest* 13 no. 1 (1970): 2.

Two of the more prominent lines of research regarding means of entering a peak performance mental state are the use of visualization and pre-performance routines. The 2001 PETTLEP (Physical, Environment, Task, Timing, Learning, Emotion, and Perspective) model from Holmes and Collins provides a domain-general model for ideal use of visualization, and will be examined and applied in detail.[48] PETTLEP-style imagery has been shown to be more effective at improving performance than other kinds.[49] Imagery and visualization research largely lives within the sport psychology discourse, but crosses over into motor learning through findings that show visualization improving the rate at which new skills are acquired and improved in novices.[50] The journal *Medical Problems of Performing Artists* is largely devoted to physical ailments and disorders like repetitive stress injuries, but also explores psychological issues of living and working as a performer.[51]

The research on pre-performance routines has a significant grounding in sports, partially because of the simplicity and large number of repetitions associated with many skills in sports like golf swings, baseball pitches and swings, and basketball shots. This simplicity allows for easier evaluation of success than the multi-variable and subjective tasks found in music. Perhaps the most well-known example of pre-performance routines are basketball players taking free throws; a 2008 analysis determined that correct execution of a player's pre-performance routine

[48] Paul Holmes and David Collins, "The PETTLEP Approach to Motor Imagery: A Functional Equivalence Model for Sport Psychologists," *Journal of Applied Sport Psychology,* 13 no. 1 (2001), 60-83.
[49] Robert Weinberg, "Does Imagery Work? Effects on Performance and Mental Skills," *Journal of Imagery Research in Sport and Physical Activity* 3 no. 1 (2008).
[50] Dave Smith, Caroline Wright, Amy Allsopp, and Hayley Westhead, "It's All in the Mind: PETTLEP-Based Imagery and Sports Performance," *Journal of Applied Sport Psychology* 19 no. 1 (2007): 80-92.
[51] Susan Raeburn, "Psychological Issues and Treatment Strategies in Popular Musicians: A Review, Part 2," *Medical Problems of Performing Artists* (March 2000): 6-16.

had a significant positive impact of correct execution of the subsequent skill.[52] This issue of preparation immediately before performance is directly applicable to performing artists.

A link has been asserted between sports and music training, albeit with an unnecessary distinguishing of performance psychology into subfields of sport psychology and music psychology.[53] This study views performance psychology as primarily remedial, writing that its use "does not guarantee winning a position or advancing in an audition, but this positive, competitive mentality is certainly better than doubt, fear and other forms of anxiety."[54] Dominique Bellon's 2006 interview-based dissertation of six performers was focused on process of preparation, goal setting, pre-performance routines, visualization, focus, and elements interfering with or promoting peak performances. Each topic was examined in relation to the performance psychology literature, and then to interview data.[55] Bellon held that "sport psychology and its application to music performance should not be seen only as a help to deficient athletes or musicians," but rather as an additional tool to enhance performance regardless of the presence or absence of anxiety.[56] Each of these studies focused entirely on performance psychology applications to music performance; I aim to integrate performance psychology within the larger expert performance discourse. A 2016 study of 212 instrumentalists examined deliberate practice effects through the lens of self-regulated learning, and found that

[52] Chris Lonsdale and Jimmy Tam, "On the Temporal and Behavioural Consistency of Pre-Performance Routines: An Intra-Individual Analysis of Elite Basketball Players' Free Throw Shooting Accuracy," *Journal of Sport Sciences* 26 no. 3 (2008): 259-266.
[53] Dimitry Olevsky, "The Study of Success in Music: Applying Methods Developed by Sports Psychology towards Achieving Peak Performance," (DMA Diss., University of California Santa Barbara, 2012): 3.
[54] Olevsky, "The Study of Success in Music: Applying Methods Developed by Sports Psychology towards Achieving Peak Performance," 45.
[55] Bellon, "Application of Sport Psychology to Music Performance," 2006.
[56] Ibid, P. 90.

pre-organization of practice schedules was "not a main aspect of their self-regulation," implying that even advanced performers often do not have a deliberate plan for their improvement.[57]

The reach of Don Greene and Noa Kageyama show existing demand from musicians for content and guidance on sport psychology issues. While books like the *Inner Game* series, *Peak*, and *Talent is Overrated* are frequently recommended for musicians, these are largely domain-general examinations with little direct applications to performing artists in context. Greene's books and clinics suggest successful application of his practical sport psychology experience with world-class athletes toward audition-trail musicians. Kageyama maintains a popular website and podcast series. Both of them tailor their work to the lay audience, translating between psychological research and the musicians that make up their reader and student bases. Greene and Kageyama's success demonstrate value and demand in these topics; my work builds on theirs to unify applications and clarify connections.

1.7 Method

I offer a conceptual framework for understanding multidisciplinary research within a context of music performance training. [58] Chapter 2 describes the loop and the interrelated processes encompassed by it. Chapters 3 and 4 offer a more detailed explanation of its operation and the individual five elements of motivation, mental representations, pre-performance routines, feedback, and prioritization.

My method follows the constructivist grounded theory model with documents as data. This process is associated with the work of Kathy Charmaz, and follows a pattern of moving

[57] Marcos Araújo, "Measuring Self-regulated Practice Behaviours in Highly Skilled Musicians," *Psychology of Music* 44 no. 2 (2016): 289.
[58] Yosef Jabareen, "Building a Conceptual Framework: Philosophy, Definitions, and Procedure," *International Journal of Qualitative Methods* 8 no. 4 (2009): 49-62.

from known data points toward a more general, higher-order theory.[59] In this case, the data points are represented by the peer-reviewed documents in the relevant sciences, supporting the constructed theory that is the deliberate practice loop. My data consists of sources listed in the literature review of this chapter, as well as additional ones examined in Chapter 2.

I aim to answer my primary research question, "How can the research of expert performance, performance psychology, and motor learning inform an effective process of deliberate practice for music performance improvement?" by creating this conceptual framework and unifying multidisciplinary ideas to understand domain-general improvement and targeting for music performance. The text of Chapters 2 through 4 seek to jointly answer my first two sub-questions, "What are domain-general elements of effective deliberate practice?" and "How can these elements be used in domain-specific ways?" My third sub-question, "How can a process of improvement for music performance be concisely expressed?" is answered through the deliberate practice loop itself, as a construct uniting the techniques and research fields examined.

I identify relationships between domain-general concepts and domain-specific processes to support my deliberate practice loop. This will be done through engaging with existing publications in the domains of expert performance, motor learning, and sport psychology. These related fields often support each other through different vocabulary and different methods; my work uses these connections to establish an understandable method for training performing musicians. This work focuses on the process of improvement through unifying long-term practice, kinesthetic training, lifestyle optimization, and mental strategies.

[59] Kathy Charmaz, *Constructing Grounded Theory* 2nd ed, *(*London: SAGE Publications 2014).

Research analysis and interpretation were the primary means of creating and developing this conceptual framework, and prior publications related to expert performance, motor learning, and sport psychology are the core of relevant data. The deliberate practice loop was created through recognition of relationships between published research of different fields. The next step was deeper examination of each of the five elements of the loop to determine key features of its correct implementation. The final stage was example application; this was the creation of example scenarios using the loop concepts toward percussion training in Chapter 4.

This research meets the need for well-founded and legitimate training strategies expressed in a unified, meaningful, and understandable way. The current landscape of patchwork engagement with small subsections of the larger sphere of expert performance leads to musicians often finding one or two data points, or a single piece of advice from which to build their entire view of deliberate practice. This leaves significant improvement on the table for countless musicians and students. My unified approach aims to give musicians the information needed to optimize both practice efficiency and long-term improvement. I mean to empower musicians with the tools of knowledge, uncovered in our own and other domains, that best support their maximum possible achievement.

CHAPTER 2: THE DELIBERATE PRACTICE LOOP AND PARALLELS OF PERFORMANCE

Music and sports are the two most prominent domains studied in the science of expertise, motor learning, and sport psychology. Sport training functions as a simpler testing ground for expertise research because of the greater simplicity of evaluating sport performance compared to the complexity of artistic endeavors like music. Events like a basketball going through a hoop or golfball going in a hole are binary and easy to evaluate and record, while determining whether a musical performance was successful takes far more knowledge and awareness; the commonality is that both domains require practice for improvement. Parallels between music and athletic performance show the cross-applicability of concepts, and suggest methods for improvement to enhance music performance training. In the following section, athletic concepts are given as preliminary examples of the scientific backing for the concepts of the deliberate practice loop, and popular examples of their use by exemplary performers in their own domains show practical value.

First, I present the bodies of research from which elements and sub-elements of the deliberate practice loop are found. Then I present the loop itself, leading into an examination of each main element of the loop in order. Each element is linked to others, so the examination necessarily references back to earlier stages in the process. The science of expertise, modern thinking in motor learning, and performance psychology's value for musicians will be briefly examined, before detailed examination of their intersections which comprise the deliberate practice loop.

2.1 Deliberate Practice, Motor Learning, and Performance Psychology

Ericsson's landmark 1993 study defines deliberate practice as "those activities that have been found most effective in improving performance" and differentiated from "other activities, such as playful interaction, paid work, and observation of others, that individuals can pursue in the domain."[60] This differentiates among active, targeted improvement and all other sport-related activities, including playing in competitive games, watching film, watching the sport be played by others, or even team practices, which often focus more on team tactics and strategy than on individual skills. In many sports, deliberate practice is no more an element of a team practice than it is of an ensemble rehearsal for the musician; athlete and musician each require individual time to focus on individual performance needs.

Three constraints must be optimized for deliberate practice to be effective: resources, motivation, and effort.[61] Ericsson's resource constraint includes time, access to information, and coaches. The effort constraint refers to reaching an ideal balance between workload and recovery to maximize improvement and avoid burnout. The conclusion of Ericsson's 1993 study remains the key finding regarding acquisition of expert level performance in music: greater amounts of lifetime deliberate practice hours correlate with greater levels of performance.[62] This implies that long-term success requires optimization not merely of practice sessions but of lifestyle, particularly in light of competition. Timpanist Jason Haaheim of the Metropolitan Opera writes that deliberate practice is a "framework for improvement that experts will attest to across fields

[60] Ericsson, "The Role of Deliberate Practice in the Acquisition of Expert Performance," 367-368.
[61] Ibid, pp. 368-369.
[62] Ibid.

as far-ranging as tennis, neurosurgery, chess, corporate leadership, theoretical physics, orchestral music, 'Jeopardy!', and number-memorizing competitions."[63]

The OPTIMAL theory is a synthesis of multiple threads of motor learning research into a unified set of actionable, testable principles. I rely on this theory for a unified set of motor learning concepts to apply toward deliberate practice and the achievement of expert performance to exemplify the parallel between sports and music. The theory consists of a three-step process of motor learning: factors that influence effective focus, focus itself, and the performance of the skill. A study of throwing with the non-dominant hand in novices to test the OPTIMAL theory found that practice scenarios using "enhanced expectancies, autonomy support, and an external focus resulted in more effective learning," suggesting early support for practical testing of the OPTIMAL theory's key points.[64] This has relevance to the structuring of the practice environment for musicians.[65] Many collegiate athletic coaches employ some or all of these strategies with their athletes; one of the theory's authors, Rebecca Lewthwaite, played softball at UCLA alongside eventual coaching legend Sue Enquist for UCLA's first three seasons fielding a team (1975-1977).[66] The theory's diagram of the interrelationships between elements is included below:

---

[63] Jason Haaheim, "A Process for Everyone: Teachers, Freelancers, and Big-Job Auditioners," October 18, 2017, https://jasonhaaheim.com/a-process-for-everyone-teachers-freelancers-and-big-job-auditioners/.

[64] Gabriele Wulf, Rebecca Lewthwaite, Priscila Cardozo and Suzete Chiviacowsky, "Triple Play: Additive Contributions of Enhanced Expectancies, Autonomy Support, and External Attentional Focus to Motor Learning," *The Quarterly Journal of Experimental Psychology* (2017): 1-9.

[65] Rebecca Lewthwaite and Gabriele Wulf, "Optimizing Motivation and Attention for Motor Performance and Learning," *Current Opinion in Psychology* 26 (2017): 40-41.

[66] Wulf and Lewthwaite, "Optimizing Performance Through Intrinsic Motivation and Attention for Learning: The OPTIMAL Theory of Motor Learning," 1382-1414.
2015 UCLA Softball Record Book, p. 33, accessed May 25, 2021.
www.uclabruins.com/documents/2015/2/23/2015SBRecordBook.pdf

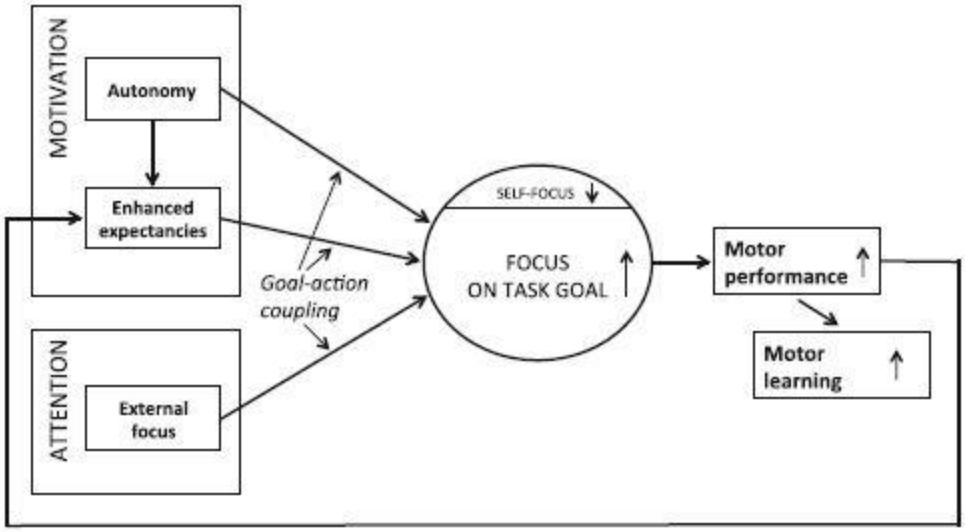

Figure 1. Schematic of the OPTIMAL Theory.[67]

Autonomy and enhanced expectancies are categorized jointly as motivational factors feeding effective focus, leading to skill improvement. External focus – placing the performer's sensory focus on something external to their own body – is called an attentional factor, also improving focus and performance. The autonomy factor states that the performer's belief that their choices and actions matter and affect the outcome of a performance increases the rate of learning. Enhanced expectancies refers to the positive effect of a performer's belief that the outcome of their at-least-partially-autonomous action is likely to be a success. Each of these elements will be examined further in their relevant context within the deliberate practice loop.

Performance psychology's role in this process of deliberate practice is to increase consistency and minimize differences between a performer's best possible execution, and any given single performance. Gallwey presents a simple equation to illuminate this issue: performance = potential – interference. Deliberate practice increases performance potential;

[67] Wulf and Lewthwaite, "Optimizing Performance Through Intrinsic Motivation and Attention for Learning: The OPTIMAL Theory of Motor Learning," 1391.

performance psychology aims to realize that potential in the moment. Greene has applied sport psychology techniques for performing artists, and states that elite athletes achieve peak performances in high-pressure situations through deliberate training: "there are many similarities, but one of the differences between musicians and athletes, is athletes have had sport psychology for 30 years, to teach Olympic and professional athletes how to perform better because of the adrenaline."[68] This difference in familiarity with the concepts of sport psychology and mental strategies for attaining peak performance is a common theme in Greene's work.

These core sources represent the foundations of my deliberate practice loop. The work of Ericsson, the OPTIMAL theory, the PETTLEP model, and Greene's application of performance psychology toward musicians will be augmented with practice-based, real world examples of the use of these concepts and their relationships to each other to show the coherence and viability of this model.

2.2 The Deliberate Practice Loop

My original deliberate practice loop (Figure 2) depicts a repeatable process for continuous refinement. It is based on the above-mentioned and below-examined intersectionality of diverse research threads, for application of proven science in other domains toward music training.

[68] Sarah Willis Interview, "Dr Don Greene Live on Sarah's Horn Hangouts," August 14, 2015, 2:35-3:00, accessed May 25, 2021, https://www.youtube.com/watch?v=O0em8bAV2EA.

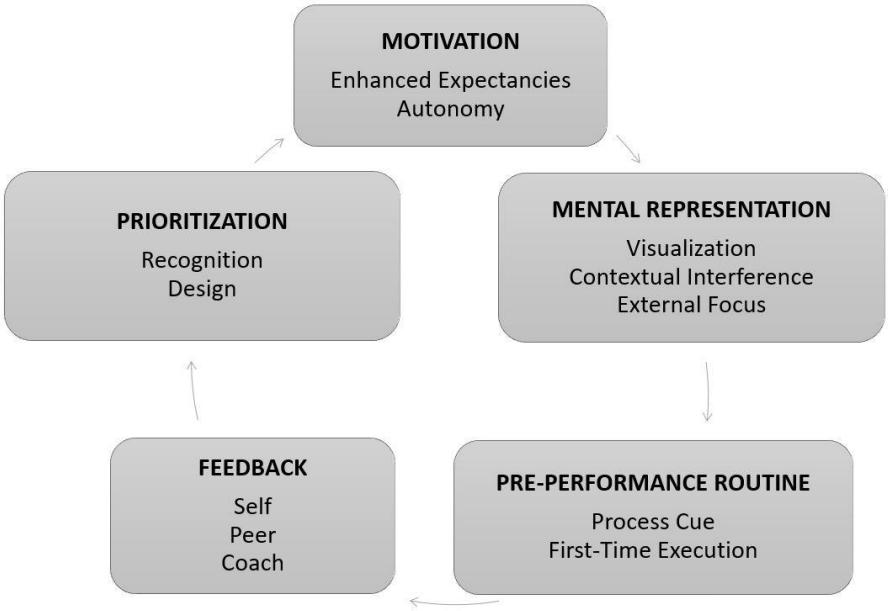

Figure 2: The Deliberate Practice Loop

This loop is designed to be used in repetition for additional refinement, and is inspired by the OODA loop associated with US Air Force colonel John Boyd.[69] That loop was developed for fighter pilots in air combat, and its acronym stands for "Observe, Orient, Decide, and Act." Boyd's military career spanned service flying F-86 Sabres during the Korean War, attending and then instructing at the Air Force's Fighter Weapons School outside Las Vegas, functioning in command roles during the Vietnam War, and working in aerial tactics and theory as a consultant for the Pentagon after retirement. His theories of chaos and speed in decisions during dogfighting had a significant impact in the development of the American F-15 and F-16 fighters.[70] On Boyd's death in 1997, then-Commandant of the Marine Corps General Charles Krulak wrote of his contributions to US strategic planning in the First Gulf War that "John Boyd was an architect

[69] John Boyd, "Patterns of Conflict," Edited by Chuck Spinney, Chet Richards, and Ginger Richards, 2007, accessed May 25, 2021, http://www.projectwhitehorse.com/pdfs/boyd/patterns%20of%20conflict.pdf.
[70] John Olsen, "Boyd Revisited." *Air Power History* 63 no. 4 (Winter 2016): 7-16.

of that victory as surely as if he'd commanded a fighter wing or a maneuver division in the desert."[71]

Boyd's loop itself began as a tactical concept designed to explain that speed of action and decision is key in air-to-air combat, and that the pilot and aircraft able to more quickly change maneuvering based on current facts has an advantage. It was quickly expanded into broader military contexts, and has subsequently been used widely in non-military applications for its explanation of effective decision-making flow beginning from gathering information, determining a course of action, taking that action, and then re-assessing and gathering information to determine the next action.[72] A central premise of Boyd's loop is constant re-evaluation of new information being run through the same decision process; this holds true for my loop as well. After each round through the five elements with performances and/or practice hours, the new state of the performer's capability is reassessed and goals retargeted for the next pass. The deliberate practice loop represents the practical manifestations of overlapping research across discourses related to expert-level performance. It is presented in domain-general form, allowing for understanding how domain-specific activities function in the domain-general context of striving for high achievement.

2.2a Motivation

The first element of the loop includes both motivation related to an individual's desire, and physiological effects from training methods that have been shown to improve performance.

---

[71] Charles Krulak, "Letter to the Editor," *Inside the Pentagon* 13 no. 11 (March 13, 1997): 5.

[72] Richard Feloni and Anaele Pelission, "A Retired Marine and Elite Fighter Pilot Breaks Down the OODA Loop, the Military Decision-Making Process that Guides 'Every Single Thing' in Life," August 13, 2017, https://www.businessinsider.com/ooda-loop-decision-making-2017-8
Mark Bonchek and Chris Fussell, "Decision Making, Top Gun Style," Sept. 12, 2013, *Harvard Business Review*, https://hbr.org/2013/09/decision-making-top-gun-style

This distinction between cognitive, desire- and choice-focused motivation and the effects of certain mentalities, focuses, and practice setups breaks down into the difference between motivation as choice, and motivation as context. Brett Ledbetter's distinction between person and player is illustrative; the intrinsic meaning of motivation is for the performer as person, exercising drive to improve.[73] Motivation for the performer as player includes elements from the OPTIMAL theory that are not conscious decisions, but rather observable performance effects in the presence of certain scenarios. Both person and player are active in deliberate practice over a long period of time; the person is primarily in charge of lifestyle optimization and desire-based motivation to continue the pursuit, while the player is actively using the deliberate practice elements to improve performance.

Learner choice during the gaining or refining of a motor skill enhances acquisition, retention, and improvement. This occurs regardless of whether the learner's choice is relevant to the motor skill.[74] An empirical study of the OPTIMAL conclusions tested novice learners at lasso throwing for differences in learning and retention based on offering or denying choices to the learner; the authors state that "offering choice, particularly when it need not be consequential, or when the extent of learners' skills and insights are unknown, appears to be a useful approach or adjunct strategy for teachers and coaches to make the most of motor learning opportunities."[75]

[73] Brett Ledbetter, *What Drives Winning* (Green Dot, 2015): 13-36.
[74] Wulf and Lewthwaite, "Optimizing Performance Through Intrinsic Motivation and Attention for Learning: The OPTIMAL Theory of Motor Learning," 1392.
[75] Wulf, Gabriele, Takehiro Iwatsuki, Brittney Machin, Jessica Kellogg, Clint Copeland, and Rebecca Lewthwaite, "Lassoing Skill Through Learner Choice," *Journal of Motor Behavior* 0 no. 0 (2017): 1-8.

The OPTIMAL theory presents a biological-psychological underpinning to the importance of motivation, requiring optimism about a situation and belief of agency in affecting its outcome.[76]

Deliberate practice of the intensity and duration needed to achieve expert-level performance skill requires an intrinsic drive for the activity. Elite athletes "love the grind and repetition of training and they are willing to suffer to succeed. Most basically, their love of their sport precedes their love of competing and winning."[77] This focus has two intertwined positive effects: perspective and sustainability of deliberate practice. These elements are crucial, because a player interested only in winning may find a lack of instant success fatal for their long-term improvement. An understanding that anything competitive necessarily has fewer champions than participants leads to a need for a participant to be satisfied with merely being in the game and striving for the goal, without requiring the goal to be met for their own personal satisfaction. Ledbetter, a performance and culture consultant for elite NCAA athletic programs, presents a relevant concept of focus on the person first rather than the player, allowing personal improvement to feed into performance improvement.[78] Ledbetter's core model is that character feeds into process, and process produces results; he thus advises athletes and coaches to focus on character first and allow that to drive the other two elements as outcomes.

Performers act when convinced that their decisions and agency will be responsible for positive effects.[79] This statement explains the foundation for the theory's autonomy and enhanced expectancies elements, and for their classification as factors affecting motivation. Thus

[76] Wulf and Lewthwaite, "Optimizing Performance Through Intrinsic Motivation and Attention for Learning: The OPTIMAL Theory of Motor Learning," 1384.
[77] Jim Taylor, *Prime Sport: Triumph of the Athlete Mind* (New York: Writers Club, 2001): 12
[78] Brett Ledbetter, *What Drives Winning* (Green Dot, 2015): 13-36.
[79] Wulf and Lewthwaite, "Optimizing Performance Through Intrinsic Motivation and Attention for Learning: The OPTIMAL Theory of Motor Learning," 1384.

regardless of a performer's interest in an activity, a lack of either learner choice or expectation of improvement may not only stifle the performer's interest in practicing, reducing the amount of deliberate practice, but also the effectiveness of their practice.

2.2b Mental Representation

This second element of the deliberate practice loop refers to a performer's understanding of how a successful execution looks, sounds, and feels. The terms visualization, mental practice, and mental rehearsal refer to a process of multisensory imagery, thinking through a performance or other action before actually going through it.[80] This mental representation includes both an internal figurative videotape of an ideal performance, as well as the performer's collected domain-specific knowledge that supports it. These representations are created by combining memory and imagination.

The mental representation as an idea is rooted in the chess studies of de Groot along with Chase and Simon, and the psychological concept of chunking: expert performers in a domain have the ability to reduce multiple pieces of information to one compound data point.[81] This meaning refers to an expert performer's set of mental constructs in their particular domain that allow the performer to access complex scenarios or systems of information without processing in real time, because of their in-domain training. This encoding of large information sets as smaller, easier-to-retrieve mental models is the foundation of the mind's ability to represent an ideal performance. Figure 3 illustrates examples from three types of experiments testing the ability of

[80] Weinberg, "Does Imagery Work? Effects on Performance and Mental Skills," 2.
[81] Adriaan De Groot, *Thought and Choice in Chess*, (The Hague: Mouton, 1965).
William Chase and Herbert Simon, "Perception in Chess," *Cognitive Psychology* 4 no. 1 (January 1973).
K. Anders Ericsson and Neil Charness, "Expert Performance: Its Structure and Acquisition," *American Psychologist* 49 no. 8 (1994): 725-747.
K. Anders Ericsson, "The Scientific Study of Expert Levels of Performance: General Implications for Optimal Learning and Creativity," *High Ability Studies* 9 no. 1 (1998): 75-100.

experts to chunk and reproduce their representation in disparate domains as compared to non-experts. This shows the transferability of the chunking phenomenon into separate domains, built on the same neural activities despite differing types of information being represented.

Despite the difference in type of task, these examples exemplify the ability to reproduce differences in skill in laboratory settings. Chess players were asked the best move for the white pieces, typists asked to type the text, and musicians asked to perform the excerpt twice identically, and in each case experts performed consistently better than non-experts. These kinds of short-exposure tests of aptitude with limited processing time show that amassed domain-specific knowledge and chunked mental representations offer performers a means for achieving greater success.

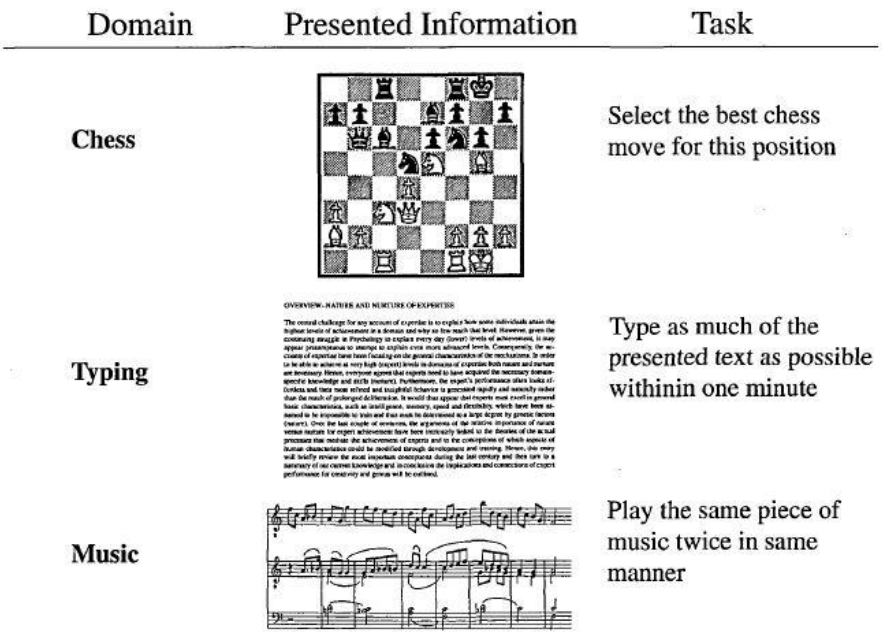

Figure 3: Examples of tests for Mental Representation Effectiveness in Three Domains[82]

[82] K. Anders Ericsson, "The Scientific Study of Expert Levels of Performance: General Implications for Optimal Learning and Creativity," *High Ability Studies* 9 no. 1 (1998): 82.

Ericsson offered this explanation for an expert's ability to consistently perform at higher levels than non-experts: "In most domains, better performers are able to rapidly encode and store relevant information for representative tasks in their memory so that they can efficiently manipulate it mentally."[83] This idea is not limited to data storage and retrieval, but also includes multisensory mental imaging – the mental representation. This encoded memory and information functions as data, populating the imagined ideal performance video in the performer's mind with details, goals, decision trees, or any other information relevant to the specific domain in question. A mental representation can be understood as a multisensory combination of memory and imagination in a performer's mind's eye, functioning as an internal recording of the most ideal possible execution currently conceivable by the individual.

Figure 4 is Ericsson's diagram of three kinds of representation active in music training: the goal, the means of execution, and the audience experience. This triad of representations directly relate to the task and perspective elements from the PETTLEP model of motor imagery. Task is represented by the "desired performance goal" element, while "playing a piece of music" and "listening to the music being played as if it would be experienced by an audience" map to the first-person and third-person perspectives of motor imagery respectively.

[83] Ibid, 91.

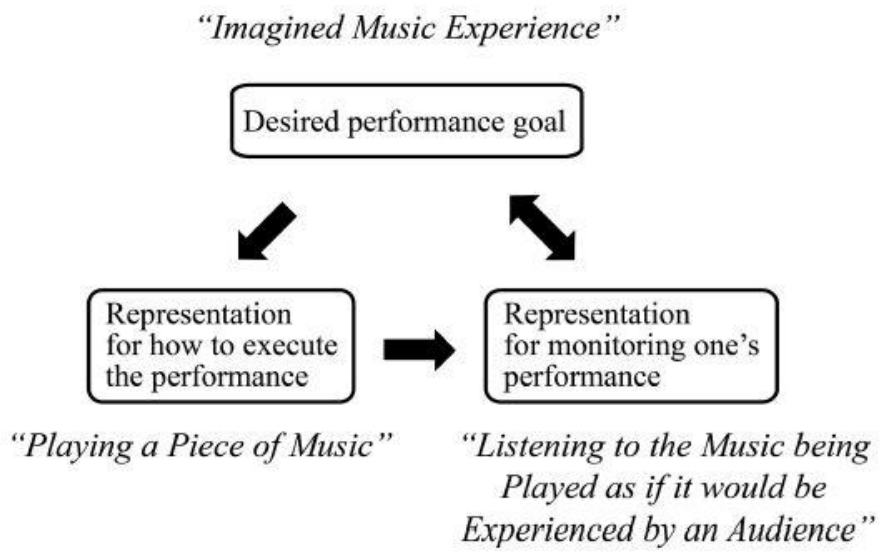

Figure 4: Three Mental Representation Types for Music Performance Improvement[84]

Visualization is one of the more well-known elements of sport and performance psychology, commonly cited as an aid for helping performers understand exactly what they should be visualizing or imagining, and how to do it. Existing research on the contextual interference effect can support visualization techniques by suggesting practice schedules and surroundings around practice. A study of an all-time elite basketball player's free throw method demonstrates practical applications of these ideas, and adds implications for first-time execution in music performance. The concept of domain-specific knowledge and its impact on achieving seemingly impossible performance levels will be examined, and finally a focus element central to the OPTIMAL theory of motor learning adds an additional element of a performer's mental representation of success.

The PETTLEP model of motor imagery lists elements that should be present in a performer's visual representations of a task. Timing has a peculiarity to music performance in

[84] Ibid, 92.

relation to rhythm and tempo, and manipulating tempo in practice is a common improvement technique in music performance. Athletes and performance psychology researchers alike show that PETTLEP imagery use improves confidence, anxiety management, and motivation.[85] The use of imagery allows performers to "see themselves succeeding… or performing a skill correctly that they had trouble performing in past competitions."[86] The OPTIMAL theory refers to this as generating enhanced expectancies.

PETTLEP imagery has been shown more effective than non-PETTLEP imagery in improving task performance over a six-week period with college-aged field hockey players, and gymnasts between the ages of seven and fourteen.[87] This model has only recently been successfully applied to music performance; recommendations for research include examining the effects of varying the perspective of visualization between first and third person, and visualization of performance environments. [88]

The OPTIMAL theory and PETTLEP model are understood in their function and represent what is known to work in application; effective means of structuring practice sessions must be examined as well despite greater uncertainty. Contextual interference refers to adding elements to the learning or development of a skill that distract, impede, or otherwise interfere with the learner. In practice, it often takes the shape of periodically shifting the practice activity to avoid long periods of time spent on the same thing, in a process known as interleaved practice.

---

[85] Weinberg, "Does Imagery Work? Effects on Performance and Mental Skills," 9-12.
[86] Ibid, 8.
[87] Smith, Wright, Allsopp, and Westhead, "It's All in the Mind: PETTLEP-Based Imagery and Sports Performance," 80-92.
[88] Elliott Folvig, *Imaging Mastery: Applying the PETTLEP Model of Imagery to Music Performance Practice,* (Melbourne: University of Melbourne, 2011).
David Wright, Caroline Wakefield, and Dave Smith, "Using PETTLEP Imagery to Improve Music Performance: A Review," *Musicae Scientiae* 18 no. 4 (2014).

The effect has been shown to reduce or worsen the performance of the task during the learning process, yet increase levels of performance in retention. The CI effect is difficult to produce consistently, and reasons why it functions in some scenarios and not others are unclear; however there has long been evidence that use of contextual interference in learning and development of a motor skill increases subsequent performances of that skill, especially when surrounding context has changed.[89] This value on change of context is crucial to musicians for being able to effectively perform in more than one physical setting.

The CI effect's relevance for deliberate practice primarily surrounds the relationship between first-time execution and repetitive practice. Short-term memory is known to be more effective for correct performance than long-term memory, suggesting two opportunities for improving first-time execution: the performer can create methods of practicing first-time performance from long-term memory, and/or find ways to perform from short-term memory. The first option is the one related to contextual interference – for a performer to practice a first-time repetition from long-term memory, their practice sessions must be constructed in such a way that the skill being practiced is continually shifted out of short-term memory. Interfering with context by practicing an unrelated skill – a different excerpt, piece of music, instrument, even practicing in a different room – before returning to the previous one allows the player get more first-time, long-term memory repetitions. The traditional common practice method of doing many repetitions of a skill in a row results in only one repetition of a first-time execution, and many repetitions of a second-time execution.

---

[89] John Shea and Susan Zimny, "Context Effects in Memory and Learning Movement Information," *Advances in Psychology* 12 (1983): 361.
William Battig, "The Flexibility of Human Memory." In *Levels of Processing in Human Memory*, edited by Laird Cermak and Fergus Craik, (New York: Erlbaum, 1979).
"Why Shooting 95% From the Free-Throw Line Is Almost Impossible (ft. Steve Nash)," WIRED video, March 28, 2019, https://www.youtube.com/watch?v=BKIOqbx3sbU.

The CI effect was observed in the free-throw approach of Steve Nash, the highest percentage free-throw shooter in NBA history.[90] Nash routinely practiced free throws in small chunks between other skills, mimicking the game-situation use of the motor skill, and preventing himself from entering automatic repetitions of the task. The research and experience surrounding the use of CI in improvement of motor skill performance suggests that extended time practicing a single musical technique may be less valuable than periodically changing between practice drills. The effect is particularly helpful for improving the execution of a skill under stress, as required in auditions or live performances with a cold entrance – the equivalent of a first-shot free-throw attempt. The contextual interference effect is valuable for improving retention of skill learning and increasing success rates of first-time execution; it is not a proven strategy for practice across all goals.

Domain-specific knowledge is a supporting foundation of the mental representation. Seemingly superhuman awareness or reaction time abilities in elite athletes are results of domain-specific knowledge simplifying cognitive tasks and their resulting real-time responses. Ericsson comments that "experts can circumvent any basic limits on the serial motor processes constraining a novice by using advance cues to prepare movements."[91] Inherent to exceptional expertise is an exceptional knowledge base about the domain in question. A latchkey discovery regarding the importance of domain-specific knowledge to performance improvement through deliberate practice is a 1973 study of what chess players of differing ability levels perceive when looking at a board. One conclusion is that "the superior performance of stronger players (which does not appear in random positions) derives from the ability of those players to encode the

[90] Steph Curry's percentage is currently higher, but Curry remains an active player. https://www.basketball-reference.com/leaders/ft_pct_career.html, accessed May 25, 2021
[91] Ericsson, "The Role of Deliberate Practice in the Acquisition of Expert Performance," 397.

position into larger perceptual chunks, each consisting of a familiar subconfiguration of pieces."[92]

That experienced chess players see combinations and formations of pieces rather than individual ones is not a novel concept, but a lack of difference in perception among players of varying ability levels when pieces are arranged in ways foreign to an actual game is notable.[93] This suggests that a skill necessary for success in a given domain is linked to the circumstances and context present in that domain. In response to this finding, Ericsson writes that "experts' superior memory performance must be mediated by knowledge about the domain, knowledge that enables them to encode meaningful relations between the elements of the stimuli."[94] A 2012 study of free throws in basketball found that asking performers to execute the skill outside its game-used context by using different distances was detrimental to performance, even when the change is toward a less difficult skill.[95]

Expert badminton players observe advance cues in an opponent's swing to predict shots before they occur.[96] A study of the Canadian Women's National Field Hockey Team found that elite players' ability to predict shots is based on superior technique awareness and game sense rather than superior domain-general anticipation ability.[97] One study focusing on reaction time notes that for pitch speeds common to collegiate and professional baseball, there is insufficient time to react if the hitter waits until the pitch is thrown to begin the swing; these authors

---

[92] William Chase and Herbert Simon, "Perception in Chess," *Cognitive Psychology* 4 no. 1 (January 1973).
[93] Adriaan de Groot, *Thought and Choice in Chess*, (The Hague: Mouton, 1965).
[94] Ericsson, "The Role of Deliberate Practice in the Acquisition of Expert Performance," 397.
[95] Gavin Breslin, Nicola J. Hodges, Andrew Steenson, Mark Williams, "Constant or variable practice: Recreating the especial skill effect," *Acta Psychologica* 140 (2012): 154-157.

[96] Bruce Abernethy and David Russell, "Expert-Novice Differences in an Applied Selective Attention Task," *Journal of Sport Psychology* 9 no. 4 (1987): 342.
[97] Janet Starkes, "Skill in Field Hockey: The Nature of the Cognitive Advantage," *Journal of Sport Psychology* 9 no. 2 (1987): 156-157.

conducted experiments in volleyball and with members of the Canadian Women's National Basketball Team and found that "different sports develop different sorts of perceptual strategies."[98] The key finding from all of these studies is that expert performers have superior levels of knowledge in the relevant domain compared to non-experts, and use that knowledge to improve their performance. While the unpredictability of sport stands in contrast to the nature of non-improvised music performance, the relevance of this body of research on domain-specific knowledge is in enhanced perception. Greater levels of experience and context give the performer increased ability to understand meaningful significant indicators during performance. The OPTIMAL theory's external focus element refers to a performer targeting their attention at an object or point outside the body. This may "propel performers' cognitive and motor systems in productive 'forward' directions and prevent 'backsliding' into self- and non-task focused states."[99]

2.2c Pre-Performance Routine

This section continues to examine applications from free-throw improvement, and links to elite percussionists who have used similar methods. Greene's application of the techniques used with Olympians and other elite athletes toward musicians is featured here, including a type of pre-performance routine. The three main benefits of effective pre-performance routines are creation of routine, improved first-time execution, and mitigation of performance anxiety. A 2012 study examined causes and management of performance anxiety in musicians through

[98] Fran Allard and Neil Burnett, "Skill in Sport," *Canadian Journal of Psychology* 39 no. 2 (1985): 297.
[99] Wulf and Lewthwaite, "Optimizing Performance Through Intrinsic Motivation and Attention for Learning: The OPTIMAL Theory of Motor Learning," 1382.

interviews with teachers, students, and professional performers; the top two factors were high exposure and performance evaluation.[100]

Just as contextual interference can be used to reset the mental representation and manipulate short-term and long-term memory to better prepare for first-time execution in practice, pre-performance routines can be used to shift the player into short-term memory in the moment before performance. A study of free throws in the 2006 NBA Western Conference Semifinals analyzed the pre-shot routines of each player, evaluated every free throw taken for whether the player correctly executed their routine or not, and tracked the results. The authors found that consistency of a player's pre-shot routine was directly linked to greater success in performing the skill. The correct execution of a player's pre-shot routine increased their accuracy by 12.43%.[101] That difference can be outcome-altering: the average NBA team takes slightly more than 21 free throws per game, making 12.43% translate to between two and three points per game.[102] This represents empirical evidence supporting that effective pre-performance routines improve performance. In addition to his contextual interference free-throw training, Nash also used a kinesthetic pre-performance routine of practicing his free-throw form before being given the ball, "accessing the motor pattern and moving it to the working memory."[103] In this way Nash was able to greatly reduce the variance between first-shot and second-shot percentage that commonly affects free-throw shooters, by ostensibly performing the skill before executing the first shot.

---

[100] Peter Kuan, "Performance Anxiety and the College Musician: A Survey Study of Situational Triggers, Symptoms, and Ways of Coping," (PhD. Diss., New York University, 2012).
[101] Lonsdale and Tam, "On the Temporal and Behavioural Consistency of Pre-Performance Routines," 259-266.
[102] NBA Team Free Throws Attempted per Game, 2017-2018 Season, https://www.teamrankings.com/nba/stat/free-throws-attempted-per-game
[103] Brian McCormick, "Why Everyone Should Shoot Like Steve Nash," accessed May 25, 2021, https://180shooter.com/why-everyone-should-shoot-like-steve-nash

Los Angeles Philharmonic principal percussionist Matthew Howard partially attributes his audition success to his addition of pre-performance routines to his playing, based on sport psychology concepts he learned from golf.[104] Given the absence of an existing, universally agreed-upon metric for grading musical performances analogous to free-throw percentage, the effect of using pre-performance routines cannot be studied in music through quantitative comparison. However, the high pressure but non-direct competition of free throws makes them a plausible parallel for applications toward music from the standpoint of mental preparation for high-stakes execution.

Greene's key recommendation for musicians is a combination of visualization and pre-performance routine that he calls "centering."[105] Centering is a process of breathing and thinking designed to achieve a mental state capable of peak performance and reduce "conscious internal processing of information as much as possible" to maximize potential during performance.[106] The centering process consists of a pattern of three deep breaths, each of which is linked to a thought. The method is designed to relax and focus the player, and remind how a peak performance looks, sounds, and feels. A 2014 pilot study of students at the Melbourne Conservatorium in Music found results suggesting that Greene's methods targeted for musical application have measurable positive effects on music student progress.[107]

Centering unites the pre-performance routine with mental representation in a process that can add performance psychology preparation to a musician's constant routine of deliberate

---

[104] "How Matt Howard Used Mental Practice to Win LA Phil," Rob Knopper Video, 3/28/2017, https://www.youtube.com/watch?v=hsqSsa1OerQ
[105] Greene, *Audition Success*, 48-65.
[106] Robert Nideffer, *Getting Into The Optimal Performance State*, Web-published, 5, accessed May 25, 2021, https://nideffer.com/wp-content/uploads/2016/06/Optimal-Performance.pdf
[107] Margaret Osborne, Don Greene and Don Immel, "Managing Performance Anxiety and Improving Mental Skills in Conservatoire Students Through Performance Psychology Training: A Pilot Study," *Psychology of Well-Being: Theory, Research and Practice* 4 no. 18 (2014).

practice; Greene believes it should be an element of "every performer's daily routine."[108] Performers who include centering in their deliberate practice regimes are giving themselves repetitions not only of the motor skills required for achieving expert performance, but also the mental readiness required for producing it in pressure scenarios.

This centering technique mirrors mental strategies used by elite athletes. Current Golden State Warriors head coach and former NBA player Steve Kerr said "In Houston early one season, I shot an absolutely perfect free throw. After that, every free throw I took that year, I would say, 'Houston,' before I shot it. I wanted to put that picture in my head, that feeling."[109] Kerr's willingness to change his cue word based on a newer vision of the ideal is notable; the process cue's primary requirement is that it be related not to technique or domain-specific aspects of the motor skill, but rather general statements of the ideal.[110] This anecdote illustrates unification of pre-performance routine with process cue, visualization, and an external focus in free-throw technique.[111] Lonsdale and Tam suggest that free-throw shooters might be trained to focus on the rim while pairing their personal pre-shot routine with a cue word like "hoop."[112] The centering technique is valuable across many different sports; Greene claims every musician he's ever coached to an audition win was trained with it.[113]

This combination of the ideal with a cue word functions to load the mental representation into the pre-performance routine, leading to more consistent and successful execution. The performer's domain-specific knowledge, experience, feedback received, and imagination

[108] Greene, *Audition Success,* 65.
[109] Bilas, *Toughness,* 105.
[110] Greene, *Audition Success,* 54.
[111] Lonsdale and Tam, "On the Temporal and Behavioural Consistency of Pre-Performance Routines," 265.
[112] Ibid.
[113] Willis, "Dr Don Greene Live on Sarah's Horn Hangouts," 15:17-15:28.

combine to create a PETTLEP image of the ideal, which is then built into the routine immediately before performance to prepare the performer to achieve at the height of current potential.

2.2d Feedback

The OPTIMAL theory's cyclical concept of one motor performance influencing the next requires that the learner have feedback in some form. This feedback comes from three sources: a coach or teacher, peer observers, and self. Feedback from a coach is often obtained through practices or rehearsals; in music feedback from a teacher is more commonly acquired from one-on-one instruction. The increasing prevalence of enhanced statistics in athletics is another form of performance feedback, in addition to the traditional use of game film and practice tracking.[114] Outside peer observer feedback for a musician can be gained through mock auditions. The value of self-recording for high-level music performance improvement has been documented outside percussion as well.[115]

Jason Haaheim explains that these three forms of feedback for musicians come in the form of lessons, mock auditions or performances, and self-recording.[116] This spectrum is the basis for my deliberate practice loop's breakdown of feedback into sources of self, peer, and coach. Self-recording is the most common kind since it can be used most often, while mock audition panels and teachers require appointments, and commitments of time and money. It is

[114] Rob Arthur, "How Baseball's New Data is Changing Sabermetrics," *FiveThirtyEight,* 3/17/2016, https://fivethirtyeight.com/features/how-baseballs-new-data-is-changing-sabermetrics/.
Ken Pomeroy, "2021 Pomeroy College Basketball Ratings," Accessed May 25, 2021, https://kenpom.com/.
[115] Jennifer Montone, "Sample Audition Preparation Plan," Accessed May 25, 2021, https://www.jenmontone.com/practice-tips.
Greene, *Audition Success,* 45.
[116] Jason Haaheim, "Practicing Without Feedback is Like Bowling Through a Curtain," March 19, 2018, https://jasonhaaheim.com/practicing-without-feedback-is-like-bowling-through-a-curtain/.

also the easiest to gain: no specialized equipment is required as even a smartphone is capable of recording at a level high enough to glean most required information. As part of audition preparation, Haaheim created a digital repository of his own timpani excerpt self-recordings that is highly systematic and organized, complete with images of the part and intensely detailed text descriptions of every musical decision he has made regarding his interpretations of each timpani excerpt, and the rationale behind them.[117]

Peer feedback is represented by mock auditions, or what amounts to a practice performance. In addition to the benefit of experience performing the material for an audience, the player also receives feedback from those in attendance, ideally those who do not play the same instrument. Music performance's long tradition of one-on-one instruction from beginners to elite players has cemented coach feedback in the minds of musicians, but while lessons are often the most valuable type of feedback, they are also the most costly and time-limited. Thus, maximizing feedback from all three sources through recording and archiving is a crucial opportunity for improving efficiency of deliberate practice.

The OPTIMAL theory's enhanced expectancies factor refers to the expectations that performers have of their own performance, related to confidence in their capability to successfully execute the skill, largely due to outcomes of past executions of the skill.[118] This causes motor performance to feed into enhanced expectancies, as ever-improving skill in executing a motion raises the performer's expectations of each subsequent execution. In this way, feedback from coach, peer, or self can enhance confidence in positive outcomes from the next performance of a motor skill. This feedback also supports additional confidence in the

[117] Jason Haaheim, "Process of Auditions" course content, NYU Steinhardt 2016-2020.
[118] Wulf and Lewthwaite, "Optimizing Performance Through Intrinsic Motivation and Attention for Learning: The OPTIMAL Theory of Motor Learning," 1382-1414.

performer's agency in creating those outcomes. This feedback similarly affects the mental concept performers hold of their own ideal performance.

2.2e Prioritization

The final element of the deliberate practice loop is the least active, but most crucial in differentiating between deliberate practice and other kinds. Deliberate practice must be specifically designed for the performer's particular weaknesses and areas of needed improvement. As performers advance in experience and training they will be able to take ever-increasing ownership and control of this process; beginner musicians are those most reliant on teachers to guide it. Prioritization is a two-step process of analyzing data gained through feedback for determining the most relevant points requiring improvement, and designing practice methods to attack those weaknesses.

College sports coaches grade individual performances through film of practices and games.[119] College teams in many sports have a full-time video coordinator and associated staff who record every practice, grade player performance, and cut clips for the coaching staff and players to review. This individual evaluation is especially widespread in sports like football, in which a single player's success or failure in their assignment in a play does not always reflect the team outcome of that play. These evaluations provide data for the coaching staff to make informed decisions around playing time and points of emphasis in practice for individual and team improvement. By attaching consequences to certain behaviors (e.g., additional running in practice for committing errors), coaches can create incentive for desired performance skills. This

[119] Brandon Marcello, "Will Muschamp Graded Film After Florida Fired Him," *Alabama* August 18, 2015, http://www.al.com/auburnfootball/index.ssf/2015/08/will_muschamp_graded_film_afte.html.
Dan Mullen, Postgame Press Conference, November 18, 2017, http://hailstate.com/watch/?Archive=5387&sport=3&type=Archive.

consequence model for inflection points attaches stress and feelings of meaning to actions in practice.

Enquist, former head women's softball coach at UCLA, created a drill for prioritizing failure recovery.[120] The drill requires the third base player to make routine throws to first, but has the first base player sitting on a bucket, reducing her range of motion and presenting a smaller target for the thrower, inducing a greater number of throwing errors. Upon committing a throwing error, the drill demands that the thrower take responsibility for the error, and that her teammate respond with verbal support. The result is the creation of a team-wide habit of taking responsibility for mistakes, and a team culture of productive support rather than destructive judgment when mistakes occur. The drill includes three priorities: a motor skill (making effective throws from third base to first base), individual accountability (taking responsibility for performance failures), and team culture (interpersonal support for teammates when they commit errors). This drill exemplifies the interconnectedness of performance, character, and organizational behavior.

The prioritization process for deliberate practice is the most domain-specific of the five elements of the loop. Because these decisions are designed to mitigate weaknesses based on feedback from a performer's existing version of a skill, domain-specific issues of technique and instrument manipulation are often central to being able to execute musical ideas. Detailing the process without an example is difficult since this stage is the one most tailored to the individual performer, current abilities and experiences, the particular music being practiced, and the artistic and technical issues associated with it.

[120] Brett Ledbetter, *What Drives Winning* Workbook, p. 49.

Chapter 3: THE LOOP IN MUSIC PERFORMANCE TRAINING

This chapter demonstrates the domain-specific application of the loop to music performance. Chapter 2 presented the distinct elements of the loop and their research foundations in a domain-general sense; operationalization toward musicians is the focus of Chapter 3. This application will not be contained to a particular instrument field; percussion-specific applications drawing on instrument- and scenario-specific needs will be presented in Chapter 4. The aim is to show how the research that underpins deliberate practice may be translated from theory and their home domains toward music training. This chapter is organized by the five elements of the loop, each of which will be discussed in terms of operationalization of demonstrated principles toward music.

3.1 Motivation

The first element of my deliberate practice loop has three points – initial motivation, autonomy, and enhanced expectancies. The first refers to the performer's reasoning and desire to achieve; this represents the 'person' part of Ledbetter's person-player duality. For the 'player,' autonomy and enhanced expectancies can be jointly understood as the level of belief performers have in their ability to affect the outcome of a motor performance, and confidence in the positive outcome of that ability. The musical implementation of the contextual interference effect will also be discussed in this section, for its relevance to motivation as a factor improving motor learning.

The motivation element of the loop refers to harnessing mental states that aid retention and improvement in motor learning, as well as a performer's will or desire to perform, improve, train, or study. The term motivation certainly has connotations regarding the will to engage in

hard work over a long period of time; however it has an additional meaning for the purpose of this research. The feeling of autonomy, for example, may or may not coincide with an individual's feeling of readiness or eagerness to train on a given day. The Flow state associated with the work of Mihaly Csikszentmihalyi is separate from the desire to improve through rigorous work, and each can be present in the absence of the other. The same is true for enhanced expectancies – performers may have a high level of earned confidence in their ability to perform alongside a low level of interest in that performance, or the reverse.

The feeling of motivation is a relevant element of deliberate practice and long-term skill acquisition and refinement. Initial motivation may come from innumerable sources including encouragement or pressure from family or peer group, inspiration through seeing an expert performer, and/or perceived non-task-related benefits of a high level of skill in a given domain. In a highly competitive field, motivation should be centered on enjoyment or fulfillment through the task itself in order for long-term success to be achieved.[121]

The autonomy factor from the OPTIMAL theory refers to the feeling of agency and control performers have over their performance and training. This detail is clearly more viable to be implemented later in a musician's career with a wealth of domain-specific knowledge, as a performer begins to choose repertoire to play and which gigs to take, and form their own musical ideas and interpretations. Application of autonomy for beginner musicians is outside the scope of this study, while application for more experienced players pursuing expert-level performance is a relevant area.

Musicians have several opportunities to implement the exercise of autonomy in training.

[121] "Jason Haaheim: On Practice, Talent, Motivation, and Playing the 'Long Game,'" Bulletproof Musician interview with Noa Kageyama and Jason Haaheim, November 4, 2018, https://bulletproofmusician.com/jason-haaheim-on-practice-talent-motivation-and-playing-the-long-game/, 18:04 – 20:30.

The above-mentioned categories of repertoire, types of performances, and interpretation are perhaps the most obvious, but not the only ones. These content-level decisions are the musician choosing which type of music to perform, with whom, at which venues, and similar issues. These decisions themselves have multiple levels – full-time orchestral musicians have chosen a very different career path than freelancers working within several genres. However, both of those groups have a near-infinite level of subgroups, as orchestral players may choose to limit themselves only to orchestra work, or opera work, or may continue taking auditions after having earned tenure. The types of variables offered within a long-term freelance career are myriad: commercial work includes film scores, jingles, and theatre; freelance orchestra work can rely on both chairholding in per-service orchestras and working as a substitute in those and fulltime ones; freelancers in popular music styles can choose to limit themselves to a very narrow band like experimental jazz or progressive metal, or work as jacks-of-all-trades. These represent career-level choices that while often malleable and reversible, can affect a player's life for years or decades.

Smaller autonomy choices are perhaps more relevant for the implementation of the deliberate practice loop in a day-to-day process of improvement. This element is fulfilled by making informed decisions about which excerpts, styles, pieces of music, or techniques to prioritize. Even though these decisions are made in concert with feedback received from peers and coaches, the structuring of individual practice time is solely the player's responsibility for both planning and execution, and creating an organized plan for approaching deliberate practice is an autonomous choice on its own. Within that decision, the larger-scale issue of interpretation choices informed by domain-specific knowledge becomes an element of in-the-moment autonomy, as while a player is in the act of repeating a given passage or excerpt for

improvement, refining musical decisions that are at least in some way the player's own enhances the autonomy factor of motivation as well.

If the performer lacks the intrinsic, conscious desire to engage in the task, then neither the depth of focus nor extensive time commitment required for deliberate practice will exist. This form of motivation is more of a prerequisite for deliberate practice than an active element of the process. In contrast, the physiological elements of motivation – enhanced expectancies and autonomy – are drivers of both continual interest and increased efficiency. They are both drivers of and results from the rest of the process; their absence demonstrates ineffectiveness of process and hampers continual improvement.

3.2 Mental Representation

Visualization is an almost ubiquitous topic of advice in music training, creating an opportunity to elevate the understanding of an existing topic. The key additions to this concept from the body of research are the PETTLEP model and the contextual interference effect. PETTLEP's relevance is obvious, since the model is directly related to visualization of ideal performance to aid in achieving current potential. Contextual interference's relevance is less immediately apparent; the effect is relevant to the mental representation because of the its ability to solidify the player's understanding of the ideal. Minimizing regression through diversifying improvement leads to a more complete mental representation. As stated in Chapter 2, this application is using only the narrow definition of the term mental representation used by Ericsson et al.

3.2a PETTLEP Applications

The seven elements of Physical, Environment, Task, Timing, Learning, Emotion, and Perspective provide an opportunity for a highly specialized approach to visualization and improvement of mental representation. This type of imagery can be seen as giving full context to a mental representation, so the player needs certain experiences or information in order to create a PETTLEP-consistent mental representation – and thus the player must know what those required data points are before even starting to create it. The authors write that their "suggestions support the use of novel approaches (such as new perspectives) but only on the basis of an understanding of their modus operandi."[122] This comment seems to indicate that unique domain-specific applications being different from their example applications is functional within the model.

3.2a-1 Physical

A PETTLEP mental representation begins with the performer imaging the body, instrument and implements, motions, and any other relevant physical elements of the performance image. The physical element is the easiest to create through self-recording, mirrors, and combining memory with imagination. Imaging the body performing correctly includes delineating muscle group shifts, and correct posture whether standing or sitting. Task-irrelevant physical elements like attire, footwear, or jewelry should be included as well – even though these do not affect the performer's ability, they are part of the performance experience and including them helps prepare the performer for the moment.

[122] Paul Holmes and David Collins, "The PETTLEP Approach to Motor Imagery: A Functional Equivalence Model for Sport Psychologists," *Journal of Applied Sport Psychology,* 13 no. 1 (2001): 78.

This stage includes the external focus; as noted in the OPTIMAL theory a performer placing attention on a point outside the body improves performance. Examples might include string players using the bow or strings as an attention point, or wind players using their keys or valves. Another possibility is to place the focus on the performer's recording device. Attentional focus on a recording device allows the performer to have a consistent audience point that can be present during solo practice, mock performances, lessons, auditions, and performances. This also allows the performer to be more present in practice, gaining experience performing while being recorded, minimizing the novelty of performance and thus potentially mitigating performance anxiety. With the physical stage fully imaged, the core of the performance exists in the mental representation; the remaining six elements fill it out with details.

3.2a-2 Emotional

Emotional regulation is an even more complex topic for musicians than athletes or other real-time performers, given potential emotional affects or demands of the music being performed. A core concept to understanding emotional regulation for the purpose of successful performance is the individual zones of optimal functioning (IZOF) model associated with Yuri Hanin.[123] This model holds that each performer has a unique relationship to emotional arousal, with its effect on attention and tension, and that this relationship must be understood in order for the performer to operate in their ideal range and subsequently have a greater chance of performing at their peak. Thus, a musician's PETTLEP-compliant representation includes the emotional element in two interconnected dimensions: first across a dual spectrum ranging from calm to excited and from confident to anxious, and second in a less systematic use of the emotion

[123] Montse Ruiz, John Raglin and Yuri Hanin, "The Individual Zones of Optimal Functioning (IZOF) Model (1978-2014): Historical Overview of its Development and Use," *International Journal of Sport and Exercise Psychology* 15 no. 1 (2017): 41-63.

meant to be portrayed by the musical performance. In this way, there is a model for the player to include in the mental representation both internal emotion about the performance, and the external emotion intended to be encoded in the performance, linking back to Ericsson's three versions of the mental representation as shown on page 43.

Another emotional consideration for musicians is the venue and type of performance being prepared for. A screened orchestral audition, an onstage performance in a pop style like jazz or funk, and a run of a musical in a pit each have different expectations of appropriate energy levels and performing behaviors. The silence required to maintain the integrity of screened anonymity is unnecessary and undesired in an onstage scenario in which extramusical performative energy is a core element of the performance itself.

3.2a-3 Task

A task can be represented two ways in a PETTLEP image – internal focus and external focus. The difference is most often not in the type of task being represented, but in the element of the task receiving the most attention. In the example of competitive rifle shooters, pre-elite competitors focus primarily on visuo-spatial processing, as opposed to elite shooters who focus on their own motor control.[124] This means that non-experts are consumed with data gathering in finding and focusing on the targets, while experts are able to direct their focus to manipulating their tool correctly. The dichotomy is relevant because research shows different brain areas being activated in performance of internal as opposed to external motor skills.[125] For musicians, this can be understood as the difference between a xylophonist actively looking for and finding the

[124] Paul Holmes and David Collins, "The PETTLEP Approach to Motor Imagery: A Functional Equivalence Model for Sport Psychologists," *Journal of Applied Sport Psychology,* 13 no. 1 (2001): 73.
[125] Jean Decety et al, "Mapping Motor Representations with Positron Emission Tomography," *Nature* 371 (October 1994): 600–602.

correct keys to strike in physical space, and a more expert player being able to functionally automate that task and redirect mental processing toward lateral movement around the keyboard, stroke height and velocity. The amateur-elite dichotomy is also present in many instrumental domains, depending on their relevant circumstances; within the percussion field newer players are often primarily focused on mistakes that can be seen, while professionals are often primarily focused on mistakes that can be heard or felt.

The relevant application of this PETTLEP element is to determine – potentially in consultation with a teacher or coach – whether a given task is executed primarily through internal or external focus, and then to match the mental representation's focus to that variable. "Instructions directing attention away from one's body parts or self and toward the intended movement effect have consistently been found to have an enhancing effect on performance and learning."[126] This recommendation of external focus being conducive to greater motor learning with internal being detrimental presents a potential contradiction between these two publications. The salient difference is that for the OPTIMAL authors, this refers to an attention focus, while the PETTLEP authors are referring to an imagery focus. The attentional focus refers to the point from which the performer is seeking and gaining required information, and to which the performer as seeking to aim their efforts. The imagery focus refers to where the majority of mental energy is being spent to create the mental representation. Thus the operational application for musicians is to find some external point or implement on which to place attention in any case possible; while likewise determining on a case-by-case basis, often in consultation with a coach,

[126] Wulf, Gabriele, and Rebecca Lewthwaite, "Optimizing Performance Through Intrinsic Motivation and Attention for Learning: The OPTIMAL Theory of Motor Learning," *Psychonomic Bulletin & Review* 23 no. 5 (2016): 1396.

whether the task at hand is more important to be mentally rendered in external or internal points of emphasis.

3.2a-4 Timing

Musicians have a unique relationship with time compared to other performance domains. Any activity with direct competition occurring in real time has an inherent benefit to speed in execution, leading to an obvious benefit for performers in those domains creating a correct-speed representation. For musicians however, time is a core and crucial element of the task itself, adding complexity when creating PETTLEP imagery for a musician. Practicing musical passages slower than performance tempos is a ubiquitous technique.[127] Performer anecdotes and teaching tradition support this practice, as does the science of motor learning regarding myelination.[128] Observational studies of practice methods used by musicians across ability levels often include examination of how often slow practice is used.[129] Playing slow at a speed conducive to correct execution before attempting a faster and more difficult tempo is supported by research around creation of new neural pathways and chunking, associated with the discourse on skill acquisition in chess.[130] The findings around the difficulty of replacing incorrectly encoded habits/motor

[127] Paul Sikes, "The Effects of Specific Practice Strategy Use on University String Players' Performance," *Journal of Research in Music Education* 61 no. 3 (2013): 318-333.
Nancy Barry, "A Qualitative Study of Applied Music Lessons and Subsequent Student Practice Sessions," *Contributions to Music Education* 34 (2007): 51-65.
Noa Kageyama, "Is Slow Practice Really Necessary?" 7/21/2012, https://bulletproofmusician.com/is-slow-practice-really-necessary/.
[128] Bill Bachman, *Stick Technique* (Cedar Grove, NJ: Modern Drummer Publications, 2011).
Dominique Bellon, "Application of Sport Psychology to Music Performance," 18.
[129] Susan Hallam, "The Development of Metacognition in Musicians: Implications for Education," *British Journal of Music Education* 18 no. 1 (2001): 27-39.
Susan Hallam et al., "The Development of Practising Strategies in Young People," *Psychology of Music* 40 no. 5 (2012): 652-680.
Susan Hallam, Andrea Creech, Maria Varvarigou and Ioulia Papageorgi, "Are There Differences in Practice Depending on the Instrument Played?" *Psychology of Music* 48 no. 6 (2019): 745-765.
[130] William Chase and Herbert Simon, "Perception in Chess," *Cognitive Psychology* 4 no. 1 (January 1973): 56.
Rose, "An Orchestra Audition Preparation Handbook for Bass Players."

skills with correct ones have a wide audience reach.[131] Since it is so common for musicians to work under tempo, PETTLEP imagery by necessity must be adjusted in its timing application. The two considerations are for the performer to create an at-tempo representation even early on in the process before playing ability reaches performance tempo, and to also create a functional representation at slower tempos matching the player's current ability and practice speeds.

The creation of a full-speed mental representation even before the player is capable of executing at full speed has several benefits: conscious and unconscious improvement to match the representation, awareness through the entire process of which techniques and muscle groups will be required, and psychological preparation and reinforcement that the player is capable of the full-speed execution. This links to the OPTIMAL theory's autonomy and enhanced expectancy factors, as well as an opportunity to prepare musical phrasing and physical gesture decisions mentally before being able to execute physically.

The full-speed mental representation allows a musician to apply the existing domain-specific knowledge to achieve performance tempo sooner. Any musician beyond the initial learning stage has experience and knowledge of instrument techniques required for a successful performance that may not be necessary or relevant for physical execution in the early stages of slow preparation. However, a full-speed mental representation can give the performer reason to think about those elements of domain-specific knowledge relevant to the music being prepared earlier in the process. Percussion educator Bill Bachman, known for his work teaching hand technique especially for marching quads, advises to "practice the faster tempo's technique slowly."[132] This approach combines the value of slow practice for correct myelination and

[131] Charles Duhigg, *The Power of Habit: Why We Do What We Do in Life and Business*, (New York: Random House, 2012).
[132] Bill Bachman, *Stick Technique,* (Cedar Grove, NJ: Modern Drummer Publications, 2011).

mental processing of complex motor skills with the motions and muscle group combinations needed at performance speed. In this way, a full-speed representation can change the player's physical approach to practicing at slow tempos, minimizing the problem of changing techniques – accessing and implementing fundamentally different motor skills – as practice tempo increases.

As explained in Chapter 2 and discussed in Section 3.4, a musician seeing his or her own successful execution through feedback positively impacts learning through the motivational factors of autonomy and enhanced expectancies.[133] This effect can be understood as successful performances increasing player confidence. This can then be combined with the positive effects of imagery to improve motivational factors of motor learning, through the player creating a mental picture of ideal performance even before they are able to produce it.[134] This use of visualization combines the work associated with de Groot, Wulf and Lewthwaite, and Holmes and Collins for greater effectiveness. The musician's domain-specific knowledge of the workings of their instrument and technique inform a full-speed PETTLEP-compliant mental representation, which pre-emptively enhances learning as shown by the OPTIMAL theory.

The more experienced a musician is and the greater body of domain-specific knowledge, the more effective this will be. Elite players with expansive understanding of their field and subfield will have an easier time creating a mental representation that accounts for all PETTLEP elements. This advantage is yet another benefit of extensive domain-specific knowledge and expert-level accumulated deliberate practice hours. However, the positive effects of early-process formulation of an at-tempo PETTLEP mental representation will be perhaps even more

[133] Gabriele Wulf and Rebecca Lewthwaite, "Optimizing Performance Through Intrinsic Motivation and Attention for Learning: The OPTIMAL Theory of Motor Learning," *Psychonomic Bulletin & Review* 23 no. 5 (2016): 1385.
[134] David Wright, Caroline Wakefield, and Dave Smith, "Using PETTLEP Imagery to Improve Music Performance: A Review," *Musicae Scientiae* 18 no. 4 (2014).

beneficial for less experienced, non-expert musicians, as an aid to help them more quickly unify their early-process version of a musical example with the end goal performance version.

Leveraging PETTLEP for a mental representation is also valuable at the player's practice tempo. Improvement of a motor skill includes successful motor performances, driving increasing autonomy and enhanced expectancies.[135] Therefore, a musician practicing at a slow tempo needs those repetitions to be as correct as possible to myelinate and create neural pathways for correct execution. PETTLEP imagery is known to improve performance, so a PETTLEP mental representation should be used to improve performance of practice repetitions, allowing the player to practice most effectively. In this way the player benefits from creating a downtempo version along with the full-speed mental representation. This link between down-speed and real-speed practice has a long history of support; Griffith held in the late 1930s that slow practice of baseball swings is not helpful if not followed up on with full-speed practice to integrate the down-tempo improvements into the real-time execution.[136]

This slower mental representation should still include all PETTLEP elements. Physical, task, learning, and perspective will be largely unaffected by the change in time and speed. The emotion element can be altered to reflect that the repetitions being conceptualized are practice reps, allowing the player to tailor this element of the mental representation to the emotional state in which they practice most effectively. The environment element can also be adjusted away from the performance venue representation needed for the full-speed version, toward a practice environment.

[135] Gabriele Wulf and Rebecca Lewthwaite, "Optimizing Performance Through Intrinsic Motivation and Attention for Learning: The OPTIMAL Theory of Motor Learning," *Psychonomic Bulletin & Review* 23 no. 5 (2016): 1385.
[136] Christopher Green, "Psychology Strikes Out," *History of Psychology* 6 no. 3 (September 2003): 274.

3.2a-5 Learning

The learning element refers to including the improvements the player has made over time in capability, technique, performance, and perception in the mental representation. This leverages the feedback and prioritization elements of the deliberate practice loop to allow the player's memory of correct execution and recognition of appropriate priorities to directly fuel present motor performance. A player's long-term process of improvement feeds directly into the creation of a complete mental representation, as well as a useful and accurate image for the pre-performance routine. Section 3.4 will detail the ways musicians can acquire, archive, and analyze feedback on their playing. The use of digital archiving of recordings along with self-recording, mock auditions/performances, and lessons creates for the player a wealth of data that can function as a basis for understanding progress.

This foundation of information created by the feedback element of the deliberate practice loop allows for more effective and detailed understanding of the performer's learning than is possible without such an archive. This systematized approach to feedback allows for progress tracking over years without the loss of fidelity inherent in using only the player's memory, and allows the performer to leverage their current level of enhanced perception toward performances from an earlier point in development. This then offers the musician the greatest possible breadth and depth of understanding progress, enhancing the learning element of the PETTLEP model for a more correct, complete, and useful mental representation.

3.2a-6 Environment

The concept of visualizing ideal performance in the context of the performance venue is not a novel one; the recent and modern interest in practice techniques has resulted in

practitioners and consultants giving this advice to musicians broadly.[137] At its most basic, this concept involves the player having prior knowledge of the venue, and using that awareness to create the setting for the mental representation. This requires the player to know what the venue will be, and have either firsthand experience or access to as much information as necessary to either re-create from memory or pre-create via imagination the environment as the setting for the representation.

This initial, surface-level application of the environment factor is easiest for tenured orchestra players or established freelancers with a consistent engagement at a particular hall or theatre. Students also have similar relationships to their home venues at the university and conservatory level. Experienced tour musicians coming to a venue they are familiar with also have the firsthand knowledge to create a mental representation with the environment correct. In a scenario in which the player has not been to a venue before, secondhand information must be sought to create the setting for the representation. In the internet age, this primarily involves seeking pictures and video to create the visual image, as well as video and audio to get as detailed an understanding of acoustics as possible.

Musicians have several environmental factors unique from other domains that must be included. The first concerns any large instruments involved; handheld instruments fall under the physical element, but larger, furniture-sized instruments that can't be carried like grand pianos, marimbas, or pipe organs belong more to the environment than the performer's own body. Next is the presence of other players in the performance space. In an ensemble performance of any

[137] Marc Gelfo, "The Critical Importance of Visualization in Music Practice," June 8, 2018, https://www.modacity.co/blog/the-critical-importance-visualization-music-practice/.
Noa Kageyama, "A 7-Point 'How-To' Guide for Effective Mental Practice," https://bulletproofmusician.com/pettlep-a-7-point-how-to-guide-for-visualization/.
Gerald Klickstein, "Mental Imaging," 7-5-2010, https://www.musiciansway.com/blog/2010/07/mental-imaging/.

size, the player's mental representation needs to account for the other musicians involved in as much detail as possible. Number of players, their arrangement in space, their instruments, chairs, music stands, all should be imaged. Performance lighting and temperature should be included in the mental representation. Acoustic issues like reverberation and articulation, as well as relative appropriate volume for the space need to be included as well. Other issues like presence of an audition screen, known audience members or VIPs, or any microphones or cameras in the setup are valuable in completing the representation.

There is an additional element of the dichotomy between creating a mental representation based on the performance environment to be used during practice, and leveraging a practice environment representation in performance situations. This technique allows the performer to use a PETTLEP representation to prepare for the performance environment, and then to leverage the same idea to calm potential nerves in a high-stakes performance.

3.2a-7 Perspective

Holmes and Collins frame the majority of the PETTLEP model from a standpoint of first-person imagery. Their reasoning is the preponderance of available evidence and studies at the time pointing to a first-person or internal perspective's value in motor imagery. They do however begin to examine the mounting evidence for the value of a third-person, external point of view in motor imagery in the perspective section of the original publication.[138] Their ultimate position is that each perspective is valuable, and using first-person and third-person is valuable, and using both or shifting between them can be especially helpful for advanced and expert performers.

[138] Paul Holmes and David Collins, "The PETTLEP Approach to Motor Imagery: A Functional Equivalence Model for Sport Psychologists," *Journal of Applied Sport Psychology,* 13 no. 1 (2001): 76-78.

For the performing musician, the difference in acoustic properties between what the player hears at the point of performance and what the audience hears is a significant enough reason to implement both first- and third-person perspectives. Players on the orchestral audition circuit will benefit from creating a first-person perspective and a behind-the-screen perspective, which itself will be affected by the environment. While musicians working in remote pits or recording studios are similarly concerned only with sound, onstage performers can benefit from uniting the physical and perspective elements in order to include any visual or attitude elements they wish in incorporate into a performance.

The background information accounted for in the environment element is crucial to both the first- and third-person perspectives, albeit in different ways. Envisioning the performance venue from the player's position and the audience's vantage point will create the setting for the mental representation, visually and aurally. Relevant domain-specific knowledge might include microphones, speakers, and effects being used, presence or absence of a screen, and approximate distance between player and hearer as the kinds of variables that can impact the differences between the two perspectives.

In contrast to this third-person perspective from far away, a third-person-close perspective can be valuable for certain contexts. Vocalists may use this near-field third-person representation to envision the objective, non-interfered sound that would be captured by a nearby recorder, in contrast to what they perceive in first person. Musicians who spend the bulk of their playing time in small spaces – orchestral jobseekers with few performance opportunities, theater players in remote rooms, recording artists – may also find this third-person-close perspective valuable as it mimics their most common scenario. As the third-person-far perspective is primarily valuable for the change in acoustics of a large performance space, the third-person-

close offers a performer the benefits of creating and experiencing an imaged performance outside their own body, while remaining close to their imaged performing self. The choice between near and far is domain-specific and tied to the context of the performance being prepared for.

The third-person-close perspective is also valuable for improving technique and instrument/implement manipulation. As the player uses the deliberate practice loop with self-recording along with coach feedback and recognizes technical weaknesses, the player will have a wealth of visual information related to technical deficiencies like finger placement, muscle groups, embouchure, or posture. This information can then be leveraged to create a correct version of the technique element being targeted; a mental representation from the same perspective as the placement of a video recorder can make plain any differences between the performer's intended motor skill execution and actual execution. This exemplifies of the link between the mental representation and feedback elements of the deliberate practice loop.

3.2b Performance and Analysis States

Gallwey's popular concept of Self 1 and Self 2 has become the key popular takeaway from the *Inner Game* series and is a common topic among music teachers, and mimics the concept of Flow associated with Mihaly Csikszentmihalyi.[139] For Gallwey, Self 1 is the conscious state of mind that makes statements like "Come on, Tom, meet the ball in front of you" directed at Self 2, the performer.[140] Csikszentmihalyi's Flow is a concept of mental quiet and total absorption in the task at hand, with the confluence of high-demand and high-skill. The dichotomy between "teller" and "doer" has subsequently been shown to be backed by evidence in the research literature and is fundamental to the understanding of how to implement deliberate

[139] Mihaly Csikszentmihalyi, *Flow: The Psychology of Optimal Experience*, *(*New York: Harper and Row, 1990).
[140] Gallwey, *The Inner Game of Tennis,* 28-30.

practice. I refer to these separate concepts not as differing identities within the performer, but as a performance state and an analysis state.

The simplest version is that the performance state is mentally quiet, oriented on the current moment in time, relaxed and focused on execution while the analysis state is mentally active, oriented toward a moment in the past, engaged and focused on applying scrutiny to the previous performance. Gallwey's premise, supported by the research literature, is that analysis is required for improvement, but analysis during performance causes interference and impedes the performer from achieving at current potential.[141] The interference Gallwey refers to here is not the helpful CI-effect form that improves rate of improvement through greater retention, but a detrimental interference degrading to performance in the moment. Therefore, analysis and performance must be separated from each other.

This concept is a core reason for the inclusion of feedback as a major element of the deliberate practice loop; if analysis and performance could be done simultaneously with no detriment, a separate step would not be necessary. Since these two states are exclusionary, at least in their most effective form, the analysis state demands a segment of undivided attention. Appropriate practice targets cannot be most effectively identified while executing the motor skill or musical segment being practiced, and can only be best discovered through thorough analysis of feedback from any or all of the three sources.

The Mental Representation and Pre-Performance Routine elements of the loop exist in the performance state, and the Feedback and Targeting elements exist in the analysis state. Motivation is not included in either state and functions as a higher-level element, a sort of

[141] Angela Mouton, "Performance Coaching in Sport, Music, and Business: From Gallwey to Grant, and the Promise of Positive Psychology," *International Coaching Psychology Review* 11 no. 2 (2016): 131-134.

deliberate practice executive function that is able to continue the performer's chosen pursuit. The Motivation element sends the performer through the process of the deliberate practice loop, with greater and greater efficacy feeding on the results of the other four elements and sending the performer back through them again and again.

The mental representation is how the performer can funnel data points from the analysis state into a mental image that represents the highest level of execution that the performer can envision. The pre-performance routine is designed to prime the performer to enter the performance state in real time, using information gained by the analysis state as well as the performer's cache of domain-specific knowledge. The performer then shifts into the analysis state, which can be thought of as moving from data collection to categorization and analysis. The feedback element is collection and categorization, as the performer gathers data in the form of feedback gleaned from the three sources of self, peer, and coach. The identification of priorities is a more detailed form of data analysis, in which the performer and coach create an action plan based on the feedback data.

3.3 Pre-Performance Routines

The third element of the loop, pre-performance routines, is another element that has some pre-existing research and usage within music already. Domain-general applications and their relevance to music were established in Chapter 2; this segment aims to show means of application for musicians.

Greene's centering technique, adapted from Robert Nideffer, is a three-breath technique designed to focus the player, and move them to a performance state. The first breath has the performer focus only on breathing itself. The second focuses the player's mind on center of

gravity, hence the name of the process. The final breath focuses the player on the task at hand through use of a cue word, a pre-planned word or phrase designed to orient the player toward the goal. This goal for the musician is the intended interpretation, and ideas for how to shape and craft a given excerpt or piece of music: the mental representation. The purpose of the first two breaths of the centering process is to move the musician from an analysis state or other mental state into the performance state, and the purpose of the third is to activate the musician's mental representation. Thus the entire process results in musicians being mentally prepared to perform at their current potential, and focused on what they mean to achieve. This process cannot be optimally used without a complete and well understood mental representation on which to base the cue word.

The first breath, with the player's focus on breathing itself, has obvious relevance for vocalists and wind instrumentalists, as well as non-technique-based importance for other instrumentalists. The calming and relaxation benefits make this first breath not only valuable for its inherent use, but also as part of the centering technique's relevance in routine, offering the musician the same consistency in varying performance environments as the free-throw shooter in varying environments of distraction and chaos.

The second breath's emphasis on center of gravity is designed to ground the player and allow them to perform from a mental position other than analysis. The concept is that a brain- or head-focused performance is filled with questions, directions, notes from lessons or practice and other details and anxieties the player may have built up through years of deliberate practice, constantly coming face-to-face with weaknesses and failures. The focus on center of gravity is designed to release the musician from that analysis which is essential for long-term improvement, but detrimental to immediate execution.

The third breath is the most complicated and important of the three. The first two breaths have moved the musician into the performance state; this breath is responsible for targeting that focus. To effectively use a cue word to access the musician's mental representation, such a cue word must of course first be decided upon. The cue word is meant to embody a general statement of the ideal performance unrelated to technical jargon or means of implementation, so words relevant to hand or finger motions, face and embouchure technique, or other specialized elements of the task are ill-suited to this use.[142] Conceptual statements like "free," "even," "energetic," or "stately" that encapsulate the musician's intent for performance are the kind intended for use as cue words. This term must be decided upon specifically for each excerpt, song, movement, or piece of music, and the cue word can and should change as the player improves.

In addition to the centering breaths, there exist other pre-performance routine elements that have been shown effective and which can be applied to musicians. Task-relevant physical motions can be implemented into a pre-performance routine effectively, for the purpose of accessing the mental representation of a skill and the cognitive structures from long-term memory, moving into short-term memory.[143] Since short-term memory has been shown more effective than long-term memory, a mimed dry run of the task before actual execution is valuable, demonstrated by Lonsdale and Tam's study of free-throw shooters.[144]

---

[142] Don Greene, *Audition Success*, (New York: Routledge, 2015): 68-75.
[143] "How Matt Howard Used Mental Practice to Win LA Phil," Rob Knopper Video, 3/28/2017, https://www.youtube.com/watch?v=hsqSsa1OerQ
[144] Chris Lonsdale and Jimmy Tam, "On the Temporal and Behavioural Consistency of Pre-Performance Routines: An Intra-Individual Analysis of Elite Basketball Players' Free Throw Shooting Accuracy," *Journal of Sport Sciences* 26 no. 3 (2008): 259-266.

Domain-specific application of this concept will vary significantly based on not only the instrument of the performer, but also the technique required for the individual musical task at hand. Examples of developing this task-specific motion will be shown in Chapter 4.

This task-relevant physical motion, in concert with PETTLEP visualization, can be used to apply the OPTIMAL theory's external focus point. A performer's focus on something external to the body is more effective than a mental focus on the body itself, leading to focus on targets, implements, and instruments rather than muscles controlling them. In the same way as in the mental representation stage the performer must decide what external point is most relevant and beneficial on which to place focus, in the pre-performance routine stage the performer can leverage a consistent routine engaged before each repetition in practice or performance to remind themself to place that focus on its intended object. A task-relevant physical motion attached to a centering routine should include a step of placing visual attention on the point of external focus – similar to the example of a free-throw shooter focusing on the rim while miming their shooting technique before each shot.

3.4 Feedback

In order to accurately judge current performance and have data form which to plan future practice sessions, feedback is required. In either the absence of feedback or the presence of misinformation, mistakes are likely to remain not because of inability to remedy them, but simply do to lack of awareness of the mistake's existence. In my deliberate practice loop, feedback comes from the three separate sources of self, peer and coach. Coach feedback in the form of one-on-one lessons with a trusted teacher is the most ubiquitous form of this element within music, followed by peer feedback and self evaluation, which are often not given the same systematic rigor as lessons. Despite often being the two less-discussed forms of feedback for the

musician, self and peer do not require scheduling and paying a teacher, making them often more readily available sources of feedback than lessons. Coach feedback is often expensive, whether as part of higher education or a private teaching relationship, and limited to merely a few hours per month. In contrast, peer feedback is often given with no exchange of money and with easier setting of appointments. Self feedback requires no resources beyond basic recording capability, and no additional time beyond regular practice hours, and non-practice analysis time. For this combination – resource and time expense – self feedback is by far the most common source for musicians.

The key and primary means of optimizing self-feedback is through a systematic digital archive of recordings, relevant domain-specific knowledge, interpretation decisions, technical and artistic problems discovered and their appropriate solutions, feedback given, and other relevant data. An archive system allows a performer the ability to review previous ability to understand improvement over time, store lesson advice, and make it easier to bring a piece of music back to its previous level after a long period without playing or studying it. This method of tracking progress mimics the emphasis in sports on film breakdown and study. This segment of Chapter 3 is largely focused on the methods of creating and managing this digital archive for long-term improvement.

In the present day, smartphones, personal computers, cloud storage and easy-to-use data storage programs are ubiquitous. Multiple possible options exist for creating and organizing this archive – Haaheim uses a method leveraging iTunes metadata to embed information into mp3 files of self-recordings, mock auditions, lessons, and recordings of live auditions.[145] Regardless

[145] Jason Haaheim, "Practicing Without Feedback Is Like Bowling Through a Curtain," 3/19/2018, https://jasonhaaheim.com/practicing-without-feedback-is-like-bowling-through-a-curtain/.

of the software setup employed, this archive allows for the systematic record keeping of advice and learning throughout the course of a musician's career, allowing easy reference particularly when revisiting a work not performed for some time. In addition, this archive can include relevant domain-specific knowledge including tempos, style, instrument-specific decisions (tunings, fingerings, pedalings, bowings, breath decisions), and a list of recordings consulted. Haaheim's preparation process for an individual timpani excerpt included gathering roughly 30 reference recordings from respected orchestras and clocking each of them for exact tempos, from which to extrapolate a mean average of tempos as well as a tempo range. These tempo data points allow the musician to create a highly informed decision as to the tempo most likely to be expected by the greatest number of listeners – clearly relevant for the committee-based blind auditions of American orchestras as well as more subjective processes.

Self-feedback relies primarily on self-recording; use of mirrors during practice can be helpful for certain instruments with visually apparent technical skills, but does not offer the ability to shift from the performance state to the analysis state to observe the performance the way recording does. This recording is possible with merely a modern smartphone, a dedicated all-in-one video recorder, or a high-end studio quality camera and microphone setup. Regardless of the technology, performers can set up their own recording to capture their current ability for later study and analysis. The core reason for this, in addition to archiving for study months or years later, is to separate the performance state from the analysis state. The Self 1/Self 2 model of Gallwey's *Inner Game* series is based on the psychological concept that the performer is not capable of completely focused analysis during performance, nor is the performer capable of total performance focus while analyzing success or failure. Through self-recording, the musician is able to focus entirely on playing during practice, and outsource analysis tasks to a later time. An

ancillary benefit of this technique is that the musician gains extensive experience performing while being recorded, reducing anxiety by gaining familiarity.

The musician's process of reviewing and analyzing self-recordings benefits greatly from a quantifiable priority structure. One such way of ordering musical priorities is the pyramid structure posed by Haaheim, shown below in Figure 3. While the overall deliberate practice loop is cyclical and presents each element linked to each of the others with all valued essentially equally, this pyramid for ordering priorities is a hierarchical one. Elements at the top represent the ultimate aim at which deliberate practice is pointed, while those at the bottom are the foundational blocks that are absolutely essential to allowing the structure to stand at all. Haaheim credits the creation of this structure partially to former National Symphony timpanist and current Indiana University Professor of Percussion John Tafoya; it is targeted specifically for orchestral timpani playing but is largely domain-general in nature.[146] The pyramid is built atop a three-legged stool, noting with that analogy that each leg is vital to the structure and without any one of them, the entire construct falls. This concept conveys that within orchestral timpani playing, each of the three bottom points is foundational: a failure in time, rhythm, or intonation is so systemic as to render the above elements irrelevant. These three elements also differ from those above them in that they are objective – metronomic time, rhythmic relationships and intonation are objectively correct or incorrect and can be assessed without need for stylistic or other subjective determinations. The pyramid itself then follows a bottom-up model of priority, asserting that mistakes in elements lower on the pyramid take precedence over higher order points. Haaheim's pyramid is presented here not as a crucial element of the deliberate practice loop, but an example application of a construct designed for domain-specific application of

[146] John Tafoya, *Beyond the Audition Screen: Advanced Repertoire for the Orchestral Timpanist* (Hal Leonard, 2012).

orchestral timpani auditions. The domain-general concept can be applied to other musical domains, tailored for each application by the musician using it. Various other art music styles may preference sound quality or timbre more importantly than the foundations of Haaheim's model; stage musicians might feel that stage presence and performative energy have a foundational place. The placement of specific elements and which ones appear in the structure are malleable by domain; the concept of a structure of musical priorities that can guide listening and prioritize improvement is consistent. The function of this pyramid is to guide the player's listening in when reviewing recordings, and as an aid in the recognition of practice priorities.

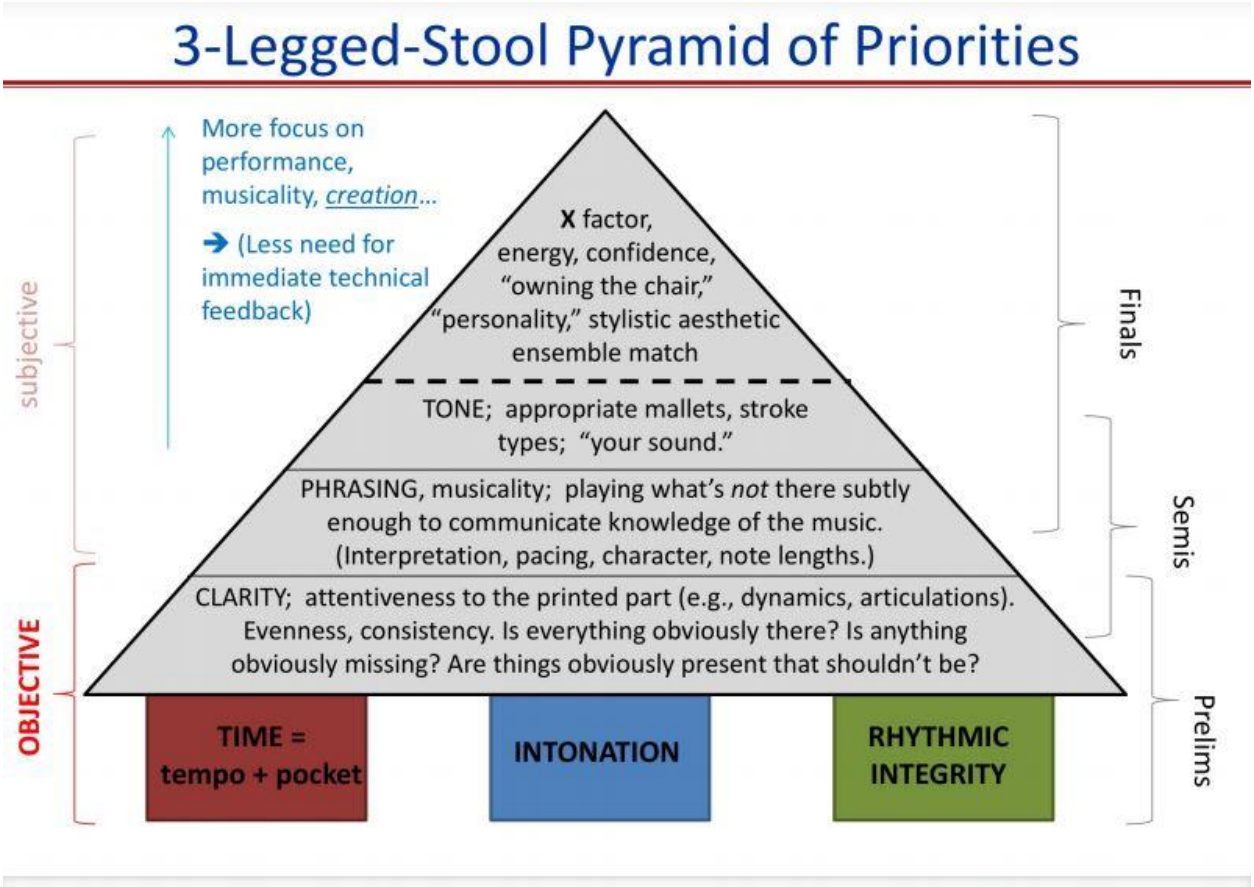

Figure 5: Jason Haaheim's 3-Legged-Stool Pyramid of Priorities

Self feedback is invaluable in feeding into the enhanced expectancies element of motivation, and the PETTLEP mental representation. As the musician continues reviewing recordings, continual experience seeing improvement feeds directly into the confidence of enhanced expectancies, resulting in improved motor learning and greater interest in continuing the process. Likewise, as the player continues observing effective improvements in execution, these experiences go on to fuel the player's evolving mental representation of an ideal performance. Yet another intra-loop connection is to the pre-performance routine, as musicians can use a similar method to Lonsdale and Tam's study to track percentage of correct routine executions, and relationship between correct routine and successful performance repetitions.

Peer feedback is more freely available than that from a teacher, while still an opportunity to gain relevant and informed opinions from trained ears. This element comes in two primary forms – formal mock auditions/performances, and informally playing for a peer. While the latter has value for both mitigating nerves of performance and gaining feedback, mock performances are far more useful given their total mimicking of the performance state.[147]

Mock auditions should be organized with as much consistency between the mock conditions and the actual performance as possible. Examples of elements to be matched include playing full performance runs without interruption, using correct instruments, implements, and effects, as normal of a performance space in size and acoustics as possible, and screens if appropriate. The two primary advantages of mock auditions over self-recording are experience

[147] Astrid Baumgardner, "Mock Auditions at the Yale School of Music: A Rich Growth Experience for Music Entrepreneurs," 9/18/2015, https://www.astridbaumgardner.com/blog-and-resources/blog/ysm-mock-auditions/.
Jason Heath, "Contrabass Conversations 560: Mock Auditions at the San Francisco Academy," 1/28/2019, https://contrabassconversations.com/2019/01/28/mock-auditions-sfa/.
Golden Lund, "Orchestral Tuba Audition Preparation: The Perspective of Three Successful Teachers," (DMA Diss., University of Nebraska-Lincoln, 2013): 6, 34, 43.

performing the selected repertoire for a live audience, and data about the subjective elements of the musician's interpretation.

While a musician can reliably self-assess the objective issues in performance that tend to be at the lower, foundational part of the priority structure, the opinions of other informed musicians are crucial to getting feedback about the higher, more subjective elements. In seeking out this primarily subjective peer feedback, the player must maintain a network of trusted peers at a similar skill level, capable of listening in an informed way and willing to give engaged comments. The determination of who to invite for mock auditions is up to each musician; exact match of ability level and interest is less important than familiarity with the musical style, sufficiently advanced musical perception, and ability to communicate feedback understandably.

The player continues to accrue the same benefits from recording mock auditions as from self-recording in terms of archiving for long-term study in the future, and separating performance and analysis states. Additionally, this stage gains the added benefit of allowing the player to be fully present after performance in conversing with peers instead of focused on taking notes. The player also benefits from recording mock auditions in the ability to archive feedback received over time, to compare feedback from different sources and at different points in time. The musician also has the ability to reference a mock performance's recording and compare to the feedback received.

Access to coach feedback is rare and usually expensive, increasingly so as the musician progresses in their career and needs ever more specialized training and feedback. Thus the musician requires a way to maximize this type of feedback given its value and scarcity. The purpose of seeking coach feedback is to gain knowledge the player does not already have. Coach feedback is about information and guidance to increase potential and more consistently reach it,

not primarily an increase in potential during the lesson itself. This requires an effective teacher-student relationship, and a student's effective preparation for the lesson itself.

The centerpiece of this preparation is a list of problems and questions the player means to bring to the teacher, based on observations from self and peer feedback. In this way, the lesson's total time can be spent on information transfer, demonstration, and implementation for maximum effect. A lesson so dense with information will benefit from being recorded, just as self and peer feedback do. Pending the teacher's permission, each lesson should be recorded, stored in the player's digital archive, and rewatched afterward for notes. This allows the player to focus totally during the lesson rather than interrupt it constantly to take notes, similar to how self-recording allows the player to work fully in the performance state while practicing and fully in the analysis state when reviewing the recording. Haaheim recommends total verbatim transcription of each lesson.[148]

3.5 Prioritization

The last element of the loop is the one that guides deliberate practice. The most important weaknesses, recognized through analysis of feedback received, drive creation of targeted exercises designed to mitigate and eliminate performance weaknesses. This element of the loop is the one most contingent on domain-specific variables, since performance-critical inflection points vary so widely between types of musicians. Because of their highly contextual nature, practice priorities are largely recognized in consultation with a coach. Likewise, ways of practicing to improve these priorities are also often derived through coach advice, with additional

[148] Jason Haaheim, "No One Gets There On Their Own," Oct. 15, 2018, https://jasonhaaheim.com/no-one-gets-there-on-their-own/.

experimentation by the performer. This high reliance on teacher feedback to inform practice prioritization underscores the need to record and archive lessons for analysis and reference.

Three main categories exist for priorities in deliberate practice for the musician: mechanics, fundamental execution, and interpretation. Mechanics refer to physical motion and instrument manipulation. Fundamental execution includes foundational elements of performance that are more objective and exist lower on the priority structure; examples include time, intonation, and adherence to the printed score. Interpretation includes higher-level artistic considerations and performer decisions like phrasing, tempo and dynamic alterations, and timbre decisions. These elements feed into each other in a similar way to the bottom-up relationship of musical concepts. A compelling interpretation may be the higher-level goal of the performance, but without proper execution of the fundamentals supported by correct mechanics, the high-level artistic considerations can be rendered irrelevant through being marred by mistakes. The interpretation point refers to the macro-level stylistic intent of the performance and elements like note lengths, phrase shaping, overall artistry and expression of musical ideas that live at the top of the Haaheim pyramid. These examples are illustrative rather than empirical; differing genres and styles of performance value different elements of performance.

Mechanics are the most technical of the three types, with the greatest emphasis put on instrument and implement manipulation – the musician's physical control of their tools. These are elements that can be easily observed through self-recording, and experienced performers usually have a wealth of domain-specific knowledge on which to rely for analysis. Initial recognition of failures in mechanics can be done either through video itself, or through hearing mistakes that are clearly related to failure of mechanics. Once this weakness has been identified,

future rounds of deliberate practice can benefit from altered camera placement to get ideal angles for evaluation in self feedback.

Fundamental execution refers to elements of performance that are more objective and foundational to the performance like time, rhythm, and intonation, along with basic elements like characteristic sound quality. This level is commonly where failures in mechanics manifest their musical results; for example, weak breath support for a wind player resulting in an inability to play a long lyrical phrase in one breath. Weaknesses at this level, as with mechanics, are best targeted through exercises designed to work the specific deficiency. These exercises may be drawn from a domain-relevant method book or other pre-existing resource, or created by the player and coach specifically for the player.

Interpretation execution relates to the higher elements of a priority structure that are more subjective, as artistic concerns outweigh technical ones. At this level, instrument-specific techniques become irrelevant and only the effectiveness of the performance is at hand – making peer feedback from sources that do not play the performer's instrument most valuable in recognizing subjective weaknesses. Another value in soliciting feedback from musicians who don't play the performer's instrument is in avoiding dogma about technique schools and teacher-tree tribalism. Interpretation priorities are less instrument-specific than mechanics and fundamentals, but feedback for the interpretation of individual pieces or excerpts is highly specific since it largely relates only to the music in question.

Once the player has identified these elements needed to improve, focus turns toward the day-to-day work of improvement itself, through applied deliberate practice and repetition of the exercises created for them. Ericsson notes one of the core elements of deliberate practice is its focus on small elements of the skill rather than its totality in non-immediately-rewarding

repetitive informed practice.[149] The feedback and prioritization elements of the deliberate practice loop combine to inform the player's practice, so that sufficient repetition can be efficient – but is not a replacement for extended time improving the skills.

3.6 The Deliberate Practice Loop in Greater Detail

I present here a deeper diagram explaining the inter-relationships between loop elements as discussed in Chapters 3 and 4. This version of the graphic is intended to add depth and illustrate the complexity of the loop; the added information requires it to be laid out left to right rather than the circular structure. As noted earlier, John Boyd's OODA loop functioned as the inspiration and model for my deliberate practice loop conception, and Boyd's work featured both a supremely simple version depicting the core of the idea, and an expanded graphic demonstrating the interrelationships and deeper understandings of the concept. This graphic aims to fill that role here, now that the loop's scientific foundations and musical applications have been examined in depth.

[149] Ericsson, "The Role of Deliberate Practice in the Acquisition of Expert Performance," 368.

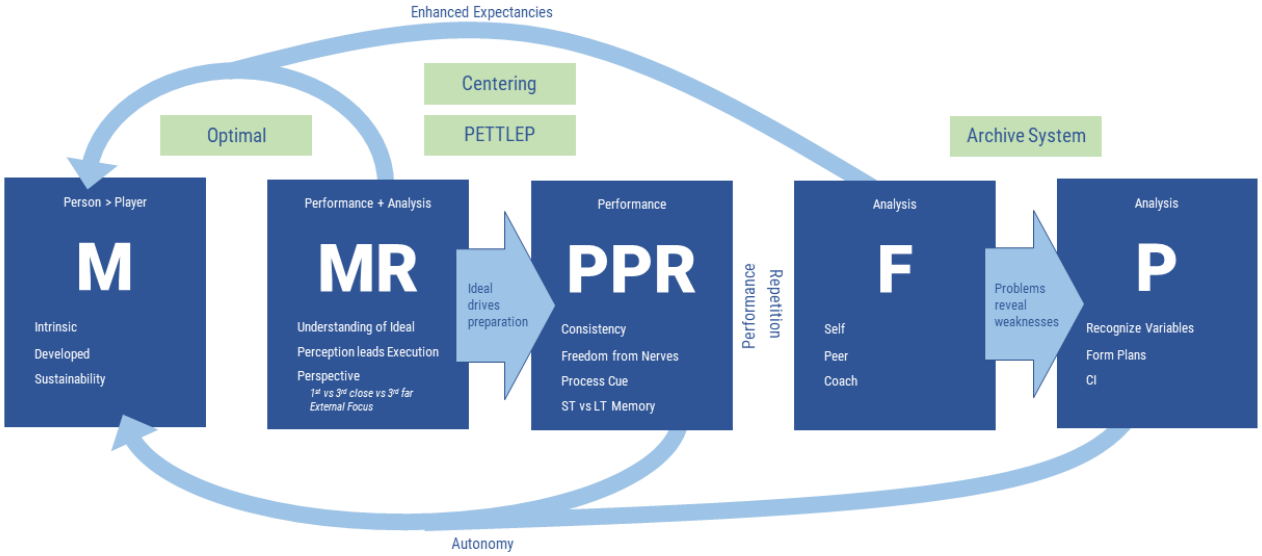

Figure 6: The Deliberate Practice Loop in Greater Detail

Each box represents the five elements of the loop in order left to right, with text inside the box denoting the mental state of the musician during the element of the loop; motivation is an exception, including instead the person before player reminder. The green boxes overlapping multiple elements represent core ideas that exist and support both elements they cover. Arrows pointing right represent the means in which elements drive directly into the next; mental representation becomes data that is loaded by the pre-performance routine, and feedback becomes data that the targeting stage determines how to use. Arrows pointing leftward represent the points of the OPTIMAL theory that enhance motivation; enhanced expectancies from the player experiencing progress through feedback and mental representation, and autonomy felt as control of outcome through practice targeting and ever-more-tailored pre-performance routines. Below each element are the three to five key sub-elements included within it; performance and

repetition are represented between the pre-performance routine and feedback stages. This version of the graphic is designed for use to explain the concept in greater detail visually than is possible in the first version, and as a more complete representation for players who already understand the constant turnover of the deliberate practice loop.

The deliberate practice loop is valuable for performers of any domain and at any level, but will be applied differently by domain. The most salient and observable difference in loop usage between novice, advanced, and expert performers will be in the feedback stage; as a performer gains skill and experience their reliance on coaches and lessons wanes in an inverse relationship to their command of their craft. The intuitive and natural appearance of expert performance in any domain is a marker of an individual's understanding of their tasks and ability to self-diagnose an greater percentage of possible errors.

This difference is supported by the greatly expanded depth and breadth of an expert's mental representation. Compared to the novice, the expert's version is more detailed in its audiovisual fidelity and the details of its other senses; this advantage extends through each element of the PETTLEP model. The expert is able to load this more complete and useful representation into a pre-performance routine that has been used many more times, in which the expert is able to trust through countless repetitions of using it to launch into increasingly-effective performances with diminishing distraction. The expert is able to more quickly analyze feedback because of their greater understanding of which elements are core and key to effective performance and their extensive understanding of priorities for each individual task at hand. The many years and countless repetitions in various environments and at extremes of comfort and anxiety, and the presence and absence of pressure give the expert earned confidence and a

sweeping feeling of control – the physiological elements of motivation that increase practice efficiency.

CHAPTER 4: PERCUSSION-SPECIFIC APPLICATION

This chapter demonstrates loop application in two example percussion applications, solo marimba and orchestral timpani. These two are chosen for their complexity, relevance to the percussion community, presence of literature from which to extrapolate domain-specific issues, and ability to exemplify the ways in which the deliberate practice loop can be applied in myriad other musical applications. This chapter is not designed merely to be a guide for marimbists and timpanists working in these very narrow applications, but more importantly to illustrate how the concepts of the loop can be applied toward a musical situation in an informed way. I rely on published statements in each field, along with my own expertise to illuminate the issues at hand and how the loop addresses them.

4.1 Solo Marimba

In this section, I apply the deliberate practice loop to *Reflections on the Nature of Water* (1986), a six-movement marimba solo by Jacob Druckman which has become a standard for graduate students and professionals alike.[150] The second movement, "Fleet," is primarily based around a single technical idea known as the 4312 permutation; mallets are typically numbered 1-2-3-4, left to right from the player's perspective. This specific permutation is extremely common in solo marimba repertoire, and is idiomatic for all the common grips used to play the marimba with four mallets.[151] Both hands are executing lateral movements from outside to inside mallets, a motion suited for fast playing.[152]

---

[150] Jacob Druckman, *Reflections on the Nature of Water*, (Boosey & Hawkes: 1986).
[151] Payton MacDonald, "Disappear Swiftly: An Analysis of 'Fleet' from Druckman's 'Reflections on the Nature of Water,'" *Percussive Notes (*June 2003): 38.
[152] Nicholas Papador, "Singles, Doubles, Triples: Rudimental Building Blocks as Applied to Four-Mallet Keyboard Technique," *Percussive Notes (*August 2004): 52.
Leigh Howard Stevens, *Method of Movement for Marimba*, Asbury Park: Keyboard Percussion Publications (2000): 36.

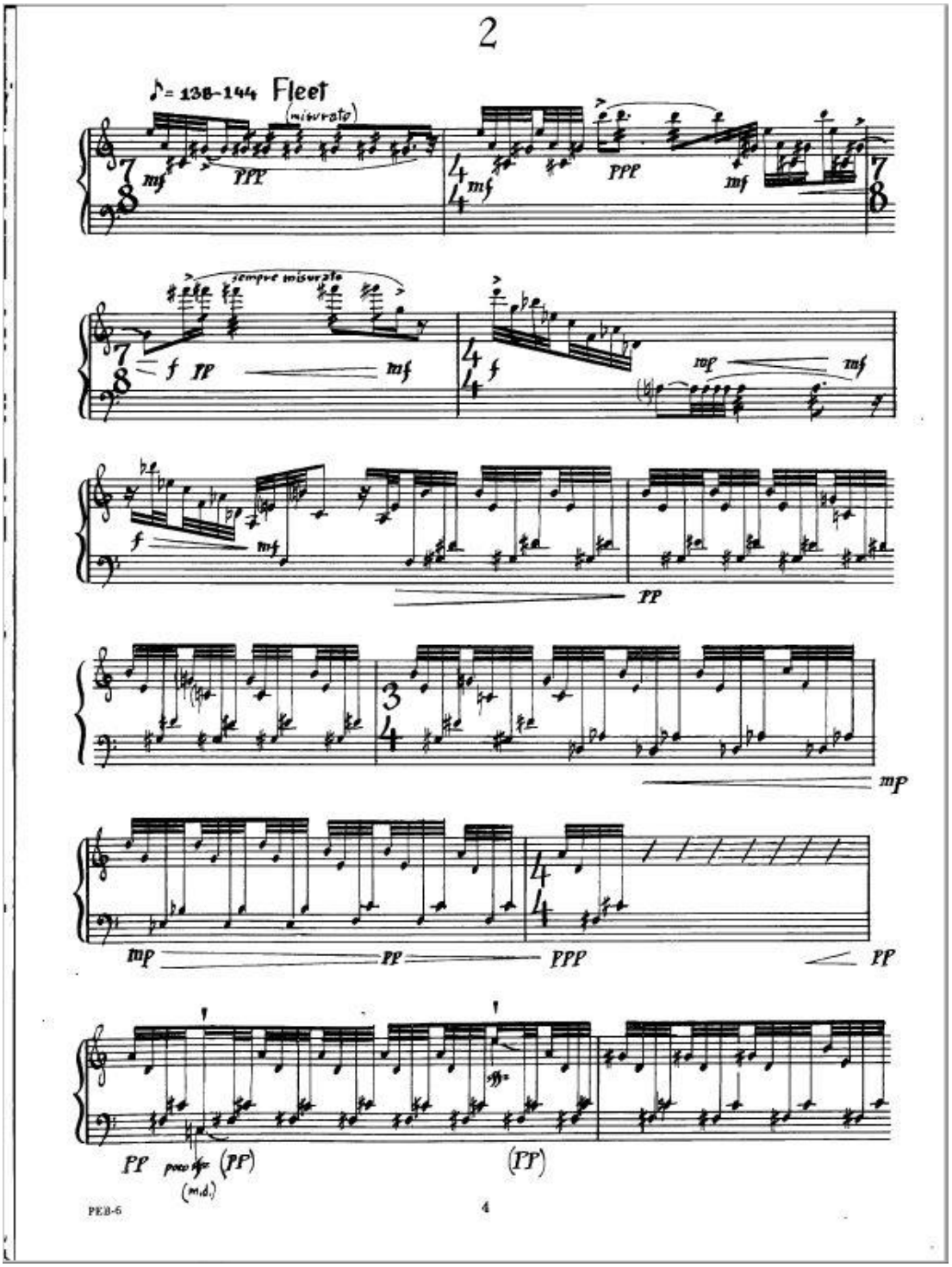

Figure 8: First page of "Fleet," *Reflections on the Nature of Water*

Following its commission through the National Endowment for the Arts in 1986, this work has become a cornerstone of the solo marimba repertoire.[153] Because of this, initial motivation to begin the deliberate practice process might stem from an understanding that there is a weight and gravitas expected from performances of *Reflections*, and meeting or exceeding that bar can have positive reputational effects on a musician's career. The work is often asked on lists for graduate school admission, assistantships, and solo competitions,[154] so there may be an additional financial incentive to play at the highest level possible. The OPTIMAL elements of increased competence and autonomy based on increasing successes at performing the work are not relevant motivational factors at the outset, because no deliberate practice has been done. However, it is possible for autonomy to be felt if there was a choice in selecting the music, and musicians can also draw on previous experience with other music for expectancies.

The ubiquity of the 4312 permutation means that on seeing the music for "Fleet" the first time, there is an instant familiarity with the technical demands of performing it – especially when compared to the more abstract first, third, and fifth movements of *Reflections*. This movement contains the most traditionally idiomatic marimba writing among the six, [155] making it a simple task to create a mental image of an ideal performance. Therefore, the initial representation will move to a higher level of detail, including concepts like beating spot, physical positioning, and footwork. Difficulties can be anticipated before they are encountered, such as the need to move

[153] I-Jen Fang, "The 1986 National Endowment for the Arts Commission: An Introspective Analysis of Two Marimba Works," (DMA Diss., University of North Texas 2005): 1.
[154] Universal Marimba Competition and Festival Belgium http://www.marimbacompetition.com/nl/repertoire
World Marimba Competition http://www.worldmarimbacompetition.com/2020/repertoire.html
Percussive Arts Society Solo Percussion Competition https://www.pas.org/soloartist
New York International Percussion Competition https://www.newyorkipc.com/repertoire.html
[155] Payton MacDonald, "Disappear Swiftly: An Analysis of 'Fleet' from Druckman's 'Reflections on the Nature of Water,'" *Percussive Notes* (June 2003): 38.
I-Jen Fang, "The 1986 National Endowment for the Arts Commission: An Introspective Analysis of Two Marimba Works," (DMA Diss., University of North Texas 2005): 21.

physically to the left in the first half of m. 4 to be in correct position for the repeated A's in the end of that measure. Dynamics should be included even in this early conceptualization, and differences in tone quality for the *poco sFz* and *sFFz* in m. 11 should be imaged as well. The composer's son, New York Philharmonic percussionist Daniel Druckman uses bold text in a companion book to emphasize the importance of this dynamic tiering.[156]

The physical, task, timing, and perspective elements of the PETTLEP model can be included in the representation even before any physical practice. Experience allows effective imaging of body position, grip, muscle groups, and footwork without a great deal of feedback on this particular movement, and working the music up to speed creates its own level of familiarity sufficient to update the mental image with ever-improving capability in both task and timing. Practice room experience can be used for first-person perspective imaging, with self-recordings aiding to create third-person images using the practice setting as the environment. This mental representation includes the performance itself, but not the eventual environment and audience, previous improvement and learning over time, or the dual emotion components of self and audience.

Creating a representation for this movement includes recognizing musical priorities. The Haaheim pyramid shown in Chapter 3 functions as a model, but requires alteration for this differing application. The objective, non-negotiable foundations are similar – this highly-rhythmic movement requires good time and rhythm in order to function artistically, but intonation is not a performance concern for the marimbist. Because a performer is not capable of controlling pitch during performance, that element can be better expressed by the term

[156] Daniel Druckman, "Marimba Masterclass on *Reflections on the Nature of Water*," (Galesville MD: Meredith Music, 2012): 8.

"accuracy;" simply striking the correct bar is a difficult element of marimba performance. Above this foundation of time, rhythm, and accuracy sit the elements of fundamental execution – adherence to the dynamics, tempos, and character of the printed part, convincingly performing the syncopated phrase groupings later in the movement, and effective footwork supporting hand technique. Above that are more subjective issues including timbre – mallets chosen, beating spots, velocity – and bringing to the movement the energy and drive needed to support its title and character. Toward the upper, more artistic end of the structure is that character itself – using the more technical building blocks of the performance like mallet choice, beating spot, and velocity to create a coherent soundscape toward a compelling interpretation. The structure is topped with connecting to the audience; this goal is extremely subjective, but can be a functional guide for improvement in interpretation. As noted above, this structure is based on Haaheim's pyramid, but altered to be relevant and effective for this performance application.

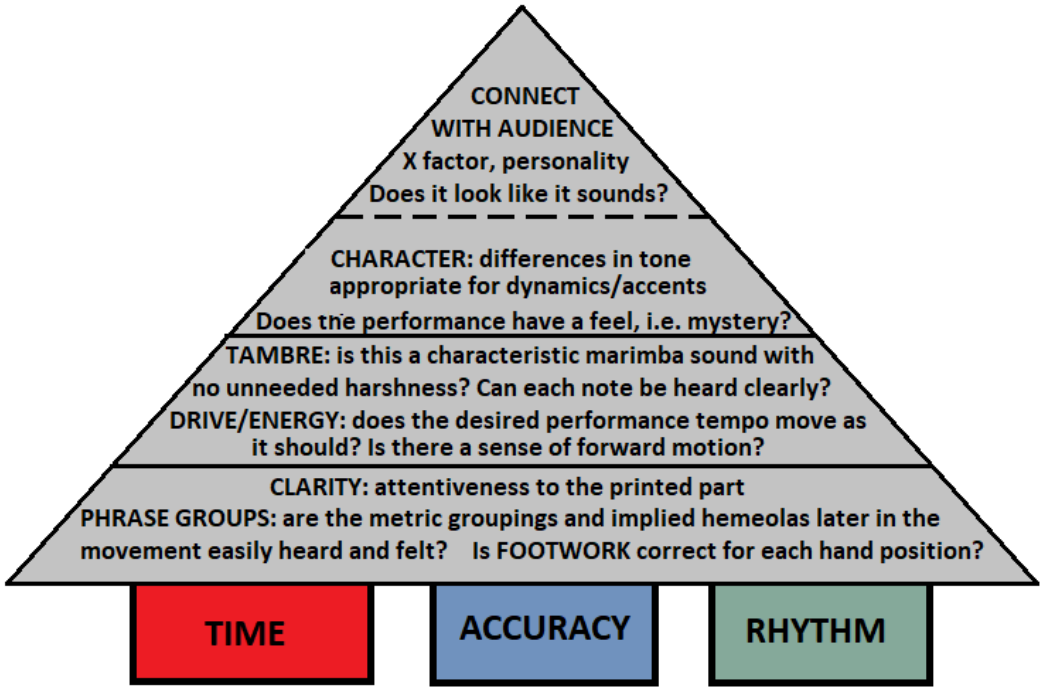

Figure 9: A Priority Pyramid Targeted for "Fleet"

The early stage of preparation requires gaining familiarity with the physical motions required to play accurately with ideal beating spots. Inhaling while lifting the hands one count before playing will prepare for the motion. Movement and kinesthetics are the primary focus with pitch accuracy functioning as a diagnostic indicator of success; Gordon Stout's marimba technique book *Ideo-Kinetics* addresses ways for marimbists to train their proprioception and spatial skills for accuracy across the keyboard.[157]

A common issue with this 4312 permutation can be incorrect turning force, which is when the inside mallet and outside mallet do not strike the bar with the same energy. When this occurs, it leads to an uneven sound quality with an unintended rhythmic emphasis on the first and third notes of each group. This can appear to the percussionist through self-recording. The technical solution is to actively apply turning force to the stroke of the inside mallet as a second part of the stroke. Leigh Howard Stevens, noted marimbist and namesake of one of the three modern four-mallet grips, refers to this turning force as "torque;" this has become a standard term among marimbists.[158]

This problem in the permutation may be noticed either by hearing uneven sound quality or seeing a lower height from the inside mallet. These dual means of diagnosis are a premier example for the value of audio-video recording over audio only. The cause, insufficient torque, can be recognized either by self-diagnosis or in consultation with a teacher. Current execution of the chosen four-mallet grip should then be examined, identifying the correct technical changes

[157] Stout, Gordon, *Ideo-Kinetics*, *(*Keyboard Percussion Publications, 2001).
[158] Stevens, *Method of Movement,* 35-36.
Ney Rosauro, "Crossing Grip Extensions," *Percussive Notes* (February 1998): 32-35.
Julie Spencer, "The Horizontal Concept of Marimba Technique," *Percussive Notes* (Fall 1987): 38-39.
Nicholas Papador, "Singles, Doubles, Triples: Rudimental Building Blocks as Applied to Four-Mallet Keyboard Technique," *Percussive Notes* (August 2004): 48-56.

needed to even out the height and velocity difference, and creating a plan for correcting this technical insufficiency.

While self-feedback is sufficient for analysis of objective elements like consistent volume, appropriateness of tone is much harder to judge given microphone limitations and the inherent difference in experience between recorded sound and live. This makes peer feedback and mock performances valuable, particularly for the low C and high E in the bottom line of the first page. These notes are intended to stand out from the texture, and it can be difficult to calibrate the exact force and velocity with which to play them in order to achieve the two-voice dynamic effect, while avoiding the abrasive sound and risk of instrument damage that can easily result from striking a low-register marimba bar with articulate mallets and high velocity. And given the sometimes-significant difference between timbre heard in the player's position and even ten feet away, the performer is not able to discern it by oneself, but does not necessarily require a teacher's expertise. This is a prime opportunity to use mock performances to gain subjective interpretation feedback data, by asking informed listeners if those notes are effective as currently played.

With the initial representation, a starter pre-performance routine, the self-diagnosed torque issue in the 4312 permutation, and an appropriately dialed-in dynamic on the accented notes in the bottom line, the player is prepared for an extremely efficient lesson. Thus the lesson skips an initial diagnosis-ex-nihilo phase and moves directly to informed analysis of the most important current problem.

The priority at this stage is this inconsistency of sound quality in the repeated 4312 pattern – easier to recognize with the earlier creation of an informed priority structure placing rhythm as a foundational leg. Thus, given the prioritization choices this player has made,

successes in timbre on the accented notes are less important than the obfuscated rhythm because of its more foundational position at the bottom of the structure, resulting in a lesson focused on the most pressing issue rather than an interpretation-focused session that misses the most glaring flaw in the current performance. Correct torque then becomes the priority for this permutation in general, and this segment of "Fleet" in specific. The collaboration between teacher and student on a plan to fix this technical deficiency creates awareness of how to execute the skill correctly.

As the loop returns to its starting point, motivation is enhanced by the more detailed level of information into personal execution that has been earned by deliberate practice up to this point. The OPTIMAL theory's autonomy factor refers not only to learner choice, but also the feeling of agency and control – thus increased understanding of the variables in the player's control supports greater learning and retention. The self-diagnosis of the torque issue, along with dialing in an effective stroke type for the accented notes, gives greater understanding and command over elements that impact a successful execution. In the same way, expectancies are enhanced through having watched, heard, and experienced improvement through feedback. Multiple subsequent recordings will have shown greater familiarity and comfort with the music, as well as improved rhythmic consistency through technical focus on torque. Sound quality improvements are more difficult to immediately notice in most cases depending on microphone and playback quality, but improvements in creating a suitable sound on the accents will support improved confidence as well. This autonomy and confidence combine to improve learning and retention, fueling initial motivation and desire to continue working.[159]

[159] Gabriele Wulf and Rebecca Lewthwaite, "Optimizing Performance Through Intrinsic Motivation and Attention for Learning: The OPTIMAL Theory of Motor Learning," *Psychonomic Bulletin & Review* 23 no. 5 (2016): 1384.

The continuing process integrates new knowledge and skill improvement into the mental representation, and adds the rest of the PETTLEP elements. The multisensory video representation will be enhanced with additional focus on the accented notes and correct torque, as supported by the technique plan devised in consultation with a teacher. This can be done either during mental practice time set aside specifically for this purpose, or in spare moments according to the player's schedule. Awareness of the outsized importance of inner mallet torque in the 4312 permutation leads to a zoomed-in focus on that element in the mental representation, as well as while watching self-recordings. As an example, m. 9 contains only the permutation with no pitch changes – an ideal opportunity to focus on imaging the pattern correctly, with perfectly matched height and velocity between all four mallets. This represents an example of the learning element of the PETTLEP model; improvement over time is being included in the representation as capability and understanding of the ideal is enhanced.

Adding environment to the mental representation is contextual – with a great deal of time left before a performance, the player may decide to continue using the practice room or lesson room as the setting of the representation since these are the most relevant contexts for the music. If performances are rapidly approaching, setting the mental representation in the environment of the performance is pivotal for mentally preparing for that moment – an opportunity for pre-mitigation of performance anxiety. This element should include the exact performance instrument itself to account for potential differences in bar width, ergonomics, acoustics, and sight picture between the performance instrument and any practice instruments being used.[160]

[160] Linda Maxey, "On Stage: The Art of Performing. Part II: Developing Confidence in Performing," *Percussive Notes* (June 1998): 36.
Payton MacDonald, "Wuorinen's *Marimba Variations*: Adventures in Memorization, Performance Practice and Improvisation," *Percussive Notes* (January 2013): 54-57.

Additional inclusions are the standard points for all musicians – the hall, audience, acoustics, temperature, and lighting.

"Fleet," like *Reflections* as a whole, is a nonprogrammatic work, so arriving at a decision on the type of emotional content to encode for the audience is both difficult and illustrative. In attempting to include every element of the PETTLEP model, a musician would be reminded to consider this issue which can clarify and aid the process of making interpretation decisions. This particular movement's rhythmic drive and variations in timbre make abstract concepts like curiosity and mystery good options; Payton MacDonald's analysis refers to "the unstable, shimmering character of the surface gestures."[161] Including the player's internal emotional state while performing the movement is another opportunity to mitigate performance anxiety ahead of time. In the case of a frequently-nervous or stressed performer, including a sense of calm or authority in the representation can result in that actual feeling manifesting at the moment(s) of a performance, because the moment has been seen and felt many times before.[162]

This mental video should not be of some hypothetical marimbist, but a vision of the player's own body, in performance dress, on stage at the performance venue, in the right lighting and temperature, behind the marimba to be used in performance. The visualization should also include as detailed a picture of the audience as can be anticipated, at as close to the performance tempo as can be consistently imaged at the current understanding of the ideal, while feeling the desired performance-state emotions from both first-person and third-person perspectives. This level of detail now includes each PETTLEP element, to maximize the positive impact of using imagery. The goal is to create a complete mental image of the highest level of performance

[161] Payton MacDonald, "Disappear Swiftly: An Analysis of 'Fleet' from Druckman's 'Reflections on the Nature of Water,'" *Percussive Notes* (June 2003): 34.
[162] Don Greene, *Audition Success* (New York: Routledge): 79-80.

currently conceivable; creating this image requires practice time devoted to mental practice similar to training the body to execute physically.

With a targeted priority, a focused routine can be created. A cue word must be chosen that invokes the ideal and is not based in technique; for this example, "pulsing" would be appropriate, as it includes the ideal of rhythmic clarity and has some relevance to the title. MacDonald mentions "swift" and "undulating" to describe the movement's soundscape and these may be helpful as well.[163] This focus on the goal rather than the means frees the mind from the analysis and micromanagement that is necessary while working on the exercises to improve the technique, but detrimental in performance.[164] A task-relevant motion might be added, mimicking the motion of the 4312 pattern with correct torque behind the instrument just before performance – pulling the motor skill from long-term memory into short-term for better execution. Thus an example of a complete routine would include: while standing back from the marimba, inhale. Exhale slowly while mimicking the 4312 pattern with correct torque. Inhale, think "pulsing" and step forward to the instrument and bring hands up, with mallets over the initial 4 pitches. Exhale for relaxation, inhale one beat before starting, and play. This routine takes less than ten seconds, but offers consistency of start, second-time motor function on first-time execution, relaxation, focus, and a guiding statement of the ideal. All of these pre-performance routine benefits are rooted and based in the work completed in the other four elements of the deliberate practice loop.

[163] Payton MacDonald, "Disappear Swiftly: An Analysis of 'Fleet' from Druckman's 'Reflections on the Nature of Water,'" *Percussive Notes* (June 2003): 34-39.
[164] Patrick Thomas, Shane Murphy, and Lew Hardy, "Test of Performance Strategies: Development and Preliminary Validation of a Comprehensive Measure of Athletes' Psychological Skills," *Journal of Sports Sciences* 17 (1999): 708.

In continuing to review self-recordings for assessment the primary interest is the torque issue, but focus is on evenness of sound rather than torque itself in order to recognize whether the goal has been achieved. The next step is visual assessment of whether technique is correct, whether the height and velocity of inside mallets matches the outside mallets, and if there is an inconsistency between hands. Recognition of new problems may lead to self-diagnosis, allowing independent initiation of the loop's next stage without need of direct teacher guidance. If a performance level has been reached at which no new problem can be self-recognized, or a new problem is recognized but cannot be self-diagnosed, peer or coach feedback through mock performances or lessons offer opportunities to gain the necessary additional data.

From this feedback, a new priority will emerge. The low C in the bottom line of the page requires the right hand to cross over the left.[165] Because of the crossover technique, a common mistake is a higher-than-necessary right hand position for the low C, causing a more acute angle to the bar and a thinner sound with more overtones compared to the fundamental pitch. This stroke is also physically inefficient, with significantly more energy used than normal for the amount of volume produced because of the angle problem. These notes are meant to pop out of the 32nd-note texture as a second voice, so the player must create a full sound in these instances, not a muffled or harsh one. In consultation with a teacher, a plan will be created to train for effective execution of this technique.

As the loop begins again for a third time, greater confidence has been earned not only through enhanced understanding of what causes a successful execution, but also through hundreds of increasingly successful executions in hours of deliberate practice after the last

[165] I-Jen Fang, "The 1986 National Endowment for the Arts Commission: An Introspective Analysis of Two Marimba Works," (DMA Diss., University of North Texas 2005): 22.

priority was recognized and incorporated into the routine. This process is not effective without repetition, both to create consistency and leverage the confidence benefits of seeing successful executions over and over – through video recording, mental rehearsal imaging, and through a player's own eyes during execution. Many repetitions of improvement give additional confidence, engaging enhanced expectancies to a higher degree. A higher degree of autonomy is engaged through additional understanding of the variables affecting successful execution of the 4312 skill and the right hand crossover skill.

The low-hand, correct-velocity crossover stroke is added to the previous mental image of a correct-torque 4312 permutation, creating a more detailed mental representation. This is based on experience playing the low C too harshly, having felt the stiffness of the mallet in the hand as it responds to that stroke, and having heard the difference between a full, fundamental-focused sounding low C resonating over the 32nd-note figure warmly as opposed to the short and overtone-heavy tone of the incorrect approach. These kinesthetic and aural experiences can inform the representation as well, allowing focus on the correct feel in the mallet's response of the bar and the most desirable tone out of the pitch.

An updated cue word that more correctly meets current needs for maximizing the chance of successful execution can be chosen. With the newer priority of a low-hand, correct-velocity crossover in m. 10, the cue word might be "round" or "full" or some other word that describes the ideal sound of that single note. Practice hours have moved from working one measure at a time, toward potentially repetitions of the entire first page. Even for this larger segment, the most important problem is currently the crossover in m. 10, so it is valuable for the cue word to focus on that single note. There are 283 notes struck on the first page of "Fleet," yet in this example the highest priority for successful execution of this segment is to correctly execute only one, so

mental energy can be focused on that one note with trust in prior stages of deliberate practice to correctly execute the other 282.

Recordings can then be analyzed for effectiveness at the priority of low-hand and correct-velocity crossover in m. 10, alongside continual awareness and analysis of torque in the 4312 permutation, and all other concerns leading from the bottom of the priority structure moving toward the top. Even though the performance state is no longer focused on correct execution of the original priority, the analysis state is still responsible for assessing it. This analysis state determines whether the issue remains resolved, or if it has reappeared and requires additional attention. This exemplifies a core reason for separating performance state from analysis state, to create a scenario in which the player can perform in the moment without constantly processing small details, while also continually analyzing to focus practice for continual refinement.

By this point, execution has become consistent for both the 4312 permutation and the crossover in m. 10. Technical deficiencies that were causing musical imperfections have been resolved, leading to the new focus becoming higher-order musical issues at the top of the priority structure rather than technical ones at its base. An orchestral player focused on screened auditions would move to primarily listening with little interest in the visual aspect of the recording, since visual indicators of technical imperfections are no longer required. However, the marimba soloist, who performs for audiences who are influenced by the visual aspect of the performance, continues to have significant use for the visual element of self-recordings.[166]

[166] Mary Broughton, and Catherine Stevens, "Music, Movement and Marimba," *Psychology of Music* 37 No. 2 (2009): 137-153.
Sofia Dahl, "The Playing of an Accent: Preliminary Observations from Temporal and Kinematic Analysis of Percussionists," *Journal of New Music Research* 29 (2000): 225–233.
Sofia Dahl and Anders Friberg, "Visual Perception of Expressiveness in Musicians' Body Movements," *Music Perception* 24 (2007): 433–454.

Contemporary solo percussionist Cameron Leach refers to creating an "intentional and empathetic performance" through use of self-recording in order to judge effectiveness of his interpretation decisions and their effect on an audience.[167]

A possible distracting mannerism in the first page of "Fleet" is to take a noticeable physical relaxation moment in m. 9, allowing a visual if not audible letdown in the intensity inherent in the character of the music. Since m. 9 is the simplest measure of the page to execute, "perhaps even more legato than measure 6,"[168] and the only one in which no mallet changes pitch, the player's breath, posture, and demeanor may inadvertently suggest momentary apathy. In this scenario, focus has moved toward the upper ends of the priority structure – basic and intermediate concerns have been rectified, exposing high-order issues of artistry that were hidden behind rhythmic inconsistency and harsh sound quality before.

The immediate next subsequent round of the deliberate practice loop would include continued motivational benefits from increased knowledge of controllable factors affecting success, and additional recordings of improvement. The mental representation will continue to integrate improvements to the crossover low C, along with others made through the practice process. To fix the newfound visual relaxation issue in m. 9, intentional mental practice time should be spent crafting how to physically perform so that it looks the way the player wants it to sound. The pre-performance routine's length and rhythm can remain, but the cue word may

---

Jane Davidson, "Visual Perception of Performance Manner in the Movements of Solo Musicians," *Psychology of Music* 21 (1993): 103–113.
Michael Schutz and Scott Lipscomb, "Hearing Gestures, Seeing Music: Vision Influences Perceived Tone Duration," *Perception* 36 (2007): 888–897.

[167] Renee-Paule Gauthier, *The Mind Over Finger Podcast* Ep. 24 Cameron Leach: Communicating Through Intentional and Empathetic Performing, 28:35-30:54, March 14, 2019.

[168] Daniel Druckman, "Marimba Masterclass on *Reflections on the Nature of Water*," (Galesville MD: Meredith Music, 2012): 8.

benefit from an update; instead of "pulsing" with the focus on the rhythmic pattern or "round" for crossover sound quality, "engaged" may be most effective for staying mentally and physically energized during the entire movement, even the moments of technical ease. This move toward the top of the priority structure will shift even more responsibility onto peer and coach feedback, as mock performances and lessons are increasingly more responsible for getting ever-more-subjective feedback on interpretation and presentation elements in polishing the overall performance.

4.2 Orchestral Timpani

This example demonstrates loop application for a commonly asked timpani excerpt, the coda of the first movement of Beethoven's Ninth Symphony. This particular excerpt has eight measures of a 32nd-note figure at letter S that are well-known in the timpani community for the difficulty of playing them evenly in terms of time, dynamic, and tone quality.[169]

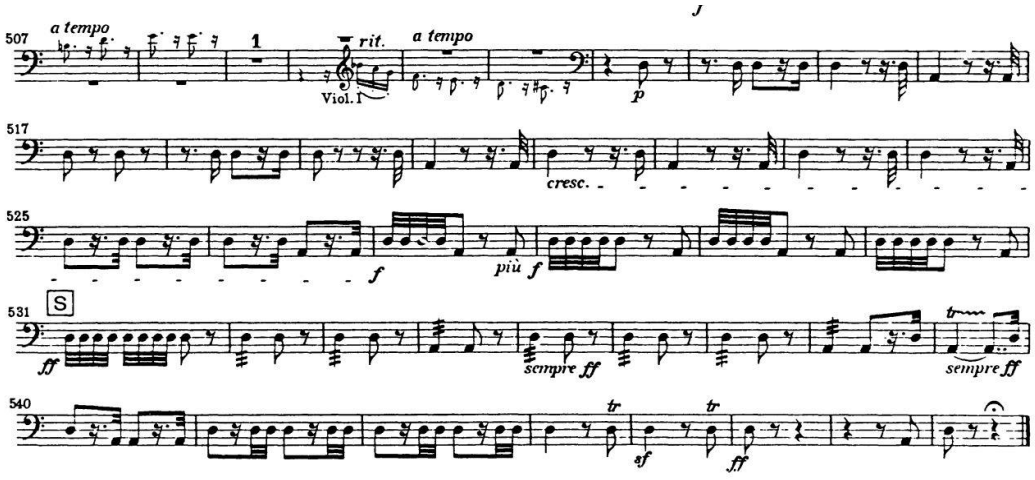

Figure 7. Beethoven's Ninth Symphony, Timpani. First Movement Coda.[170]

[169] Michael Israelievitch, "Beethoven: Symphony No. 9, 1st Mvt," New World Symphony video, 3:00, https://musaic.nws.edu/videos/beethoven-symphony-no-9-1st-mvt.
John Tafoya, *The Working Timpanist's Survival Guide* (Carl Fisher, New York, 2004): 40.
[170] Ludwig van Beethoven, *Symphony No. 9 in D Minor*, Opus 125 (Leipzig: Breitkopf und Härtel, 1863).

The process begins with the performer's initial desire to engage in the activity. This excerpt is one of the most frequently requested for professional auditions, summer music festivals, and graduate schools alike, so this initial motivation is likely to be found in a causal relationship between being able to perform the excerpt at a high level, and achieving professional goals.

In the first stage of deliberate practice, expectancies are not yet enhanced because no feedback and experiences have been collected. Autonomy is low as well since audition repertoire is chosen by audition committees rather than candidates. There is also little choice in musical interpretation at this stage, because the music is not known with enough depth to understand the breadth of options available. Initial motivation may be intentional and conscious; the physiological benefits of motivational factors of motor learning are not yet active before beginning the deliberate practice process.

An initial mental representation is built from a combination of score study, listening, and the initial pass of playing through the excerpt. The resources needed are the printed part, the score, quality recordings, and practice time. Key points here are to study the most relevant edition and check for any discrepancies between part and score. In this example, there is a sFz marked in m. 532 that is commonly ignored.[171] In addition to a sense of what the music sounds like along with style and character, another goal is to acquire a target tempo for performance. This can be easily done by listening to multiple recordings, using a metronome's tap function, making notes of these tempos, and marking the average range of tempos used by major orchestras. After disregarding outliers and recognizing patterns, a musician can make a more

[171] Michael Israelievitch, "Beethoven: Symphony No. 9, 1st Mvt," New World Symphony video, 10:37, https://musaic.nws.edu/videos/beethoven-symphony-no-9-1st-mvt.

informed decision on target tempo combining one's own preference with a dataset representing a normative range. For this orchestral timpani application, the player is seeking yes votes from a committee of trained orchestral musicians, and thus is benefitted by presenting an interpretation that is consistent with the committee's expectations. San Francisco Symphony principal timpanist Ed Stephan uses the phrase "conceive, then achieve" in his teaching; with part, score, recording, and tempo range in hand, all necessary information to conceive a desired sound is present.[172]

As a performer prepares an excerpt, the internet offers many resources, some more valuable than others. Options like YouTube, Spotify, Idagio, and Medici TV allow performers access to representative recordings from which to glean data to inform an interpretation – in consultation with a trusted teacher to determine which recordings should or should not be referenced. For this excerpt, there exists a wealth of publicly available online recordings that can be measured for tempo, creating a data set from which to make an informed decision about target tempo for an audition version. Armed with this knowledge, an initial practice session of familiarization with the music can begin including physically playing the part on the instruments, along with making initial decisions about sticking, instrument choice, and tuning. With score study, listening, and familiarization with playing the excerpt completed, the initial mental representation can be created by combining memory of favored recordings with imagination of ideal performance, resulting in a multisensory image of the current goal.

Pre-performance routines should be established as early in the learning process as possible, to leverage the benefits of their use even in the initial stages of preparation. Los

[172] Ed Stephan bio, San Francisco Conservatory, accessed May 25, 2021, https://sfcm.edu/faculty/ed-stephan.

Angeles Philharmonic principal percussionist Matt Howard partially attributes his audition win to his use of task-relevant physical pre-performance routines targeted for the motor skill that needs to be executed.[173] The task-relevant motion in this application is simple – determine where hands and sticks need to be positioned to prepare each repetition for success, and include moving to that position in the routine. The excerpt begins at a low dynamic with material that is not challenging from a technique standpoint, allowing for placing the mallets on the heads silently in the correct beating spots as a way to make the first notes predictable every time. This has an additional benefit of anchoring the player in a familiar physical position each time the excerpt is started whether in practice, mock performance, lesson, audition, or live performance. Additional elements to be included in this routine are placing feet on the pedals to be prepared to correct intonation errors, and setting correct posture and distance from the drums – these take virtually no time at all, and ensure an optimal physical starting point.

This excerpt's 2/4 time signature and simple, unsyncopated rhythms lend themselves to being easily judged for correct time. Thus a cue word like "time" or "precise" is appropriate to focus the player on a key element of the music that is clear for listeners to assess. Time is one of Haaheim's three legs supporting the pyramid of his priority structure for orchestral timpani; its objective nature and clear importance make it a reasonable focus for early improvement in this excerpt.

The next element of Greene's centering process to be applied is the player's breathing.[174] The first breath is for relaxation and focus, with the sticks placed on the heads on the exhale as posture and positioning are checked kinesthetically. A second preparation breath can then be

[173] Rob Knopper, "How Matt Howard Used Mental Practice to Win LA Phil," March 28, 2017, https://www.youtube.com/watch?v=hsqSsa1OerQ&t=665s
[174] Don Greene, *Audition Success* (New York: Routledge): 62-64.

taken, on the silent beat 1 of the first measure of the excerpt, starting mental 16th-note subdivision before playing the first note on beat 2. This process ensures physical readiness, emotional relaxation, and cognitive focus before the first note of the excerpt, with a prescribed silent physical motion that begins the performance. This pre-sound start is preparation for ideal execution of consistent rhythmic pulse every time the excerpt is started, and creates consistency.

After continued practice to increase familiarity with the excerpt and integrate the routine, self-recordings should be reviewed and analyzed for successes and failures measured against the priority structure. Failures lower on the structure take priority for refinement, since those errors – for example, an incorrectly-tuned perfect 4th interval – so mar the performance that successes in interpretation or phrasing are irrelevant. For example, consider that after several self-recording repetitions it is determined that time and rhythm are being played correctly, but that the passage at mm. 531-538 is unclear because of dynamic and sound quality inconsistencies. This common issue is usually caused by inconsistent stick height, angle, velocity, or grip pressure between right and left hands. Saul Goodman – New York Philharmonic principal timpanist from 1926 to 1972 – writes that "the tympani should be struck in the same area of the head each time. If this is not done, a variety of uneven sounds are produced" and "it is essential that the player equalize the strokes in order to produce an even sound."[175]

The first task is to attempt to self-diagnose this issue. This is an example of a technical deficiency at the lower end of the priority structure creating a musical problem at the higher end. Targeted camera angles in additional self-recordings can be useful in showing which of these problems is causing the inconsistent sound quality.

[175] Saul Goodman, *Modern Method for Tympani* (Alfred Publishing, 1948).

Peer feedback through mock auditions is also valuable in recognition and diagnosis of this type of problem. Other trained timpanists can be expected to notice the sound difference, quickly recognize potential causes, and suggest using the recording process to look for hand-to-hand technique discrepancies. Non-timpanist musicians will lack the domain-specific context to diagnose and prescribe, but may be even more effective at hearing the initial sound differences.

A lesson will be far more efficient in solving this pre-diagnosed problem; rather than the teacher having to spend precious minutes identifying the problem, that time can be saved for additional depth of focus making recommendations and testing them, or moving on to additional problems from other music the student is preparing. Systematic use of self and peer feedback before the lesson results in greater efficiency during the lesson, more information transfer, and thus more effective practice afterward.

Common methods of improving these issues are extensive technical exercises designed to match hand movements and velocity, and a focus on kinesthetic awareness of grip pressure. Use of mirrors during practice is an extremely common tactic across percussion applications as well; in this case watching the hands and sticks in a mirror while repeating the 32nd-note task in this segment can immediately illuminate any stroke inconsistencies.[176]

The prioritization stage will then focus on creating practice methods and exercises to target the weakness – inconsistent 32nds caused by inconsistent hand technique. This 32nd-note passage is a classic example of a musical demand that is simultaneously simple and difficult – each of the nine notes in this grouping needs to speak in a consistent volume and tone, despite

[176] Jeffrey Moore, "Specific Practice Strategies," *Percussive Notes* (April 2003): 24-25.
Stephen Howard, "Efficient and Effective Practice," *Percussive Notes* (August 1997): 54-57.
Kirk Gay, *Pedal to the Kettle: Etudes and Solos for Timpani* (Portland, Tapspace 2009): 5.
Donald Gilbert, "Timpani Education Report," *Percussionist* 16 no. 1 (Fall 1978).

being played with two different hands, each holding a different stick, and playing on a head with slight changes in tension after each strike. Any difference in hand position, angle, starting stroke height, or stroke velocity will result in differing amounts of energy transferred into the head by each stick, and contact with different parts of the mallet and the head, causing the sound inconsistency. Remedies will include significant repetition of hand-to-hand warmup exercises at all dynamics and tempos, with primary attention to consistent wrist position within the context of correct time, rhythm, and intonation. While visual and kinesthetic focus are necessarily on the two hands matching their stick motions, this process also benefits from auditory focus on sound quality, to monitor for the musical benefits of this technical work.

This new level of awareness that sound quality in the 32nds is contingent on matched technique between the hands functions to support autonomy. In addition to choice in learning, autonomy as defined by the OPTIMAL theory also includes confidence that the performer has the knowledge and ability to create success.[177] Thus the additional information from the previous round of deliberate practice enhances motor learning for future improvement. Reviewing archived recordings likewise supports enhanced expectancies.[178] Through seeing continual improvement over the course of practice, the expectation for the level of the next repetition is raised, supported by the feeling of control noted above. The original conscious motivation remains, but successes enhance it to serve as a more solid foundation for continued deliberate practice.

[177] Gabriele Wulf and Rebecca Lewthwaite, "Optimizing Performance Through Intrinsic Motivation and Attention for Learning: The OPTIMAL Theory of Motor Learning," *Psychonomic Bulletin & Review* 23 no. 5 (2016): 1395.
[178] Shannon Clark and Diane Ste-Marie, "The Impact of Self-As-A-Model Interventions on Children's Self-Regulation of Learning and Swimming Performance," *Journal of Sports Sciences* 25 no. 5 (March 2007): 577-586.

The mental representation can now be updated with this new information. With this experience of playing the excerpt alongside time spent reviewing self-recordings, a multisensory and multi-perspective model of ideal performance can be created. The hand position priority should be included, giving extra attention to imaging and imagining two hands perfectly matched, in the exact correct position – even if current performance ability has yet to be able to physically do this.[179] Creating this model allows comparison between ideal and actual performance in the next round of feedback review. While the first mental representation was primarily audio and based almost entirely in recordings and the printed part, there is now a full audiovisual mental video of the player's own physical body playing the music as correctly as it can currently be conceived.

This new representation can now be mentally loaded before performance, so the cue word should be updated. Part of the benefit of a consistent pre-performance routine is in moving the motion from long-term to short-term memory, so a task-relevant motion similar to Nash's free-throw routine can also be helpful to gain the benefits discussed in Chapter 3.[180] The 32nd-note passage beginning in m. 531 is the current priority, so a pre-performance motion emulating that as closely as possible is appropriate, to consciously and physiologically remind of intended execution. This adds an additional step to the routine – before the existing step of placing the sticks on the heads to prepare, the player silently plays two measures at m. 531 in the air, focusing on correct height, angle, and wrist position, and hearing the most ideal sound quality of that phrase in the mind's ear. In this way, the last ten to fifteen seconds before the practice or

[179] Dave Smith, Caroline Wright, Amy Allsopp, and Hayley Westhead, "It's All in the Mind: PETTLEP-Based Imagery and Sports Performance," *Journal of Applied Sport Psychology* 19 no. 1 (2007): 89-90.
[180] Chris Lonsdale and Jimmy Tam, "On the Temporal and Behavioural Consistency of Pre-Performance Routines: An Intra-Individual Analysis of Elite Basketball Players' Free Throw Shooting Accuracy," *Journal of Sport Sciences* 26 no. 3 (2008): 259-266.

performance move the 32nd-note motor skill into short-term memory along with the mental representation.[181] Then, the original routine of placing the sticks on the heads, breathing, and using a cue word commences. To line up with the new focus, the cue word is changed to "even" or "matched."

When self-recordings are reviewed with this new information, attention is immediately focused on hand position and technique at letter S. As hand positioning is continually refined, sound quality can be listened for in order to assess the musical effectiveness of the technical improvement. Should the hand position problem remain, it is now more easily visually identified. Once recognized, it is easier to unify video feedback with the kinesthetic-included mental representation. The best-case scenario is a performance of the excerpt that has markedly better consistency in the 32nd-note passage at S, with a visibly correct technique between both hands resulting in an audibly clearer musical phrase.

With the 32nd-note issue understood, focus can shift to improving artistic interpretation and phrasing through mock auditions. A commonly nebulous issue in this excerpt is exactly how loud the roll in m. 539 should be, along with timbre and roll speed (the frequency of stick strikes against the head, creating the illusion of a sustained tone). By assembling panels of trained musicians, it is possible to create focus groups to try varying options against each other, gain subjective feedback, and make an informed decision.[182] Consider a scenario in which three mock auditions are held, each with five musicians listening. At each event, a version A and a version B of the excerpt are performed; version A is more aggressive, with greater volume and faster roll

[181] Dennis Norris, "Short-Term Memory and Long-Term Memory are Still Different," *Psychological Bulletin* 143 no. 9 (2017): 993-994.
[182] Musical U, *The Musicality Podcast*, "Music Learning at Warp Speed, with Jason Haaheim," Nov. 2, 2018, 1:06:30-1:08:00, accessed May 25, 2021, https://www.musical-u.com/learn/music-learning-warp-speed-jason-haaheim/.

speed compared to version B's more relaxed interpretation. If listeners are asked their preferred version and at the end of the process there are significantly more votes for version A than for version B, that would suggest that the more aggressive approach to m. 539 is usually more effective. With a large enough sample size to account for statistical noise in the data, this technique allows interpretation decisions on subjective issues to be based on feedback and data rather than merely personal preference and intuition.

This subjective data for interpretation alongside continued self-recording feedback for technical improvement results in preparedness for a lesson of discovery of new problems and solutions, rather than rehashing previous information for incremental gains. With the technical deficiency obfuscating correct time and rhythm at 531 reduced or rectified, and an effective dynamic interpretation of the roll at 539 in place, a teacher might now be able to shift higher up the priority structure toward phrasing, with an ear for the macro-crescendo that characterizes this excerpt from start to finish.[183]

Focus has now shifted toward artistic and interpretation concerns in longer phrases, shifting the priority from individual technical concerns and shaping single measures toward musical storytelling. In both the sparse opening section and the more active one beginning at m. 527, there is now less concern about ability to control time and dynamic, and instead more concern about shepherding the listener's experience through that moment dynamically. Therefore, practice repetitions which isolate the section from mm. 513-526, and mm. 527-530 are less relevant than a transitional segment from mm. 525-528 focused on dynamic and sound character, to unify these segments for a greater whole.

[183] Michael Israelievitch, "Beethoven: Symphony No. 9, 1st Mvt," New World Symphony video, 1:00, accessed May 25, 2021, https://musaic.nws.edu/videos/beethoven-symphony-no-9-1st-mvt.

A timpanist preparing this excerpt is likely to experience these particular issues, but they are of course not exhaustive. A comprehensive list of all possible mistakes and their subsequent remedies is not possible, helpful, or the focus of this chapter; I aim to present how individuals can use this method to take agency in their own deliberate practice process. This segment has been designed to be illustrative with examples that are both easy to understand and commonly encountered, both for the good of timpanists looking to apply this method and for musicians in general. Any performer with enough training and experience can self-diagnose technical and musical issues, in consultation with peers and teachers, to subsequently apply this method to their personal priorities for improvement.

CHAPTER 5: CONCLUSIONS AND FUTURE RESEARCH

This interdisciplinary deliberate practice loop combines existing findings for a unified approach to a music improvement process. My novel contribution is in combining existing science toward a single model for their unified application. It offers musicians a research-backed method for increasing practice efficiency. Techniques like visualization, pre-performance routines, archiving feedback, and prioritizing process over results have long been used by players in fields with systematic and highly competitive auditions; this model offers a clear explanation of known valuable techniques and a concise way to unify them. This chapter examines the ways in which I have answered my guiding inquiries, presents the two graphic representations of the loop once more, and suggests directions for future study.

5.1 Research Answers

The overarching question guiding this research has been "How can the research of expert performance, performance psychology, and motor learning inform an effective process of deliberate practice for music performance improvement?" The deliberate practice loop functions as an integrated construct answering that question. The loop represents the intersection of the science around long-term lifestyle decisions conducive to high achievement, human physical skill training, and mental strategies for peak performance. This intersection aims to unify strategies proven effective for improvement into a single multifaceted process. The loop also presents a holistic picture of interrelated deliberate practice strategies that can function as an antidote to musicians or teachers narrowly using a single book or technique for peak performance strategies, the way Gallwey or Greene's books are often recommended.

Chapter 2's examination of the science behind the deliberate practice loop and common applications answers the first sub-question: "what are domain-general elements of effective deliberate practice?" The main elements are an intrinsic desire-based motivation, enhanced expectancies, learner autonomy, multisensory mental representations supported by experience and domain knowledge, targeted use of contextual interference, creation and integration of pre-performance routines, self-recording, mock auditions, effective lessons, an archival method, and targeted prioritization of practice time. Many of the examples used in that chapter come from sports and games: chess cognition, free throws in basketball, film study, and skill acquisition studies in any number of sports. The nature of deliberate practice lends itself toward things that have clear success conditions because those types of activities are easier to assess – makes and misses, wins and losses. This clarity in these studies offers data illuminating deliberate practice strategies, with enough similar studies being done in music to demonstrate transferability of the concepts underlying the tested methods. The loop diagram is entirely domain general, and was created by recognizing combinations of domain-general findings from the sport psychology, motor learning, and expert performance discourses.

The next sub-question, "How can these elements be used in domain-specific ways for performing musicians?" is about operationalizing the research-backed strategies in practical ways. Most of the answers to this question are existing practice strategies known to be useful for music training; the novel contribution of this work is in relating them to scientific research and combining them for snowballing improvement. Strategies like PETTLEP visualization, targeted pre-performance routines designed for each musical task, self-recording, deliberate mock performances and lessons, and digital archiving represent the key operationalizations for music

training. Chapter 3 examined these applications toward music training broadly; Chapter 4 demonstrated how to create targeted plans sharpened over time alongside continued refinement.

The final question surrounds packaging deliberate practice as an understandable process, asking "How can a process of improvement for music performance be concisely expressed?" The loop construct is the primary answer to this question, as a single unified construct encompassing the concepts from research and practice that drive effective deliberate practice. The graphics, presented again below, are designed to visually represent the elements of deliberate practice. The initial version is designed as a simple, surface-level explanation of the basic concept; the second is designed to more completely explain the interrelationships of the distinct elements.

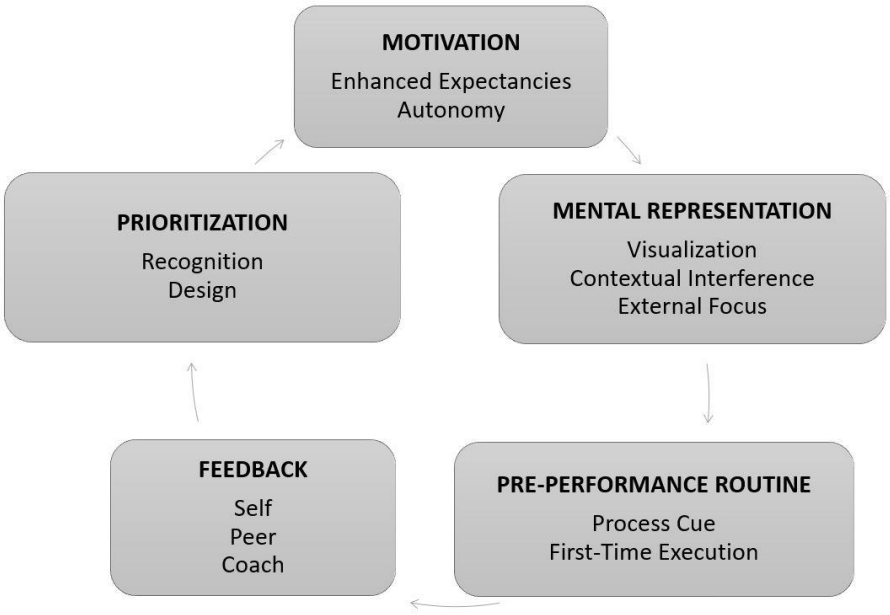

Figure 17: The Deliberate Practice Loop Initial Graphic

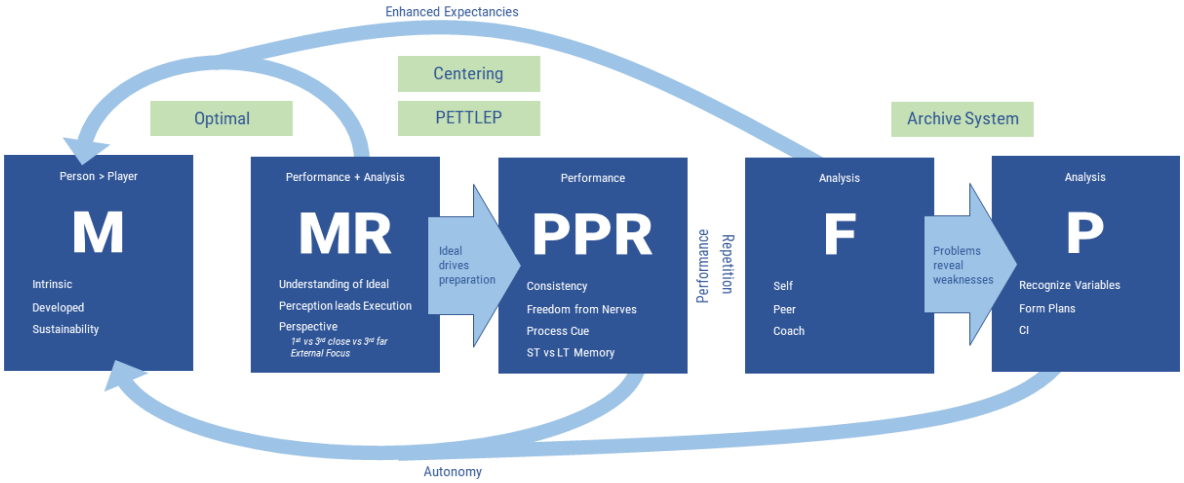

Figure 18: The Deliberate Practice Loop Graphic in Higher Detail

5.2 Future Research

My recommendations for future research include three potential lines of inquiry: detailed application to non-percussion music performance applications, testing and conclusion-checking of the deliberate practice loop in qualitative or quantitative means, and an expansion of this inquiry into including issues of team performance.

5.2a Applying the Deliberate Practice Loop

The fourth chapter of this dissertation examined actionable applications toward examples in percussion performance. In addition to being usable for multiple types of percussion professionals and educators in theory and practice, it was also designed, in concert with Chapter 3, to exemplify application of the principles of the deliberate practice loop toward a music performance scenario. The most widespread opportunity for continuing this research is for other researchers to take the domain-general framework of the deliberate practice loop, and apply it to

their own domain-specific needs. This option lends itself particularly well to scholar-performers doing research activities in other instrumental fields. This type of work would have greater depth and be more narrow in focus, and thus necessarily be applicable to many fewer readers.

The explanation of the scientific concepts from sport psychology, expert performance, and motor learning in Chapter 2 of this dissertation can provide a foundation along with the bibliography I have compiled, upon which the researcher would be able to apply the concepts to the technical, musical, and psychological demands of their specific performance field, resulting in a targeted, actionable, and research-backed method for improvement that would be relevant to instrumental and voice communities about which I have no domain-specific knowledge. These applications could be as wide in scope as applying the loop toward practice for the soprano voice type, or as narrow as targeting for the operatic soprano in Wagnerian repertoire, or anywhere in between. This process could also, of course, be used by percussionists in subfields that I have not focused on, or to go in greater depth or specificity on the ones I have.

This kind of expansion on my work would continue to add publications based in rigor and evidence to the knowledge base for performing musicians, and do so in ever more specific subfields. This also would refute and/or add to the ubiquitous claims of Gallwey, Gladwell, Levitin, Colvin, and Duhigg and bring the rigor of Ericsson, de Groot, Greene, Wulf & Lewthwaite, and Holmes & Collins to new instrumental audiences that I don't have access to, which would continue to elevate the discourse around these topics for the entire music community, both academic and professional.

5.2b Testing the Deliberate Practice Loop

Opportunities abound to test my loop construct, as well as the ways that I suggest it can be operationalized for music performance training. I see value in both quantitative and

qualitative methods for doing so, with benefits to both approaches. Both the OPTIMAL theory and PETTLEP model from which my loop draws heavily, along with the OODA loop on which its structure is modeled, benefitted from significant testing following their release. Each of these concepts was fundamentally a theory designed to fit with existing evidence but could not be relied upon until tested; my work currently sits at this early stage of completed concept requiring field testing for validation. This testing could be done by career musicians and music graduate students, or by members of the scientific communities from which my work draws so heavily, who have a deeper contextual basis for engaging with the experiments that lead to the conclusions on which my work is founded.

A quantitative method might look similar to the Ericsson 1993 study, by counting amounts of deliberate practice hours. Given the loop's elements and phases, it would be illustrative to break deliberate practice hours down into amount of time spent focusing on motivation, focusing on mental representation, creating or practicing pre-performance routines, asking for and analyzing feedback, and recognizing priorities alongside time spent in actual repetition playing the music being practiced. This method would also benefit from pre-measurement assessment of subjects and post-measurement to recognize growth over time.

Such a study may be done by tracking the progress of music students, doing initial assessment of their level of ability, and dividing students between a deliberate practice loop group, a non-loop deliberate practice group, and a control group. This assessment would have greater accuracy the more technique-based it is; this approach would minimize the research's ability to track improvement in musicality and style, but would also minimize subjectivity on the part of the professor or researcher doing the assessments.

A qualitative method would allow greater examination of not only interpretive improvement of the subjects' musicianship, but also the experience of using deliberate practice over time. A case study approach would treat each student as its own case, allowing for maximum adaptability of analysis and coding. This could be done through recording the subject's performances at sequential points using the loop, along with semi-structured interviews focused on the subject's experience of playing and mental and physical state while engaging in long-term deliberate practice. This research would have a small sample size and be difficult to generalize, but would provide some data about the effect of using the deliberate practice loop on a total musician.

A broader approach tracking more participants would offer a greater sample size and focus more on trends among subjects using the loop simultaneously, to uncover elements of the experience of deliberate practice that are more generalizable. This approach would be more valuable for determining the potential broad impact of using the loop; for example, use within a college instrumental studio as a department head would have the benefit of a generalizable study examining the effects on a reasonable sample size of students.

5.2c Applying the Deliberate Practice Loop's Concepts to a Team Environment

This dissertation focused on applying the science of expert performance, motor learning, and sport psychology toward the music performance improvement of an individual performer. My next interest as a researcher is in examining the application of these concepts in a team environment. Potential examples of the musical teams range from a few members (i.e., chamber groups and bands) to the 15-30 member range (drumlines, college studios, large theatre pits) to several dozen in a large ensemble (orchestra, wind band) or several hundred (drum corps, marching band).

Along with the research already studied in this dissertation, examining expert performance on the team level would require the addition of interpersonal dynamics. These concepts are commonly referred to as leadership, organizational behavior, and organizational culture. There is a significant scholarly discourse around these topics in the literature around sports, much of which is related to sport psychology. There is also significant publication, scholarly and popular, in the business literature as well. Scholars like Sophia Jowett have examined the coach-athlete relationship with great depth; the work of Brett Ledbetter in examining how elite coaches in American sports use these concepts in action would enhance that research.

This dissertation has shown the myriad similarities between athletics and music performance at the individual level; this avenue of future research would investigate the parallels at a team level. The relevance of athletic coaching methods from sports toward music performance has potentially huge upside for instrumental and voice professors, conductors, music directors, contractors, and anyone else in charge of managing musicians over time. I anticipate issues of supporting environments and competition to be significant. I also expect significant crossover between this dissertation and this future team-based research; for example, the team focus would include the performer creating and maintaining a network for effective peer feedback, and examining the coach-athlete relationship as it affects the performer's ability to use coach feedback and discover priorities.

As stated before, the goal of this dissertation is illustrative, not exhaustive. This research does not add to the body of psychological research around human performance, but combines existing scientific research and experiential practice toward a real-world actionable method. This process explains how research into human improvement combines with the immense amount of

repetition required for long-term improvement – it would be a misapplication of the research on which my work is built to justify insufficient physical practice time with claims of greater efficiency.

Bibliography

Abernethy, Bruce and David Russell. "Expert-Novice Differences in an Applied Selective Attention Task." *Journal of Sport Psychology* 9 no. 4 (1987): 326-345.

Allard, Fran and Neil Burnett. "Skill in Sport." *Canadian Journal of Psychology* 39 no. 2 (1985): 294-312.

Andersen, Lotte, Stephanie Mann, Birgit Juul-Kristensen, and Karen Søgaard. "Comparing the Impact of Specific Strength Training vs General Fitness Training on Professional Symphony Orchestra Musicians: A Feasibility Study." *Medical Problems of Performing Artists* (June 2017): 94-100.

Andrews, Bernard. "Student Team Learning in Music Instruction: Restructuring the Traditional Task-Incentive System." *McGill Journal of Education* 31 no. 2 (1996): 159-178.

Araújo, Marcus. "Measuring Self-regulated Practice Behaviours in Highly Skilled Musicians." *Psychology of Music* 44 no. 2 (2016): 278-292.

Arjmand, Susan. "A Curriculum on Performing Arts Medicine: Perspectives on Theory and Implementation." *Medical Problems of Performing Artists* 24 no 1 (2009): 18-25.

Arthur, Rob. "How Baseball's New Data is Changing Sabermetrics." FiveThirtyEight, 3/17/2016. https://fivethirtyeight.com/features/how-baseballs-new-data-is-changing-sabermetrics/

Battig, William. "The Flexibility of Human Memory." *In Levels of Processing in Human Memory,* edited by Laird Cermak and Fergus Craik. New York: Erlbaum, 1979.

Beethoven, Ludwig. *Symphony No. 9 in D Minor,* Opus 125. Leipzig: Breitkopf und Härtel, 1863.

Bellon, Dominique. "Application of Sport Psychology to Music Performance: A Study Based on a Review of Sport Psychology Literature and Selected Interviews with Professional Musicians." DMA Diss., Arizona State University, 2006.

Berry, Jonathon. "The Mindful Musician: A Percussionist's Guide to the Application of Mindfulness Techniques in Music." *Percussive Notes* 54 no. 3 (2016): 25-26.

Bilas, Jay. *Toughness: Developing True Strength On and Off the Court*. New York: Penguin, 2013.

Bonchek, Mark and Chris Fussell. "Decision Making, Top Gun Style." *Harvard Business Review,* Sept. 12, 2013. https://hbr.org/2013/09/decision-making-top-gun-style

Borgeaud, Phil and Bruce Abernethy. "Skilled Perception in Volleyball Defense: *Journal of Sport Psychology* 9 (1987): 400-406.

Boyd, John. “Patterns of Conflict.” Edited by Chuck Spinney, Chet Richards, and Ginger Richards. 2005. https://www.dnipogo.org/boyd/patterns_ppt.pdf

Boyd, Joni, Ashley Andrews, Janet Wojcik, and Charles Bowers. “Perceptions of NCAA Division I Athletes on Strength Training.” *The Sport Journal* (2017). http://thesportjournal.org/article/perceptions-of-ncaa-division-i-athletes-on-strength-training/

Brantigan, Charles, Jan DeGaetani, Dorothy DeLay, Garland DeNelsky, Julie Nagel, Mark Proctor, Sanford Weisblatt, and Frederick Zlotkin. “Coping with Stress.” *Medical Problems of Performing Artists* 1 no. 1 (1986): 12-16.

Breslin, Gavin, Nicola J. Hodges, Andrew Steenson, Mark Williams. “Constant or variable practice: Recreating the especial skill effect.” *Acta Psychologica* 140 (2012): 154-157.

Broughton, Mary and Stevens, Catherine. “Music, Movement and Marimba.” Psychology of Music 37 no. 2 (2009): 137-153.

Chase, William and Herbert Simon. “Perception in Chess.” *Cognitive Psychology* 4, no. 1 (1973): 55-81.

Charmaz, Kathy. *Constructing Grounded Theory* 2nd ed. London: SAGE Publications 2014.

Cheong, Jadeera, Brendan Lay, and Rizal Razman. “Investigating the Contextual Interference Effect Using Combination Sports Skills in Open and Closed Skill Environments.” *Journal of Sports Science and Medicine* 15 (2016): 167-175.

Colvin, Geoff. *Talent Is Overrated: What Really Separates World-Class Performers from Everybody Else*. New York: Penguin, 2011.

Creswell, John. *30 Essential Skills for the Qualitative Researcher.* London: SAGE, 2016.

Creswell, John. *Qualitative Inquiry and Research Design: Choosing Among Five Approaches*. London: SAGE, 2013.

Dahl, S. “The Playing of an Accent: Preliminary Observations from Temporal and Kinematic Analysis of Percussionists.” *Journal of New Music Research* 29 (2000): 225–233.

Dahl, S. and A. Friberg, “Visual Perception of Expressiveness in Musicians’ Body Movements. *Music Perception* 24 (2007): 433–454.

De Groot, Adriaan. *Thought and Choice in Chess*. The Hague: Mouton, 1965.

Druckman, Jacob. *Reflections on the Nature of Water.* Boosey & Hawkes: 1986.

Duhigg, Charles. *The Power of Habit: Why We Do What We Do in Life and Business*. New York: Random House, 2012.

Ericsson, K. Anders, Ralf T. Krampe, and Clemens Tesch-Römer. “The Role of Deliberate Practice in the Acquisition of Expert Performance.” *Psychological Review* 100, no. 3 (1993): 363-406.

Ericsson, K. Anders. “Deliberate Practice and the Modifiability of the Body and Mind: Toward a Science of the Structure and Acquisition of Expert and Elite Performance.” *International Journal of Sport Psychology* 38 (2007): 4–34.

Ericsson K. Anders. “Why Expert Performance is Special and Cannot be Extrapolated from Studies of Performance in the General Population: A Response to Criticisms.” *Intelligence* 45 (2014): 81–103.

Ericsson K. Anders and Jerad Moxley. “The Expert Performance Approach and Deliberate Practice: Some Potential Implications for Studying Creative Performance in Organizations.” In *The Handbook of Organizational Creativity*, edited by Michael Mumford, 141-167. London, England: Academic Press, 2012.

Ericsson, K. Anders and Robert Pool. *Peak: Secrets from the New Science of Expertise.* New York: Houghton Mifflin, 2016.

Feloni, Richard and Anaele Pelission. “A Retired Marine and Elite Fighter Pilot Breaks Down the OODA Loop, the Military Decision-Making Process that Guides 'Every Single Thing' in Life.” *Business Insider*, August 13, 2017. www.businessinsider.com/ooda-loop-decision-making-2017-8

Folvig, Elliott. *Imaging Mastery: Applying the PETTLEP Model of Imagery to Music Performance Practice*. Melbourne: University of Melbourne, 2011.

Gallwey, W. Timothy, and Barry Green. *The Inner Game of Music*. New York: Random House, 1986.

Gallwey, W. Timothy. *The Inner Game of Tennis: The Classic Guide to the Mental Side of Peak Performance*. New York: Random House, 2010.

Gladwell, Malcolm. *Outliers: The Story of Success*. New York: Little, Brown, and Co., 2008.

Greene, Don. *11 Strategies for Audition and Performance Success: A Workbook for Musicians*. Self-Published, 2012. http://psi.dongreene.com/

Greene, Don. *Audition Success: An Olympic Sports Psychologist Teaches Performing Artists How to Win*. New York: Routledge, 2015.

Greene, Don. *Fight your Fear and Win.* New York: Broadway Books, 2001.

Gross, Sally and George Musgrave. *A Study into the Incidence of Musicians Mental Health.* Westminster: MusicTank Publishing, 2017.

Haaheim, Jason. “A Process for Everyone: Teachers, Freelancers, and Big-Job Auditioners.”

October 18, 2017. jasonhaaheim.com/a-process-for-everyone-teachers-freelancers-and-big-job-auditioners/

Haaheim, Jason. “Practicing Without Feedback is Like Bowling Through a Curtain.” March 19, 2018. https://jasonhaaheim.com/?s=feedback

Haaheim, Jason. “Well-Documented Failure.” August 4, 2017. https://jasonhaaheim.com/well-documented-failure/

Halleland, Helene, Anette Harris, Silje Sornes, Robert Murison, and Holger Ursin. “Subjective Health Complaints, Stress, and Coping in Orchestra Musicians.” *Medical Problems of Performing Artists* (June 2009): 58-62.

Hambrick, David, Frederick Oswald, Erik Altmann, Elizabeth Meinz, Fernand Gobet, Guillermo Campitelli. “Deliberate Practice: Is That All It Takes to Become an Expert?” *Intelligence* 45 (2014): 34-45.

Harper, Beatrice. “Workplace and Health: A Survey of Classical Orchestra Musicians in the United Kingdom and Germany.” *Medical Problems of Performing Artists* (June 2002): 83-92.

Hill, Colin Jeffrey. “The 10,000-hour Threshold: Interviews with Successful Percussionists.” PhD diss., University of Kentucky, 2013.

Hill, Colin. “The Path to Mastery: Practice Like the Pros.” *Percussive Notes* 51 no. 5 (2013): 42-44.

Holmes, Paul and David Collins. “The PETTLEP Approach to Motor Imagery: A Functional Equivalence Model for Sport Psychologists.” *Journal of Applied Sport Psychology,* 13 no. 1 (2001), 60-83.

Jabareen, Yosef. “Building a Conceptual Framework: Philosophy, Definitions, and Procedure.” *International Journal of Qualitative Methods* 8 no. 4 (2009): 49-62.

Johansson, Yvonne and Töres Theorell. “Satisfaction with Work Task Quality Correlates with Employee Health: A Study of 12 Professional Orchestras.” *Medical Problems of Performing Artists* (December 2003): 141-149.

Kageyama, Noa. "Pre-Performance Routines: How Consistent Do They Need to Be?" *The Bulletproof Musician.* January 15, 2017. www.bulletproofmusician.com/pre-performance-routines-consistent-need/

Knopper, Rob. “How Matt Howard Used Mental Practice to Win LA Phil.” YouTube Video, 3/28/2017. https://www.youtube.com/watch?v=hsqSsa1OerQ

Kreutz, Gunter, Jane Ginsborg, and Aaron Williamon. “Music Students’ Health Problems and Health-promoting Behaviours.” *Medical Problems of Performing Artists* (March 2008): 3-11.

Kuan, Peter. “Performance Anxiety and the College Musician: A Survey Study of Situational Triggers, Symptoms, and Ways of Coping.” PhD. Diss., New York University, 2012.

Ledbetter, Brett. *What Drives Winning*. Green Dot Publishing, 2015.

Ledbetter, Brett. *What Drives Winning* Workbook. Green Dot Publishing, 2015.

Lehmann, Andreas and K. Anders Ericsson. “Performance Without Preparation: Structure and Acquisition of Expert Sight-reading and Accompanying Performance.” *Psychomusicology* 15 (1996): 1–29.

Lehmann, Andreas and Hans Gruber. “Music” in *Cambridge Handbook of Expertise and Expert Performance*. New York: Cambridge, 2006. 457 – 470.

Levine, Seymour and Robert Levine. “Why They’re Not Smiling: Stress and Discontent in the Orchestral Workplace.” *Harmony: Forum of the Symphony Orchestra Institute* 2 (1996): 15-25.

Levitin, Daniel. *This is Your Brain on Music: The Science of a Human Obsession.* New York, NY: Dutton, 2006.

Lewthwaite, Rebecca and Gabriele Wulf. “Optimizing Motivation and Attention for Motor Performance and Learning.” *Current Opinion in Psychology* 26 (2017): 38-42.

Lonsdale, Chris and Jimmy Tam. “On the Temporal and Behavioural Consistency of Pre-Performance Routines: An Intra-Individual Analysis of Elite Basketball Players’ Free Throw Shooting Accuracy.” *Journal of Sport Sciences* 26 no. 3 (2008): 259-266.

Macnamara, Brooke, David Hambrick, and Frederick Oswald. “Deliberate Practice and Performance in Music, Games, Sports, Education, and Professions: A Meta-Analysis.” *Psychological Science* 25 no. 8 (2014): 1608-1614. www.ncbi.nlm.nih.gov/pubmed/24986855

Macnamara, Brooke, David Moreau, and David Hambrick. “The Relationship Between Deliberate Practice and Performance in Sports.” *Perspectives on Psychological Science* 11 no. 3 (2016): 333- 350.

Macnamara, Brooke, David Hambrick, and David Moreau. “How Important is Deliberate Practice? Reply to Ericsson (2016).” *Perspectives on Psychological Science* 11 no. 3 (2016): 355-358.

Marcello, Brandon. “Will Muschamp Graded Film After Florida Fired Him.” *Alabama,* August 18, 2015. www.al.com/auburnfootball/index.ssf/2015/08/will_muschamp_graded_film_afte.html

McCormick, Brian. “Why Everyone Should Shoot Like Steve Nash.” Accessed May 25, 2021. https://180shooter.com/why-everyone-should-shoot-like-steve-nash

Meinz, Elizabeth and David Hambrick. (2010). “Deliberate Practice is Necessary but not Sufficient to Explain Individual Differences in Piano Sight-Reading Skill: The Role of Working Memory Capacity.” *Psychological Science* 21 (2010): 914–919. doi:10.1177/0956797610373933

Miller, John and David Baker. "Career Orientation and Pedagogical Training: Conservatoire Undergraduates' Insights." *British Journal of Music Education* 24 no. 01 (2007): 5-19.

Mills, Janet. "Addressing the Concerns of Conservatoire Students About School Music Teaching." *British Journal of Music Education* 22 no. 01 (2005): 63-75.

Montone, Jennifer. “Sample Audition Preparation Plan.” Accessed May 25, 2021. http://www.jenmontone.com/sample-audition/

Mouton, Angela. “Performance Coaching in Sport, Music, and Business: From Gallwey to Grant, and the Promise of Positive Psychology.” *International Coaching Psychology Review* 11 no. 2 (2016): 129-141.

Morris, David. “George Szell’s Editing of the Timpani Parts to Schumann’s Symphonies.” *Percussive Notes* 39 no. 4 (2001): pp. 54-56.

Mullen, Dan. Postgame Press Conference. November 18, 2017. http://hailstate.com/watch/?Archive=5387&sport=3&type=Archive

Nagel, Julie. “How to Destroy Creativity in Music Students: The Need for Emotional and Psychological Support Services in Music Schools.” *Medical Problems of Performing Artists* (March 2009): 15-17.

NBA Team Free Throws Attempted per Game, 2017-2018 Season. www.teamrankings.com/nba/stat/free-throws-attempted-per-game?date=2018-06-09

Nideffer, Robert. *Getting Into The Optimal Performance State.* Web-published. Accessed May 25, 2021. https://nideffer.com/wp-content/uploads/2016/06/Optimal-Performance.pdf

Noble, Jeff, Mark Vermillion, and Kewa Foster. “Coaching Environments and Student-Athletes: Perceptions of Support, Climate and Autonomy.” *The Sport Journal* (2016). http://thesportjournal.org/article/coaching-environments-and-student-athletes-perceptions-of-support-climate-and-autonomy/

Olevsky, Dimitry. “The Study of Success in Music: Applying Methods Developed by Sports Psychology towards Achieving Peak Performance.” DMA Diss., University of California Santa Barbara, 2012.

Osborne, Margaret, Don Greene and Don Immel. “Managing Performance Anxiety and Improving Mental Skills in Conservatoire Students Through Performance Psychology Training: A Pilot Study.” *Psychology of Well-Being: Theory, Research and Practice.* Vol. 4 no. 18 (2014).

Platz, Friedrich, Reinhard Kopiez, Andreas C. Lehmann and Anna Wolf. “The Influence of Deliberate Practice on Musical Achievement: A Meta-Analysis.” *Frontiers in Psychology* 5: no. 646 (2014): 1-13.

Pomeroy, Ken. “2021 Pomeroy College Basketball Ratings.” Accessed May 25, 2021. https://kenpom.com/

Raeburn, Susan. “Psychological Issues and Treatment Strategies in Popular Musicians: A Review, Part 2.” *Medical Problems of Performing Artists* (March 2000): 6-16.

Rietveld, Boni and Camilla Winterkorn-Pierrot. “Seventh Biannual Symposium on Medical Problems of Dancers & Musicians, Amsterdam, October 11, 2008.” *Medical Problems of Performing Artists* (March 2009): 43-49.

Robson, Sean and Thomas Manacapilli. *Enhancing Performance Under Stress*. RAND, 2014.

Rose, Christopher. “An Orchestra Audition Preparation Handbook for Bass Players.” DMA Diss., Arizona State University, 2011.

Ruiz, Montse, John Raglin and Yuri Hanin. “The Individual Zones of Optimal Functioning (IZOF) Model (1978-2014): Historical Overview of its Development and Use.” *International Journal of Sport and Exercise Psychology* 15 no. 1 (2017), pp. 41-63.

Schmidt, Richard and Craig Wrisberg. *Motor Learning and Performance: A Situation-Based Learning Approach*. Champaign, IL: Human Kinetics, 2008.

Shea, John and Susan Zimny. “Context Effects in Memory and Learning Movement Information.” *Advances in Psychology* 12, 1983.

Simonton, Dean. “Creative Performance, Expertise Acquisition, Individual Differences, and Developmental Antecedents: An Integrative Research Agenda.” *Intelligence* 45 (2014): 66–73.

Smith, Dave, Caroline Wright, Amy Allsopp, and Hayley Westhead. “It’s All in the Mind: PETTLEP-Based Imagery and Sports Performance.” *Journal of Applied Sport Psychology*. 19 no. 1 (2007): 80-92.

Snider, Larry. “Auditions—The Mind Game.” *Percussive Notes* 37, no. 4 (1999).

Starkes, Janet. “Skill in Field Hockey: The Nature of the Cognitive Advantage.” *Journal of Sport Psychology* 9 no. 2 (1987): 156-157.

Sternberg, Robert. “The Costs of Expertise.” In *The Road to Excellence: The Acquisition of Expert Performance in the Arts and Sciences, Sports, and Games*, edited by K. Anders Ericcson, 347–354. Mahwah, NJ: Erlbaum (1996).

UCLA Athletics. 2015 UCLA Softball Record Book. Accessed 3/7/2018. www.uclabruins.com/documents/2015/2/23/2015SBRecordBook.pdf

Taylor, Jim. *Prime Sport: Triumph of the Athlete Mind*. New York: Writers Club, 2001.

Thomas, Patrick, Shane Murphy, and Lew Hardy. "Test of Performance Strategies: Development and Preliminary Validation of a Comprehensive Measure of Athletes' Psychological Skills." *Journal of Sports Science* 17 no. 9 (1999): 697-711.

Weinberg, Robert. "Does Imagery Work? Effects on Performance and Mental Skills." *Journal of Imagery Research in Sport and Physical Activity* 3 no. 1 (2008).

Willis, Sarah. "Dr Don Greene Live on Sarah's Horn Hangouts." YouTube Video. August 14, 2015. https://www.youtube.com/watch?v=O0em8bAV2EA

WIRED. "Why Shooting 95% From the Free-Throw Line Is Almost Impossible (ft. Steve Nash)." YouTube Video, March 28, 2019. https://www.youtube.com/watch?v=BKIOqbx3sbU.

Wulf, Gabriele, and Rebecca Lewthwaite. "Optimizing Performance Through Intrinsic Motivation and Attention for Learning: The OPTIMAL Theory of Motor Learning." *Psychonomic Bulletin & Review* 23 no. 5 (2016): 1382-1414.

Wulf, Gabriele, Takehiro Iwatsuki, Brittney Machin, Jessica Kellogg, Clint Copeland, and Rebecca Lewthwaite. "Lassoing Skill Through Learner Choice." *Journal of Motor Behavior* 0 no. 0 (2017): 1-8.

Wulf, Gabriele, Rebecca Lewthwaite, Priscila Cardozo and Suzete Chiviacowsky. "Triple Play: Additive Contributions of Enhanced Expectancies, Autonomy Support, and External Attentional Focus to Motor Learning." *The Quarterly Journal of Experimental Psychology* (2017): 1-9.

Wright, David, Caroline Wakefield, and Dave Smith. "Using PETTLEP Imagery to Improve Music Performance: A Review." *Musicae Scientiae* 18 no. 4 (2014).

Wrisberg, Craig. *Sport Skill Instruction for Coaches*. Champaign, IL: Human Kinetics, 2007.

Appendix A – Publications Demonstrating the Popular Interest in the Topic

This table lists relevant publications in the popular discourse around issues of mental preparation, long-term practice methods and performance psychology. These works are commonly referenced by musicians as resources for improving performance, but are not scholarly research works. Their writers are largely not scientists presenting new scientific findings but rather authors commenting on trends and relaying them to a broad audience.

Year	Author	Publisher	Title
2021	Adam Grant	Viking	Think Again: The Power of Knowing What You Don't Know
2019	Marc Bubbs	Chelsea Green	Peak: The New Science of Athletic Performance that is Revolutionizing Sports
2018	James Clear	Random House	Atomic Habits: An Easy & Proven Way to Build Good Habits & Break Bad Ones
2017	Brad Stulberg	Rodale	Peak Performance: Elevate Your Game, Avoid Burnout, and Thrive with the New Science of Success
2016	K. Anders Ericsson	Houghton Mifflin Harcourt	Peak: Secrets from the New Science of Expertise
2016	Angela Duckworth	Scribner	Grit: The Power of Passion and Perseverance
2016	Cal Newport	Grand Central	Deep Work: Rules for Focused Success in a Distracted World
2012	Charles Duhigg	Doubleday Canada	The Power of Habit: Why We Do What We Do in Life and Business
2012	Doug Lemov, Erica Woolway, Katie Yezzi	Wiley	Practice Perfect; 42 Rules for Getting Better at Getting Better
2011	Daniel Kahneman	Farrar, Straus and Giroux	Thinking, Fast and Slow
2010	Sian Beilock	Atria Books	Choke: What the Secrets of the Brain Reveal About Getting It Right When You Have To
2010	Matthew Syed	Fourth Estate	Bounce: The Myth of Talent and the Power of Practice
2009	Daniel Coyle	Random House	The Talent Code: Unlocking the Secret of Skill in Maths, Art, Music, Sport, and Just about Everything Else
2008	Malcolm Gladwell	Little, Brown and Company	Outliers: The Story of Success
2008	Geoff Colvin	Penguin	Talent Is Overrated: What Really Separates World-Class Performers from Everybody Else
2007	Josh Waitzkin	Free Press	The Art of Learning: An Inner Journey to Optimal Performance
2006	Daniel Levitin	Penguin	This is Your Brain on Music
2006	Carol Dweck	Random House	Mindset: The New Psychology of Success
2005	Angela Beeching	Oxford	Beyond Talent: Creating a Successful Career in Music
2002	Karen Reivech Andrew Shatte	Harmony	The Resilience Factor: 7 Keys to Finding Your Inner Strength and Overcoming Life's Hurdles

1997	Eckhart Tolle	Yogi Impressions	The Power of Now: A Guide to Spiritual Enlightenment
1996	Kenny Werner	Jamey Aebersold Jazz	Effortless Mastery
1991	George Leonard	Dutton	Mastery: The Keys to Success and Long-term Fulfillment
1986	Timothy Gallwey, Barry Green	Anchor Press/Doubleday	The Inner Game of Music
1974	Timothy Gallwey	Random House	The Inner Game of Tennis

Appendix B – Presentations Demonstrating Topic Interest in the Percussion Community

This table includes examples from the past ten years of clinics and presentations at the Percussive Arts Society International Convention related to issues of practice methods, peak performance strategies, and the effective process of musical improvement over a long period of time.

2020	Josh Jones	Kansas City Symphony	Redefining Technique
2020	Nadia Azar	University of Windsor	Rate and Patterns of Playing-related Musculoskeletal Disorders in Drummers
2020	David Garibaldi	Tower of Power	Learning Through Creativity
2019	Dave Elitch	Miley Cyrus, Justin Timberlake	Getting Out of Your Own Way
2019	Brian Del Signore	Houston Symphony	Preparation for Performance and Audition Perfection
2018	Russell Wharton	Middle Tennessee State	The Cavaliers Bass Drum Line: Building A Great Subsection
2017	Chris Deviney	Philadelphia Orchestra	The "Inner Game of Tennis" and Percussion Performance
2017	Laurel Black Mike Cerreto	James Madison Psychologist	The Mental Performance Habits of Today's Top Percussionists... and Where You Fit In
2016	Marc Dicciani	University of the Arts	Highly Effective Practice Techniques for the Drumset
2016	John Lane	Sam Houston State	Snare Drum FUNdamentals: A Foundation for Practice
2016	Toni Kellar	Roots To Rhythm	Drumming Up Values: Teaching Character Development Through the Interactive Rhythm Experience
2016	Brad Meyer	Stephen F. Austin	Taking Care of Yourself: Identifying, Avoiding, and Treating 'Burnout'
2015	Brian Del Signore	Houston Symphony	Symphonic Snare Lab Preparation for Snare Drum Perfection: Tools and Techniques for Orchestral Audition Preparation on the Snare Drum
2015	Rob Knopper	Metropolitan Opera	The Complete Guide to Self-Recording
2015	Mark Schulman	Cher, P!nk, Foreigner	Life's Stage Fright...the Path to Top Performance
2015	Christopher Lamb	New York Philharmonic	Symphonic Clinic/Performance A Model to Return to Often
2015	Panel Discussion		Performance Anxiety: Teaching Our Students How to Play Through the Nerves. Moderator – Pete DeSalvo. Panelists – Chris Deane, Nancy Zeltsman, Brian Masons.
2013	Jonathan Ovalle	International Percussion Institute	'I Had It in the Practice Room' Information, Tools, and Strategies to Overcome Common Practice Roadblocks and Supercharge Your Practice Results
2013	Colin Hill	Tennessee Tech	'Practice Like the Pros'
2012	Brian Del Signore	Houston Symphony	Digital Recording Tools for the Classical and Performing Percussionist
2012	Peter Flamm	San Antonio Symphony	Life in the Trenches; Timpani in Performance and Audition
2011	Will Hudgins Ted Atkatz	Boston Symphony Chicago Symphony	Symphonic Clinic Achieving Optimal Performance
2010	Jim Babor	LA Philharmonic	'A Practice System for Learning Orchestral Excerpts'
2009	Lee Vinson	Vanderbilt, Boston Symphony	Practice Techniques and Time Management