Training the string player's ear: a comparative study

by

Hester Gerbregter Fischer

Thesis presented in fulfilment of the requirements for
the degree of Master of Music in the
Faculty of Humanities at Stellenbosch University

Supervisor: Ms Danell Herbst

March 2018

Declaration

By submitting this thesis electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof (save to the extent explicitly otherwise stated), that reproduction and publication thereof by Stellenbosch University will not infringe any third party rights and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

March 2018

Abstract

The aural training offered to string instrumentalists in tertiary education is the focus of this investigation. Knowledge of sound and directed application of aural skills have been shown to have a positive influence on the performance skills of musicians and should therefore be afforded research time and space. Research has shown that studying and teaching string-specific aural training contributes significantly to the education and training of aspiring string musicians. Much research supports the hypothesis that there is a definite need for string-specific aural training at tertiary education institutions. A few international institutions (not accessible to English-only students) are already successfully implementing string-specific aural training. However, these practises have failed to produce encompassing English literature on string-specific aural training and method. Although extensive research into the concepts and general skills of aural training has been conducted, literature in English on string-specific aural training is limited. The question of how to train the string student's ear begs investigation and development. A logical point of departure in addressing this gap in music teaching would be to find out what is currently being taught to string students. Once this scenario is clear, it can be compared to what aural training is required by the string student according to international research and literature.

The object of this study was to describe the basic aural needs of the string student as portrayed by literature and to determine what is currently being taught to string students, in three different regions (United Kingdom, the United States of America, and Scandinavia). This thesis presents findings from this comparison between the aural needs and the currently taught aural skills in these regions. The knowledge gained from the study indicates that even though aspects of the aural research field is ancient, and known, academic research findings is not generally reflected in the practice of aural training of students.

Investigation into the methods used was conducted through an ethically considerate survey in which an online questionnaire was presented to the persons responsible for a string student's tertiary education. The survey is not a representative sample of the regions of the study, because of the low number of respondents. This could be attributed to the e-mail distribution method which has become suspect as a result of cybercrime that makes respondents wary of responding to e-mail questionnaires. However, the secondary findings are more pertinent. The comparison was drawn between the areas identified by the participants as important aural areas, what the participants include in their teaching, and the literature. The study found that there is very low interest among pedagogues in the aural training field and that the impact of aural training (or the lack thereof) on their subject is misunderstood.

Opsomming

Die gehooropleiding van strykinstrumentaliste in hul tersiêre opleidingsfase is die fokus in hierdie ondersoek. Kennis van gehoorvaardighede het 'n groot invloed op die prestasievaardigheid van musici en behoort dus navorsingstyd en ruimte gebied te word. Daar is bewyse wat die hipotese vir die behoefte aan stryk-spesifieke gehooropleiding by tersiêre onderwysinstellings ondersteun. 'n Paar instansies (nie toeganklik vir Engelstalige studente nie) implementeer reeds stryk-spesifieke gehooropleiding. Hierdie praktyke lewer egter nie 'n volledige Engelstalige literatuur oor stryk-spesifieke gehooropleiding en -metodes nie. Uitgebreide navorsing oor die konsepte- en algemene vaardighede van gehooropleiding is beskikbaar, met baie min literatuur oor stryk-spesifieke gehooropleiding. Die vraag bly egter, hoe om die strykstudente se gehoor te ontwikkel. Dit was dus wenslik om uit te vind wat tans aan strykstudente aangebied word en dit te vergelyk met die vaardighede wat benodig word deur die strykstudent.

Die doel van hierdie studie was om die basiese gehoorbehoeftes van die strykstudent te beskryf asook dit wat tans aan strykstudente geleer word in drie verskillende gebiede (Verenigde Koninkryk, die Verenigde State van Amerika en Skandinawië). Hierdie tesis bied die bevindinge van 'n vergelykende studie tussen die gehoorbehoeftes en die gehoorvaardighede wat tans aangebied word aan. Die resultaat dui daarop dat alhoewel aspekte in die gehoornavorsingsveld oud en bekend is, akademiese navorsing bevindinge nie gewoonlik in die praktyk van gehooropleiding aan studente weerspieël word nie.

Ondersoek na die metodes wat gebruik word, is deur middel van 'n opname uitgevoer wat aan etiese oorwegings voldoen het. 'n Digitale vraelys is aan die persone wat vir die strykstudent se tersiêre opleiding verantwoordelik is, gestuur. Hierdie kwantitatiewe studie kan nie as verteenwoordigende steekproef van die gebiede beskou word nie, as gevolg van die lae aantal respondente. Dit kan toegeskryf word aan die e-pos verspreidingsmetode wat minder betroubaar is weens kubermisdaad waar respondente versigtig is om op e-pos vraelyste te reageer. Die sekondêre bevindinge is wel meer relevant. Die vergelyking is getref tussen die areas wat deur die deelnemers as belangrike gehooropleidings-gebiede geïdentifiseer is, dit wat die deelnemers in hul onderrig insluit, en dit wat in die literatuur voorkom. Die resultate van die studie het bevind dat daar 'n baie lae belangstelling onder pedagoë in die gehooropleidingsveld is en dat hulle nie die implikasie van gehooropleiding oor hul vak verstaan nie.

Acknowledgements

In the process of writing the thesis, I was surrounded by caring people. Thank you to all my students, parents and colleagues for their patience, encouragement, prayers, and cooked meals. I sincerely thank the following persons in particular:

My husband and children for their patience and encouragement.

My colleague, Marian Steyl, for inspiration, moral support and her sympathetic ear.

Rencia van Wyk and Kevin Fryer for endless patient help with technical support.

A calm voice in the storm, Tania Wait, for editing and so much more.

The final editing by Filicity Grové.

Dr Anzel Gerber for initiating and encouraging the study.

My super supervisor, Danell Herbst, for never showing frustration while skilfully guiding me.

Table of Contents

Declaration ii
Abstract iii
Opsomming iv
Acknowledgements v
Table of Contents vi
List of Figures ix
List of Tables x

CHAPTER 1: Introduction 1
1.1 Background 1
1.2 Research problem 2
1.3 Objective of the research 3
1.4 Scope of the study 3
1.5 Research questions 4
1.6 Research design 4
1.7 Research methodology 5
1.8 Chapter outline 6

CHAPTER 2: Literature Study 8
2.1 Introduction 8
2.2 Basic concepts 11
2.2.1 Rhythm (Time) 11
2.2.2 Melody 14
2.2.3 Harmony 21
2.2.4 Summary 24

2.3 Basic skills 25
2.3.1 Thinking 25
2.3.2 Listening 40
2.3.3 Reading 44
2.3.4 Performing 47
2.3.5 Summary 51
2.4 String-specific needs 51
2.4.1 Thinking 52
2.4.2 Listening 53
2.4.3 Reading 57
2.4.4 Performing 58
2.4.5 Summary 60
2.5 Regions 61
2.5.1 United Kingdom (England, Scotland, Wales, and Ireland) 61
2.5.2. United States of America 63
2.5.3. Scandinavian Countries 66
2.6 Summary 68

CHAPTER 3: Research Methodology 69
3.1 Research approach 69
3.2 Research design 69
3.3 Methodology 70
3.3.1 Questions 71
3.4 Sample selection and data collection 74
3.5 Data analysis 75
3.6 Ethical considerations 76
3.7 Reliability and validity 76

3.8 Limitations 77

CHAPTER 4: Data Analysis 78

4.1 Participant classification 78

4.2 Basic concepts 79

4.3 Skills 80

4.3.1 Thinking skills 80

4.3.2 Listening skills 81

4.3.3 Performing and reading skills 83

4.3.4 Ranked skills 84

4.4 Skills taught to enhance basic concepts 85

4.4.1 Rhythm 86

4.4.2 Melody 87

4.4.3 Harmony 88

4.4.4 Disposition of concepts 89

4.4.5 Aggregation of concepts 91

4.5 String-specific skills 91

4.6 Conclusions 92

CHAPTER 5: Conclusion 94

5.1 The research topic 94

5.2 Findings of this research 95

5.3 What the research means to us 96

Reference list 98

Addenda 123

List of Figures

Figure 2.1: Diagram of chapter layout 9
Figure 2.2: Pythagorean temperament (Lehman, 2005b) 16
Figure 2.3: Just temperament (White, 2007) 16
Figure 2.4: Musical instrument with 19 keys per octave. (White, 2007) 17
Figure 2.5: Equal temperament (White, 2007) 17
Figure 2.6: Interconnection in the brain (Thaut, 2005) 26
Figure 2.7: Anatomy of the ear indicating perception of frequency in starched out cochlea (Purves, Augustine, Fitzpatrick, Katz, McNamara, and Williams, 2001) 33
Figure 2.8: Finger chart for use during the 18th century music (Barbieri, Mangsen, 1991) 56

Figure 4.1: Ranked importance per basic concepts 79
Figure 4.2: Ranked importance of thinking skills 80
Figure 4.3: Ranked importance of listening skills 82
Figure 4.4: Ranked importance of performing and reading skills 83
Figure 4.5: Ranked importance of skills 85
Figure 4.6: Skills taught to enhance the concept Rhythm as aural skill 86
Figure 4.7: Skills taught to enhance the concept Melody as aural skill 87
Figure 4.8: Skills taught to enhance the concept Harmony as aural skill 88
Figure 4.9: Disposition of concepts 90
Figure 4.10: Aggregation of all skills taught for concepts: rhythm, melody, and harmony 91

List of Tables

Table 3.1: Activity of e-mail sent to potential participants 74

Table 4.1: Participants' ages 78
Table 4.2: Disposition of concepts 89
Table 4.3: Responses to string-specific education 92

CHAPTER 1

Introduction

1.1 BACKGROUND

The virtue and importance of aural training for music students, and especially string players, is recognised by many (if not all) academics and music teachers. Gary Karpinski (2000:6), a leader in the aural training field, notes that "listening skills are essential to musicians because music belongs fundamentally to the aural domain." The level at which a musician's listening skills are refined impacts directly on the level of the musician's performance. It is thus crucially important to train and develop the music student's hearing and so enhance the musical performance. Denyoe and Guyver (2006:5) found that "the ear is the most valuable asset to any musician, and it must be tended to with the same care one would give to his/her own instrument." Aural training is of vital importance for the enhancing of musical performance.

The research presented in this thesis focuses on the enhancement of the string player's musical ear. My interest in the field of aural training that would serve this purpose was sparked by my passion as a cellist, a cello teacher, and a teacher of aural skills development at a Western Cape high school. In preparing learners for their aural assessments – especially learners in their final year of school (Grade 12) – it became evident that the aural skills (and the lack of appropriate skills) that learners demonstrated, were often related to the instrument(s) they play. At first, I thought that this was because each group of instrumentalists (e.g. flautists or violinists) had the same person as practical teacher and it could possibly be that each teacher's skills focus is different. Research supported this: Wei (2013:4) noted that "students only had access to material taught by their teacher." Some students are not exposed to a complete array of music subjects until they start music in a specialised music school or at a tertiary institution. As an aural teacher, I felt that this lesson was the equalising factor.

Teachers' lesson topics come from various sources. Mishra (2000:1) found that many teachers adopt the ideas of influential pedagogues, or recall the way in which they themselves were taught. As will be explained, these influences are not always scientifically grounded. My experiences as a student were diverse: there was institutional aural training, as well as an unusual type of aural training presented by an East European teacher where the focus was on the needs of a string player. Another interesting experience arose when an Italian teacher requested me to teach his violin students solfège singing on a fixed-doh method. A further realisation of how diverse the methods of aural teaching actually are, crystallised when I encountered Dalcroze Eurhythmics. From these experiences, I realised that there are unique sets of aural skills that need conquering in a player's education as a string musician. I also realised that with the current group of high school learners in my aural class, this space is not necessarily the only place where they learn skills that typically belong to the 'aural' class.

Further interest was sparked by my teaching an Alzheimer patient to play the cello (about Grade 4 level). I was fascinated by and became curious about the intricate functioning of the brain, memory, physical string playing and perception. Much research about the functions of the brain focus on studying the absence of these functions. Examples of this form of research relate to perception and cochlear implants (McDermott, 2004) and the music perception development of children with cochlear implants (Polonenko, Giannantonio, Papsin, Marsella, & Gordon, 2017). The student's remarkable ability to sight read on a "bad day" was notable as this is a very complex skill with great demands on memory.

Information and various insights gained through this research will enable string teachers and instrumentalists to revisit their method of developing aural skills and subsequently their level of performance on their instrument. Information and knowledge are key aspects to understanding most skills development and I agree with Walker's (2010:11) view that states "as both a teacher and a student, … a skill is easier to improve when one understands various aspects of the skill." The understanding and implementation of research in the field will greatly enhance the string student's experience in becoming a performer.

1.2 RESEARCH PROBLEM

There is no clearly defined system available to the English-speaking world to train the string player's ear. There are however methods available in Russian[1]. As mentioned above, the current method used by English-speaking countries relies solely on the teacher's ability, experience and discretion. The acceptable ranges of elements that need to be developed are not agreed on or researched. To this end, researchers often focus on the limitations of intonation (Walker, 2010:4). Although intonation constitutes a substantial and very important part of the string player's aural abilities, it is not the only aspect required by the string player. Additional skills need to be developed to produce a competent string player. Compared to South Africa, the Scandinavian countries are better informed about string players' aural needs, and because the English language supplies a vehicle for an improved understanding of the situation, we as South African researchers can gain greater insight into and learn much from their methods.

[1] Training guide for violin teachers at Tver music school named after MP Mussorgsky, 2004.

1.3 OBJECTIVE OF THE RESEARCH

The aim of this research is to identify the full scope of aural requirements of the string player. The findings of the research could serve to guide teachers and researchers in developing methods to train the string player's hearing in a more structured and comprehensive manner.

1.4 SCOPE OF THE STUDY

The study focused on the aural training of string players. String instruments are similar with regard to ear training and the production and manipulation of sound. However, the cello is often the research focus in general string instrument research, because of its role in the sound stage: as solo instrument, melodic line, playing thirds and fourths under the melody, harmony (alto and tenor), as well as bass and rhythmic bass. The string instrument family features strongly in the baroque to modern periods, where each period confronts the string player with a unique set of demands.

In this study, research was limited to tertiary students. In South Africa, students are not necessarily exposed to aural lessons at primary and secondary school levels. The younger learner's aural training is limited to lessons with the practical music teacher – generally, no formal music lessons are dedicated to aural training. Only more advanced students are afforded ensemble experience. Music students develop certain aspects of aural skills, which are assessed during their UNISA, Trinity or ABRSM graded exams. These tests are standardised across the instrument range and do not differ according to different instrumentalists and ages. Although tertiary institutions in South Africa offer more structured lessons for aural training, instruction is not group-specific. Some aural skills are however developed through ensemble playing. This research is therefore focused on adding value to tertiary education. Some of the aspects that will be identified for aural training are string instrument-specific and will feature more in this research, although more general aspects will also be discussed. There are differences in the terminology referring to the training of skills that pertain to the ear. In this research I used aural training to refer to aural training, ear training, and aural skills development; except for direct citations using the alternative terminology.

The criteria applied in the choice of countries to be included in this research include accessibility to the teachers and the language of instruction. In the selected countries, English is used (or available) as language of instruction.

1.5 RESEARCH QUESTIONS

The main research question for this study is:

How do different regions approach aural training for string players?

The sub-questions that guide this study in answering the main research question, are:

1. What aural skills are required to teach basic concepts?
2. What aural skills should string players develop to enhance performance excellence as professionals?
3. How does the approach in aural training in the different regions (UK, USA, and Scandinavia) compare to that prescribed in academic writing?

1.6 RESEARCH DESIGN

The research consists of an empirical study. This type of study is described as the 'scientific' method and is often used by researchers of the Arts. Dirkse (2011:25) encourages the use of empirical pedagogical music research, for the information that is gained improves the teaching methods and stimulates further research. Empirical researchers gain insight into their subject through the collection and interpretation of qualitative data. This research is used to answer primarily academic, but also practical questions. Moustakas (1994:11) acknowledges that empirical phenomenology also determines the meaning of experiences by the respondents. It was therefore important for me to work in an ethical manner with the collection of data to ensure the validation and reliability of the study. This research was quantitative in nature. Du Plooy-Cilliers (2014:18) points out that the method used influences the way the study is judged, and it is important to justify the chosen method. The strengths and weaknesses of the study are discussed in Chapter 3.

The data was collected via survey. The survey is a very old form of information collection, with Babbie (2014:247) finding reference to surveys held in the Old Testament in the Bible. Babbie considers descriptive, explanatory, and exploratory surveys as appropriate for social topics where the population is too large for direct observation and to measure attitudes among respondents (Babbie, 2014:247). My social study topic involves the description of aural training, where the population – a large number – have differing views and explanations, and opinions on the topic and sub-topics of aural training of the string player. These differing opinions and descriptions are evident through the literature review and should be mirrored in the data collected through the survey. Du Plooy-Cilliers and Cronjé (2014:149) describe the survey as a cross-sectional design that describes a phenomenon at one point in time. The data is collected once from the respondents with no follow-up or repeats. This study thus measures the state and attitude of aural training within a specific population at a specific time.

1.7 RESEARCH METHODOLOGY

Since questionnaires are effective in surveying (Creswell, 2003:14), I decided to make use of questionnaires in this research. Babbie and Mouton (2001:233) note that a questionnaire has as many statements as questions to determine the attitude of the respondent towards the statement. The questionnaire was sent via e-mail as an invitation to answer the questions hosted on a secure website. Du Plooy-Cilliers and Cronjé (2014:150) note that a questionnaire sent through e-mail is inexpensive and limited human resources are needed. The survey is self-administered and has both positive and negative aspects.

Data collection has to its advantage that the respondents can complete the survey in a time and place convenient to them. However, questions cannot be clarified immediately. The respondent will not be influenced by the person conducting the interview, as described by Smagorinsky (2007) and Du Plooy-Cilliers and Cronjé (2014). Some aspects that are eliminated as influence on the respondents by administrating the chosen method are the gender of the interviewer and facial expressions of the interviewer. This method of administering the questionnaire adds to the reliability of the survey. A negative aspect of this self-administered survey is that the respondent has no contact with the researcher if an area of the questionnaire is not understood. The researcher also has no opportunity to ask a follow-up question for greater clarity.

The data for the study was collected through a cross-sectional, inter-coder mail survey as described by Koonin (2014:253). There were no repeats of the survey. The question material was constructed from the material in the literature study. The study therefore investigates to what degree aural aspects are being taught to string players compared to what academic literature identifies as the requirements of the string player.

My role as researcher in this study was limited to setting up the questionnaire through the careful study of literature in the field of aural training. I distributed the invitation to potential participants. I present the data in this thesis and draw conclusions.

The aim of the research was to understand the experience of participants (Bezuidenhout & Cronjé, 2014). Assuming that there are no absolute 'truths' regarding human behaviour or experiences, such research is by definition subjective. As Smagorinsky (2008) describes the work of Vygotsky (1987), we learn that research is concerned with cognitive frameworks that are internalised through cultural practices. Although this study focuses on the teaching of string players of Western classical music, the respondentswere from different countries, backgrounds, and cultures of pedagogy. The experiences of the participants to achieve the final product were taken into consideration.

The population of the survey consisted of the four groups involved in the teaching of string instrumentalists: the practical lecturer for violin, viola and cello, the aural lecturer, orchestra or ensemble leader/lecturer and harmony lecturer. I believe that this is where the decisions about what is taught to the string player are made and executed. The research relationship did not influence the study, because I had no contact (except for the survey) with the respondents. Institutions I surveyed are a representative number of the tertiary institutions in the United Kingdom, Universities in the United States of America, and Scandinavia. These institutions have a significant number of string players that aspire to becoming professional musicians.

The reduction of surveys into statistics was initially done with the aid of a statistician. The data is analysed and expressed numerically. As described by Koonin (2014), it is important to ensure the validity of this study through a large sample size, random sampling and reliable research tools. The survey was constructed with the design and variables contained. The survey does not predict future behaviour.

Where research interacts with persons, ethical considerations need to be considered. The intended research and the design were presented to the Departmental Ethics Screening Committee (DESC), where it was deemed to be low risk. According to the institution's rule, the collection of information is allowed to proceed after this process. The research was then forwarded to the Research Ethics Committee (REC) of Stellenbosch University.

All care was taken to ensure the reliability of the data. The details of the process can be found in Chapter 3. The study is limited to the three regions (UK, USA, and Scandinavia); the specific needs of the string player; the basic concepts that were studied; and the single method used.

1.8 CHAPTER OUTLINE

Chapter 1 provides an overview of the study as well as the background, research question and research methodology that was used.

Chapter 2 is a literature review, which is presented in four sections. The first contains concepts required in aural training, specifically rhythm, melody, and harmony. The second section deals with skills set out in the index of aural pedagogue Karpinski's book, *Aural Skills Acquisition* (2000). The three concepts are investigated under four sub-headings: thinking, listening, reading, and performance. The third section addresses the pertinent needs of string players and how they relate to the four aural skills discussed in the previous section. The fourth and last section is a short history and investigation into the chosen countries' music education systems.

Chapter 3 describes the methodology used in this research. The chapter covers the research approach, philosophy, research design, methodology, role of the researcher, description of participants, data analysis, ethical considerations, reliability and validity, and limitations.

Chapter 4 submits the results under the main headings presented in the literature study and found in the questionnaire. The data is integrated with the literature and conclusions are drawn in the summary of the chapter.

Chapter 5 reminds the reader of the research question and summarises the topic. The research questions are answered through the presentation of all secondary findings. The research's validity is discussed, and potential further research recommendations are made.

CHAPTER 2

Literature Study

"If tones relate to tones only,
how can they ever relate to a man,
move a man?"
(Cooke, 1960:105)

2.1 INTRODUCTION

Many researchers, like Lars Edlund (1963), share my sentiment that aural training is interdisciplinary and cannot exist as an independent discipline (e.g. Beckman, 2011:2). Fortunately, the interdisciplinary application of aural training is already apparent in many music classrooms worldwide. In aural training research done at selected American tertiary institutions, Butler (1997:41) found that even with different method and set outcomes, the structure of the programmes is based on the link that exists between aural and performance practice. The interdisciplinary nature of the field is beyond mere music. Tirovolas and Levitin (2011:23) refer to music education's interdisciplinary nature by listing elements in education as: experimental psychology, music theory, musicology, computer science, biology, psycho-physics, neuroscience, and linguistics. In the preface to Lars Edlund's book on post-tonal aural education (1963:7), it is evident that he also supports the idea that aural training is multifaceted, and he urges that, because of the "intimate connection" of aural and the practical music making, teaching aural skills should be done in a manner that ensures a cohesive type of training. From interdisciplinary consideration of aural training, thought should be given to the elements included in the syllabus of budding musicians. However, the teaching of interdisciplinary subjects does pose problems.

Taking the forementioned into consideration, it is necessary to remark that the concept of teaching any music-related subject to improve performance is questioned by some researchers. Byo (1997:52), Gardner (1991), Price (1992) and Grutzmacher (1987) point out that the skill developed in one area or lecture may be transferred to other areas (performance or teaching) with great difficulty. Thus, what is taught in aural training lessons is not necessarily used in other musical areas of music development. These findings seem to be substantiated by research in which graduate and undergraduate music majors responded alike on a test of their ability to detect performance errors: more experience did not give graduate students an advantage in the perception of pitch or rhythm errors (Byo, 1997:52). This transfer of skills acquired in one field is only possible if the individual understands both the musical and the notated representation (Wolf &

Kopierz, 2014:2). The skill transfer should therefore be possible if the subject is taught with complete understanding and connection to all relevant sections.

This chapter considers the categories and areas with which aural training lessons concern itself. The following diagram (Figure 2.1) presents a map of how this chapter is set out.

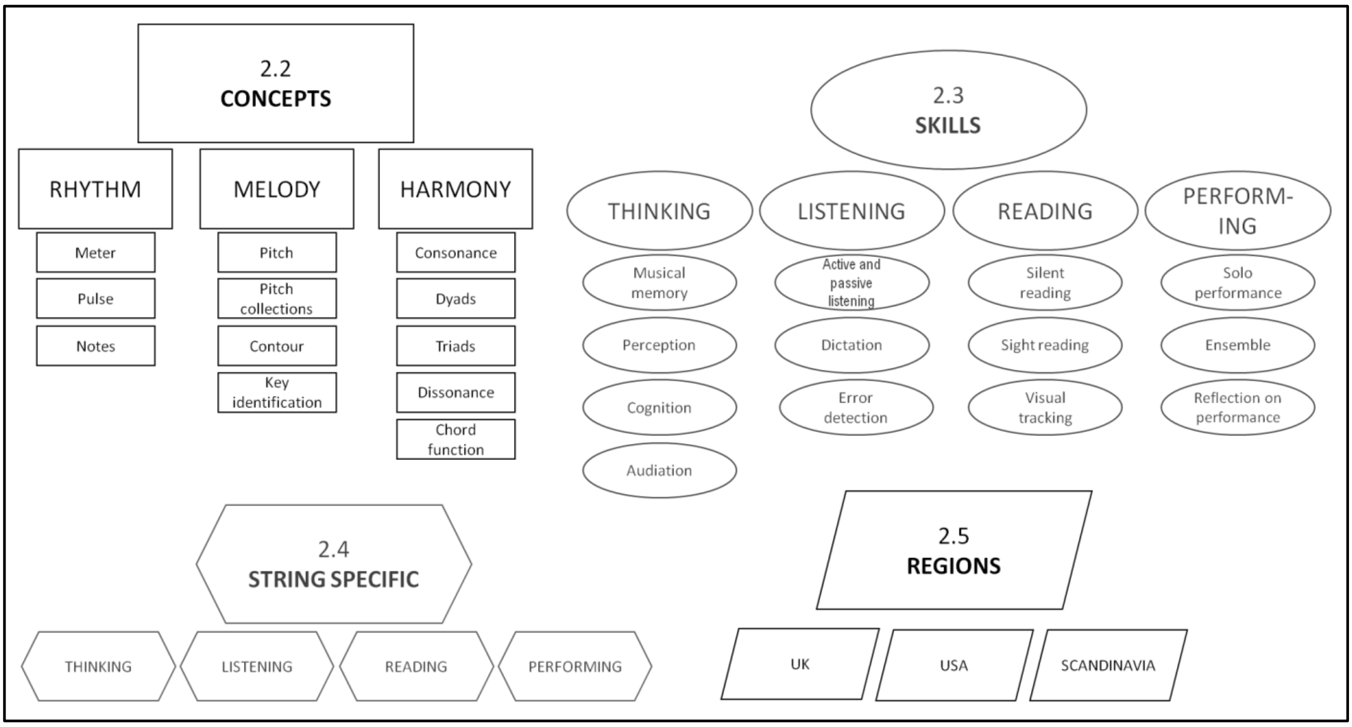


Figure 2.1: Diagram of chapter layout

The chapter answers the following questions pertinent to the aural needs of the string instrument student: what should be taught (concepts); why and how it could be taught (skills); who will benefit from this study (string students); and the regions included in this study (where). Aural education topics are discussed in two main sections: aural concepts and aural skills. Concepts and skills are divided into hierarchical sub-sections.

Concepts and skills

The difference between concepts and skills is explored for clarification. In a pedagogical article, Gault (2005:1) describes how he taught a skills course and how he observed that these skills were improving his students' understanding of concepts. Just as one can possess skills, they may also be lacking or missing. The author needed skills to transfer or teach concepts. The skills did not necessarily have to do with the concepts, thus inferring that skills from unrelated disciplines can aid the conceptual understanding of the discipline of music. Therefore, one can accept that concepts can be gained from the skills of another person. This echoes the teachings of Emile Jaques-Dalcroze, who had not originally intended an instructional book, but relied on the skills of the teacher.

Hayes (1985:319) identifies three problems in teaching skills: firstly, the vast quantity of knowledge that takes years to acquire (for both the teacher and the student); secondly, the large number of skills required, that cannot be simplified; and thirdly, teaching methods unique to each individual. Skills to be taught are interdependent and cannot necessarily exist on their own. A specific skill can be identified, but it is gained or achieved in different ways. When skills of one discipline are required in another unrelated discipline, the need should be identified and taught.

In classroom music, the skills taught are often not purely musical, but could include elements such as social skills through music (i.e. working productively within a group, getting along). McClung (2000) notes that the skills taught will not be found in lesson plans, but that they are "subtext" to the curriculum. McPherson and Renwick (2011:234) argue that mastering a musical skill requires overcoming challenges, such as focusing over long periods, learning in a competitive environment, and overcoming setbacks. In other disciplines, these challenges might also be called skills. Individuals use different yardsticks to determine what qualifies as a skill, and to identify the challenges they might face.

Skills are developed through practice; concepts are taught. Shuker (2005:xvi) makes a distinction between concepts and terms; terms are more specific and descriptive of a musical practice and concepts are a "general analytical framing label". The psychologist, Woodruff (1970:51), believes that exceptional conceptual capacity is what sets humans apart from animals, and this characteristic should be the essence of educational concern. He states that in all human acts, apart from reflex, a conceptual component of some kind is involved. He believes that concepts enable a person to perceive what he is doing (in the case of automatic behaviour), provide the basis of deterministic control, and provide capacity for critical analysis and conscious decision-making. He describes the repertoire of concepts as being determined by the environment in which a person finds himself. Concepts are thus necessary for learning any skill. It is important to note that the naming of concepts is not necessarily essential for the learning of skills, but can be required for the reflection on performance.

The methodology of teaching skills through concepts is ever changing. Stabley (2001:29) explains the changing of teaching methods: using improvisation and movement to teach concepts improves skills. Later in the article she mentions that some of the improvements include increased understanding of harmonic progression, tonal and rhythmical patterns, and expressive musical elements. The inclusive nature of aural training is hereby highlighted.

Rhythm (time), pitch (melody), and harmony are considered basic concepts in this chapter. These three concepts are identified as basic for they are found in most music (Krumhansl, 2000:159). Most researchers identify rhythm and pitch as basic building blocks of music. Kinney and Forsythe (2012:69) found that the perception and recreation of pitch and rhythm are the fundamental building blocks to learning and development in music. Ella Fourie's (2016) research on sight-reading credits rhythm as the area in which students make the most mistakes during examinations. She defines the reading of notation as twodimensional; pitch and rhythm, thus strengthening the idea that pitch and rhythm are the most important in teaching. Jerde, Childs, Handy, Nagode and Pardo (2011:1572) drew on neuro-imaging studies to conclude that rhythm and melody are processed separately in the brain – melody and pitch in the short-term and rhythm in the long-term memory (no similar research was done on harmony). Although there are several elements that need to be studied in the discourse of aural training, Alvarez (1980:229) believes elements differ from one style period to the next, leaving only rhythm, melody and harmony as common elements. Therefore, this chapter will investigate them as basic concepts in their hierarchical subdivisions as well as their interdependency.

The necessary skills in aural training are discussed based on the process of music making. Gary Karpinski's book, *Aural Skills Acquisition* (2000), serves as guideline to structure this section:

- Thinking (Musical memory, Perception, Cognition and Audiation);
- Listening (Audiation, Active and passive listening, Dictation, Error detection);
- Performing (Ensemble, Reflection on performance);
- Reading (Sight-reading, Visual tracking)

Specialised skills essential for the string player follow from the previous section to debate the skills that need to be added or refined to form a rounded education for a string player: Thinking; Listening; Reading; and Performing. Timbre will be discussed in detail in this section.

2.2 BASIC CONCEPTS

2.2.1 Rhythm (Time)

The notion of 'rhythm' is construed in many ways, offering different meanings to different people. The intended meaning is usually understood from the context of the sentence. Comparing phrases that contain the word rhythm illustrate the different interpretations of the word: to play in a fast rhythm; play the incorrect rhythm; use jazz rhythms; or have a natural sense of rhythm. This broad spectrum of meaning is attributed to the complexity of this compound and multifaceted concept. In some instances, the word should be replaced for clarity, for example: fast tempo. In other instances, the same word or term evokes different terms – a result of the many philosophies about time and rhythm.

Two important writers on this topic, Justin London (1993, 1995; 1999; 2002; 2012) and Christopher Hasty (1981; 1997; 1999) interpret the concept of rhythm and meter in completely different ways. London (1999) summarises some of his arguments against Hasty, departing from Zeno's[2] paradox of time as infinitely

[2] Zeno of Elea, 5th century Greek philosopher.

dividable (London, 1999:261). That poses the problem that no matter how far you have travelled, the remainder of the time can always be halved. The suggested solution is denying that time is infinitely dividable. Bergson's philosophy of time (experience of duration) is that of an event which requires awareness of the present while remembering the immediate past, but which remains distinct from the present – hence, experiencing the present as a continuation of the past (London, 1999:262). It is the experience of change, and as Susanne Langer (1953:112-113) explains, time is filled (physically, emotionally, or intellectually) with tension. She believes time is experienced and exists as tensions and resolutions, leading into the chicken-and-egg discussion of the being and becoming of an event. Vere Chappell (1962:517) derives the theory of coinciding of events; becoming and existing. Whitehead and Bergson's philosophy explains that the world is an ongoing state of becoming as it endures through time (London, 1999:262). From the previous section, it is noted that the comprehensive and complex concept of time has been contemplated since the beginning of philosophy. For the purpose of this study, London's philosophy of time is followed, viz. that of the subdivision of time into several concepts. This section of the chapter will deconstruct and explore the basic components of rhythm as meter, beat and pulse, and notational rhythm.

2.2.1.1 Meter

Meter is a feature common to many cultures of the world. Gotham (2014:1) finds that meter and rhythm are ubiquitous in the world surrounding humans. The concept of meter has various explanations. Gotham (2014:2) notes that it was a slightly forgotten aspect until the 20th century when research was conducted into the definition of meter and the interaction with structures. Hasty (1999:275) comments in his response to Justin London's article (1999) that they do not "articulate" the same concept of meter. As a theoretical concept, it is the organising of timing structures in music. Holzapfel, Krebs and Srinivasamurthy (2014:1) explain that the metrical structure provided by meter can be partitioned into different time spans (e.g. beats and measures or bars). These beats or pulses are silent, but easily perceived pulsations that are grouped into bars. Beats have hierarchy, alternating between strong beats and weak beats. Normally the first pulse of each bar, the downbeat and strong pulse, determine the meter.

Meter can be anticipated. Several studies using tap research provide evidence. Rankin, Fink, and Large (2014:256) found not only that subjects can anticipate changes in tempo fluctuations that are made for purposes of emotional expression, but also that there could be inappropriate fluctuations, although with slight deterioration in quality. The anticipation of meter affects the interpretation of music. London (1993:3) describes the determining of metric content followed by the maintainenance of the perceived content. He likens the determining of metric parameters as matching content to "a small number of metric archetypes" (London, 1993:3). After determining of metric content, the following activity is cognitively less demanding: the listener will maintain the meter through complex patterns and syncopation until new, obvious cues are given. London (1993) calls this the structuralist approach to meter, where meter is not part of the music as much as pitch or timbre, but heard and felt.

London (2002:4) holds that meter does not originate from the music, but should be seen as a synchronisation response to perceive "recurring events" from the environment. He therefore concludes that meter is "listener-generated". Meter can be perceived in two ways: as a response to stimuli created by musicians or as the result of interaction between musician and audience. The concept of hypermeter, a larger scale relationship than simple or compound rhythmic patterns, is often mentioned. Interpreting meter as an organising system of pulses alone is missing the main function of meter.

2.2.1.2 Beat and pulse

There is a difference between pulse and beat. Pulse is a point in time without any duration and without the ability to give measurement to anything. It can be described as a "regularly recurring feeling of musical stress" (Karpinski, 2000:21-22). Pulse is an important aspect of rhythm (time) and is highlighted by Karpinski (2000:20) when he claims that all the temporal aspects of music listening and perception rely on pulse to create the feeling of meter, the notion of beat and the measurement of rhythmic durations. Beat, on the other hand, is the time between successive pulses that can be units of measurement (Karpinski, 2000:22). A beat cannot be perceived by feeling and it is thus incorrect to refer to feeling the beat of a song – it is the pulse that is felt.

Pulse is not as steady as initially taught to students. The fluctuation in pulse is bent by musicians to aid interpretation and emotional expression. Rankin *et al.* (2014:3) are among the researchers who note the fluctuation of tempo in performance. They observe that in the synchronization with the fluctuation, pulse is anticipated and tapping rate corresponds to performance without any 'lag' (Rankin *et al.*, 2014:3).

Further research in defining pulse leads to the hypothesis by London (2002:35) that hearing a pulse requires the potential of hearing an equal subdivision of the pulse. At a very fast tempo only simple (binary) divisions are possible (200-300ms[3]), as the smallest notable division is 100ms (London, 2002:38). The change in tempo alters the possible divisions and therefore the possible hierarchical configurations do not remain constant. The subdivision of the pulse into simple or compound creates the rhythmic character of the pulse. Epstein (1995:7) emphasises that pulse, as experienced in the actual performance of music, is not purely periodic, but responds to tempo change in a way that is important in the conveyance of motion and emotion in music. A listener's natural sense for pulse identifies sequences of identical sounds and groups them together in twos, fours or threes. The number of elements in each group depends on the tempo. Karpinski

[3] Milliseconds

(2000:15) notes that even though a performance uses fluctuations of tempo for expressive reasons, the audience infers a steady pulse that is the mean of the tempo experienced.

In an attempt to find an effective way to test the perception of pulse, Karpinski (2000:20) agrees with Madsen, Duke and Geringer (1986) that the most effective pulse test is in performance or conducting. The inter-relations of pulse, meter and rhythms are so complex that the listener would have to be sure about what he/she is hearing, before being able to notate it. For this purpose, Karpinski (2000:20) suggests using protonation leading to notational rhythms that are built on the silent pulse.

2.2.1.3 Notational rhythm

Notational rhythms are often described as the length of notes and the time between successive notes. London (2002:3) and Jerde *et al.* (2011:1572) describe notational rhythm to be the temporal organising based on patterns of duration, which is the onset between the attacking points of successive events. It is created from isochronic and non-regular occurring ‘beats’. This is a hierarchical system. Large (2008:90) summarises musical rhythms as encompassing complex patterns of stress timing that is not periodic.

The learning of rhythm can occur in several ways and my view is supported by Kinney and Forsythe (2012:70): as an accompanying cognitive process to tonal information, as a separate phenomenon, or as incidental learning. Kinney and Forsythe (2012:70) motivate their views by referring to several studies revealing the effect of other musical concepts, non-rhythmic and non-temporal elements on the recollection of rhythm.

As mentioned earlier, the teaching of ‘rhythm and pitch’ to students is considered a very important (if not the most important) aspect in music teaching. As with the multiple meanings associated with the often-encountered concept ‘rhythm’, so too the term ‘pitch’ is sometimes misused – the more appropriate concept of “melody” is understood.

2.2.2 Melody

Melody, like rhythm, is a compound, hierarchical concept, but with less misconception than rhythm. Krumhansl (1979:346) notes that individual elements can be defined accurately in terms of their “physical properties”, but the combination of the elements can be more complex. Melody is found ubiquitously. It is also the first element of music to which children respond (Nakata & Trehub, 2004:456; Schmuckler, 2011:94). The study of melody is not only useful for the aural teacher and student, but for many other practitioners of music. Butler (1989:219-220) lists as outcomes for the study of melody the understanding of the listener’s capabilities and limitations, as well as the musical information conveyed to the listener through the complex relationships of all concepts. It is therefore important to study melody in all its aspects for not only aiding the understanding of aural performance, but also the understanding of the relationship the melody holds to other concepts of music making. This section will investigate pitch, pitch collections, contours, tonality, and melody.

2.2.2.1 Pitch

In scientific terms pitch is the frequency of a sound wave measured in Hertz (Hz). Theoretically, there is an infinite number of pitches (both audible and inaudible to the human ear). For the performance of most Western classical music, according to Prince, Schmuckler and Thompson (2009:368), the differences between the tone frequencies are calculated logarithmically. However, the situation is not as straightforward as Prince *et al.* (2009) explain. There are different ways of calculating the tone frequencies: the logarithmic calculation as mentioned above is called equal temperament (Barbour, 1951). Four different temperaments will subsequently be discussed: Pythagorean temperament, Just temperament, Mean-tone temperament and Equal temperament.

The significance or implication of temperament holds true for all non-fixed tuned instruments and singers. Therefore, the temperaments are discussed in this general section of the chapter with string-specific implications discussed later.

A **Pythagorean tuning system** is achieved by dividing the string of an instrument in half and then sounding it. The first four positive integers (tetraktys) are formed yielding the octave (2:1), perfect fifth (3:1) and perfect forth (4:3) above the unstopped string. An alternative explanation is stacking eleven perfect fifths on top of each other until all 12 tones are found (typically from E-flat to G-sharp). The problem is that the last fifth in the cycle is given the remaining cents[4] (a diminished sixth flat by 24 cents). Figure 2.2 demonstrates that stacking perfect fifths does not yield a perfect octave, but overshoots it a little. This is known as the Pythagorean comma (Siljestam, 2013).

[4] Jessop (2017:91) describes cents as subdivisions of a tone. Each semitone is divided into 100 cents. It is used to describe the ratios of temperament.

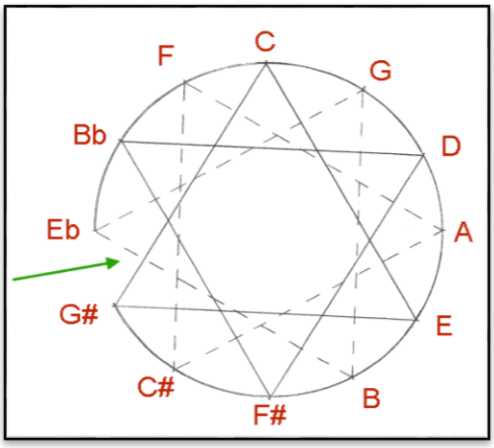


Figure 2.2: Pythagorean temperament (Lehman, 2005b)

Just temperament has no defined origin in practise. Figure 2.3 illustrates this mathematical calculation that stems from the Greek theorist Ptolemy (Lewis, 1998). He divided the same string mentioned in Pythagorean tuning into five and set the foundation of just tuning. The use of this temperament is very speculative: White (2007) quotes Barbour when claiming that the temperament was favoured in the Baroque period as church modes were replaced by a diatonic system of scales. However, the tuning system is not very practical. Lewis (1998) believes that the system was purely of theoretical interest, because it was not possible to execute on a traditional fixed-tune instrument. Figure 2.4 presents an image of an organ with 19 keys to the octave that was intended to use for just temperament (White, 2007).

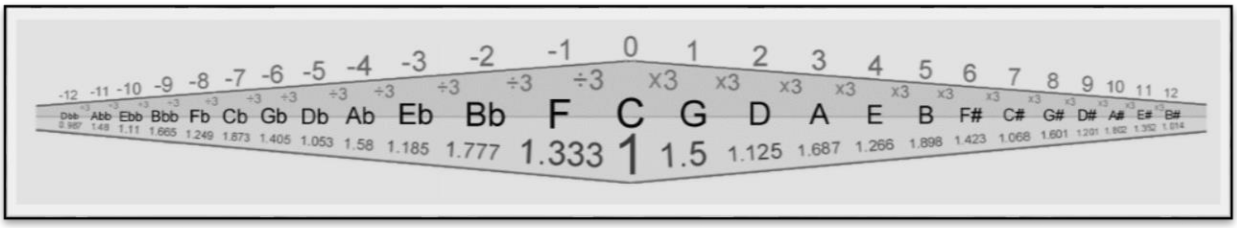


Figure 2.3: Just temperament (White, 2007)

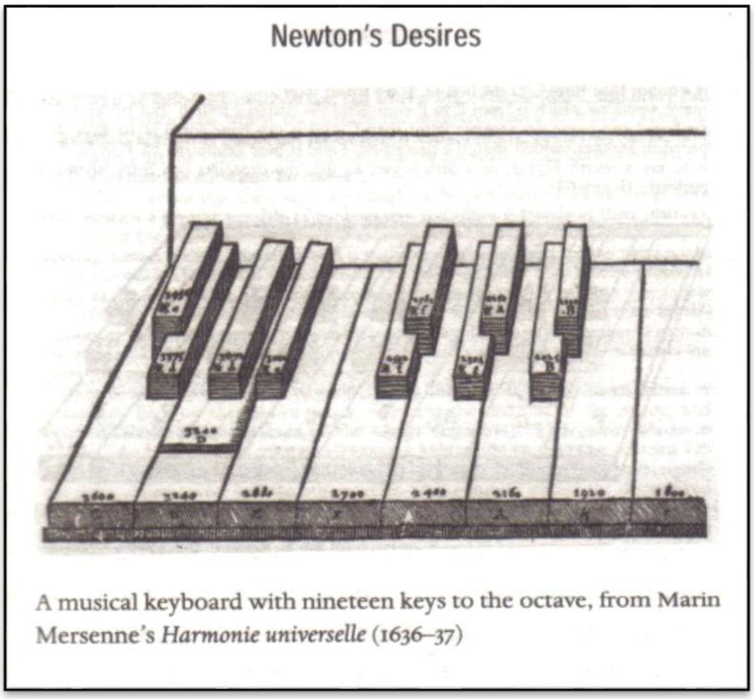


Figure 2.4: Musical instrument with 19 keys per octave. (White, 2007)

Mean-tone temperament has elements of both Pythagorean and Just temperament. It is based on intervals of fifths, but the pure fifth ratio of 3:2 is smaller and the thirds are larger (Lehman, 2005a). Mean-tone temperament was the leading tuning system during the 16th and 17th centuries. The system's shortfall was the ability to modulate effectively to unrelated keys (Lehman, 2005a) and keyboard instruments with split keys (15 notes per octave) would have been needed to accommodate this temperament.

Equal temperament was proposed by Aristoxenus in approximately 350BC and detailed by Galilei in 1581, but it was adopted into general practical use only in the mid-19th century (Barbour, 1951:2). Rameau was a great supporter of equal temperament in the 18th century (Barbour, 1951:4; Jerold, 2015:94). Equal temperament is the tuning that is found as the standard on all modern keyboard instruments. Researchers such as White (2007) see equal temperament as the answer to the temperament debate and as the ultimate compromise. In equal temperament only the octave is a 'pure' interval. The octave is divided in twelve equal parts, thus making all the intervals (except the octave) 'imperfect'. Figure 2.5 demonstrates the equally-distributed frequency of the octave. This division of equal steps makes modulations to very distant keys possible. The negative aspect of the equal temperament is that the 'colour signature' of each key is weakened.

Note name & amount in cents	C 0c	C#/Db 100c	D 200c	D#/Eb 300c	E 400c	F 500c	F#/Gb 600c	G 700c	G#/Ab 800c	A 900c	A#/Bb 1000c	B 1100c
Pitch Freq. (2dp)	1	1.06	1.12	1.19	1.26	1.33	1.41	1.5	1.59	1.68	1.78	1.89
Octave higher	2	2.12	2.25	2.38	2.52	2.67	2.83	3	3.17	3.36	3.56	3.78
Octave lower	0.5	0.53	0.56	0.59	0.63	0.67	0.71	0.75	0.79	0.84	0.89	0.94

Figure 2.5: Equal temperament (White, 2007)

Recently, the discussion on temperament and tuning systems has fallen out of favour with researchers. Levitin and Rogers (2005:27) identify four reasons for this trend:

i. the pitch accuracy of real performers as measured by Carl Seashore in the 1930s proved that singers and violinists are remarkably inaccurate (up to 25 cents) and that Western classical audiences and musicians are not noticeably disturbed by the pitch intonation of professional performers;
ii. on average, professional piano tuners fail to tune notes more accurately than about 8 cents – this means that even if performers could perform very accurately, they would find it difficult to find suitable instruments;
iii. apparently, listeners adapt to whatever system to which they have been exposed. Most Western classical music audiences find Just intonation 'weird'-sounding rather than 'better'. Moreover, professional musicians appear to prefer equally tempered intervals to their just counterparts; and
iv. the perception of pitch has been shown to be *categorical* in nature. In vision, many shades of red will be perceived as 'red'. Similarly, listeners tend mentally to 're-code' mis-tuned pitches so that they are experienced as falling into the correct category. Mis-tuning must be remarkably large (>50 cents) before they draw much attention. This insensitivity is especially marked for short duration sounds.

The theoretical, mathematical explanation is almost a simplification of what happens in practice. Bachem (1950:80-81) describes the sensation of pitch as consisting of two elements: the tone height or logarithmic frequency, and the "c-ness" or the variations related to the notes in the octave often referred to as "tone quality" or "chroma", which is not to be confused with tone colour or timbre. The distinction between the tone height and chroma is subjective based on experience. This raises the question of absolute pitch (AP). AP is the ability to identify a pitch that is sounded without any associated pitch by which to calculate. The identification of pitch by calculating relation to another pitch is called relative pitch. It is popularly believed that AP is an inborn ability, which allows the absolute pitcher to identify frequencies in a very similar way colours are identified. The absolute pitcher is only taught the name of the pitch (like the name of a colour is taught). Hung (2012:58) also reminds his readers that absolute pitch is not perfect and, in his research, absolute pitchers rate the same as relative pitchers at identifying intonation errors. Furthermore, Levitin and Rogers (2005:28) found that an absolute pitcher that honed their skill on a piano that is not properly tuned will always be out of tune. Levitin and Rogers (2005) also noted that some musicians can learn the one absolute pitch to which his/her instrument is tuned. AP is believed to be developed or stimulated in early childhood from a latent ability (Vitouch, 2003:111); it is not taught. However more research is required.

2.2.2.2 Pitch collections

Pitch collections or patterns refer to ordered pitches that make up a melody. These pitch collections or patterns can encompass several different structures. Milne, Sethares, Laney and Sharp (2011:1) give examples of these structures as chord tones, scales, tuning, or virtual and spectral pitches heard in response to complex tones or chords. There is thus an analytical process that places the pitches in relation to a structure. Chrisman (1971:59) describes the pitch collections analytically as pitch content (the class-representation of the pitches usually related to a scale system) and the relationships between the pitches (intervals). Pitch collections' content used compositionally can be reduced to pitch sets, which is the pitch represented in the pitch collection. Chrisman (1971:60) demonstrates this by example of a collection that contains many c and d pitches and would thus have a pitch set of c and a pitch set of d. This analytical process of pattern recognition is at the heart of the chunking process. It is a cognitive process that will be discussed under skills (2.3.1.1).

2.2.2.3 Contours

Contour is often referred to as the design or shape of the melody, the pattern of ascending and/or descending pitch intervals of a collection (Heaton, 2005:788). Even though there are variations in the explanation of contour, Edworthy (1985) mentions context of melody (e.g. melody length); Salamon and Gomez (2012) harmony, pitch continuity and exclusive allocation as melodic and non-melodic influences on perception of contour; they all acknowledge that contour is regulated by theoretical rules that 'balance' melodies. Müllensiefen and Wiggins (2011:2) stress the importance of contour when constructing a good melody referring to theoretical 'rules' such as balance between skips and step-wise motion. Contours are among the important elements to consider when analysing melody.

Another consideration is the similarities that exist in language and music regarding pitch contour. Stevens, Keller and Tyler (2011:59) attribute the ability of music and speech to communicate to pitch contour as it is present in both. Tonal language speakers (e.g. speakers of several Asian languages) are more sensitive and effective in music contour interpretation (Wayland, Herrera & Kaan, 2010:654). It should furthermore be noted that contour is also experienced in rhythm. The relationship between music and language is an extensive field of study: Stevens *et al.* (2011:60) identify elements such as pitch, stress, and timing (syllable duration and pause). The interpretation of contour is thus reliant on more than merely pitch. Schmuckler (2016) links contour with tonality as the primary influence in perception and memory skill (see 2.3).

2.2.2.4 Tonality identification

Tonality is a daunting concept if the cultural essence is considered. Krumhansl and Schmuckler (1979:347) describe tonality as a central organising structure of music. The diversity of understanding tonality is not only reliant on the culture, but also on each musical period, culture and theoretic tradition (Krumhansl, 2004:253). While researchers report several different tonalities – e.g. Žabka (2014:180) found seventy-two scale types in South India – the dilemma is not addressed by focusing only on Western classical music. A large selection of folk music influences Western classical music, e.g. the Hungarian tonal set or the pentatonic mode; church modes; jazz modes; and ragas. Furthermore, Western classical compositions have started moving away from tonality, first gradually with chromaticism, and then embracing bi-tonality, polytonality, and a-tonality – a significant shift in the thought process in recognition of tonality. Lewin is one of the first researchers to attempt an analytical tool that uses mathematical formulae to calculate tonality and his formula includes a 'neo-Riemannian' theory (Hasegawa, 2013:574). Rink (2005) and Tymoczko (2011) developed a coherent theoretical framework for chromaticism. These tools have been formulated as an attempt to encapsulate all scale systems.

Krumhansl (1979:347) describes the diatonic scale as a set of seven pitches chosen from a set of 12 (the octave). The chosen seven are diatonic tones and the remainder are non-diatonic or chromatic tones. The diatonic tones conform to a fixed pattern of intervals. There is a well-established relationship between the tones and the tonal centre, the tonic. The non-diatonic tone has the weakest relationship and is thus unstable in relation to establishing a key. The dominant is the second stable tone after the tonic. The tonic, mediant and dominant sounded together (tonic triad) is the clearest key establishing unit. The tonic triad is sounded before many of the aural training exercises and tests.

Some aural training modules move beyond diatonic tonalities. Lars Edlund (1963) provides an example of post-tonal aural training. While most Western classical literature gives preferrence to the diatonic scale, it is not the only source of tonic identification, but arguably the most stable. Prince *et al*. (2009:368) identify the hierarchy of pitch classes with the tonic triad set as the most stable, followed by the rest of the diatonic pitches, and lastly the non-diatonic pitches.

2.2.2.5 Melody (pitch in context)

Melody is the culmination of pitches linked together to form intervals, in turn to form pitch collections with predetermined contour set in a tonality. Melody is thus not the mere organisation of successive pitches in time. Dowling and Fujitani's (1971:524) argument in favour of this is that melody is determined by the relationship between the tones and not the absolute pitches themselves. Dowling and Fujitani (1971:530) describe melody (rhythm ignored) as a series of intervals between successive pitches. When melodies are transposed, the chroma and ultimately the pitch are altered. Dowling and Bartlett (1981:30) found in their research that even if the contour and the logarithmic sequence (intervals) of the melody remains the same, that test subjects could identify when a well-known melody had been transposed.

It is argued that melodies are built on harmonic structures, thus forming the bases of the tonality (Krumhansl, 2004:253). Researchers such as Temperley (1999:65) will even go as far as indicating that in establishing tonality, it is more important to establish the chords and chord progression sequence than to know what pitch is heard. Considering that each pitch is determined by the underlying or implied harmony, melody is based on harmony.

2.2.3 Harmony

The concept of harmony has been discussed and debated since Plato[5], hence the connection with mathematical algorithms (Fletcher, 2002:1205). The relationship between music, specifically harmony, and the natural world can be found in topics such as "harmony of the spheres"[6] and 'influences of music on plant growth'[7]. This study will not venture into the complex mathematical equations or relationships with nature regarding harmony. Rather, harmony will be studied as the juxtaposition of notes (two or more) in which a relationship is formed with notes sounded either simultaneously (vertically) and/or after one another (horizontally). Parncutt (2012) describes harmony theoretically as notes forming chords, combining sets of chords and finally chord progressions. It should be noted that chords are but mere sounds, they do not classify as harmony. Toch (1977:1) describes chords as empty vessels "waiting to be filled with substance". This substance is referred to by Toch (1977:1) as meaning that will then be harmony. Clusters of notes (chords) are not harmony; they become harmony when put into a context of more chords. Randel (2001:366) highlights horizontal positioning by drawing attention to the fact that the time (rhythm) of the harmony is also important. Harmony could be described as note clusters forming chords that are rhythmically placed between other chords to form meaning. This section will consider harmony under the following subheadings: consonance, dyads, triads and dissonance, and chords in harmonic function.

2.2.3.1 Consonance

Consonance is described clearly by Plack (2010:R476) as the combination of notes (vertical or horizontal) sounding pleasant or resolved. The debate about consonance has raged for many decades, but research has moved far beyond the early 20th century Seashore's sense of consonance – the debate can be traced as far back as the Pythagorean aesthetic absolute and Aristoxenus' relativism. The study of consonance often resorts to the field of psychoacoustics. Terhardt (1973:1061) refers to the psychoacoustics of harmony when he tries to describe an interval as "tonal consonance" which is "reliant on the absence of rapid beats" or also called roughness. Devaney and Ellis (2008:144) describe the beats as produced by interference between tones of proximate frequency. They are in support of literature claiming that two pitches whose overtones (upper-partials) are similar will sound consonant, whereas the absence of such similarity produces dissonance (Devaney & Ellis, 2008:144). These beats are thus formed by the proximity of two sinusoidal waves (sound waves). According to this theory, the degree of similarity can be determined by measuring

---

[5]Plato (ca. 429-347 BC) wrote in his monologue *Timaeus* in Greek, about the 'harmony of the spheres' that created the World-soul' as created by the Demiurge (a type of creator god) (Godwin, 1993). The music produced by the movement causes harmony.

[6]An introduction to the topic is found in *The Music of the Spheres: Music, Science, and the Natural Order of the Universe* (James, J. 1995. USA: Springer-Verlag).

[7]Several studies have been made on the effect of different music on plant life. Recommended for further reading on the subject. Measuring effects of music and healing energy using a seed germination bioassay (Hashi & Rochde, 2017). *The Journal of Alternative and Complementary Medicine*, Volume 10, Number 1, 2004, pp. 113–122.

the number of beats produced when the two tones are played simultaneously. In 1877, Helmholtz considered this the first scientific description of consonance which later led to the Helmholtz-Krueger theory in 1906 (Peterson, 1925:19). There is a definite relationship between harmony and mathematics. Cazden (1945:3) believes that music (and all its concepts) follows natural laws ("universal and eternal laws") and therefore can be calculated mathematically. Fletcher (2002:1205) supports the mathematical calculation of consonance by referring to the calculations of Pythagoras (dividing a string length to form simple integers) to find "pleasant" sounds. Cazden (1945:3) describes the overtones following a "harmonic series"; the frequencies of the overtones are multiples of the fundamental frequency. The first six overtones are consonant harmonically to the fundamental tone.

In contrast, some researchers believe that the physiological and psychological aspects of tones should be taken into consideration (Plack, 2010:R476). The psychological research was led by Stumpf in the 19th century. He concluded that the more consonant the tones, the more they will be perceived as just one tone – this is called the fusion degree (Hofmann-Engl, 2010:854). McDermott, Lehr and Oxenham (2010:1035, 1038) made several ground-breaking discoveries in their empirical study of consonance. Using non-musical sounds, they found that participants who found beating unpleasant were not averse to dissonant harmonies. They concluded that consonance is learned by our preference of harmonic series (harmonicity). This degree of consonance leads to the idea that some harmonies are ranked major, minor, diminished and augmented, in decreasing order of consonance (Cook & Fujisawa, 2006:108). They also concluded that musical training and experience influence the concept of consonance. The cognitive research model was produced by Hofman-Engl in 1990 based on Terhardt's virtual pitch model (Hofmann-Engl, 2010:855). Ironically the cognitive model is also explained through mathematical equations.

Another factor to take into account when studying consonance is social habituation. As mentioned before, training or experience in music plays a role. Cazden (1945:5) also considers age, culture (in and outside Western civilisation), historical time, and comparison against consonance (degree of consonance). Several researchers believe that consonance is innate (Tymoczko, 2011; Crowder, Reznick & Rosenkrantz, 1991; Kagan & Zentner, 1996; Trainor & Heimniller, 1998; Trainor, Tsang & Cheung, 2002; McDermott & Hauser, 2005b) – they tested the responses of adults against those of infants and several animals. The natural world interacts in a very predictable manner to consonance and dissonance.

2.2.3.2 Dyads

Dyads consist of two tones. Not all researchers regard dyads as harmony. Cook and Fujisawa (2006) believe harmony starts from triads. This can be understood psycho-acoustically when considering that dyads' possibility of being dissonant is less than the possibility of dissonance of three note chords, with the exception of intervals of a second (or inverted second) (Rasmussen, Santurette & MacDonald, 2014:5). With reference to Bones and Plack (2015:9), who remind us that consonance and dissonance are achieved only when the dyad is considered in relation to harmonic function, dyads might be included in considering the phenomenon of harmony. Research on dyad harmony concerns itself mostly with consonance and dissonance. The consonant dyads are identified as major or minor, whereas dissonant chords are identified as diminished and augmented (Johnson-Laird, Kang & Leong, 2012:19; Rasmussen *et al.* 2014:2). Rasmussen *et al.* (2014) mention that a further complication arises in considering dyads, as harmonies become more complex as the pure tones become dissonant as the frequency spacing is altered up to a ¼ tone – thus when the temperament is adjusted (as with mean-tone and equal temperament). The harmonic function assists in the classification of the dyad in such instances.

The difference in temperaments is highlighted in the use of harmony. The overtones of pure intervals will create fewer beats than any other intervals (Devaney & Ellis, 2008:144; Thompson, 2013:107). However not all researchers agree with this sentiment; Rasch (2008:2) suggests that only equal temperament should be used in performance. Another option would be to separate melodic teaching (using non-equal temperament) from harmonic teaching (using equal temperament). Rameau (1971:3) followed this route of separating the study of music into melody and harmony, but states that knowledge of harmony is sufficient to understand music. He also values the relationship of high pitches *(aigu)* with low *(grave)* pitches, thereby approaching the *status quo* of teaching as it is done today; only using equal temperament. For Karpinski (2000:112) it is more important that a performer understands the ‘harmonic implications’, because appreciation of the implied chord of a bar allows access to the notes more readily. Also, the cognition of harmonic structure can lead to a more musical performance. Combining more than one set of complex dyads causes more complex harmonies.

2.2.3.3 Triads

Triads consist of three notes. The consonant triads are defined as major and minor. Tones of the major triads are found in the overtones of a fundamental note (Snyder, 1980:47). The minor triad is not provided for in the overtone range of the fundamental tone, yet the major and minor triad are equal in music practice (Ibid.). The minor triad consisting of the altered third was adopted by Rameau in *Traite de 1'harmonie* (1971), after the discovery of resonance explained the existence of lower partials or sub-tones where the minor third is found on the lower 12th and 17th overtone. The major triad can be found in the upper partial (overtone) 12th and 17th (Snyder, 1980:47). This explanation is still valid today.

2.2.3.4 Dissonance

Dissonance is not merely the opposite of consonance. Discussion about dissonance will be continued in the skill section of this chapter. Johnson-Laird *et al.* (2012:20) explain dissonance as a dual-process theory; based psychoacoustically and theoretically on the principals of tonal music. It is important that both principals should be employed. The psychoacoustic aspect is explained earlier in this section: consonance is the absence of beats, and therefore the presence of beats will make harmony dissonant. Dissonance is expressed by Plack (2010:R476) as “unpleasant or unresolved” while Leonard Meyer (1959) describes the dissonance of triads as restlessness. The restlessness is caused by the equal distance of the intervals of a third that crave to be resolved. Although Cook and Fujisawa (2006:109) do not give a reason for the perception of unresolvedness, they deduce that when a triad is unresolved, it is dissonant.

2.2.3.5 Functional harmony

Functional harmony is often described as the interplay of dissonant chords that resolve in consonant chords. All the chords are based on tonality. Bharucha and Krumhansl (1983:65) refer to the hierarchy of tones (and chords built on tones of the scale) grounded according to their stability. Rameau theorized in the 18th century that consonance has something to do with the bass note and tonality (Terhardt, 1973:1062). Much mathematical research is frequently undertaken trying to prove and disprove Riemann's chord classification system (Hofmann-Engl, 2010:855). As quoted earlier Karpinski (2000) does not place much musical value in the mathematical and theoretical understanding of harmony (regarding aural training). Alvarez (1980:230) criticizes the method of teaching harmony, together with the late introduction of aural harmony, noting that a student’s first encounter of aural harmony follows well after the theoretical first introduction.

The element of voice leading that forms an integral part of theoretical harmony, gives rise to melody. Bharucha and Krumhansl (1983:65) refer to analysis of melodies into its implied, abstract chords to address the possibility that listeners have a pre-existing knowledge of chord functions activated by melodic patterns. Melody, in all its complexity, is based on harmony. Harmony is based on tonality, which is part of melody. It is therefore imperative that aural skill training should include all the basic concepts, for they are interrelated, and dependent on one another.

2.2.4 Summary

The three basic concepts (rhythm, melody, and harmony) are complex to define. Theorising on the concept of rhythm dates back to the ancient Greek philosophers. Although elements of rhythm are common to many cultures of the world, the implementation thereof is different and anticipation of rhythm is determined by it. My focus is mainly on the pitch interpretation of different temperaments, which influences instrumentalist of non-fixed tuned instruments. Melodic elements influencing anticipation are highlighted. Harmony is defined as consonance and dissonance and the anticipation that accompanies the concept. In the following section, the basic concepts will be investigated in terms of the basic skills.

2.3 BASIC SKILLS

Concepts are taught as part of basic skills. This will be illustrated in this next section. The basic skills will be discussed under four headings: thinking, listening, reading, and performing. Each of the headings will discuss several elements that are pertinent to each skill. The elements of each heading will follow the basic concepts (rhythm, melody, and harmony) as structure.

2.3.1 Thinking

As mentioned in the section defending the choice of different concepts, the brain processes the three different concepts in separate areas. The predisposition of the human brain for music will be evident from the understanding of the working of memory in the brain. This section of the thesis will investigate the physical attributes of the human body that will prove that humans are predisposed to musical processing. Thinking skills will be discussed as musical memory, perception, cognition, and audiation.

2.3.1.1 Musical memory

Musical memory (as with all memory) is the ability to recall information. Herrmann (1995:31) explains that there are two theories that aim to explain the function of the brain: The first is the triune brain theory that describes three sections of the brain that developed along with evolution of the homo sapiens. They are known as the brainstem or ancient, primitive reptilian brain, found in the core of the organ; the limbic or mammalian brain, that is on top of the ancient brain; and neocortex forming the outermost layer of the organ. Each section is responsible for the processing of different kinds of information. The neocortex is responsible for higher order thinking and reasoning, the part of the brain that interprets art as meaning. This section of our brain becomes slower when facing stressful situations. The limbic brain, also found in mammals, is responsible for the emotions. Engaging the limbic brain while learning (movement, pictures, and music) will aid the neocortex's function. The brainstem's function is survival, the basics. We have this part of the brain in common with reptiles. It works quickly and can hamper the function of the other areas when in a stressful situation (Herrmann, 1995:31).

The second is the left brain/right brain theory that is structured around the grey matter forming two lobes, described as specialised structures with unique patterns of brain function. Figure 2.6 below indicates the fibres that interconnect the hemispheres (left and right) of neocortex and limbic to itself as well as the neocortex to the limbic. The auditory nerve makes its way to five of these structures: two parts of the reptilian brain, the limbic brain, both halves of the neocortex (Crowe, 2004:105). One part of the reptilian brain is the hypothalamus – responsible for processing activities below consciousness (passive listening). She (Ibid.) explains that each neuron group responds to different elements of music, but there are also neurons returning from each section to the ear. This allows the ear to adjust for selective hearing. The ear and auditory nerve will be discussed in section 2.3.1.2.

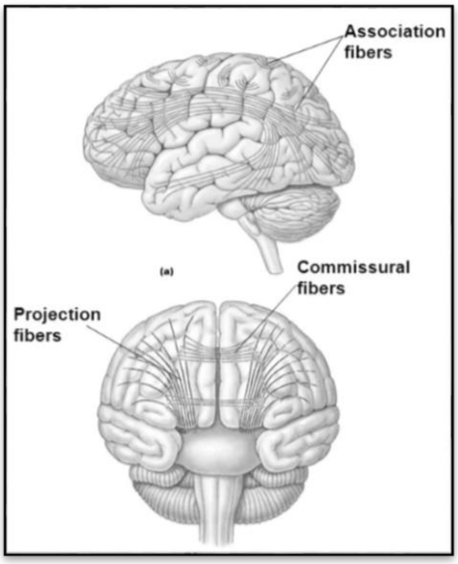


Figure 2.6: Interconnection in the brain (Thaut, 2005)

In psychology, memory is the ability of neurons (nerve cells) found in the brain to alter the strength of connection to other neuron cells in ways that extend over time. The events that cause forgetting (Jonides, Lewis, Nee, Lustig, Berman, & Moore, 2008) and incorrect memories (Vuvan, Podolak & Schmuckler, 2014) is a field that should be included when discussing memory, but this falls outside the scope of my study. According to Snyder (2000:4) and Crowe (2004:112), the chemical change that is created with the connections outlasts the process and therefore we can conclude that memory is the function of all neurons. There is a closer connection between emotion and hearing, than between emotion and seeing (Crowe, 2004:112). Memory is not a singular concept; different processes are linked to certain brain functions. More recent studies, as those done by Jonides *et al.* (2008) note that the processes are more interconnected than what was previously thought. Processes are identified as echoic, early processing, short-term memory, and long-term memory. Echoic memories can fade within seconds. Raw acoustical data is extracted during the feature extraction process. Perpetual binding data are connected to other data occurring at the same time to form a coherent sound picture. Snyder (2000:4) remarks that the information is no longer continuous, but encoded, and data is significant less. The information is then again grouped into events with other relative data in a process called perpetual categorisation. The events activate similar events (conceptual categories) in the long-term memory. The long-term memory is filled with information of past events that is brought to conscious awareness either spontaneously or unconsciously (recognised or reminded) through conscious effort. Forming and consolidation of long-term memory can take weeks or even months. A context for current awareness is formed by the events that do not become immediately conscious. This context takes the form of expectations, memory of the past and related knowledge. These events are semi-activated: neurologically activated, but in the unconscious. Long-term memory is said to be in the highest form of activation, called “in focus of conscious awareness” and informs current perception (Snyder, 2000:5). The conscious long-term memory can be short term memory and generally fades after 3-5 seconds if not repeated or rehearsed. When rehearsal takes place in the right way and conditions, the information can become or alter long-term memory. There is thus a constant shift of long- and short-term memories.

Short term memory can store only seven events. To stretch the short-term memory’s capacity, chunking is applied. Chunking is a process whereby each event is not considered to be (from a musical perspective) an individual note or rhythm, but a larger concept, for example a scale passage. These chunks can consist of five to nine elements each (Snyder, 2000:54; Fourie, 2016). The grouping process is an important element in chunking, which is reliant on associations made between the elements. Examples of these associations are structural repetition, rhythmic and melodic motives, themes and variations, and harmonic progression groups (Cambouropoulos, 2006:249). Chunking is a process that implies both short- and long-term memory, and for that reason chunks themselves can become parts of larger chunks.

Music memory relies not only on repetition, but on different kinds of knowledge. Peretz and Zatorre (2005:96) give as a reason the highly structured nature of music. Musical memory is a skill both musicians and non-musicians possess. The entertainment industry and marketing industry often use musical memorys ability to their advantage. Deutsch and Feroe (1981:205) describe the process of memory as coding and placing in hierarchies which are determined by the goal. Aspects like the visual, or language (speech) are all coded in different structures, which make it important to find the hierarchies of melody. Deutsch and Feroe (1981:205) highlight that not all information is memorised and that the memory is stored in patterns that allow for interpretation of some of the information. This information can be interpreted differently and makes memory inaccurate sometimes.

Memory of music is predisposed in humans. Trehub’s (2000:427) investigation into the processing of music in the human brain (of both adults and infants) found a biological basis for this predisposition. One of the great reasons for the predisposition to musical memory is the anticipation that is created. Vuvan *et al.* (2014:2) go as far as to call the anticipation the sole purpose of memory.

External, non-physical factors such as cultural familiarity and age also play a role in music memory. Krumhansel (1990:427) found that older children have better preservation of traditional songs than their younger siblings; regular structured melodies have a more successful chance of being memorised, and formal training enhances the ability for memorisation of melodies. Aural training should help in the building of chunks and making associations to aid musical memory. Fetherston (2011:36) refers to the memory section of aural or ear training as “mind training”. Research on the human brain function has not been completely successful and working memory is not fully understood (Schultze, Dowling & Tillman, 2012:255). Every brain is also predisposed to learning in different ways. The inability of humans to memorise and recognise melodies is called amusia. PET scans indicate activity in the whole brain in the processing of music (Jensen, 2000:12). Memory and familiar sounds are activated in Braca’s area found in the left hemisphere of the brain. Harmony activated the left brain more than the right as well as the inferior temporal cortex.

Kinney and Forsythe (2012:69) connect the skill of music memory to that of the rote teaching system, relying on memory, and not notation to reproduce music. "Rote learning relies on the ability of learners to imitate a sequence of sounds whether pitched (e.g. echoing a melody) or non-pitched (e.g. echo clapping a rhythm pattern" (Ibid.). Their main goal was to prove that non-rhythmical elements assisted the recollection of rhythmical patterns such as melody (Ibid.:70). Jerde, *et al.* (2011:1572) attest to the independence of rhythm and melody by quoting research on brain damaged patients' ability to recollect either melody or **rhythm**, but not both. The areas of pitch and rhythm are processed and stored in different parts of the brain and can thus function independently.

After mastering the rote system, students can be taught to read the note system. While musical literacy is a major goal of music education at every level of learning, it is not a necessary aspect of musical enjoyment nor is it required for every type of performing. Yet, developing perceptual expertise is an ongoing part of music education regardless of whether efforts to teach music reading succeed or not.

A problem with the rote system is that there is no study as to the accuracy of the memorisation while using this system. Horvath (1999:37) studied the modelling practice of string students and offers a possible reason for this phenomenon, as the importance of acquiring this technique at a basic level as more important than the accuracy of replication.

The research in the field of music memory is divided in opinion on the role of pitch and rhythm in this cognitive act of memorising. There is ample evidence for both arguments against the joint or interactive influence of the two concepts as well as for the separation or independence of the concepts (Jones, Johnson & Puente, 2006; Krumhansl, 2000). More recent research in the field of melodic memory (Prince, Schmuckler & Thompson, 2009:369) is based on how to accommodate the research done to prove both independence and interactive processing theories to form theories inclusive of both.

Pitch memory is needed to perform recognition and dictation. Because of this function, Pembrook (1987:157) as well as Dowling and Fujitani (1971:525) name pitch memory as a crucial skill for musicians. Pitch matching is different to pitch memory in that there is a time lapse between the perception of the pitch and the recreation or recognition of the pitch. Karpinski (2000:36) comments that even a few milliseconds of time lapse requires some memory activity. Considering that the physical manifestation of pitch is the activity shown on a PET scan in the left back section of the brain called the precuneus, and possibly in the right auditory cortex area (Jensen, 2000:12), it is interesting to note that the processing is done in the Broca's area. Karpinski (2000:37) names two activities involved in the test of pitch memory recognition and recall. The process areas in the brain are different for memory and for perception.

A musician's ability to identify and reproduce **pitch collection** sequences relies on memory. Karpinski (2000:39) claims that evidence of this skill is the recall of scale patterns at first glance, and that pitch collections should form part of pitch memory. However, he explains that it is the process that is different: a very swift, unconscious tonic identification. Pitch collections are the culmination of several aspects of music seen in its total *(gestalt) (Gestalt* will be discussed in more detail in section 2.3.1.2). This leads researchers to finding many aspects influencing the memory of pitch collections. Krumhansl (1979:349) found that sequences containing the tonic triad are more correctly memorised as well as more accurately identified in transposition and fewer sight-singing errors occur. Karpinski (2000:141) warns that students will only truly understand pitch collection exercises when the sequence of learning is ready for it.

Contour is a concept that is nurtured in musicians. Contour and interval information are processed differently in the brain, according to Rogers (2013:37). He also maintains that it is a stronger skill in some musicians than in others. Heaton (2005:788) and Deutsch (2013) hold the view that the temporal process involved in contour identification is different to that of specific intervals and chords. Contour is often committed to memory and recognised more easily than interval distance. Edworthy (1985:376) found that accurate contour information was immediately available after first hearing, while interval information was inaccurate. Identification of melody after transposition relies on contour. Dowling and Fujitani (1971:524) as well as Edworthy (1985) observed that contour memory was important when melodies are novel, transposed or tonally weak. It is suggested that interval recognition belongs to the area of long term memory, but contour is easily forgotten. Considerable research is done on identification of melodies that are transposed or altered in some way. Most often contour is cited for the phenomenon. Dowling and Fujitani (1971:525) found that long-term and short-term memory of melodies relied not only on the contour, but also on the transposition or rather not being transposed. In long-term memory experiments, the researchers applied distortions to the melody used, while only contour was retained. The participants were most successful where contour was consistent. More important is that Stevens *et al.* (2011) found that both adults and infants psychologically extract melodic contour. This implies that contour is learnt at a very young age.

The recognition of a melody requires encoding of the intervals between successive notes. Musicians and non-musicians (from a young age) are capable of recognising melodies by memorising the note relationship to each other based on intervals (Lee, Janata, Frost, Martinez & Granger, 2014:163). Most research in the field of **melody** memorisation is often to establish factors that aid or detract from the memorisation or recall of melodies. There is not always consensus among researchers. Lee *et al.* (2014) found that melody is remembered better when the length of the melody is longer – they offer as reason the Krumhansl-Schmuckler key finding algorithm. The key finding algorithm determines that a greater amount of information about the melody can provide tonal context and thus help establish tonality. In contrast to their finding, Schulze *et al.* (2012) found that longer melodies (sequence length) lead to weaker memory of the melody. More extreme research ideas that are also offered is that music with an anticipated ending is more readily remembered than melodies with unpredictable endings (Vuvan *et al.*, 2014:2). The idea that more tonal context can lead to longer sequences in the process of forming chunks has not been fully proven, and depends totally on the context. The study by Lee *et al.* (2014) set out to prove that melody is remembered better by individuals when the melody is set to some harmonic context, and they found that higher order abstractions (harmony, melody) last longer than those of the lower order (absolute pitch). This method of memorisation results in melodies being recognised even if they are transposed to a different key.

Not only does the length of the melody influence the memory, but timbre plays a significant role in the memorisation of melody. Weiss, Trehub and Schellenberg (2012:1074) refer to the section identified in the brain that responds to vocal stimuli only. Another factor in the perception and memory is the register of the original stimuli. Several researchers (Horvath, 1999; Deutsch & Feroe, 1981) have found that transposing stimuli melodies in a different register, to the one to which subjects need to respond (violin vs. cello and soprano vs. tenor), influence the accuracy of memory. More success is achieved by having the stimuli melody in the same timbre and register as that to which the test subject can respond. Both Deutsch an Feroe (1981) and Horvath (1999) observed that register plays an integral part in long-term remembering of melody. Melody activated both sides of the brain in a PET scan (Jensen, 2000:12). Jensen did not specify melody when he made this statement, because he also claimed that timbre is the only right-sided activated element.

There is ample support for melodic memory of (especially) Western classical music; it has a predictable structure that makes it possible to anticipate certain outcomes (Bigand & Poulin-Charronnat, 2006; Tillmann, Bharucha, & Bigand, 2000). Repetition also plays a role in the accuracy of the recall. Schellenberg and Habashi (2015:1022) established that if a melody is repeated often enough in the same key, pitch, and timbre, up to 70 percent of study subjects could sing the same melody on different days on the same pitch and tempo. Thus, memory improves if frequent repetition of tonality, tempo and timbre are unchanged. Memory was negatively affected by change of timbre in this study. Dowling and Bartlett (1981) observed that identifying melodies in different keys was easily done, but when contour was maintained and intervals were distorted, the task was far more difficult. In research by Cuddy and Cohen (1976) musical knowledge was found to aid the memory as the context of the notes was understood. Lee *et al.* (2015:164) refer to the activation of "Melodic gestalt".

2.3.1.2 Perception

The anatomy of perception is important to this study since it suggests what can form part of education and what is physically part of the human body. Psychoacoustic studies the responses of individuals' inner perception of sinusoidal waves from the outer world (Fyk, 1995). The ear relays the stimulus of sound (sinusoidal waves) to the auditory nerve. There are three sections of the ear: the outer ear, the middle ear, and the inner ear. Everest (2001:41) explains the anatomy as follows: The auditory canal starts from the outer ear and ends at the ear drum (tympanic membrane). This is the start of the middle ear cavity that has three tiny bones (ossicles), called the malleus, incus and staples, suspended in air. The ossicles are attached to the oval window in the inner ear. The cochlea of the inner ear is filled with fluid and ends in the auditory nerve, which sends stimulus information to the brain. Everest (2001:41) and Deutsch (2013) describe the human ear as very sensitive and the threshold of audibility has been adjusted through evolution (required). Plomp (2002:1) defines the ability to isolate and describe a single sound from all the multiple sounds around us as astounding. The ability to isolate one musical line from an orchestra of sound is even more remarkable. Vuvan *et al.* (2014:7) established that what we hear depends on what we expect to hear. Plomp (2002:1) uses a similar argument to describe perception as a passive activity. In his study of psychophysical elements, it was found that listening is not only a physical reaction to stimulus, but also the unconscious interpretation of the sounds (through audition and cognition).

Music perception is a stimulus that is created through art (Vuvan *et al.*, 2014:1). The process of perceiving music unfolds over time, making the ability to predict what comes next in the musical experience (anticipation) fundamental to the perception of music. Vuvan *et al.* (Ibid.) found that when initial contact is made with the stimuli; it sets into motion flexible reflex mechanisms and activities that are developed largely through education. These complex mechanisms are part of the aesthetic experience as it embraces both experience and creation. We should understand it as part of development and not as stimulus-response: to differentiate between acculturation (familiarisation through contact and exposure - involuntarily, passive familiarity with the work) and education (perceptual development through support in acquisition of concepts and symbols that provide definition of forms). As perceivers of sound we find ourselves divided into two categories often referred to by researchers as musicians and non-musicians. Francès and Dowling[8] (2014:2) describe the two groups as trained listeners and "pre-trained" listeners and explain the process through which the latter group attains their grounds for aesthetic choices as acculturalisation. The basis for acculturalisation is the contact with music with similar properties. The steps that lead the trained musician are based on perceptual activities, abstraction and schematisation, fixation and differentiation in musical hearing (Ibid.). These steps give rise to comprehension, taste, and aesthetic judgement (Francès & Dowling, Ibid.:3). Both musicians and non-musicians start the process of perception before birth. Honing (2011:7) refers to earlier studies that found that the cry of German babies has a descending pitch where French babies have ascending pitch, providing evidence that perception of acculturalisation takes place in the womb. Aspects of culture should always be considered.

The study of perception investigates the listener's ability to process musical elements. Elements that are considered as part of music perception are loudness, pitch, and timbre (Moor, 2010; Dowling, 2001:470). Moor (2010:409) considers loudness subjective and therefore difficult to measure in a quantitative manner.

---

[8] Dowling translated the 1958 French book, *Perception of music* by Robert Francès.

Kinney and Forsythe (2012:69) regard perception and recreating fundamental to the development of young music students. Education in music influences the expectation and thus perception of music. Seesjärvi, Särkämö, Vuoksimaa, Tervaniemi, Peretz and Kaprio (2016:506) describe the nature of music perception as duration (rhythm), pitch, and perception if tones fall within the tonal scale structure. This study considers rhythm, melody, and harmony.

One of the main concerns with **rhythm** is how it is perceived; i.e., the temporal experience of time. Like London (1995), Epstein (1995:7) advocates a duality in time; the mechanically measured and equal periods, and that which relies on what one might experience. There is thus a difference between the purely theoretical experience of rhythm or time, compared to the perception thereof. The experience of the listener (perceiver) is different to that of the performer. Pulse and meter are responses to patterns of timing and (depending on the theorist) stress in the acoustic rhythm. They are therefore perceptions. Although responsive to stimulus properties, pulse and meter are not in themselves stimulus properties. According to Large (2008:190), those terms refer to endogenous dynamic temporal referents that shape experiences of musical rhythms. These rhythms of music, which are temporally complex and richly articulated, are heard in relation to a relatively stable perception of pulse and meter. Pulse provides a stable, dynamic referent with respect to which a complex musical rhythm is experienced.

In defence of active listening (which is dealt with in greater depth in section 2.3.2), London (2012:12) mentions the ability of judging temporal displacements, which involves the temporal expectation for completeness and closure. This skill requires that we focus attention, which London (2012:14) describes as being selective (from our noisy environment) by nature. London (Ibid.) also notes that the listener responds to features such as accents, thus making it a less passive activity. The listener generates metric patterns, which some people refer to as rhythm, in the absence of musical stimuli.

Much research has been conducted on the structural similarities of music and language. Gordon (1974:39) discusses the relationship between learning to read spoken language and learning music. The metrical grid used for finding the stressed syllables in words and sentences can be compared to the metrical grid on which music is structured to produce rhythm. In a book written after a very successful symposium about language and music, Fitch (2006) suggests that primitive and apomorphic elements are found in both the rhythm of music and the rhythm of speech. Rankin, Fink and Large (2014:256) note the similarities between music and speech, but state clearly that the timing of speech is more flexible than that of music.

The recreation of rhythm is often taught to beginner students through rote learning. The perception of rhythm is therefore an important aspect in learning to recreate music, especially during the beginning stages. Kinney and Forsythe (2012:69) regard perception and recreating as fundamental to the development of young music students. Learners need to learn right from the onset to detect (perceive) and correct errors. Error detection forms part of the musicians' performance. Orman (2002:38) believes musicians discriminate the accuracy of their own and other musicians' performances while teachers use the same detection and correction skills to assess and teach students.

Common ground between rhythm (or time) and melody, is the concept of movement. It builds from the idea or concept of *gestalt* and involves more disciplines than just music. Gestalt is the conceived or perceived image. The perceived image may differ from its physical execution. Geringer, McLeod and Allen (2010:335) explain *gestalt* through the example of the shining of two lights in the front end of a dark room, then switching one of them on and off, then repeating the action with the other light. This is the reality, the action, but the experience of the observer is different. The observer experiences the combination of the two lights with the difference of the one on/off to the next as motion (Ibid.). In music, it can be interpreted as pre-set pitches, at set time intervals. Although the *gestalt* picture is a combination of several concepts to form music, one of which is the concept of melody, even melody is a sub-set of *gestalts* of its own.

The study of **pitch** perception is focused on whether it is dependent on peripheral timing, rate-place information, or both (Oxenham & Micheyl, 2013:1). Moor (2010:417) explains that the rate-place theory is based on the idea that different frequencies excite different places along the ear's membrane and thus different neurons. Figure 2.7 demonstrates this theory. The "temporal" theory, also called phase locking, is related to a time pattern of neural impulses evoked by the tones that occur at exact points in the wave form of the ear's membrane Moor (2010:417).

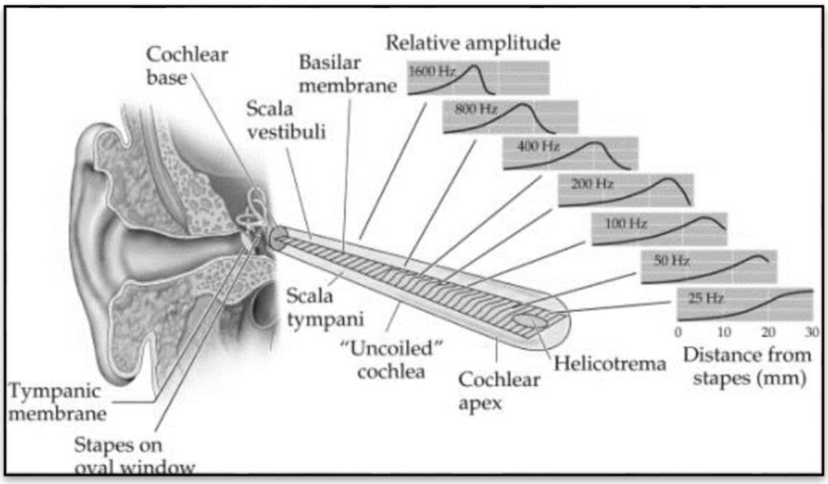


Figure 2.7: Anatomy of the ear indicating perception of frequency in starched out cochlea (Purves, Augustine, Fitzpatrick, Katz, McNamara, and Williams, 2001)

The complexity of a tone depends on the overtones produced. From psychoacoustic research we know that pure tones have few overtones. Moor (2010:429) describes the importance of overtones (upper partials) in the perception of fundamental tones. Some listeners perceive a fundamental tone when only overtones are played to them (Coffey, Colagrosso, Lehmann, Schönwiesner & Zatorre, 2016:3). The important theory to acknowledge in this respect is that pitch coding differs from person to person.

There is no consensus regarding how timbre is perceived. Timbre, according to Moor (2010:429), depends on the distribution of energy over the frequency; the recognition of the instrument is a little more prominent than the onset of transients and the temporal structure of the sound. As an example, he states that a piano has a rapid onset and gradual decay, and if reversed it would sound like a harmonium or accordion. Saeedi, Blamey, Burkitt and Grayden (2016:8) claim that pitch, together with pitch comma attribute as timbre (spectral shape) is contained in the auditory nerve. Thus, according to Saeedi *et al*. (2016) timbre is perceived while Moor (2010:418) explains that timbre is interpreted.

Research has confirmed that it is rare to find perception without any action (Windsor & De Bézenac, 2012:103). The interplay of perception and cognition is described by Bharucha (1987:1) as the internalising of regularities to form expectations and in return the influence of musical context on consonance and memory.

2.3.1.3 Cognition

Louise Serafine (1988) argues that music is non-linguistic thought; it resides in the world of cognitive constructs. Her research describes an impressive series of experiments designed to unravel various proposed dimensions of developmental change in the musical understanding of people from childhood through to adulthood. Serafine (Ibid.) concludes that cognition in music is an active, constructive process. Memory and perception are not veridical. While cognition in music is an active, constructive process, there is no verification that memory and perception share the activity (Serafine, 2010:6). Even though we study perception as a skill separate from cognition, the two skills are intimately connected. McNeil (2000:213) believes large parts of what we engage with consciously or knowingly are accessible to the awareness. Research on harmony is not found.

Most studies on cognition examine the association between music training and cognitive abilities (Corrigall, Schellenberg & Misura, 2013:1). This study’s concern is the association between perception training and cognitive processes. Royal (1999:143) believes that cognition can assist the design of aural skills programmes. He mentions that light can be shed on skills which can reasonably be expected to be improved by this training. An understanding of the physical working of cognition and the interplay between cognition and other skills is required to comprehend the role cognition plays in aural training. Several cognitive processes are observed during aural skills acquisition. Royal (1999:144) mentions working memory, schemas, imagery, motor programmes and aesthetic response as some of the observed processes that are of interest to psychology. Serafine (2010:6) refers to the interplay of composer, performer and listener when deciphering meaning in music. For such interplay abstractions should be understood similarly between all parties engaging with the music. This can only be gained through acculturation and/or training. Serafine (Ibid.) points to the role of theory and history in aiding training.

Although the science concerning the brain is not exact, we use what we already know to interpret perceived phenomena. The physical work of cognition relies on local and non-local dependencies for processing musical information. Koelsch, Rohrmeier, Torrecuso and Jentschke, (2013:15443) indicate that the nervous system needs to present information on different frequencies together with different types of memory to enable cognition. The auditory nerve provides the frequency information as described in the previous section (2.3.1.2.) on perception. The elements of memory are described in section 2.3.1.1. Cognition is thus the culmination or processing of all the elements of skill that have been described up to this point in this chapter. Serafine (2013) reminds us that music exists due to cognitive processes: composing, performing, and listening. The processes are individually unique, but have several elements in common. This study builds on the theory that music is processed to unfold over time; at the conclusion of a piece the opinion gained is either changed or confirmed. The preference rule, ambiguity, tension, and expectation shed light on the real-time processing (Temperley, 2004:2). Temperley (Ibid.) further argues that the generative process (composition and performance) also explains the preference rule and thus not only perception, but also the creation of music that is governed by cognitive processes.

One of the processes is the forming of hierarchical structures. Martins, Gingras, Puig-Waldmueller and Fitch (2017:31) describe forming these structures as the factor that makes us fundamentally human. This is caused by, amongst others, specialised processes and abilities in cognitive architecture. Recursion is one such ability. Martins *et al.* (2017:33) argue that understanding of the connections of distant hierarchical elements of music is made more readily by musicians than by non-musicians. Recursion is the ability to recollecting larger sets of information from perceiving small parts of the larger set.

Another process of cognitive architecture is future prediction or expectation. This alludes to how intertwined perception and cognition of music are. Further evidence of the connection between cognition and perception is that structural hierarchies are learned by passive observation (Tillmann, Bharucha & Bigand, 2000:885). It is then believed that even though implicit learning is the essence of the cognitive system, explicit information aids with more complex information.

Serafine (2010:2) defines two cognitive processes that all music has in common: the one being style-specific and the other generic. She highlights this by referring to the recognition of music even though styles have changed. The sense of completion and tension is style-specific. Tonal tension is found in leading note chords, for example V7 – I. The dominant seventh chord creates tension due to the tritone relation of the leading note and seventh of the chord. This tension is resolved by raising the leading note in the same voice part to the tonic (found in the tonic chord). There are more explanations of tension. Wagner (2014:1) clarifies the cognitive approach as having knowledge of hierarchy. This is explained as the interpretation of chords and tonality perceived in relation to tonal function. Lerdahl and Jackendoff (1983) developed a generative theory of tonal music (known as GTTM) that offers a breakdown of hierarchical structure of tonal music based on perceived tension. Wagner (2014:1) summarises the rules as grouping structure (motives, phrases, and sections), metrical structure (strong and weak beats), time-span reduction (pitches position in the grouping and metrical structures), and prolongation reduction (harmonic and melodic tension and relaxation). The tonal pitch model, described by Lerdahl and Krumhansl (2004:330) places pitches, chords, and keys within a spatial representation calculating distances between them. The placing relies on theoretical principles; GTTM, TPS (tonal pitch space), treatment of surface dissonance and voice leading. Serafine (2010:7) does not consider tones or chords as elements of music, but by-products of analysis and writing with little cognitive (perceptional) meaning.

Research on the cognition of **rhythm** is plentiful. Humans are tuned in to the perception process and produce fine nuances of rhythm in music and in speech (Ravignani, Honing & Kotz, 2017:2). There are several common themes in rhythmic cognition. In an editorial Ravignani *et al.* (2017:3) summarise these themes as:

- Developmental studies: where critical acquisition periods are researched as opposed to enculturation throughout the lifespan.
- Comparative and cross-cultural: where exposure to music enculturation or specific language affects the acquisition of rhythmic patterns.
- Processing language vs. music comparisons: where processing of music and speech is compared at neural and behavioural level.
- Processing modalities and domains: if processing of metrical concepts is limited to specific domains (e.g. speech domain or dance domain).
- Context influence: the influence of social, sentimental and similar factors affects rhythmic pattern acquisition.
- Archaeological findings: early human and ancestor-rhythmic behaviour.
- Mathematical and computational models.
- Evolutionary rhythmic behaviour in animals: animals displaying evolutionary traits comparable to ancient humans and ancestors of humans.
- Rhythmic perception in animals: research into non-human potential for producing and perceiving rhythm.

The aesthetics of music has been well researched. A prominent researcher in the field is the Polish scholar Zofia Lissa, who first published her findings in the 1930s. One of her earliest theories on studying aesthetics involves locating music within the context of culture and social processes. She based her studies of aesthetics on psychological perception by studying the perception of the child, and not the empirical nature of aesthetics, as her contemporaries had done (Skowron, 2012:134). Another of her theories is that music has a meaningful message, but this theory left her with more questions than answers, which she describes as reaching the "boundary of the unknown, a wall that cannot be breached" (Skowron, 2012:137). It is further explained as the essence of that which everyone intuitively feels in music and which differs from the sound structures alone. Huron (2011:146) describes the enjoyment of music, especially that which evokes sad emotions, by both young and old. This emotional enjoyment of negative emotions in the arts has perplexed philosophers since ancient Greek times. The great question is why sad melodies make people feel better. The main conclusion is that music cannot be studied only by structure; Andrey Zhdanov named this criticism of Western music "formalism" (Skowron, 2012:141); in Lissa's explanation, music delivers the means of expression. (Ibid.). Audiation is also mentioned as a method of raising the "aesthetic value" of music (Zwolinska, 2013:145). A person sensitive to beauty is thought to be an audiation expert.

Melody and **harmony** can be anticipated. This skill is also discussed in the rhythm section of this chapter. Krumhansl (1990:1) credits anticipation to the integration of sound elements in context and each element's function being understood in context, and believes neither pitch nor duration of the perceived note is as important as understanding its context. As explained in this section, perception and cognition are reciprocal in nature. The listener therefore understands the function of the note in terms of pitch and duration and makes a calculated guess as to what will follow. Along similar lines, Boltz (1993:586) argues that anticipation of melody is due to repeated exposure to musical events or the immediate "unfolding" context. He explains that the context is the arrangement of intervals and chordal progressions that require engaging with the music. This again supports my theory stated in the introduction, that aural training is interdisciplinary.

Acculturalisation, through music contact and training, is a common theme in research for both rhythm and melodic cognition. Hannon and Trainor's (2007:465) research starts at the infant's preference for consonance and how (Western) adults are preconditioned to the tensions found in their Western classical music. The period of acculturalisation of pitch starts before birth. Duţică (2016:43) criticises that melodic cognition before tertiary level is based on the major and minor tonalities. He further notes that material is based on well-known literature focusing on the academic role of theory, harmony, counterpoint and forms and suggests that examples containing didactic information should be based on personal encounters with music. Kurth (1996:79) is of the opinion that 12-tone music relies more on motivic material than on the internalisation of the series.

Although research on melodic processing by cognitive systems is extensive, the **harmonic** processing system was entered into only by the early 1980s by Bharucha and Krumhansl (1983:64). They state that harmonic structures are fundamental to the processing of Western classical music (Ibid.). Melodies are built on underlying harmonies or if not directly, implied harmony. They further argue that the abstraction of music through analysis means that listeners have an internal representation of chord function that can aid in recursion and structured rhythm (Ibid.). Establishing tonality in a passage of music allows a sense of stability to be perceived in the music. As mentioned before, the link between perception and cognition is reciprocal interaction. This stability provides the context to the listener so that pitch can be anticipated and melodic collections can be formed.

2.3.1.4 Audiation

The term audiation was coined by Edwin E. Gordon in the 1970s. It refers to the skill of hearing music in the mind when there is no audible music. Gordon compared audiation of music to what thought is to speech.

Audiation may take place when reading notation, composing, improvising, listening, and recalling, performing or interpreting music. It is the act of giving meaning to the music, the ability to hear and give meaning to music when sound is not physically present or may never have been physically present. Researchers (like Karpinski, 2000:4) are confident that good aural skills sensitise the student to the finer nuances of music either as performer or as listener. Reitan (2009:217) defines the outcome of aural lessons as the teaching of certain skills, including audiation, "to think in music", emphasising the aim of serving the practical element of music. Audiation is therefore an important outcome of ear training.

It is generally accepted that sound in itself is not music; it is only when it is given meaning that music communicates. When you hear music from looking at notation or before you write it down before the performance of the notation, it is called notational audiation. When reading notation without hearing the music, we are simply decoding symbols. Zwolinska (2013:145) supports this view in his argument for music education that should be done in a way to express the individual's experiences. Audiation is thus necessary for self-expression. Audiation is also mentioned as a method of raising the "aesthetic value" of music (Zwolinska, 2013:145). Thus, a person sensitive to beauty is thought to be an aesthetic expert.

Audiation is also found in other fields of study besides music. The study of language is an obvious user of audiation. Gordon (2011b) based his understanding of audiation on the idea that thought is the basis of a listening vocabulary in language. Analysis of dreams and REM patterns are also credited to this skill of audiation. As these processes are under the control of most persons, Hubbard (2010:306) describes that persons with mental illness or psychopathological conditions experience audio-imagery involuntarily and find this intrusive sound distressing. One controversial researcher (mentioned by Hubbard, 2010) also credits audiation as the voice of god in some religions.

There are various factors that make up audiation. Hubbard (2010:302) divides them as follows:

- Simple features (pitch, timbre, loudness); and
- Complex musical and nonverbal stimuli (musical contour, melody, harmony, tempo, notational audiation, environmental sounds).

The ability to audiate has direct influence on error detection, musical memory, and perception. Measuring or testing of audiation is not possible. Gordon (2011b:4) believes that the "essence of music aptitude is intangible". He is therefore linking audiation to musical aptitude. One should take into consideration that the ability to audiate is not equivalent to the ability to represent with the appropriate vocal or instrumental technique. Gordon (2011:5) agrees that audiation is dependent on personal experience, vividness, musical ability and synaesthesia and provides as example the situation where a teacher asked a talented young boy to discontinue lessons because in her experience he was unmusical and suffered a mental problem – when the actual problem was her fixed-doh training system. Gordon (Ibid.) suggests that the problem could have been avoided if the teacher had used audiation as preparation for notational reading.

In the rote and note debate, it is necessary to understand the association that students make to notation when beginning musical training. Advocators of rote learning often compare language learning to music learning, because both are a form of expression. Dalby (1999:23) reasons that writing is taught only after the ability to speak is well-established. It is interesting to note that children develop various levels of musical awareness at certain ages. These include the perception and cognition of certain intervals. Child psychologists (Gooding & Standley, 2011:41) suggest that note reading should take place at the age of six, but musical maturity is achieved only by age 11. If rote would be followed strictly, notation can only be taught at this late stage. On the other hand, pedagogues from countries such as Poland and Russia do not begin teaching instrumental technique before basic sight-singing is established. We also know that this takes place at a very early age. Evidence is found in the method books like *Škola pro Začátečníky* (Böhmová, Grünfeldová & Sarauer, 2002:5-8) for beginner piano students and *Gordonka-ABC, a hangszeres előkészítő osztály tanulóinak* (Árpád, 1992) for beginner cello students. Hiatt and Cross (2006:49) add to this theory by quoting violin teacher Pierre Baillot, referring to the importance of learning solfège before learning an instrument. Gordon (2011a:42), in comparing how language is learned, stresses the importance of learning to sing by students, but only after they have learnt how to listen. Opinion on the best method for beginners is still out.

There are two levels of learning audiation, informally at kindergarten or home (developing subjective control of tonality and meter) and formally in school (developing objective control of tonality and meter). Earlier in this chapter there is mention of music acculturalisation from before birth. Considering the early possibility of audiation learning time, it is unbelievable that researchers such as Zwolinska (2013) still identified students entering the tertiary education system who do not necessarily have the ability to audiate.

Gordon (1999:58) states that music education through audiation aids an understanding of music that brings a feeling of satisfaction. Without audiation of context to serve as readiness for audiation of content, sound remains simply sound and is not translated into music by the musical mind. It is important that acquisition of a sense of tonality and recall of a vocabulary of patterns is fundamental to music learning processes. That is, context and then content, in that sequence, are learned before all else in terms of informal and formal instruction in music. Without the two being solidified in audiation, teachers can build only a faulty learning structure, because there is not a sequential foundation to support it.

Audiation is taught mainly through sight-singing. Hiatt and Cross (2006:47) describe their teaching method as using audiation to teach sight-singing and performance skills. They also emphasise the connection of note reading with the practical application (sight-singing). They suggest that learning an instrument without audiation (relying only on fingering) is not "reliable" (Ibid:48) and brings the audiation into the performance. They further suggest using technical exercises and scales as introduction to audiation and in doing so the student will have daily audiation practice with his instrument in hand (Ibid.). A suggested exercise that aids the muscular response for string players to audiation is fingered scales and arpeggios.

They also add exercises to aid intonation. Dalby (1999:22) also recommends sight-singing, "most basic to musicianship", for the improvement of harmonic and melodic intonation. Dalby suggests playing familiar, or folk songs on the instrument to develop the connection between audiation and "physical manipulation" of the instrument (Ibid.:23), by which the instrument should become an extension of the musician's body so that images can be expressed through sound (Dalby, 2005:11). The process of audiation is thus very instrument-specific. The musician should imagine the sound and body position to produce the desired sound, before it can be achieved.

Most researchers in the field of audiation agree that performance should be guided by audiation. Gordon (1989:59) goes as far as stating that note-reading without audition is "faking". Hiatt and Cross (2006:48) consider performers who produce sound from a mental image as "respected". Gordon (1989:17) associates the ability of a sensitive and expressive performance with the result of audiating before performance. A comparison can be made with the principle of thinking before speaking. Researchers (such as Hiatt & Cross, 2006; Gordon, 1989; and Karpinski, 2000) agree that a performer who acquired audiation skills is sensitive and expressive.

2.3.2 Listening

Listening has much in common with the processing of sound found in both perception and cognition. The difference discussed in this section is between passive and active listening. Huron (1989:361) best describes this as the capability of interacting with sound (active listening) in the presence of other sound (passive listening). Examples of this are following a conversation at a party or listening to a melodic line played by a soloist while being accompanied by an orchestra. Huron (Ibid.:362) also notes that there are limits to the number of lines that can be processed, with Sloboda and Edworthy (1981) being content with the attention to one voice at a time.

This section will be discussed under three headings: active and passive listening, dictation, and error detection.

2.3.2.1 Passive and active listening

There is a significant difference between active and passive listening. Wedin (2015:35) describes hearing (passive listening) as the physical capacity of processing sound, while listening (active listening) has an activity connected to it. David Elliott (1995:80) considers the processing of listening as a hidden process of listening and thinking in action, where reflection on the act of listening is possible as is verbal reflection of other action. This processing of sound is discussed in the sections of perception (2.3.1.2) and cognition (2.3.1.3). Lahav, Boulanger, Schlaug and Saltzman (2005:189) claim that playing an instrument links physical movement to corresponding auditory stimuli. They (Ibid.) refer to claims that musicians report a physical sensation when listening to music they know how to play. Recursion is credited for this phenomenon and therefore links auditory stimuli with physical movement. They (Ibid.) further mention that the visual-motor link is also made by dancers watching dancing movements. This leads to the audiation link (2.3.1.4.) with movement in similar recursion. Lahav *et al.* (Ibid.) link this skill to the innate predisposition or even prerequisite for becoming a musician. Listening skills are integrated in all the aspects of aural training. For the limitation of space in this thesis, the links will not be repeated in this section.

2.3.2.2 Dictation

Dictation is seldom found outside the aural classroom. It is often described as one of two elements of aural training (Sisley, 2008:1). It is a transcription tool: the abstraction of perceived rhythmic, melodic and harmonic perception into written notation. Dalby (2005) and Gordon (1974:40) support the idea that there is a similarity between learning to read the alphabet and notation. Paney and Buonviri (2014:402) questioned teachers about their experiences of aural training and found that this skill is often a challenge for both undergraduate and graduate students, because of the variety of skill and concepts needed (Paney & Buonviri, 2014:397; Buonviri, 2014:21). These skills are described by both Buoniviri (2014:22) and Karpinski (2000:62) as correct perception, memorisation, and notation. Students have a very negative association with dictation, which Liebhaber (2001:23) blames on rate of failure for this activity. Several researchers suggest diverse techniques to assist in the training of this skill: Karpinski (2000:20) recommends using protonation[9] while Rogers (2013:37) calls on the strengthening of melodic memory by improving chunking. Paney and Buonviri (2014:397) suggest a kinaesthetic approach which activates cognition through internalising visual interpretation (playing it on a piano). Klonoski (2006:55) believes that the separation of music elements in dictation causes the problem and that the skill should be taught as one activity that is multi-faceted, requiring several listening skills and a clear understanding of how to assimilate them. Whichever method is used, it is vital to achieve success as an aspiring musician, because most tertiary entry exams test this skill, and aural dictation is often prescribed for accredited institutions.

Most research in the field of dictation involves the improvement in teaching this skill (Chittum, 1969; Buonviri, 2014; Paney, 2007). The studies suggest a connection between analysis and aural training, i.e. training the mind and the ear. Klonoski (2006:56) mentions six listening skills needed for dictation: sub-vocalisation (singing inaudibly), meter identification, key context (identifying the tonic), hearing harmonic progressions, musical memory and chunking, and extractive listening (identifying harmonic, tonal and rhythmic elements). He elaborates on the method for improvement of each area of listening (Ibid.).

[9] Paney and Buonviri (2014:398) describes protonation as a quick sketch of contour and rhythm using dashes and other symbols that are not standard notation, but can be transcribed into standard pitch and rhythmic notation.

Rhythmic dictation is noted as important as melodic and harmonic dictation, but is not considered as problematic as melodic dictation. An interesting study by Johnson (2014:17) indicates that rhythmic dictation is tagged as a more important skill to acquire by instrumental teachers compared to choral teachers, who rank it at a lower level of importance. In the aural class, rhythm is tested through dictation or sing-back exercises that can be either with or without pitch. Kinney and Forsythe (2012:70) also indicate that the learning of rhythmic patterns is done by rote method where the students imitate their practical teacher, band, orchestra or choir conductor. Rhythm is not taught only in aural lessons, but in all facets of musical education, thus echoing the inter-disciplinary nature of the education of music as discussed in earlier parts of this chapter.

It is interesting to note that arguably the current leader in research in aural training, Gary Karpinski (2000), does not prescribe rhythmic dictation in his aural training books. This could be because rhythm is considered such a basic concept that he assumes tertiary access is not possible without it. Yet rhythm is referred to as the most problematic (earlier in chapter) by Ella Fourie (2016). Thus, the rhythmic factor should be clarified in younger students. Dalby (2005:54) describes the mathematical approach through which rhythmical relationships are taught, as ineffective. The mathematical understanding will not necessarily lead to the proper performance and he therefore suggests that audiation should be used to teach rhythmic patterns. He alludes to the expressive use of rhythm by referring to the body's 'feeling' that something is wrong; describes learning from dancers' movements as confusing and suggests conductors as guide for audiating macro beats (Ibid.). The main reason for failure in dictation at tertiary level is melodic interval identification.

The use of the **melodic** dictation skill as measure for entrance to a tertiary institution confirms the philosophy of researchers such as Paney and Buonviri (2014:397) who claim that there is a direct link between the skill of melodic dictation and musicianship. They believe that identification is a basic task that affects students' performance when taking melodic dictation (Ibid.). Both undergraduate and graduate students have difficulties in basic pitch pattern identification and melodic dictation tasks. Students who have the most difficulty in melodic dictation usually have difficulty in interval identification. The difficulty in melodic dictation lies in the number of different skills that need to be mastered when attempting this test. Foulkes-Levy (1997) lists audiation (with focus on tonality), musical memory, pattern recognition and function of scale degrees as skills required to excel in dictation.

Research on how to address these difficulties focuses on interval identification. The accuracy, ease and speed with which certain intervals are identified by students (undergraduate and post graduate) are researched and discussed. Robinson (2012) suggests strategies for effective dictation and argues that repetition increases the success rate. He agrees with several researchers (Adderley, Schneider & Kirkland; 2006; Byo, 1997; Forsythe, Kinney & Braun; 2007; Pembrook & Riggins, 1990) that intervals should not be considered as single units. Conjunct intervals are found easier to identify than disjunct intervals, as well as that the length of an excerpt is not as important as the content of the excerpt tested. Thus, the excerpt's difficulty does not lie in the length of the melody, but in the difficulty of intervals. Robinson (2012) divided melodic dictation excerpts according to large intervals or small intervals and noted that the intervals of m6, M6, m7 and M7 were most problematic. He explains that these intervals occur less frequently in performance, but should be addressed more frequently in the classroom (Ibid.).

In contrast to Robinson's (2012) findings, Paney (2007) as well as Dowling and Bartlett (1981) argue that interval size is not the factor determining the difficulty of dictation, but rather the understanding and retaining contour in melodic dictation. Other factors that influence the ease of melodic dictation are tonality, conjunct vs. disjunct motion, number of presentations in melody, tempo and contexts of presentation subjects in the musical experience of the student, and the degree of familiarity with the style of music. Benward and Kolosick (2010:167) propose starting with simple dictation exercises to build confidence. Paney and Buonviri. (2014:404) and Johnson (2014) suggest a clear understanding of music theory and harmonic function to aid melodic dictation. Dowling and Barlett (1981:30) explain furthermore that the change in "chroma" or tone colour influences recall of melodies. Paney and Buonviri (2014:379) also link sight-singing to the teaching of dictation.

The twentieth century atonal specialist book '*Modus Novum'* (Edlund, 1963:6) lists its aims as two-fold: firstly, to identify melodic structures by sight and secondly, to train the ear to identify similar structures. The structures should be placed in the context of the music to aid the understanding of the larger musical structures. Proficiency in reading, which includes an understanding of the structure, often makes it easier to place the note correctly. It also prevents the student from counting the interval rather than reading the melodic design.

Harmonic dictation is accepted as being more challenging to students than melodic dictation. This is often because harmonic dictation is made to be a compound melodic dictation. Chittum (1969:65) and Zavadska and Davidova (2015:73) criticise the method of harmonic dictation where listening to four-part choral and writing voice part by voice part (starting from bass to soprano) is accepted. Analysis follows only after this process that can only be described as melodic dictation. They find that this method does not promote harmonic listening (Zavadska & Davidova, 2015:73). Chittum (1969:65) explains that the effect is compounded by introducing this method to instrumentalists that need to read only single lines for their instruments. Understanding harmonic function is therefore a prerequisite to harmonic dictation. Harmonic hearing is an area that should be developed.

The problem with harmonic dictation is that many students enter tertiary education orientated as single line melodic readers (e.g. violinists) as oppose to harmonic orientated keyboard players (Chittum, 1969:65). This secondary method requires making the melodic orientation to harmonic dictation almost a prerequisite. In an attempt to correct the approach to harmonic dictation, Chittum (1969:66) suggests singing and eventually imagining without singing the chord arpeggiated as a triad. From there various exercises are suggested to reinforce the image of the chord, before figuring the roman numerals of the progressions.

This method of achieving harmonic dictation through melodic dictation is encouraged: Merritt and Castro (2016:viii) recognise that melodic dictation is used by some dictators to determine the harmonic sequence; there is no indication that they are against this method of achieving the harmonic progression, in fact, they encourage the identification of horizontal contours of voice leading during the harmonic dictation process. The authors also suggest listening to music in its theoretical function to become master of transcription (Ibid.:182). Encouraging the student to keep the functional theory in mind when transcribing dictation. Johnson (2013) supports the use of chunking in the process of harmonic dictation; so that larger particles can be remembered and thus processed by the transcriber during dictation.

2.3.2.3 Error detection

The importance of error detection is emphasised by several researchers (Karpinski, 2000:130; Benward & Kolosick, 2010), because of the frequency with which the music student and the musician use this skill. Despite its importance, Pembrook and Riggins (1990) found that this skill is not often found in the classroom. The reciprocal process creates a relationship between skills such as error detection and reading; or error detection and listening (Karpinski, 2000:130). Byo (1997:51) adds musical memory and aural harmonic achievement to this list of skills forming a relationship with error detection. Gonzo (1971:52) argues that students that are high achievers in theory, are also better error detectors.

Gary Karpinski (2000:130) emphasises the importance of the reciprocal process. He also links this as an important skill for solo performers, all orchestral and ensemble leaders, and teachers. Karpinski (2000:131) urges that error detection training should start as early as possible, even if proto-notation is used (2.3.3). He states further that error of **pitch and rhythm** is often used as error detection training exercises, but that other elements of music are less commonly researched and applied. He explains that the exercises in error detection should be as close to the practical experience as possible. Errors should be vocalised and discussed in detail, using proper terminology (not solmisation, proto-notation terminology, or marking on a score).

Gonzo (1971:260) notes that the prerequisite for a PED tests (Pitch Error Detection test) is that the **harmonic** style and structure, modality, range and language be appropriate for the subjects. His study with high school voice students was not done in the way prescribed by Karpinski (2000) by using language to describe the error, but rather by marking errors or ticking boxes.

2.3.3 Reading

Music notation of Western classical music has a long and complicated history, with notation becoming more specific as it developed through the decades. Although composers are proficient at transforming their musical ideas into notation, there are certain aspects of music that cannot be expressed in notation (Adorno, 2014:8). Adorno (2014:14) adds that while composers became more specific as to how the notated music should be performed, earlier composers left the performer more freedom (with subjectivity), whereas the modern composer strives for utmost clarity when notating music. Learning to interpret notation is crucial for the Western classical musician, because most of the repertoire is written down.

Reading notation involves more than just the deciphering of symbols, as the product of reading notation is producing music. Reading music is a cognitive process involving elements like memory and chunking and subsequently linking it cognitively to motor skills (Rosemann, Altenmüller & Fahle, 2016:659). Many of these processes are linked and trained amongst others through aural training. In the Czech beginner piano book *Klavírí Škola* (1971 – edition of 2002) the first pages contain exercises mostly associated with aural training. These aim to aid the beginner student to read notation. The pianist's first lessons will thus be filled with sight-singing of ascending and descending stepwise passages using crotchets and minims. Independence of hand coordination is also developed by clapping two different rhythms at the same time with different hands. The method thus starts with the interpretation of symbols that are linked directly to achievable (no instrument technique needed) performance. All the cognitive processes, including motor and audiation, have been started. Opposed to this method is rote-method learning (discussed earlier in this chapter). The rote method leaves reading of notation for a later stage.

Another complication in the pedagogy concerning reading and performing is the use movable- or fixed-doh in solmization. The origin of sol-fa notion is credited to Guido of Arezzo for relative notation, but the first system was clumsy and saw many mutations. One of the prominent mutations from the original was the inclusion of the si or ti (seventh step). Solfège is used in sight-singing exercises that are a pedagogical tool to assist the performance and listening ability of scholars (Hung, 2012:11). The choice of whether to use fixed-doh or not is often left to the teacher and its use can be placed generally according to location. Fixed-doh has been used in continental Europe and Russia since the 18th century, while movable-doh is found in the USA and UK (Hung, 2012:11). Both systems have advantages and disadvantages. The fixed-doh system's disadvantages are that the syllables do not change even if the key signature does, thus even if the interval changes, the notes retain their names. Sight-singing a piece with many sharps, flats or accidentals then becomes very difficult. The movable-doh system has the opposite problem; because the key changed, the note is identified by a different name even if the interval did not change. Pitcher (2008) was reported to say at a Kodály conference that it is not the choice of fixed or movable-doh that is important, but that a teacher use the one chosen system consistently. Italian pedagogue, Francesco Durant's answer to which system was superior, was: "If they would only sing the syllables in tune, they might name them after devils if they liked" (Harris, 1918:188). Hung (2012:2) describes the fixed-doh system as based on the absolute frequencies of notes independent of key signatures, while movable-do system is based on relative tonal relationships and is calculated according to the key.

Many researchers study the interpretation of music notation by way of studying what is absent in persons who cannot read music notation. Midorikawa, Kawamura and Kezuka (2003:232) investigated neuropsychology of musical alexia and musical agraphia – the inability to read and write music. They found that there are three different types of alexia. The first involves the inability to read single notes; the second is the inability to read pitch, and the last the inability to read pitch and rhythm. The researchers conclude that the different types of alexia imply that there are different processes in reading aspects of music. This includes the independence of rhythmic from pitch reading. Together with the inability to read, David, Wade-Woolley, Kirby and Smithrim (2007:169) observed that poor reader ability (that is determined at a lower music grade), does not improve to good reader ability at a higher grade, thus the reading proficiency cannot be taught beyond a certain level in some individuals. They connect the reading ability and musical aptitude with phonological awareness while also linking the condition of dyslexia to difficulties with rhythm (Ibid.). Reading or inability to read rhythm is governed by the same factors that govern the reading of language. Although Penttinen (2013) distinguishes three types of reading[10], this research will only distinguish between sight-reading and silent reading. Visual tracking is researched on persons efficient in the skill of reading.

2.3.3.1 Silent reading

Silent reading is a reading task without cognitively converting the symbols to motor motions even though several cognitive processes take place. Penttinen (2013:11) argues that silent reading is how performers prepare themselves or prepare for error detection. Researchers (Penttinen, 2013; Drai-Zerbib, Baccino, & Bigand, 2011) describe silent reading as essential to successful sight-reading. The idea that audiation takes place can neither be proven nor denied, for audiation is not measurable.

2.3.3.2 Sight-reading

The difference in sight-reading and rehearsed reading is that in the latter, the performer has constructed memory patterns specific to the composition being performed, while during sight-reading the performer is not granted this luxury. In many cases rehearsed reading develops into playing from memory without using any score. Sight-reading is the performance of notated music not previously seen, heard or audiated. To some researchers like Lehman and Kopiez (Penttinen, 2013:11) under-rehearsed music also counts as sight-reading. Rosemann *et al.* (2016:659) describe the process as translating complex visual symbols into appropriate movement patterns through simultaneous processing of perceptual, cognitive, and motor processes. They (Ibid.) also indicate that chunking is used in reading and that notes are not processed individually. The processes that are involved in the sight-reading skill are pattern recognition, expectation,

[10] Penttinen's (2013) three types of reading are sight-reading, rehearsed reading and silent reading.

or anticipation (Waters, Townsend & Underwood, 1998). Kopiez and Lee (2008:41) describe cognition skills to include working memory, short-term music memory, short-term memory, speed tapping, simple reaction time, trilling speed, and speed of information processing, as well as practice-related skills (including audiation). Mishra (2014b:453) notes that musicians have varying proficiency at sight-reading and that several studies have been done on the issue. There are two schools of thought on this matter, the first maintaining that it is a trainable skill and the second describes the ability more as an aptitude, academic achievement, and personality.

Training of sight-reading often includes chunking. Lars Edlund (1963:13) sets it as an aim of his book *Modus Novum* to train students in the proficiency in identifying the structures when reading, including understanding the musical structures, "to make it easier to place the note correctly and avoid interval counting." This refers to teaching an expectation of what is to follow.

2.3.3.3 Visual tracking

Visual tracking is the movement of the eye during reading. This field of study in music is about 20 years old and has product suggestions on reading notation for better results in sight-reading. The research is done mostly by comparing the movement of the eye of successful sight-readers to that of less successful sight-readers. This research is based on the idea that sight-reading skills require sequential, anticipatory eye movements (Rosemann *et al*., 2016:658). Penttinen (2013:12) describes the research as tracking the eye movement of highly-skilled readers, to find how to code and chunk music effectively. This skill is useful with activities of a high cognitive load, such as sight-reading.

The research often calculates the eye-hand span; the distance between the eye and the movement of the hand. It thus calculates the time taken before simultaneous cognition of visual impulses of music notation results in performance. Sight-reading is also regarded as a performance skill.

2.3.4 Performing

Performance is the definitive outcome of all the processes and concepts discussed in this chapter. This is not the final outcome, but in most cases the start of the next process as evaluation of own performance inevitably leads to trying again and better. This final section of skills deals with the creation of sound through motor movement. Widmer and Goebl (2004:203) explain that the act of performance involves several human processes with elements such as acoustics, physiological and psychological, social and artistic aspects. Most of these aspects have been discussed in the previous sections of this chapter, although the psychological aspects will not be dealt with in this research. Performance is a well-researched area with more than 100 years' worth of research peaking with Seashore in 1938. While most research focuses on the recreation of printed music, McPherson (1995:116) indicates that there are five aspects to musical performance; sight-reading, performing rehearsed music, playing from memory, playing by ear, and improvising. McPherson (Ibid.) says that only the first three aspects of performance require reading, while the last two do not. This section will consider solo performance, ensemble performance and performance reflection.

2.3.4.1 Solo performance

Substantial studies have been conducted on the solo artist. Gabrielsson (2003) summarises various research topics concerning performance, of which some of the most prominent are timing and dynamics, and intonation and vibrato. As a starting point, the aspects of music performance can be noted by the perception of the audience. Juslin (2003:274) notes these aspects from a comment on Paganini’s performance: timbre of the instrument together with technical skill, expression of emotion through music and the compositional techniques employed to achieve them.

As mentioned, not all aspects of music can be captured in notation; emotional expression is one notable exception. Konečni’s (2008:115) research investigates whether emotion is expressed or induced. It is generally accepted that dynamics and rhythm are responsible for the aesthetic expression, but Gabrielsson (2003:226) mentions research conducted on the performance of Chopin's *Etude in E-minor (op. 10, no. 3)* for piano, that found that dynamics and rhythm did not take aesthetic superiority in performance, but rather the touch or timbre produced by the performer. Ambrazevičius and Wiśniewska (2008) are among a larger group of researchers noting that pitch deviations are used in non-fixed pitch instruments to affect expression. Juslin (2003:275) believes that emotional expression is the most important aspect of performance, but that teaching this skill is not always done, because of the tacit knowledge that is needed. Juslin (Ibid.) describes the aesthetic response as involving emotional, cognitive, and social factors, and lists more emotionally expressive aspects as physical aspects such as motion and force, tension and resolution, and personal aspects acquired by acculturalisation (beauty, religion, and social conditions). Langner and Goebl (2003:1) suggest using auralisation for expression training. The list that is given by researchers has much in common with the skills and concepts of aural training.

Error detection is a skill used in rehearsed reading. Researchers regularly focus on error detection in performance skill acquisition (Drake & Palmer, 2000:2), with little mention of the aural training involved. While Ella Fourie (2016) blames rhythm for the most errors during sight-reading, Gabrielsson (2003:227) found in his studies on rehearsed performance that errors made by students were not harmonic by nature (nor even melodic). Performance also involves the correction of errors, but according to Cavitt (2003:119) it involves knowing what, when, and how to effect corrections, which in itself entails also technical comprehension. Dickey (1991:133) determines that error detection is taught more effectively through modelling and that demonstration should be included with verbal explanation. The ultimate performance differs from the rehearsal or daily practice session or recorded and live music. Doğantan-Dack (2012:37) is convinced that there is compelling phenomenological and aesthetic evidence of a significant difference in the experience of live performance compared to recordings.

2.3.4.2 Ensemble

Both rehearsal and performance skills are involved in ensemble participation. Research on ensemble focuses essentially on human interaction. The ensemble needs to work toward a shared aesthetic goal by synchronising their time-keeping mechanism, and shaping melodic phrases in terms of intonation and dynamics (Papiotis, Marchini, Perez-Carrillo & Maestre, 2014:1). The size of the ensemble determines whether a conductor is necessary to regulate the synchronisation. Time-keeping and melodic shaping are often reliant on visual cues, which even exceed the skills needed for solo performance. It is important to note that the individual performance is still present within the ensemble performance. The performers need to shape and align their performance with that of the group (Ibid.). The visual cues are eye-contact, facial expressions, physical gestures, and swaying movements (ancillary movements not necessary for producing sound) which serve as communication between ensemble members (May & Elliott, 1980:155). Some verbal cues are needed initially, and discussions on cues given during rehearsals of the ensembles, but the purely musical and visual cues are present in performance. McCaleb (2017) describes the unique form of ensemble interaction as intimate but not emotional. He further elaborates that these relationships are built over time during rehearsals and performances, and we can stipulate that the closer the bond between members, the more accurately the reading of both visual and musical cues will be. Even though this study will not focus on visual cues, it should be noted that perception and action are linked. The movements of production and perception of them share a common representation according to coding theory (Wöllner & Cañal-Bruland, 2010:579).

Any ensemble strives for cohesion in performance. There is always some sort of leadership, either by way of the conductor or group leader (first violinist) or the performer with the melodic line. The organisation of each ensemble is different, but there are definite roles in an ensemble. There are several auditory cues that can lead the performance to cohesion, given by the assigned leader. There is rhythmic (discussed earlier in the chapter) as well as melodic anticipation. Keller (2014:266) notes that melodic anticipation is provided through sound intensity by the melody player. Melodic lines use expressive intonation that assists in the anticipation. Keller (2014:268) states further that the non-melodic instrumentalist is expected to adjust intonation to that of the melodic instrument. It is also expected that articulation should be adjusted for expressive goals to be met. Timbre, like articulation, is essential for ensemble cohesion. In choral research, it is found that performers adjust their timbre either to blend with the choir or deliberately not to blend so as to be heard as a soloist. The instrumentalist would need to follow similar techniques based on the sound picture that is required.

Ensemble performance requires adaptive mechanisms, which Keller (2001:271) describes as conscious reaction to intentional or unintentional variations from co-performers, regulated in turn by temporal error correction. He further explains two timing mechanisms: automatic phase correction and deliberate, conscious controlled period correction (when adjusting to changes by co-performers). The idea of adjusting to co-performers leads to a complex cognitive device, which Keller (2014) calls "prioritised integrated attending." This occurs when the performer divides his attention between his own performance and that of the co-performers to monitor overall sound, so that adjustments can be made to his own performance to fit the desired sound image. Prioritised integrative attention is cognitively demanding and is used sporadically. Non-melodic performers rely on a passive response mechanism more during performance than in rehearsal. Automatic or deliberate correction is made on audiation.

2.3.4.3 Reflection on performance

In the previous section on ensemble performance, much was said about the automatic and intentional correction while performing. This correction is based on a finding that own performance needed adjustment. The basis from which this correction is approached, is that the sound image differed to the performance. In ensemble performance, the sound image that is worked towards is pre-set by the leader, but what is deemed appropriate for individual performance or individual performance in ensemble playing is determined by the individual performer.

Much research on performance reflection has been done in the field of education and student practice. Although this is not the main concern of this chapter, much can be learned about the practice of performance reflection. It is an important skill to develop as a student, because practice is often done in isolation. Herwitt (2015:299) notes that proper motivation should be the starting point of reflection. This is so that judgement can be made on progress during rehearsal (or practice). Research during the 1970s and 1980s focused on the meta-cognitive and cognitive processes, including imagery and self-verbalisation. After failure in this area, self-satisfaction and lack of outcome expectancies were blamed (Zimmerman & Schunk, 2011:49). The evaluation of performance is a cyclical view of self-regulation consisting of three parts: forethought, performance, and self-reflection (Herwitt, 2015:299). Self-reflection can thus be seen not as the end process, but as recreating the forethought.

The process does not end until a satisfactory level of achievement is reached. Miksza (2015:220) notes that mere time spent practicing is not indicative of success, it is the processes that take place during practicing that determine success. Success is also not instantaneous. Ericson (2014:i) credits success in the self-reflection skill to vast amounts of knowledge and pattern-based retrieval cognitive mechanisms that result from years of experience. Ericson (2014:1) also finds that experts have better organising systems for their knowledge than novices. It is interesting to note that experts can describe with more clarity how success was achieved retrospectively. A certain amount of experience is thus needed to achieve success, together with cognitive organisation skills. Reflection is thus part of a trial and error process, successful only with a clear idea of what the end result should be (usually determined by audiation).

2.3.5 Summary

The skills discussed in this section are all needed as general aural skills. The four skills (thinking skills, listening skills, reading skills, and performing skills) and their respective sub skills are all interlinked and are sometimes difficult to discuss without referring to other skills. The skills are inter-reliant on each other. For this reason, it is important that all these skills are obtained by all prospective musicians.

2.4 STRING-SPECIFIC NEEDS

The string student has specific aural needs. While there are areas of similarity with other instrumentalist's needs, some areas are indispensable to string players and not to other instrument students. If considering that the string player will generally spend only two years of his tertiary education in the aural training class, without an option of extending these classes, the time spent in aural training lessons is short. This section of the chapter aims to highlight the specific aural skills needed to develop the string instrumentalist, i.e., presenting a case for string-specific aural training in tertiary education systems.

Tirovolas and Levitin (2011:28) statistically analysed the topics in aural training research done from 1983 to 2010. It is thought-provoking to note the order of importance given to topical categories; some categories important to string players rated high (pitch perception rated third most studied field), while other important factors were rated very low (timbre perception was rated fourth last). The importance of my study is to show that general aural training cannot provide all that is necessary for the string player in a short period of time.

Certain skills develop faster in specific instrumentalists than in others, for example, rhythm vs. intonation in drummers. Matthews (2014:2) conducted a "quasi-experiment" (not the main aim of his research) from which he concludes that students of a specific instrument develop certain musical skills better or faster than students of a different instrument. He hypothesises that because of the inborn skill that is demonstrated by the young student, it influences the instrument to which the student is inclinedd. Aural skills are often used as entry test for music instruction. Why would time and effort be wasted on skills that are pre-requisite to play the instrument? Research found that students are more interested in the section of aural training that is pertinent to their instrument (Øye, 2013:50). Optimal learning conditions for a student are those where technical discussions link the practical instrumental skills and aural concepts (and aural skills). These discussions give the student a sense of empowerment to use knowledge practically. This repetition of information of what is heard from the practical teacher creates an optimal learning condition. Øye (2013) found that the practical teacher mistrusts the aural teacher's knowledge of the instrument to convey these issues. The integration of knowledge is essential for interdisciplinary education to be successful; as mentioned in the beginning of this chapter. Timbre is instrument-specific, and therefore it will feature more in this section (2.4.) than in the section of this chapter dealing with general music skills (2.3.). This topic will be discussed under four headings: thinking, listening, reading and performing, with the focus now on string-specific needs.

2.4.1 Thinking

The musical memory of the string player is unique as the motor movements are part of the memory. The motor movements influence both rhythm and pitch (melody). The movement patterns need to be committed to memory as well as the placement of the fingers producing pitch. As mentioned in the section on cognition, both motor and non-motor skill features in memory functions. Altenműller, Wiesendanger, and Kesselring (2006:40) studied pianists' brain organisation and found enlarged auditory and somatosensory cortex with music practice, with specific fingers linked to neurological changes. Altenműller *et al.* (2006:154) compare the motor control demands of string players to that of pianists and explain that although there are similarities (using both arms and hands) there is a significant difference on the bimanual coordination of both arms; whereas both string player and pianist differ from non-musicians. There is compelling neuroanatomical and neurophysiological evidence that practicing an instrument excites cortical changes (Altenműller *et al.*, 2006:169). Besides the physical differences between the brain of a pianist and that of a string player, the entre motor region works differently.

Anticipation and recursion of motor movement describes why there are differences in the perception of different instruments (Bangert & Schlaug, 2006:1832). The auditory system has links to motor movements associated with a certain timbre. Bangert and Schlaug. *(*2006:1832) discovered that fine motor skils are developed more in the left hand of string players, where pianists need this development in both hands. The function of the hands of the string player are different to that of another instrumentalist, therefore the motor skills and brain functions would be different.

One of the primary skills that string players need to develop is synchronicity of their hands. These movements are vital for the correct and timeous movements that produce the rhythm. Paul Rolland (1974:30) refers to the benefits for string players by studying the science of kinesiology. Many great string teachers (Fleich, Goldberg, Krazner, Temianka and Tursi) also endorsed the study of movement. Playing a string instrument is a whole-body experience. Rolland (1974:34) explains that the movement is not confined to the bowing arm of the performer, but that breath can be connected to the bow movement and *vice versa*.

Harmonic memory is similar among instrumentalists in general. There are issues with the memory and the positioning of harmony according to the temperament and expressive intonation, but these will be discussed in the next section.

Although certain aspects of aural training are the same as that of other instrumentalists (e.g. harmonic memory) the specific thinking skills needed by string players is the anticipation and recursion of movements linked to the playing of the instrument. It is thus important that the aural elements are not (for example) just sung, but also performed on the instrument so that the connection between the movement and the concept is clear and links can develop between the sound and its production.

2.4.2 Listening

String instruments express rhythm mostly by coordinated efforts of the left and right hand movements. The right hand produces the vibration by plucking or bowing the strings. The bowing action can be quite complex in terms of distribution and timbre and is left to the practical teacher's discretion. Methods of teaching rhythm, as observed by Dalby (2005:54), are diverse. Matthews (2014:7) studied the rhythmic perception of string players, drummers and pianists and found that each instrumentalist experiences the perception (active and passive listening) and production of rhythm differently. Matthews (Ibid.) explains that the elements of rhythm are affected directly by the ability to perceive and synchronise to rhythm and/or beat. Matthews (Ibid.) describes the required auditory and motor coordination unique to musicians. This ability to synchronise movement to beat and structure to rhythm is developed throughout the whole musical career. Matthews (Ibid.) not only agrees that training can improve synchronization to rhythm, but that playing a specific instrument has processing advantages due to the specific training skills unique to the instrumental study. The instrument-specific experience regarding rhythm and timing is not a very well researched area.

The interest of this study with comparing the piano to a string instrument is because the piano is most often found in the aural training classroom as instrument of instruction, because of the versatility in producing melody and harmony. As instructional instrument for aural training the piano is also called into question. Loh (2005:2) surmises that the piano found itself as prime instrument used in aural lessons due to the availability of the piano in classrooms and its wide range in pitch. Loh (Ibid.) does not consider the piano the ideal instrument for the purpose, because of the composite sound it forms by using multiple strings vibration to create one impure sound. Loh (Ibid.:3) claims that these impure tones confuse the student while in the act of pitch discrimination. Micheyl, Delhommeau, Perrot and Oxenham (2006:45) claim that musicians learn to discriminate pitch on a more advanced level because they are exposed to more pure pitches than non-musicians. Therefore, Loh argues that using the piano for ear training has little practical use for other instrumentalists and suggests that guitar would be acoustically simpler (2005:3). Pianos are often not tuned frequently enough and are then used in this state for aural training. This can hinder the intonation development of students.

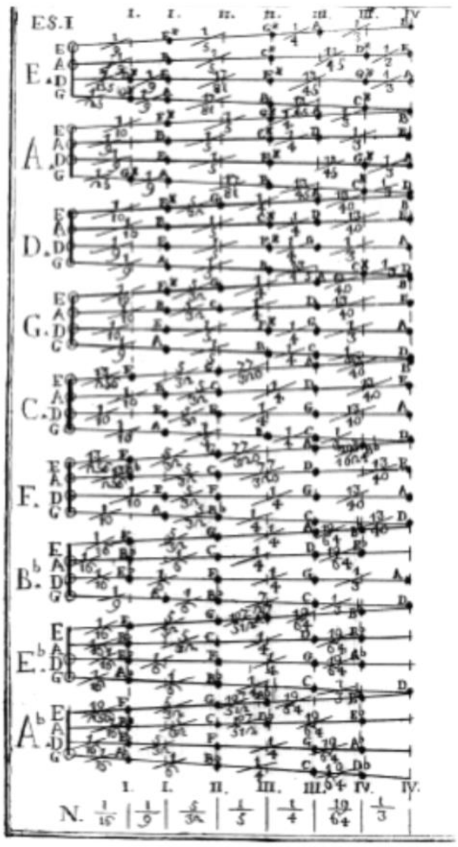
During the use of **melody** and **harmony**, there are more differences than just the obvious difference in timbre of instruments; there are several techniques or effects unique to the bowed string instruments, such as *Col Legno, Sul Tasto* or *Sul Ponticello*. Not only is the sound unique to the instrument, but it makes the compositions for the string instruments unique, as well as influence their role in the orchestra. Composer and pianist Rimsky-Korsakov's book, *Principals of Orchestration*, (1964) was intended to assist the composer by describing the timbre of each instrument in the orchestra. The common qualities of stringed instruments were: noble, warm and equality of tone. Rimsky-Korsakov (1964:8) flatters the string instrument even further by claiming that these traits make the instrument superior to others. Rimsky-Korsakov (1964:9) also notes that there is a difference of timbre between each stringed instrument and even noted the difference of timbre found between the strings of the same instrument. Noting the difference in individual instruments' timbre (violin vs. violin), Zanoni, Setragno and Sarti (2014:3) refer to the chemical makeup of the instrument influencing the timbre. Their concern is the language used to describe timbre (characteristics of individual instruments) as well as the acoustic properties. Serafine and Young (2002:99) aimed to map the movement of a violin bow so that it could imitate the "good tone" (Helmholtz motion) and investigate the contributing factors to the following bow techniques (timbres): *legato, detaché, spiccato* and *balzato*. The sensors measured bow position (distance from the bridge), acceleration, strain on the stick and flexing the bow toward and away from the scroll. The performer uses these techniques to create different timbres from the instrument. The difference in timbre created by the position of the bow on the string is also noted. This is a very basic introduction to the influence of the string player's right hand on timbre. The timbre influences the dictation and error detection of rhythm, melody and harmony.

The left hand also influences the timbre of the string instrument. Bernard Greenhouse, a well-respected cello pedagogue, described the timbre available from using different fingering (McCulloch, 2006:15). The string players first finger (index) is the strongest; the second (middle) used most expressively and having the largest surface of finger pad; the third (ring) finger is weaker; the fifth (pinkie)the weakest and shortest; the thumb is strong, but expressively limited. Using different parts of the same finger will also alter the timbre; the fleshy part will produce rich and full sound, where the tip or bony part will produce clearer and penetrating sound. Adding vibrato to a note or opting to play without vibrato is not the only option of timbre affected by vibrato, but different variations of speed and amplitude can be applied to vibrato. The right or left hand pizzicato influence timbre, while vibrato also influences the perception of pitch.

The timbre differs when plucking at different points on the string: closer to the bridge renders a stronger sound, while further away is less forced and dynamically softer. Also, that plucking with different fingers also influence the sound produced; the fleshy thumb will have a gentle sound compared to the less fleshy fingers being more percussive. This section is not intended to be a string pedagogical section, but if pedagogical books were to be included the list of the timbre elements would be much longer. Training on these elements are not found anywhere in the aural training lists. The string player is trained to identify not only when an incorrect timbre is used, but also the solution to the problem through experienced listening.

The effect of timbre on pitch discrimination is highlighted in a study by Vurma, Raju and Kuuda (2011). They investigated the effect of timbre on the perception of intonation; judging whether a musical passage is in tune or not. It should be observed that notes in the lower register (less than 1000Hz) are often perceived as lower and high register (above 2000Hz) notes are perceived as higher than what they are (Vurma *et al.*, 2011:291). Studies found that professional singers sing notes (digitally produced) by an oboe higher in pitch and the notes performed by piano were sung lower. Vurma *et al.* (2011:304) conclude therefore, that timbre effects the pitch discrimination. In Beahr's (2013) research on the similar topic, she asked violinists to sing (pitch match) a clarinet tone, which left them confused, but matching a violin tone was very easily performed. Her conclusion is that familiarity with timbre (violin notes) has a great influence on the accuracy of the intonation.

One of the complications of intonation is caused by the existence of temperaments. Temperaments, as explained earlier (2.2.2.), are different calculations in the interval size between adjacent notes when tuning an instrument. With the added complication of expressive intonation and following cues given during ensemble playing, the study of intonation should be given high priority for the string player. The historic use of temperaments also influences performance practice. Up to the 18th century, mean-tone or just temperament (with its pure major thirds and sharps lower than its enharmonic equivalent causing syntonic commas) were used freely. Composers of the time used both the notation in close proximity to each other. In the majority of cases open strings were tuned to pure fifths and musicians tried to avoid playing open strings to form a more homogeneous sound and avoiding the Pythagorean intervals. An interesting diagram or finger chart available in the Barberi and Mangsen article (1991:3), (see Figure 2.8) shows that temperament used was not equal, but differed with each key used.



2 Galeazzi's syntonic fingering charts, in different keys (1791). The fingerings have been calculated in order to have, starting from each one of the different key-notes, the same succession of major and minor tones: thus, the 5th to be narrowed by one syntonic comma is shifted according to the key. Galeazzi takes into account only the keys having up to four sharps or four flats in the signature

Figure 2.8: Finger chart for use during the 18th century music (Barbieri, Mangsen, 1991)

During the middle of the 18th century sharps were played higher than the flats in order to serve the new role of the scale degrees (the pull of the leading note to the tonic and the sixth degree on the minor seventh). The emotional expressiveness of the music was taken into account and thus a Pythagorean-type tuning was adopted by some. Into the 19th century the discrepancy between the temperaments were not resolved. Loosen (1992:526) observed that syntonic, mean-tone temperament was preferred for harmony and Pythagorean for solo playing. The use of different tunings for the enharmonic equivalent notes demanded that orchestras of the 19th century adjust their semitones accordingly, although, a compromise had to be made when performing with fixed-intonation instruments. For artists of the 20th and 21st century studies have different results: Loosen (1992:525) found that his test subjects used a system that can fall into Pythagorean and equal temperament calculations. Schonberg (Kimber, 1974:2) considered the natural temperaments (all temperaments, except equal temperament) unmusical just as one would find it indecent to go into public in a natural (implied naked) way. Barbour (1951) also concludes that equal temperament should be the standard. Composer Lou Harrison commented that twelve-tone music for string instruments (and other non-fixed tuned instruments) is an anomaly and ill-found, because the pitch will be adjusted

(Kimber, 1974:4). Composer Partch also rejects twelve-tone music and returned to principles of just intonation, thus conceptualising a scale with forty-three tones to the octave (Ibid.). This forced him to use new instruments, but his journey started with standard string instruments: violin, viola, guitar and reed organ. Other composers that exploit the microtones of string instruments are Lou Harrison and Benjamin Johnston. Researchers seem to have given up on determining the temperament used by string instrumentalists: Loosen (1992:537) deems the research irrelevant, because violinists never play in exactly one or the other, because they pay attention to other important aspects of music. Boomsliter and Creel (1963:4) describe how a singer sang 'out of tune' to any of the temperaments, but the notes were not perceived as incorrect by the audience. The significance of intonation or temperament for tertiary education is that string students are often taught intonation only according to a piano (equal temperament) as in the Suzuki method. Much of the research suggests that teachers of beginner instrumentalists use equal temperament. Another method employed by beginner teachers is drone tones[11].

Harmonic implications for string instruments go beyond the functional harmony studied in theory. The consequence of harmonic training for the string player is found in the intonation of the interval formed when executing double notes or playing with another instrument or instruments. Rimsky-Korsakov (1964:7) describes the complexity of string instruments as capable of performing full chords using three or all four strings, as well as the capability of subdividing the into playing both melody and harmony. Harmony will be discussed in more detail in section 2.4.4.

In a study done with younger students by Horvath (1999:36) where dictation is done by playing on violin, cello and double bass, showed that the difference in register affects the perception of pitch. She recommends that the instrument used in aural classes should not only correspond to the family, but individually to the instrument that the student plays. Karpinski (2000:17) emphasises that "sensitive listeners" should be able to differentiate between general and instrument-specific articulation. No research was found on the effectiveness of rhythmic dictation done by an instrument other than a piano. Error detection will benefit from instrument-specific training (see audiation in previous section 2.3.1.4). The error that is detected can be influenced by elements such as playing too close to the bridge (timbre), or using too little bow (rhythm). Thus, the error is not necessarily the obvious one heard, but the cause of what is heard.

2.4.3 Reading

In the conclusion of the previous discussion on fixed-doh or movable-doh, it was determined that it does not matter which one was used, as long as the **melodic** end result is correct. Nevertheless, it is not true when working with string students. Wachter's (2014:98) research with pianists found that there is no difference

[11] Drone tones are usually open string that are sounded with the stopped notes. This assists the string student with intonation. The stopped notes are usually contained in the drone tone's overtones, making it easy for beginner students to find the correct pitch.

in the use of either the fixed-doh or the movable-doh system, because pianists work with a fixed tone instrument, but Harris (1918) explains that using movable-doh is flawed, because using relative pitch to calculate distances according to scale degree (e.g. whole tone) is not necessarily true. He (Ibid.) also gives the example of augmented thirds and minor thirds that are identical in equal temperament instruments, but varies in non-equal temperaments. For this same reason, knowledge of temperament should affect the way theory is taught. Kimber (2011:7) describes teaching the circle of fifths regarding the tempered temperament as appose to true fifths and disregarding the enharmonic differences as an exercise in "spelling difference". Silent reading and reading while performing (sight-reading and rehearsed reading) therefore influence pitch. **Harmonic reading** will benefit more from movable-doh, because the scale function is more evident, while the **reading of rhythm** is affected similarly to that of other instruments.

Sight-reading and visual tracking are not discussed separately under string-specific needs. Sight-reading has string-specific elements, but they do not influence the aural training. Visual tracking is not different to any other instrument, as most instruments reading single lines often work with the piano accompaniment score to read the harmonic structure underlying the solo part, so that horizontal and vertical tracking apply.

2.4.4 Performing

The main concern with intonation or temperament becomes apparent when string players need to play with another instrument/s. The ensemble section (2.3.4.2) discusses the findings of researchers that found string quartets favoured Pythagorean tuning in melodic and harmonic lines. Pianos are generally tuned to equal temperament, but also have inaccuracy, especially in the extreme upper register's octaves where they are tuned wider that an octave. String players are advised to adjust their intonation when accompanied by a piano, although **rhythm** is not string-specific during performance.

The expression of emotion through rhythm, harmony and intonation is widely researched. One such study is that by Chau, Wu and Horner (2015) which focuses on the different combinations of instruments as differentiation of timbre and creation of emotion. Eerola, Ferrer and Alluri (2012) also note that there is a lack in study of timbre as emotional performance indicator. The researchers found that emotion could be gauged by timbre by infants and across cultures.

Expressive intonation during solo performance does not rely on temperaments, but performers such as Pablo Casals (Catalonian cellist), regards expressive intonation as an instinct (Sanchez, 2006:490). To many performers like Casals and Flesch it is important to see the note not as a mathematical equation, but as a process that relies on the expression of **pitch relationship**, thus within context (Ibid). Sanchez also (2006:490) refers to the sharpening of notes' gravitational attractiveness, which is found before a resting or stable note (tonic and dominant) to enhance the feeling of resolution. This intuitive method is based on giving preference to the ear as guide, regardless of what may be deemed correct according to equations.

Notes are judged in the context of their harmonic or melodic structure. Sanchez (2006:491) discusses the following as influences on expressive intonation throughout her research: musical experience, psychoacoustics, ear training, kinaesthetic movement, sense of aesthetics, bow pressure and the instrument itself. Vibrato is also a factor in expressive intonation.

Vibrato is used to move the tones until the desired comma variant (from the original tone) is achieved (Sanchez, 2006:492). Researchers who focus exclusively on the effect of vibrato agree that the pitch centre and direction remain an unresolved debated topic (Geringer, McLeod & Ellis, 2014:351). Their main concern lies with the performers' and listeners' perception of the tonal centre of vibrato (Ibid). The second concern is whether the direction of the vibrato should oscillate from the desired pitch and lower (preferred by pedagogues) or from the desired pitch and higher (Ibid.). Only a few pedagogues advise that the pitch is in the centre of vibrato. Yet each instrumentalist is unique and might be inconsistent in the use of vibrato. Studies (MacLeod, 2008; Geringer, MacLeod & Ellis, 2014) note differences in perception of tonal centres between that of string players and non-string players. My research aims to inform string pedagogy on this essential aspect.

Beyond the anticipation of musical events, Slette (2014:6) found that the string player is faced with different challenges when engaging in ensemble playing. Crucial factors involved in the performance include the role of the string player (melody, second voice, harmonic accompaniment or bass) as well as the instrumentation of the group. Each instrument in the ensemble or orchestra has a specific role and sometimes more than one role. The implication of harmonic accompaniment when using expressive intonation has been discussed in a previous section (2.3.4) of this chapter. The research indicates that the harmonic instruments need to adjust their intonation accordingly. Shackford (1956:150) adds a solution to the string instrument's problem with ensemble playing by suggesting that no open strings should be used besides adaptation to the expressive intonation used. The solution is not simply to adjust; it is to anticipate the adjustments and thus learn how to adjust to the role and instrument. Another suggested adaptation is that the lower instruments (viola and cello) of the quartet tune the lower strings of their instrument sharper, as suggested by Casals (Blum, 1987:27). As can be expected, this skill is only acquired during ensemble rehearsals. Ensemble work with a fixed-tone instrument (such as a piano) requires the melodic instrument to adjust to the equal temperament tuning. As discussed earlier, equal temperament tuning inhibits the tone colour and therefore expressive intonation.

A factor that should be considered when performing is the acoustic behaviour of a room. The acoustics change with the addition of audience. And since there is no guarantee of audience numbers a soloist can never practice in the ideal conditions. The acoustics influence the amount of sound that the soloist needs to project, sometimes influencing basic techniques such as amount of bow changes in a passage of music. Kalkandjiev and Weinzierl (2013) conducted a study into the acoustics of performances held in different rooms. A part of the object was identifying listening to each other and reverberance, but also differences when performing as soloist, or as part of a chamber orchestra or orchestra. The study found that reverberation had an influence on the tempo and dynamics chosen by the soloist (Kalkandjiev & Weinzierl, 2013:14). Galamian and Thomas (2013) indicate that knowledge of acoustical laws is crucial in public performance. The accompaniment also plays a crucial role when projecting in a room, with piano accompaniment being easier than an orchestra. Fast adjustment is essential, also as regards the tempo of the piece and awareness of the amount of echo. The projection quality is often related to the quality of the instrument, but also to the quality of tone produced, and it should not sound forced.

Replication accuracy during playback in ensemble, or singing back a melody, is also instrument-sensitive. An ensemble teacher is not required to be able to play all the instruments, yet the instruments in a string quartet are very distinct from each another (Horvath, 1999:36). The skills required to replicate an instrument in a different register are not necessarily mastered when entering the tertiary education system. String students have not all mastered the voice skills to sing melodies properly in a different register than what is given to them. Deutsch's study (Horvath, 1999:44) found that perceived register plays an integral part in the long-term memory when memorising melodies. Horvath (1999:45) draws attention to the possibility that ear training exercises developed for a class of string players, may not be as successful as previously thought.

2.4.5 Summary

The string-specific aural training is firstly built on the physical differences of playing the instrument (compared to other instruments). This physical difference is seen in the cognitive processes and manifests in a string players' brain functioning differently to that of a non-string instrumentalist (Altenműller *et al.*, 2006:40). The importance of using the fixed-doh system is not shared by all instrumentalists. The added consideration due to temperament further complicates the performance and reflective performance practises of string instruments. The elements discussed in this section are unique to the string instrumentalist and should be addressed. This section is by no means a complete list of the skills specific to the string student.

2.5 REGIONS

The regions selected for the study are connected by means of education and because they are all English speaking. The music education history of each region will be discussed as well as the development of the education system. This is done so that there is a background to the survey. The regions that will be discussed are the United Kingdom (UK), United States of America (USA) and Scandinavia. As information on aural training at universities in these regions is not readily available, I have followed the following approach to attain the necessary data: Few articles on the history of education, and music education of the regions were found. The histories of reputable institutions were accessed electronically, usually from their official web sites.

2.5.1 United Kingdom (England, Scotland, Wales, and Ireland)

The UK has a rich and respected tertiary education system that is copied by several other countries, including the USA. The region that will be discussed is confined to England, Scotland, Wales, and Ireland.

The study of music can be found as early as Aristoxenus' *Harmonic Elements* (ca.375 BCE) where music theory is regarded as an area of mathematics (Gurung, Chick & Haynie, 2009:81). This tradition of study was maintained in the UK until the 9th and 10th centuries when the liturgical chant was recognised as the union of intellectual and artistic properties, which marked the beginning of music theory (Ibid.:82). During this time there was a conscious split between the scholars: one group continued the work of the Greeks while other groups focused on the training of performers and composers. Musicians were taught by family members until the beginning of the conservatoire system, which evolved from the need of the church to train better singers. The modern conservatoire is a 19th century European product (Ibid.:83).

Institutions of the UK date back as far as the medieval time-period with institutions such as Oxford and Cambridge proudly the longest surviving institutions to date. The French revolution caused the fall of several institutions[12], but also the birth of new ones such as St David's College (*Coleg Dewi Sant*) in Lampeter, Wales (founded in 1822). The institution became St David's University College (*Coleg Prifysgol Dewi Sant*) in 1971 and is known today as the University of Wales. It was the first institution to add art education to the general specialist training. St David's College was granted a limited degree-awarding power (BA and BD only). There was great demand for higher education after the Second World War that inspired the Keele University to open in 1949, which was granted degree-awarding powers.

Little is known about the material that was studied – how aural training (if at all) was presented to the students during the initial degree programmes. Not all institutions offered the student a BMus degree (also

[12] For example, Marischal College, Victoria University.

referred to as BMus (Hons.)). One such example is Leeds College of Music. On the other hand, institutions such as Newcastle University, Liverpool Institute for the Performing Arts and Bristol University offer the graduating student only a BA (Hons.) music. These institutions do not require the students to complete a course in aural training.

The duration of the degree study time varies from three to four years. (E.g. Bangor University offers a 3-year course for BMus (Hons.)). Some institutions do specialise in one instrument group, but most do not limit themselves to one instrument group only (e.g. strings) – teachers of most instruments are represented on the permanent staff. Some institutions focus on a specific genre; for example, London College of Creative Media and Manchester Midi School offer only popular music studies and do not list aural training (of any sort) as compulsory. This practice is found not only at popular music specialist schools; Birmingham University offers a BMus without specifying aural (or similar) training as a compulsory module. Compared to the other subjects that make up a tertiary music degree, little to no information is given to prospective students about the aural training that awaits them.

The institutions of the UK do not have a uniform way of presenting or assessing aural development of students. Some institutions present a timetabled lesson dedicated to aural training. These classes are compulsory for students enrolled for practical instrumental tuition and are shared by all students on the same level of study. The duration of these lessons is also not the same across the country. The least amount of time for a lesson is set as 30 minutes per week. The lessons are generally presented in four semesters (two years) as a maximum length.

There are also institutions that present combined music theory and aural classes. It is not clear from their descriptions in exactly what way the lessons are presented. From course outlines, the lessons can either be integrated so that the concepts that are raised theoretically are then also dealt with aurally. The amount of time spent on either subject is not stipulated. Integrated lessons presented with aural vary at different institutions. The integration of music subjects can include aural, theory and keyboard skills. There are also institutions that combine part of theory (e.g. harmony) with aural training. Most institutions allocate significant time for aural training which include lectures, workshops, and self-study time.

Practical musicianship is a term often found in the courses presented to the BMus student. The Royal College of Music links their "practical musicianship" to the student's ability or level in theory. This graded system is based on The Associated Board of the Royal Schools of Music (ABRSM) grades of theory. The ABRSM description of the outcomes of practical musicianship are:

Grade by grade, the Practical Musicianship exams cover some of the key skills for the rounded musician:

- the ability to internalise music and to reproduce it;
- interpreting written music with a minimum of preparation;
- exploring the possibilities inherent in a short motif; and

- the ability to detect differences between what is heard and what is written.

It is a noble attempt to force teachers of students who are not enrolled with an institution to learn rudimentary aural skills. If a student cannot grasp the concept that is not taught, but practiced, the marks are gladly sacrificed in the practical exam. It is interesting to note that most teachers advertising their trade in the Music Union of UK website, list themselves as aural teachers. It should also be noted that there are no entry requirements (except for a small fee) to advertise these qualifications on the site.

There is no aural skill training 'methodology' course presented at any of the highly-recommended music universities of the UK. Most universities do not list the person responsible for their aural training. There is but one institute that presents its students with advanced theory as an elective in the third year of study. This could prepare a prospective teacher for more advanced harmonic skills that could aid the teaching of aural skills.

Earlier in this chapter, ensemble participation is noted as a core element of aural training. While most institutions have ensemble participation or orchestra participation as compulsory for degree purposes, there are a few institutions (e.g. Cardiff University) that have ensemble as voluntary participation for the BMus degree. Most institutions require ensemble or orchestra participation for three years of the course.

There are some noteworthy researchers in the field of aural training in the UK, like Lucy Green, George Pratt, and Michael Henson, but the UK is not known in general as researchers in the field of aural training.

2.5.2. United States of America

America's educational system is modelled after that found in Western Europe, but it is fashioned by native American conditions (Brubacher & Rudy, 2017:3). The first American university, Harvard, was modelled on Oxford University and Cambridge University from the UK in the way it was administrated, degrees were structured, and architecture and statues. Harvard University, in turn was the model for all the English American universities that followed. The admiration for These universities' admiration for UK universities was not reciprocal. This attitude, together with the difference in landscape (a vast land compared to the UK), and economic disposition of the American people convinced the university administrators that a more unique approach was necessary. One very noticeable difference that was introduced is the secular approach. Other differences came from the Scottish influence – non-residence, profession-orientation and resorting under the control of the community. It should be noted that before the 18th century the Christian religion were strongly influential in tertiary education.

The first American music school was founded in 1717, dedicated to developing reading and singing skills for better performance in religious events. Several text books were published for this teaching purpose. In 1832, the Boston Academy of Music was founded and added music theory to the course. The Swiss-based Pestalozzian system of education was influential in the manual of instruction written by the founder Lowell

Mason (co-founder of the Academy). The Pestalozzian system was relevant for the time, because it considered the plight of the poor who also needed education. Mason's involvement in Hawes School was also the start of music education in public schools that in turn lead to the need for music teacher education. The first university to offer a BMus degree (4-year course) was Oberlin Conservatory, Ohio, during the early 1900s.

The USA is well-known for the publication of aural training books and manuals, referring especially to the work of Gary Karpinski, who is resident at the University of Massachusetts. Another noteworthy book published in its English form is Steinschaden and Zehetmair's (1982) *Ear training and violin playing*, that introduces the principals of the Suzuki method, published after a symposium on the same topic. In the previous section of this chapter, rote system was explained and many of the researchers advocating the system are American. It is therefore no surprise to see this kind of book associated with the American system of education.

The universities of America are a little more forthcoming with the content of the BMus course detail. Many institutions post not only the basic outline for each module, but also the philosophy of the educator responsible for presenting the course. Even though it is a debatable topic, the aural test has a significant role in the auditions for acceptance to study at an American university. These results are used for placement evaluation for aural classes.

Some institutions embrace a trimester academic year, where other institutions still follow the two-semester academic year. The difference is that a two-year course in the first mentioned orientated institution will have six semesters compared to four semesters in the latter case. The institutions refer to the BMus student as a Major and BA student as a minor. The BMus (also known as BM) degree spans four years in total. The majority of institutions in the USA offer their students a double degree lasting five years, which equip the student with a BMus and a BA degree.

Institutions generally present Western classical music and Jazz studies, with a select few institutions also offering popular music studies. Institutions in the USA do not conduct their aural lessons in a similar way, each following a different approach. The general rule in most of the institutions is to separate jazz stream students from the classical stream. Thus, the jazz and classical students attend different classes for theory and aural and there are different curricula for the different streams of the same year of study. Some courses introduce elements from jazz in the classical aural modules (e.g. improvisation) and *vice versa*. Others opt to alternate semesters in which the jazz and classical aural concepts are taught, thus teaching each student both classical and jazz concepts.

There are institutions that separate some instrumentalists from the main group, e.g. the Manhattan School of Music. Voice students are instructed in aural skills separately from the instrumentalists. The basic outline for the courses is similar. The institute offer remedial classes for students who need tp reinforce their basic skills. No basic course outline is given for the latter course.

The faculties' sizes differ significantly according not only to the ration of student to lecturer, but also on how important a subject is deemed. Berkley College of Music has an ear training department with a staff of 35 ear training teachers. The institution requires all music majors to take four years, three trimesters each, of the ear training module. The institute requires every student in a specific year of study, to attend and pass a given module. These modules include general aural aspects, specialised rhythmic and solfège modules. The other modules separate strings, brass and woodwind students from the keyboard, vocalist, and percussion students. These courses are intended to aid performance on the specific instrument. The first module that is taught to strings, woodwind and brass focus on different scales (e.g. whole tone) and modes (e.g. church modes) and harmonies with origins in different cultures (e.g. Hungary). The second module outline emphasises the aural aspects of the practical performance of each instrument. The student is required to attend these lessons with their instrument.

Yale School of Music presents an interesting course called "hearing", where aural skills are developed by critical listening and singing of masterpieces from the choral canon (e.g. Bach *Magnificat*). The elements of composition and performance are first identified by ear and analysed on the score afterwards. The course is intended for performing and composer graduates.

Michigan School of Music, Theatre and Dance follows an integrated theory and aural system. Each year's theory module is divided into alternating aural and written semesters. The students are expected to attend four years of theory modules that see the weight of the written aspect carrying double the credit of the aural semester. The last semester of written (advanced theory) is triple the credit of an aural semester.

Cleveland Institute's handbook for music tutors, *Ear training handbook for theory tutors*, offers advice for struggling students from academic writing to sight-singing to melodic and harmonic dictation. Suggestions for similar exercises and sequences are presented at levels of increasing difficulty.

It is found that although no institution offered a course specifically intended to qualify a student as an aural teacher (methodology course), advanced theory is taught, and institutions have special programmes that send students to explore the Dalcroze and Kodály methods as presented in countries such as Australia, UK, and Sweden (who have specialised centres and training courses in English). There are unusual affiliations of music departments to different countries, such as Polish Music Centre housed and run by the University of Southern California.

Wohlman (2013:1) describes most USA tertiary institution's idea of aural training as "notation-based exercises and assignments". These lessons are mostly presented on a piano and there is little correlation between the aural skill development class and the students' progress as instrumentalist. Most institutions list aural training only for semesters (first and second year) including the University of Massachusetts Amherst, where the leader of tertiary aural pedagogy, Gary Karpinski, finds himself lecturing mainly theory. All the institutions that are listed as top tertiary music institutions made some ensemble and/or orchestra participation compulsory for music Majors.

2.5.3. Scandinavian Countries

This section will explore the educational systems of Scandinavian countries, i.e. Norway, Sweden, Finland, and Denmark. These countries are discussed as a whole because of the combined size of the population and therefore the institutions and the similar history regarding their location. Many leading pedagogues featuring in modern pedagogy come from this region.

The history of education in the Scandinavian countries is very similar, with most changes in the education system applied in the last century. Most Scandinavian countries have a history of education dating from medieval times. The original systems were changed or replaced by school systems run by the cathedrals. These schools were intended to train clergy and noblemen. Most of the Catholic schools were later changed or replaced by 'Latin schools' that have a more secular curriculum, but were intended for the same population class. After the Lutheran revolution, the church saw the need to educate every person to be able to read the Bible. This gave rise to the general schooling system that we refer to as primary education. The governments made primary education compulsory for seven years, but enforcement of this law came several years later. The compulsory school-going years were lengthened to nine and it is still enforced in several of today's Scandinavian countries. Norway and Denmark have since escalated the compulsory years to ten and Denmark is currently reviewing the possibility of twelve years of compulsory education.

Secondary school was divided into two streams: vocational training and grammar school. The latter grants access to tertiary education, whereas the first trains the work force. As much as this system is still used in the region, some countries have slightly changed or abandoned the system: Finland has granted students who graduate from the vocational stream permission to join tertiary education, but as can be imagined this is very difficult. Norway and Denmark have changed the secondary education system, removing the splitting of streams, but have a general education with several electives.

Tertiary education is generally provided by either a University or a University College. Music was added to tertiary education in the 19th century, as in other countries. E.g. Iceland was only afforded a humanities department in 1911. Both types of institutions grant degrees of BMus and BA. Undergraduate qualifications are referred to as licentiates, and post-graduate studies as degrees. The undergraduate study in performance lasts a minimum four years. Many institutions focus their training programmes for music on training for becoming a teacher of music in the primary and secondary school system. At least one institute offers the possible outcome as church musician (Ersta Sköndal University College), while other institutions focus on the use of music in technology (e.g. cell phones, movies and games).

Music education in primary and secondary school is focused on the interest and expressive quality that it provides the child. For this reason, the overwhelming genres of music found in these schools (especially in Sweden) are popular and folk music. Swedish schools do not have a national curriculum for 'music' and it is left to the teacher's discretion to decide whether a student passes or fails. Many Scandinavian tertiary institutions focus on the education, and the production of popular or folk music.

Aural training curricula are not coordinated or similar between institutions of the Scandinavian region, by country nor by institute. Each institution has a basic curriculum that states general outcomes for the module. It is left up to the expertise of the teacher to decide where emphasis should be placed, what method to use and which exercises to do. Thus, the teacher assesses the strengths and weaknesses of each group and builds the course around the needs of the group. It is common to find that, within an institution, teachers of aural training may favour different methods.

All institutions that offer a qualification in music performance have a compulsory lesson to dedicated aural training. Most are presented as weekly 90 minute lessons that are examined throughout and/or at the end of each module. In some institutions, up to five assessments may be made per module. Ear training modules are compulsory at most institutions for at least two years (four modules). Only a few institutions expect three years (six modules) of minimum of aural training. These institutions do not offer any further modules in ear training.

Most Scandinavian institutes deal with the different needs of specific instruments in several different ways. Most institutions (e.g. Norwegian Academy of Music) separate the instrumental groups (e.g. string instrumentalists) from each other in the instruction of the ear training lesson. Students are required to bring their instrument to the ear training lesson for instruction. In these lessons, general (e.g. rhythmic and meter) and instrument-specific aspects (especially the harmonic aspect) of aural skills are taught. Other institutions use an integrated system of theory and ear training to deal with the general aural skills (e.g. rhythm) and more specific instrumental aural skills are addressed in an ear training class. Many of the Scandinavian institutions list ear training as part of the course outline of the theory lessons.

At least one institution (Norwegian Academy of Music) has specialised and compulsory ear training modules where ear training is combined with theory (ear training and theory), practical instrument (ear training and practice first instrument, ear training and practice second instrument), ensemble (ear training and ensemble) as separate modules to theory, practical study and ensemble. There is no specialised course for training an educator for the role of aural training instructor. Institutions offer an advanced theory course that can lead to the student becoming an aural teacher.

The aim of ear training in Scandinavia is to examine and study the way of 'hearing' music. The course work often refers not only to practical applications, but also to physical experience of skills. Many similarities are found in the course outlines of the institutions and the research done in the field of aural. The 'general' aspects of e.g. intonation and rhythm are always present in the courses, but new concepts are also found, an example of which is the transfer of skills into the practical performance. This is achieved by combining a practical element (such as ensemble or practical performance) with the aural lesson. Another interesting concept is the 'aural vocabulary' a concept coined by Professor Lasse Thoresen, which explores the vocabulary of what the ear perceives. There are about 70 such concepts.

The Norwegian Academy of Music has five aural specialists on staff and conducts in-depth research into ear training with a project called GEFFF (the musical ear as Phenomenon, Discipline, and Function). Currently, this group of researchers are the leading institution in the field of modern ear training.

2.6 SUMMARY

Chapter 2 explores the academic and public literature on aural training. Four sections are discussed: basic concepts (2.2), aural skills (2.3), string-specific aural needs (2.4), and regions that form part of my study (2.5). The basic concepts that were investigated are rhythm, melody, and harmony. The concepts were found to be composite and having complex, longstanding philosophical ideologies. The use of each concept and term was defined through the academic literature. The four skills that are discussed were taken from Gary Karpinski's book (*Aural Skills Acquisition*, 2000). Although this is an older source, Karpinski is a leader in the field of aural training. The string-specific aural needs are discussed in the third section. This section is also structured along the four skills identified in the previous section, although it does not pretend to be a complete list. Initial research into the method of aural training of each region, as found in the literature, is covered in the last section of this chapter.

Further investigation into the aural training of the regions was made through a questionnaire (discussed in Chapters 3 and 4). The questionnaire was based on the research of Chapter 2.

CHAPTER 3

Methodology

This chapter will explain the research philosophy and scope of the current research. The chapter will explore the methodology used by addressing the following sections: research approach; research design; methodology; role of the researcher; description of participants; data analysis; ethical considerations; reliability and validity; and limitations.

3.1 RESEARCH APPROACH

This study is post-positivist constructivism – by which researchers believe they construct the view of the world based on their perception of it. The data was collected through a survey and is used to form an overall view of the aspects and issues in aural training of string players. These aspects and issues need to be addressed in the aural training lesson, i.e. finding what can be done better in aural training lessons, or where else aural training should take place. The data also records the participants' attitude towards the subject of aural training and the confidence of the teachers and the aural trainers of the same students.

The approach used in this research is the quantitative method. This is a method of identifying and classifying features (who; what; how; why; when) and then presenting the findings mathematically as statistical figures (Isotalo, 2001:5). There are several different descriptions of the quantitative method, each lacking in some way (Sukamolson, 2007:2). Sukamolson (Ibid.) found that the aim of all qualitative and quantitative research is to explain the nature of phenomena. What separates qualitative from quantitative is the kind of data that is collected and how the data is processed. The quantitative method collects numerical data (Creswell, 2003; Khan, 2014). The aim of a quantitative method research is to classify features, analyse them by means of an instrument (such as a survey), create statistical models to test the hypothesis and explain the observations. The quantitative study thus works with pre-determined hypothesis. This study is therefore deductive in nature: a theory tested through research. An advantage of quantitative studies is that it uses data analysis, and it is an efficient method: it demonstrates relationships, examines cause and effect, and there is bias control (Singh, 2006:131).

3.2 RESEARCH DESIGN

The research design used a survey whereby participants responded to a series of statements or questions. A survey is possibly the most frequently used instrument in the social sciences (Babbie & Mouton, 2001:230).

Furthermore, the researchers explain that a survey is used in descriptive, explanatory, and exploratory studies that are the best method for studying a population that is too large for a direct study. They (Ibid.) further add that surveys are excellent for measuring attitudes, and are thus the perfect tool for my research.

There are several advantages to using surveys. Babbie and Mouton (2001:263) describe one of the strengths as the ability to effectively study a large population through a carefully selected sample. Also, surveys are flexible (they can consist of many questions on the given topic). The disadvantages of the survey are linked to the limitations discussed in 3.3.

3.3 METHODOLOGY

Information for my study was collected in two different ways. Firstly, a study was made of research papers, books, and web sites. This information is referred to in this thesis as the academic literature. This information was then used as comparison against the second set of information, i.e. the information gathered through the questionnaire.

The methodology takes the form of a Computerised Self-Administered Questionnaire (CSAQ). Babbie and Mouton (2001:257) note the significant influence of technology on the research method, especially the survey. Du Plooy-Cilliers and Cronjé (2014:150) describe self-administered surveys as those completed without the help of the researcher. This method was chosen because the information, not sensitive, does have an element of judgment to it. It was presumed that the participants would not feel obliged to give answers that they think the researcher is looking for, but answer what they had really experienced in the field of teaching a string student. According to Babbie and Mouton (2001:259) self-administered questionnaires are software that asks questions and captures respondents' answers. A third party hosted my questionnaire. I entered the questions, then the web address (site where the questionnaire was hosted) and sent it to potential participants via e-mail (invitation). The answers were recorded by the software and presented to me (the administrator of the online questionnaire) as a list of anonymous participant's answers. The data refers to the participant by number only (e.g. first participant, or 10th participant). This is in accordance with the electronic survey described by Babbie and Mouton (2001:259). CSAQ entails that the participants receive the questionnaire in a digital form, software 'conducts' the survey and participants return only the data file.

The CSAQ was hosted by a third party: ACWEB. The choice of domain host was based on financial implication to me. The ACWEB domain cost was calculated based on the amount of time I require the domain to host the questionnaire, in this case five weeks. Other domain hosts (like SurveyMonkey) required me to pay for a minimum of three years, regardless whether the survey was needed for only a short amount of time. Furthermore, the type of questions in my questionnaire did not qualify for any of the common free hosting survey services.

The process of entering the questionnaire into the website involved limiting responses by either creating drop down indexes of instruments and years, or by means of a forced ranking, or comment fields. The domain address where the CSAQ is hosted (hyperlink) was added to the e-mail inviting the potential participants to access the survey. Babbie and Mouton (2001:260) report that this method does not cause a reduction in data quality.

Time considerations were made according to that prescribed by a cross-sectional study. This kind of study is described by Du Plooy-Cilliers and Cronjé (2014:147) as "a single snapshot of a single moment in time" – as opposed to a longitudinal study that can last several years. The time that the survey is conducted thus plays a crucial role in the validity of the study. I decided to conduct the study at the beginning of the academic year of the tertiary institutions abroad. The decision was made to access the pedagogues close to the time decisions were made in terms of scope and extent of what would be taught to a class. The date that the survey was loaded and first invittations sent to potential participants was 20 September 2017. The questionnaire closed on 26 October 2017, so that the questionnaire was available to the participants for five weeks (35 days). Babbie and Mouton (2001:260) advise researchers to monitor the responses, as potential respondents might forget about the invitation. The process that was followed in monitoring the responses will be discussed in 3.3.2.

3.3.1 Questions

This section will explain the type of questions that were asked in the questionnaire. The reason for adding this section to the chapter is that my methodology of rigid data collection is not customary in the field of music studies. The rigid data obtained by my study is in the form of nominal data, ordinal data and interval data. After consulting a statistician, it was decided on the use of this method. The reason for the choice of method was that very specific information was required for my study. The participant was obliged to consider elements that are forced and not open to interpretation. The method would have a wide-reaching (almost global) census of aural training. I recognise that there are different methods of aural training used in different regions of the world based on my interaction with teachers of different nationalities and I wished to obtain a fuller picture. An interview method with two or three persons would not represent the population of teachers responsible for string instrumentalists' tertiary education, for as learnt from the literature: aural is often taught in the way that the teachers themselves were taught, thus limiting the research to one region which is not an authority on the field of aural training. Comparing only literature would not give me the necessary insight into what is taught in the classrooms. As discussed in the literature (and again proven in this study) the research does not inform the aural classroom. The aim of my study was to engage in social constructivism that is described by Creswell (2003:8) as an individual's search for understanding the world they live and work in. Creswell (2003:8) further notes that constructivists often address the process of interaction between individuals to make assumptions on the history and culture. The questionnaire includes open-ended questions, which conform to the social constructivist style of questionnaire. I am trying to make assumptions (Du Plooy-Cilliers & Cronjé, 2014:147) regarding the teachers involved in developing the string student's aural skills, and due to the large population, it is most effectively accessed by means of a survey (online questionnaire).

My research survey consists of fourteen questions which record different types of data. For data to be valid, it is important that the questions qualify for the type of information required. It is important that no double-barrelled questioned are asked (Babbie, 2014:250-251) which might confuse the participant and influence the quality of the data. **Nominal data** record numbers as labels with no mathematical significance, to determine group membership, like male and female (Du Plooy-Cilliers, 2014:157). For validation purposes the categories were exhausted and mutually exclusive. No order is implied by the possible answers. **Ratio data** has a scale of equally-spaced numeral data that contains an absolute zero. Du Plooy-Cilliers (2014:159) explains that ratio data can be compared to each other with numeral results, and provides as example the age of a population, and the measurement of how much older one group is compared to another. Ranking elements of a single variable achieve **ordinal data**. Du Plooy-Cilliers (2014:158) suggests that questions should be structured in a way that the value of several elements is ranked against that of one variable. **Inventory** questions are also included. Respondents are asked to select from a list, with all the options applicable to them. Du Plooy-Cilliers (2014:154) notes that the list should not be mutually exclusive and more than one option can apply to the respondent. Conforming to these elements confirms the validity of the questions and available responses used in this questionnaire.

After the extensive literature study, considering works of numerous researchers, the questionnaire was thus compiled as previously mentioned. The questions will briefly be described in the next section.

<u>Question one</u> is a prerequisite for ethical purposes; the participant is asked for consent to use the information provided in my research. The participants also indicate that they have understood the terms and conditions of participation as set out by Stellenbosch University. The data on this question is not presented in Chapter 4 as the survey prevented participants that did not give consent from proceeding further with the questionnaire.

<u>Question two</u> is nominal data: the region of current teaching of the participant is required. The question is close-ended with the participant having only three options: USA, UK, or Scandinavia and only one of the possibilities can be selected. This question is needed to assure that the participant is a citizen of the regions that falls within the limitation of my study.

<u>Question three</u> is ratio data: years of experience in teaching. This data will provide understanding into the insight of different generations of teachers into the aural needs of the string students. The question will also indicate whether the teacher is a beginner or an experienced person in the field. The question is closed-ended and answers are selected on a sliding scale of five-year increments.

Question four is nominal data: the gender of the participant. The data have potential for comparison in my study. The data were invaluable in the understanding of phishing. This issue will be discussed in section 3.7. The question is close-ended and categories exhausted.

Question five is ordinal data. The participant is asked to rank rhythm, melody, and harmony in order of importance. The set variable to which each of the three concepts is measured is that of importance (first, second and third). This question is important as it will confirm or deny the literature study's conclusion that rhythm and melody rank higher than harmony. Participants are asked to give a reason for their answer. The explanation is voluntary and participants can skip over this if desired.

Question six is a closed ended question on the first and second instrument of the participant. This will pick up trends linked to instrumentalists' attitude towards aural training, as well as the comprehension of necessary aural skills and instrument-specific aural skills.

The next series of questions are forced ranking with no option to select all options as equally important. Closed ended questions are followed by asking the participant for a non-forced explanation for the answer.

Question seven asks the participant to rank aural skills in order of importance.

Question eight asks the participant to rank the order of listening skills in order of importance.

Question nine asks the participant to rank the order of performance skills in order of importance.

Question ten asks the participant to rank aural skills the order of performance skills in order of importance.

The last series of questions are inventory questions, where the participant is asked to list the skills taught to enhance a certain concept. The answers will show the difference in thought processes for different instruments and different regions of origin. After the close-ended question, participants are asked to explain their answer.

Question eleven asks the participant to list all skills involved in teaching the concepts of rhythm.

Question twelve asks the participant to list all skills involved in teaching the concept of melody.

Question thirteen asks the participant to list all skills involved in teaching the concept of harmony.

Question fourteen is a nominal data. The participant is asked whether any string-specific elements are involved in the teaching done. The participant is then asked to explain their answer. This question will have different implications for instrumentalists.

3.4 SAMPLE SELECTION AND DATA COLLECTION

I will discuss both sample selection and data collection in this section. Participants are all literate, a prerequisite for self-administered questionnaires according to Babbie and Mouton (2001:258). While this might be a concern in the South African conditions because of the literacy rate among adults, the participants are all tertiary educators and it is hence safe to assume that the population is literate.

The identified participant belongs to the population found in three regions: USA, UK, and Scandinavia. The potential participants are part of tertiary education staff that may have a string student in their class. This invited participant may or may not be aware that there are specifically string students in the class (as in the case of music history or instrument practical lesson). I gathered information from online sources about tertiary institutions in the different regions. I assessed whether the tertiary institutions were mentioned as 'top music performer' and the instruments that were offered at the institution. The contact information of the potential participant was gathered from the tertiary institutions' staff database that is available to the public. The biographical information available on each member of staff was analysed and instrumental string lecturers, theory lecturers, ensemble and orchestral lecturers, as well as aural training lecturers were identified and invited to participate in the survey.

As discussed in section 3.3 it is important to monitor the returns of the mail questionnaires. The day the e-mails were first sent was marked as day one. The e-mail was sent so that it reached the potential participants by Friday. This ensured that the questionnaire was accessible to the potential respondent on the Monday morning (regardless in which time zone they were). The results were monitored at least every Thursday (Day 6, 13, 20, 27 and 35). There was more frequent monitoring in the last week, before the questionnaire was closed (day 35). Table 3.1 presents the distribution of the questionnaire invitation as well as the reminders (an invitation sent to the same person). A total of 908 persons were invited to participate in the questionnaire. The distribution can be seen in the table below. The prospective participants that had been invited on day one received the invitation (reminder) twice more and received the invitation a total of three times. The prospective participants that were invited on day 15 received the invitation (reminder) once more and received the invitation twice. The invitation was sent 2 319 times. The new participants, from smaller tertiary institutions, were invited on day 15 in an attempt to boost participant numbers.

Table 3.1: Activity of e-mail sent to potential participants

	Day 1 (20 Sep 2017)	**Day 15** (6 Oct 2017)		**Day 22** (13 Oct 2017)	**Day 35** Total send to region
	New invites	Reminder	New invites	Reminder	
UK	150	150	64	214	**578**
USA	143	143	90	233	**609**
Scandinavia	210	210	251	461	**1 132**
Total invitations per day	**503**	**503**	**405**	**908**	
Total invitations					**2 319**

A total of 13 participants of the sample population that had been invited, responded by completing and submitting the questionnaire. The possible reason for the low response rate lies in the limitations discussed later in section 3.8. Another possible consideration is the risk of cybercrime known as phishing. Halevi, Memon and Nov (2015:3) describe phishing as e-mails claiming to be from a reliable source, but the goal of these are to gain access fraudulently to personal information. The criminal uses the information gained to impersonate the person attacked for financial gain. This conclusion is drawn from an e-mail received by my supervisor asking about the validity of the invitation I had sent to potential participants. Halevi *et al.* (2015:3) quote the lack of technical understanding as a reason for falling prey to these criminals and that standard security cannot be relied on by the user. Some of the statistics the researchers present is that women fall prey to these criminals more than males, and persons more aware of these crimes will protect themselves by not responding to unfamiliar e-mails (Ibid.:4).

3.5 DATA ANALYSIS

The statistician applied data from the respondents and attempted to use one-way ANOVA test (the Friedman test) to make a non-parametric comparison. Non-parametric comparisons juxtapose nominal and ordinal data to find trends. Because of the limited amount of data gathered, the test was inconclusive and comparisons between the different regions' responses did not produce any reliable results. Correlation tests were also not possible in this study. Correlation tests determine whether there is a linear relationship between sets of variables. The statistician withdrew from the study and suggested that the data be analysed by me and presented according to descriptive analysis of the data.

All data was converted firstly to data sets. Data sets are set up by determining the range of all the data. According to Khan (2014:210) this is the determining of range (upper and lower regions). Several different descriptions of the data were then applied. The central point of the data set was not required for this study. Mode determining was also used, described by Khan (Ibid.:212*)* as the value that appears most often in the data.

Analysis of the participant's age was left as a data set. This was created by determining the range and applying a frequency study to the ranges. The three basic concepts (importance of rhythm, melody, and harmony) were converted from data sets of ranking (first, second, and third). These sets were combined into 100% stacked column graphs. The same procedure was followed with aural skills data (thinking skills, listening skills, performing skills and reading skills). The sets of ranked importance (first, second, third and fourth) were combined into 100% stacked column graphs. Each graph thus indicates the frequency that each concept was ranked as first, second, third and fourth in importance.

The data from questions eleven, twelve and thirteen provided frequency data sets. The data sets of the concepts (rhythm, melody, and harmony) are presented as pie graphs where the sum total of inventory was treated as 100% and each skill's frequency is presented as a percentage of the inventory list. Each skill's frequency was juxtaposed in terms of each concept and presented as a clustered bar graph. The same data set was converted to a data set indicating the total frequency of each skill (sum total of concepts for each skill) and presented as column graph. Conclusions were made according to the data sets' ranges and compared to the literature. Conclusions made also derived from the inventory sets and compared to the data sets and the literature.

3.6 ETHICAL CONSIDERATIONS

There are ethical considerations that need to be taken when research involves human participants. My study involved consenting adults, therefore data collection could commence after the approval by the DESC (Departmental Ethics Screening Committee). The DESC referred my study – with project title: *Training the string player's ear: a comparative study*, and project no MUS-2017-1169, to the REC (Research Ethics Committee). The REC application was approved on 11 October 2017 and deemed valid until 10 October 2020 (Appendix A).

The questionnaire (Appendix C) does not have any identifying elements, beside general nominal data. The participants participated voluntarily in the survey, that was explained by a cover letter (Appendix B). It is confirmed that the participants understood the terms and conditions, and that their participation was voluntary, by a forced first question in the survey. Participants were not able to proceed before a "yes" response had been given. The remainder of the questions were voluntary, with forced ranking applied only to allow for the ranking of the variables in terms of importance. Participants could proceed to the following question without completing a question. The participants were asked to provide voluntary comments to their responses to the questions. The questionnaire did allow the participants to return to previous pages to alter answers.

3.7 RELIABILITY AND VALIDITY

The validity of an instrument relies on the reliability of the instrument, but not *vice versa*. The validity is concerned with the instrument's ability to measure what it is supposed to measure, whereas reliability is concerned with the instruments ability to measure consistency (Tavakol & Dennick, 2011:53).

Validity relies on the three main characteristics: evidence must support interpretation of the data, data must be accurate and drawing conclusions must be logical and appropriate. The construct of the validity is that what I surveyed was what was intended to be studied, what was observed was what was intended to be observed, and operation of variables was related to the theoretical concept that I wanted to measure.

The survey and questionnaire are checked for validity according to Koonin (2014:256) in the following way: the face validity is measured by calculating whether the survey measures what it is was intended to measure at face value. All the questions in the questionnaire were based on the nominal data and issues found in the literature of this thesis. The content validity is also adhered to: item validity is achieved by the content of the questionnaire being discussed in the literature of this thesis. Sample validity is content appropriate to the participants. Aural training is in the interest of all music teachers. The field is interdisciplinary, which concludes that all music teachers should take a personal stake in the subject. The sample could include any teacher of music. My study sample was tertiary music educators who had string players in their class, thus complying with the validity. There is no previous test like this test, which makes concurrent validity not applicable to this study. The test also complies with construct validity, whereby conclusions could be made that are in line with the intention of the study. My study intended to measure aural training aspects of the string player, and conclusions were made on the same subject. Further steps were taken to ensure validity in terms of the questions by following guidelines from Babbie and Mouton (2001:263) where the wording and format of the questions, the quality of the study, and thus clear, concise questions with clear instructions were made in the questionnaire.

3.8 LIMITATIONS

The greatest limitation to my research was the low number of responses received. Although the target population had been selected from several university lists, the number of participants that responded was very low. The survey was left open for approximately five weeks where the possible participants were reminded twice about the survey. This action is also suggested by Babbie and Mouton (2001:260). A solution could have been to contact the few respondents for an interview, but because the study was done in such a way to protect the identity of the participants, there was no way to gain access to the respondents. For the same reason the study could not demarcate the specific areas; eventhough 13 respondents are not representative of the set regions.

The survey questions often have standardised questions (Babbie & Mouton 2001:263). These are said to trivialise important issues. The individual voice cannot be heard. Sophisticated analysis solves this issue. The survey is impersonal. Although the questions had clear instructions, there were no explanations available to the participants where confusion could arise. This proved especially true in my research, but it also proves my research hypothesis: that there is more than one understanding of concepts. There is also confusion as to skills belonging to the aural training field. These issues will be dealt with in Chapter 5.

The survey is researcher driven. The issues noted by the researcher are not always the issues noted by the greater community. My research is based on the connection between research and practice. The issues listed in the literature review are thus tested in the practical field.

CHAPTER 4

Data analysis

This chapter will present the analysis of the data from the survey. The survey took the form of an online questionnaire and the data received was captured in the form of tables and graphs. The data will not be used to compare one region with another, but the individual sections of the questionnaire will be compared to each other, as well as to the literature. The data received will be discussed as presented and compared to the literature review in Chapter 2. The chapter will follow the structure of the questionnaire included in the addendum (Appendix C). The questionnaire is structured as follows:

- Participant classification;
- The important aspects that need to be trained (basic concepts, thinking skills, listening skills, performing skills and skills in general); and
- Skills that are taught in lessons by the participants.

4.1 PARTICIPANT CLASSIFICATION

There were thirteen responses to this study. The participants were asked to reveal their age on a sliding scale of 5-year increments. One participant of the thirteen responses received did not disclose this detail. Table 4.1 provides a summary of this data. Most of the participants were aged between 46 and 50 years of age. The second highest number of participants was 41 to 45 years of age. The second lowest number of participants was 31 to 35 years of age and with both 36 to 40-year of age and 51 years and above tied for the lowest number of participants. The age difference between the participants is greater than 20 years. No participants were 30 years and younger. With phishing targeting the persons with less technological understanding, which is often the older generation, this participation age is evidence of the phishing statistics provided in Chapter 3.

Table 4.1: Participants' ages

Age group	Number of participants
31-35	2
36-40	1
41-45	3
46-50	5
51 +	1

The participants were also asked to provide their teaching experience in terms of years. The range was between 5 and 30 years' experience. None of the participants were novice teachers and had had enough time in the profession to form strong personal opinions about the education system of which they form part. The following section will discuss the forced ranking by these participants. This element is important for the validity of this study.

4.2 BASIC CONCEPTS

The participants were asked to rank the basic concepts found in Chapter 2.2. These concepts are discussed as rhythm (2.2.1.), melody (2.2.2.), and harmony (2.2.3.). It should be noted that the list of concepts is basic and does not include all the musical concepts. The ranking order was forced between the three given concepts and thus participants could not indicate that all the concepts were equally important or add concepts. Participants were awarded space to provide reasons for their ranking of the basic concepts.

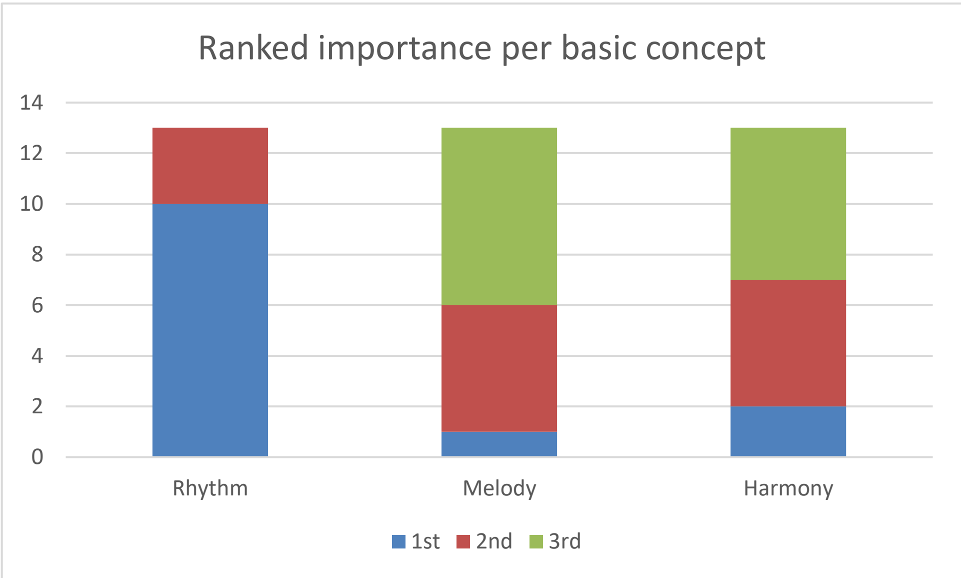


Figure 4.1: Ranked importance per basic concepts

Figure 4.1 indicates the participants' results for ranking the three basic concepts in order of importance. It indicates that most participants consider rhythm to be the most important concept that should be trained. Some participants did think that melody and harmony outranked rhythm, but these participants were significantly lower in number. The literature on the basic skills (Chapter 2.2) creates the impression that rhythm and melody are equally strong contenders as the most important concept. From this survey it proves not to be the case. Harmony and melody rank jointly second in this survey. It is interesting to note that the participants who indicated that harmony or melody was most important, indicated that rhythm was the second most important concept. This resulted in none of the participants rating rhythm as lowest on the scale of importance. From this survey and the academic literature studied, rhythm is the most important concept that should be trained.

Although the third ranked concept in the survey is that of melody, the difference between melody and harmony is not that large. This is contrary to the opinions in the literature, which indicates that harmony is the least accountable in the basic concepts. As mentioned earlier, rhythm is not ranked in this category by any of the participants.

None of participants provided any comment on the rankings provided for this question

4.3 SKILLS

4.3.1 Thinking skills

The participants were asked to rank the thinking skills found in chapter 2.3.1. Thinking skills are discussed as musical memory (2.3.1.1), perception (2.3.1.2), cognition (2.3.1.3), and audiation (2.3.1.4). These skills are based on the three concepts discussed in Chapter 2.2. These thinking skills are based on the research of Gary Karpinski (2000) who is an authority in the field of aural perception. The ranking order was forced and thus participants could not indicate that all the skills were equally important. There is a discrepancy in the total figures, caused by the fact that not all participants ranked all the skills – one participant ranked only one out of the four sections.

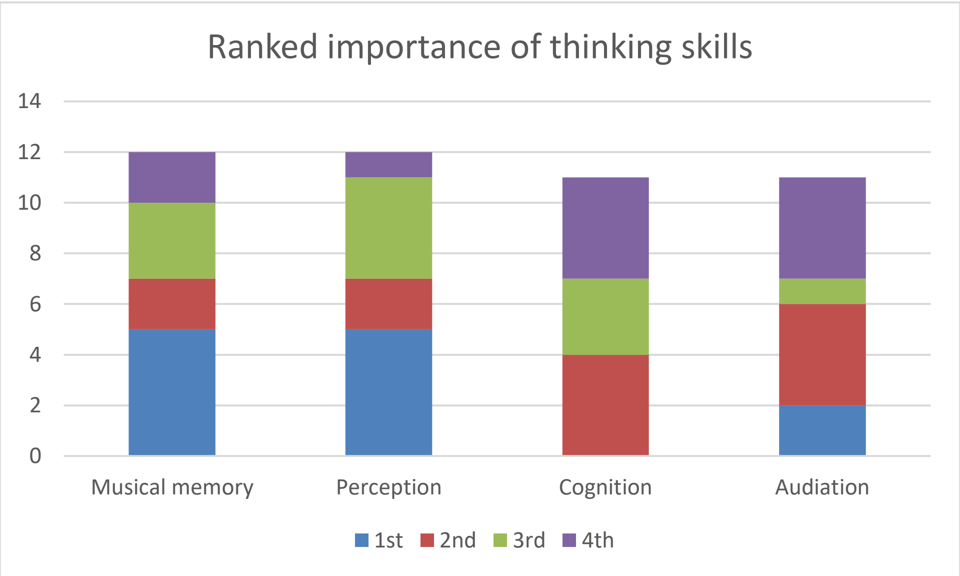


Figure 4.2: Ranked importance of thinking skills

Figure 4.2 shows that musical memory and perception were ranked equally as the most important of the four thinking skills presented. Audiation was also ranked as most important skill by the minority of the participants, while none of the respondents marked cognition as most important. According to the literature, thinking skills rely heavily on cognition (Chapter 2.3.1.3). The understanding of musical elements leads to musical memory (both long term and short term). Thus, musical memory relies on cognition. The literature differs from the results achieved by the survey. The participants expect students to memorise musical elements without firstly understanding. One participants' comment underlines the conclusion: “Remembering anything has always got to be first step! Without memory – musical, in this case – no achievement is possible”.

Making a strong argument about the order of thinking skills, a participant who rated audiation as the most important skill, asked: “Can one do the others without audiation?” The answer from the literature review would refer to acculturalisation of the student. Also, students (especially string students) would need to understand what they hear, what causes the effects, and they must have experienced the sound before audiating it, and thus, creating the desired sound during performance.

Another respondent commented on the contents of the list: “This seems to be an ordering based on sequence. First [,] we perceive, then we understand. Memorization can come next.” The respondent did not mention audiation in this comment, thereby following more closely the trend set in the literature, by listing perception as first step in thinking skills. The literature suggests more than just an order, but interplay between the skills. The perception is proven to start before birth, but without solid evidence of other thinking skills present, technically that could be considered the first step.

The participants ranked cognition and audiation as joint lowest skills of importance. Both memory and perception are also represented on the list of lowest ranked thinking skills. For this skill to represent the literature, the skill rating should have delivered a close contest in all four sections for top and bottom ranked skill. There is evidence that there is definite importance given to memory and perception, while cognition and audiation are regarded as less important.

4.3.2 Listening skills

The participants were asked to rank the listening skills found in Chapter 2.3.2 and discussed as active listening and passive listening (2.3.2.1), dictation (2.3.2.2), and error detection (2.3.2.3). In the survey, active and passive listening skills were separated. It was dealt with in one section in the literature review as a way of juxtaposing to distinguish the skills clearly. The ranking order was forced and thus participants could not indicate that all the concepts were equally important.

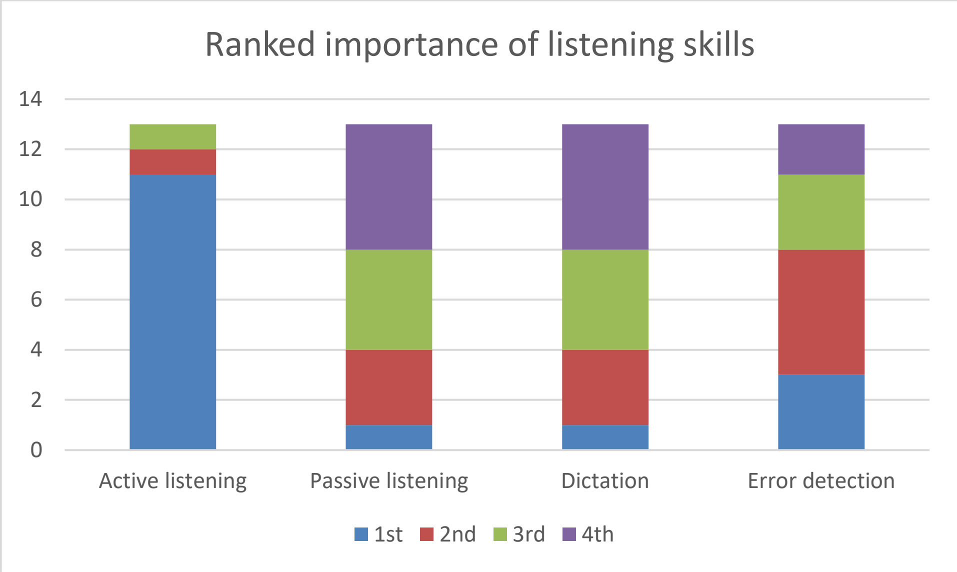


Figure 4.3: Ranked importance of listening skills

Figure 4.3 presents the results of listening skills ranked in order of importance. Active listening is ranked as the most important skill by almost all the participants. This was the expected answer.

The literature also supports the ranking of active listening as the most important skill although some literature defends the passive listening skill as the most important. The literature notes that active listening is not a skill that is used for long stretches, because of the cognitive processes that create passive listening. According to the literature active listening is mostly present during rehearsals and not performances. Thus, passive listening should be the most predominant form of listening while performing, and if this skill is not acquired, issues -such as ensemble performance- can derive.

One participant defended dictation as most important skill: "Spotting errors is the trickiest skill as it requires consummate [complex] aural ability." While error detection can be tricky, it is not essential enough to be the most important skill, but as a complex skill it could qualify as the most important skill. The literature mentions the complexity of error detection in terms of rhythmic, pitch, timbre, and reading mistakes. The complexities of error detection are also discussed under string-specific needs (Chapter 2.4). In contrast to the comment of the previous participant, another participant defended active listening over error detection: "If one listens actively, one would detect errors." This defence is not contained in the literature, but it would be apparent that an aural specific exercise would be performed using active listening. While performing, and passive listening is engaged, hence error detection should also be engaged.

Another participant disagrees with the literature: "Listening should rarely be passive. Dictation arises out of active listening. Error detection helps verify dictation." The participant denies that passive listening is present in any form of music making, because listening is described as the essence of music in Chapter 2.1. The second statement is also the view of an earlier participant. The last statement made by this participant is supported by the literature, where processes involved in music are interlinked.

No participants rank active listening as the lowest ranking skill. This is a predicted outcome, because as pedagogues it is their profession to engage a student's critical ear, which is the active listening skill. Passive listening skills are ranked as least important skill as expected, but the ranking is shared equally with dictation. Passive listening could be considered as not a skill that is teachable, but dictation is not in the same category of teachable. It should be noted that passive listening and dictation’s scores are identical. Dictation was mentioned in two comments by participants, while passive listening was not mentioned once. Dictation, as related to audiation, is mentioned in the literature as an important skill. Several significant researchers (Chapter 1) refer to aural training creating a seeing ear and a hearing eye. This refers to the skill of audiation where one that can see the notation as you hear the music and hear the music when you see the sheet music. Dictation with audiation is thus one of the core skills of aural training according the researchers.

4.3.3 Performing and reading skills

The participants were asked to rank the performing and reading skills listed in Chapter 2.3.4. Performing and reading skills are discussed in Chapter 2 as ensemble performance (2.3.4.2), reflection (2.3.4.3), and sight-reading (2.3.3.). I decided to combine the two sets of skills, not to influence participants into thinking I would want to prove either rote or note theories through aural training. The ranking order was forced and thus participants could not indicate that all the concepts were equally important.

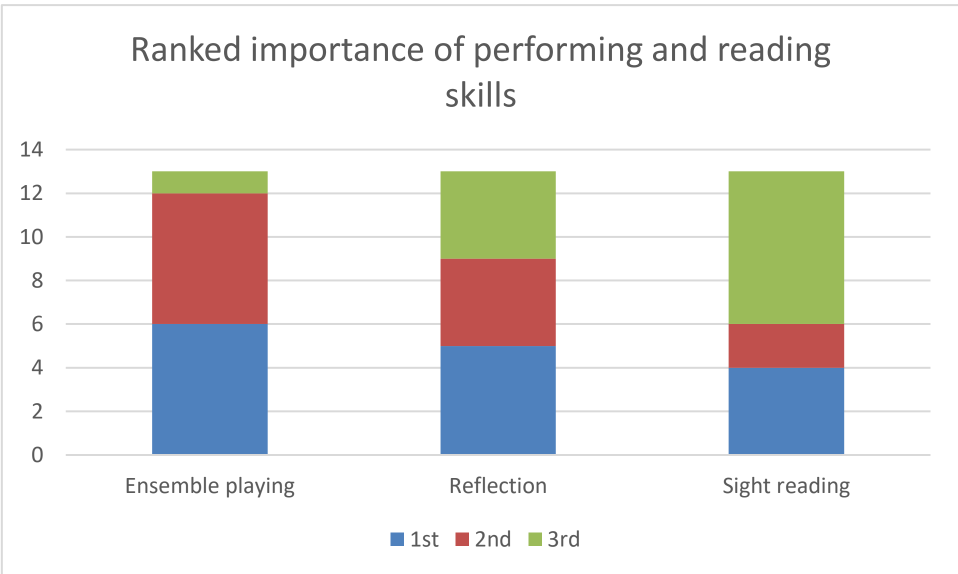


Figure 4.4: Ranked importance of performing and reading skills

Figure 4.4 displays the results of ranking performing and reading skills in order of importance. Ensemble playing is ranked here as the most important skill. Reflection follows close in ranking. The ranking of ensemble playing as most important skill is also shared by the literature. Ensemble playing is also indicated as the second-most important skill by most participants.

This question was most misunderstood by the participants, thus the weakest question. Three of the participants commented: “These depend on the individual and his/her career needs.”; “Not clear: ‘Reflection in performance’ – is it the feedback/analysis? That’s how I understand the question.” These misunderstandings could be explained if the survey had assumed the form of an interview, but unfortunately as an online questionnaire there was no contact between the participants and the researcher.

The third participant comment alluded to the inability of the participants to rate two skills as equal important. “Sight-reading requires the other two skills in tandem.” From the literature it is not indicated that sight-reading requires ensemble skills interrelated with reflection. In the cognition section (Chapter 2.3.1.3) reflection is mentioned as an essential part of reading skills (in general), not as an interrelated skill, but more as sight-reading and reflection in tandem with each other to be able to participate in ensemble, which also requires reflection.

Sight-reading is ranked as the least important performance skill by most of the participants. This was the anticipated result.

4.3.4 Ranked skills

The last question of this section asked the participants to rank the importance of all the skills. These skills are discussed in Chapter 2 as thinking skills (2.3.1), listening skills (2.3.2), reading skills (2.3.3), and performing skills (2.3.4). The ranking order was forced and thus participants could not indicate that all the concepts were equally important. This question is the culmination of all the previous questions. The participants had rated elements of each skill in the previous questions, and they were now asked to rate the different skills against each other.

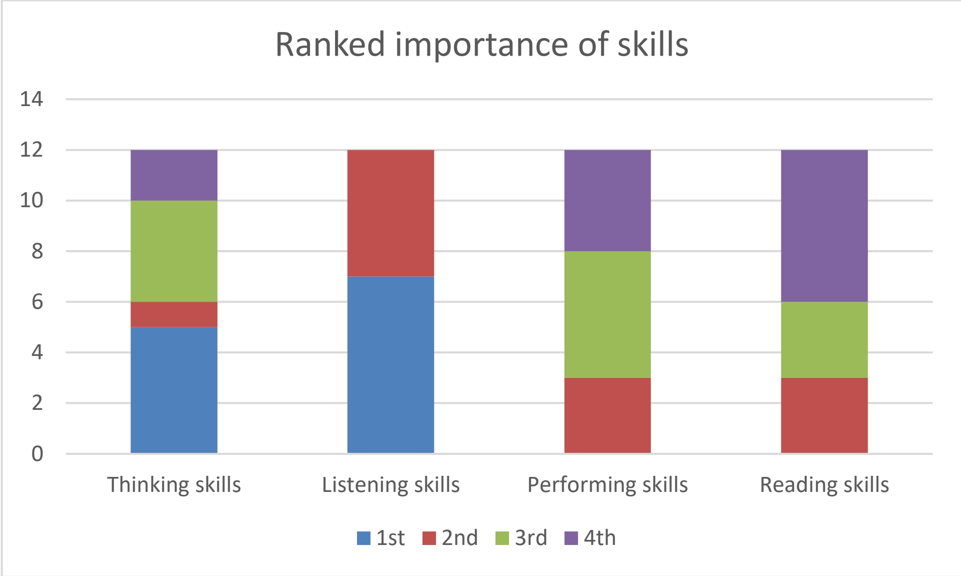


Figure 4.5: Ranked importance of skills

Figure 4.5 reflects the answers given by the participants when asked to rank the four skills. Participants ranked listening skills as most important by a larger margin. Thinking skills are ranked most important by the second largest number of participants. This result is as anticipated: the literature supports this finding. Performance skills and reading skills are not ranked as first by any participant. The result is unexpected, as in the previous question the participants had rated ensemble playing as an important aural performance skill.

4.4 SKILLS TAUGHT TO ENHANCE BASIC CONCEPTS

In the next section of the questionnaire the participants were asked to indicate the aural skills taught to enhance the individual concepts: rhythm, melody, and harmony. No limit was imposed on the possible responses. The expectation was that all the fields are taught for each concept (perhaps with single exceptions). The responses are presented in two ways: Each concept is assessed individually, and then responses regarding the concepts are juxtaposed. This is done so that conclusions can be drawn, based on frequency of the skill taught for each concept

4.4.1 Rhythm

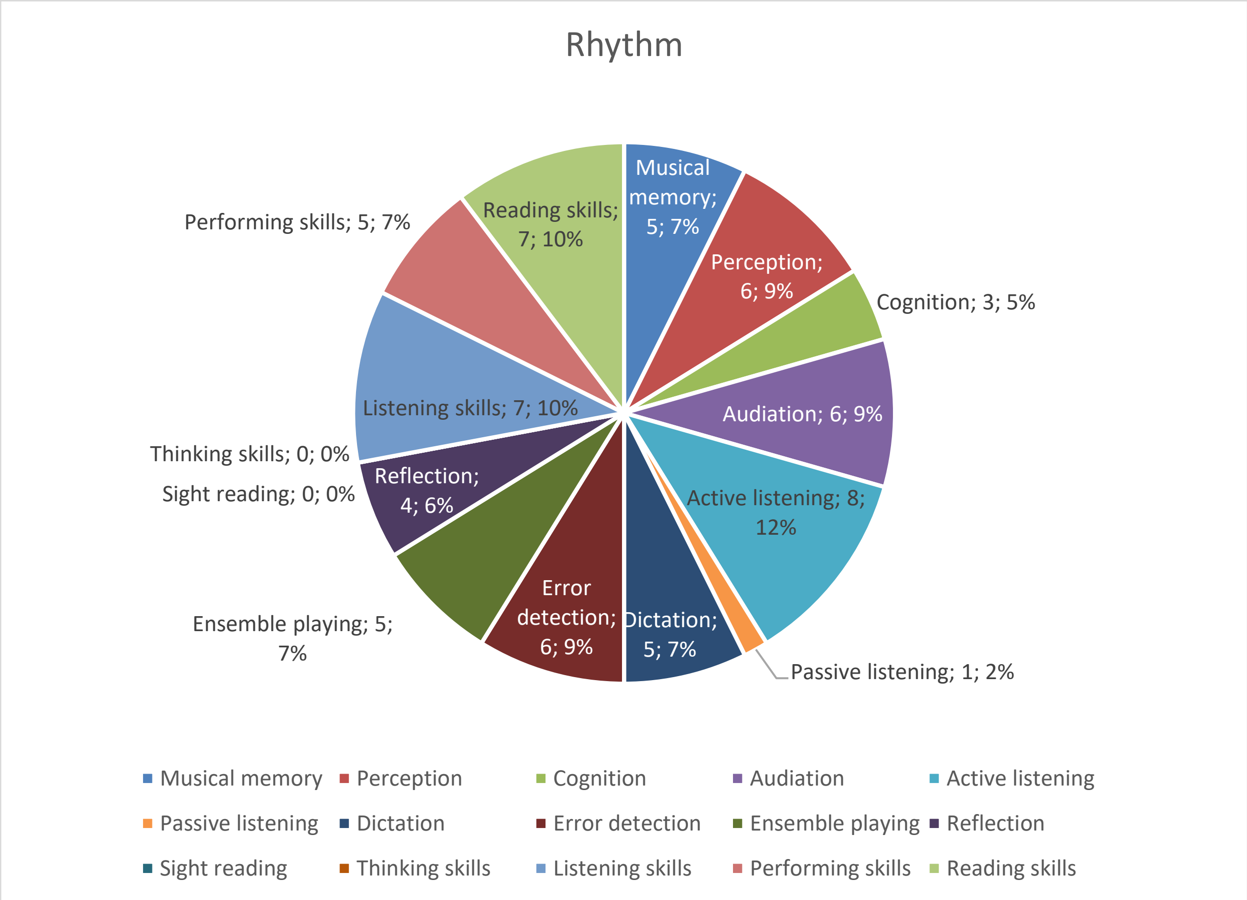


Figure 4.6: Skills taught to enhance the concept Rhythm as aural skill

Figure 4.6 maps the result of the instruction to list the skills taught to enhance aural skill in rhythm. The data were converted to a percentage of the total number of selections. The skill that is indicated as being taught most to enhance rhythm is active listening (8.12%), which is listed in the previous section of this chapter (5.1.3) as the most important skill. It is followed closely by listening skills and reading skills (7.10% each). This is a predictable response, also supported by the literature (Chapter 2.2.1).

One of the participants commented on the rating question: "All and none of the above – it's not so prescribed and is on a more subtle *[sic]* level." The comment speaks of the participant's unfamiliarity with aural as an interdisciplinary subject; that aural teaching crosses the border of the aural training classroom, and not subtly. As discussed in Chapter 2.1, the skills learned from one area can inform other areas of teaching (if taught in the correct way).

The skill least taught to enhance rhythm is listed as passive listening (1.2%). In the literature, researchers often discuss notational rhythm (Chapter 2.2.1.3). The method of teaching is often referred to as rote – thus listening skills. These listening skills include both active- and passive listening. It is thus surprising (although also predictable considering previous answers) that passive listening is listed as low as it is.

4.4.2 Melody

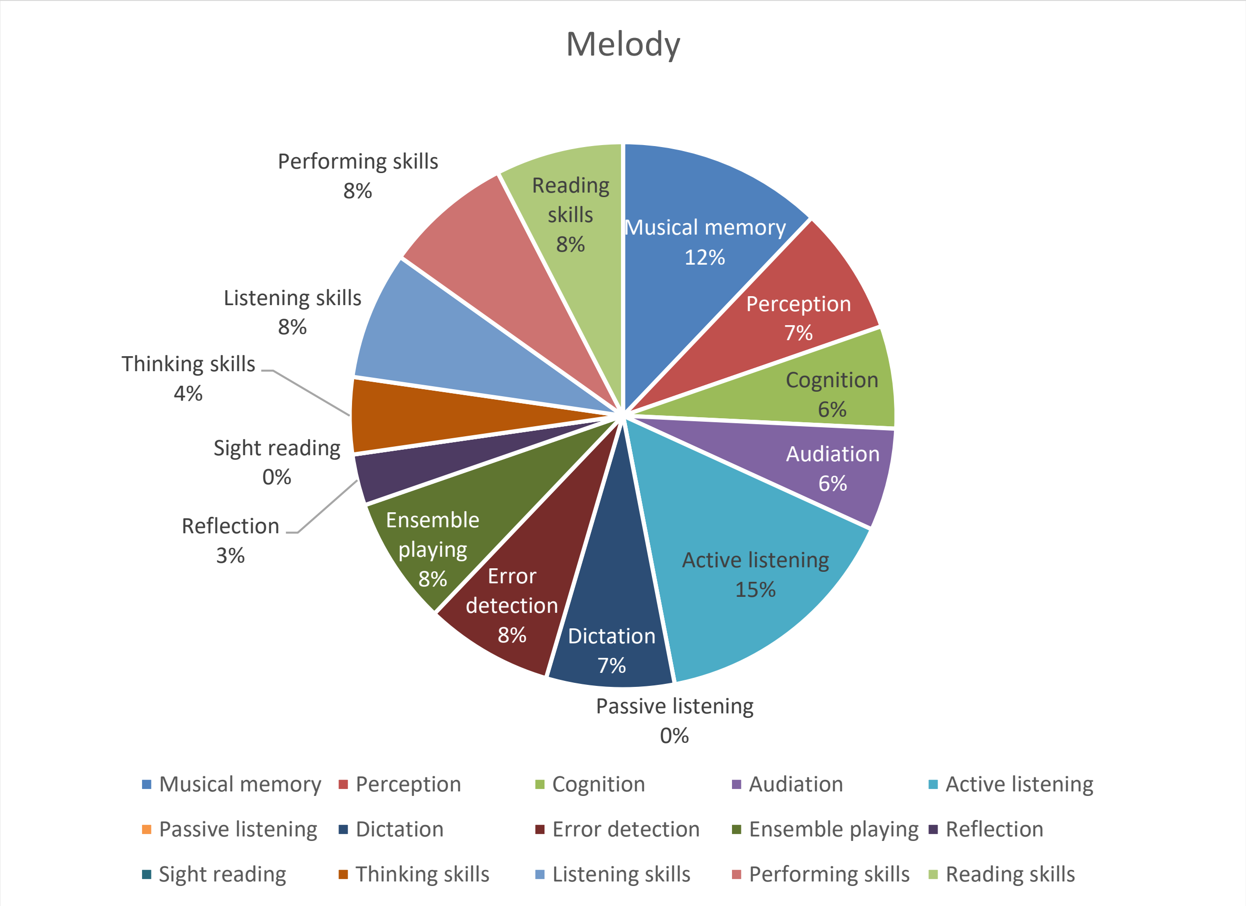


Figure 4.7: Skills taught to enhance the concept Melody as aural skill

Figure 4.7 maps the result of the instruction to list the skills taught to enhance aural skill in melody. Active listening (15%) was rated the most taught skill in the enhancing of melody. It is listed in the previous section of this chapter (5.1.3) as most important skill. The second rated skill taught is melodic memory (12%). The expectation was that all participants would teach melodic memory to enhance melody. Six participants do not teach the skill of melodic memory to enhance melody as a concept.

Participants were unclear about the definition of the melodic concept: “[It] is little unclear. Is it tone and timbre, or composition/improvisation?” Definitions should have been provided – not only would this have highlighted the complexity of the concepts discussed in the literature (Chapter 2.2.2), but it would also have revealed that there was insufficient understanding of the concepts.

The least-taught skill in enhancing melody is reflection (3%). The problem lies with the string-specific training (Chapter 2.4.2) that requires reflection for pitch (intonation). The melody involves the correct timbre that is required for emotional expression. Passive listening is not listed as a skill taught.

4.4.3 Harmony

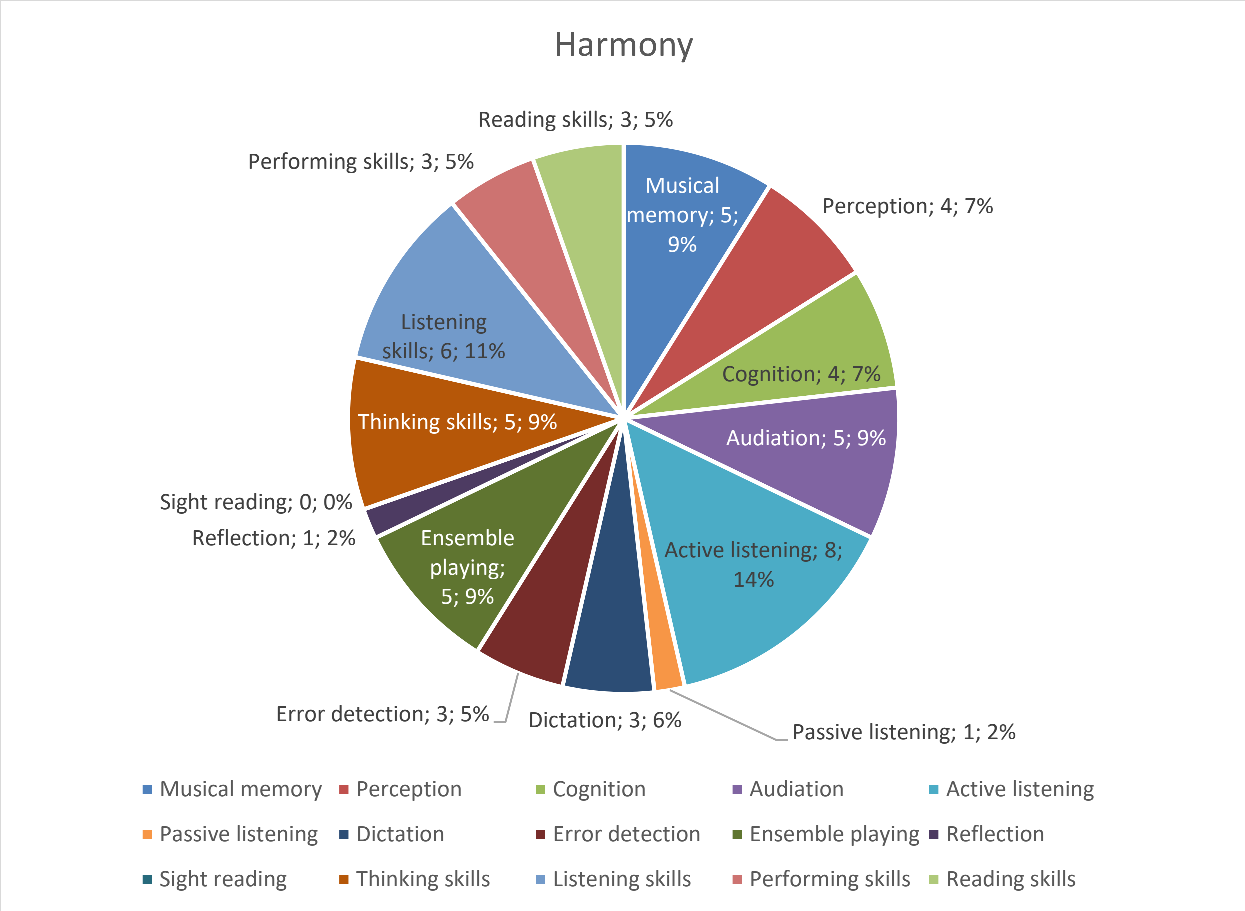


Figure 4.8: Skills taught to enhance the concept Harmony as aural skill

Figure 4.8 maps the results of the instruction to list the skills taught to enhance aural skill in rhythm. The data were converted to a percentage of the total number of selections. Again, active listening is rated as the most-taught skill in enhancing harmony (8.14). This is a predicted rating; active listening is listed in the previous section of this chapter (5.1.3) as the most important skill.

The same participant that commented in the section discussed on rhythm (5.3.1), noted: “Again, I find the questions missing the target.” As explained in the section above, the comment speaks of the participant’s unfamiliarity with aural as an interdisciplinary subject. The comment will not be discussed again.

The skills taught least to enhance harmony are reflection (1.2%) and passive listening (1.2%). Considering the trend being revealed by the previous questions, this result is to be expected. Again, the literature does not support this result.

4.4.4 Disposition of concepts

The results of the previous three questions were juxtaposed to find the figure below – no new questions were asked of the participants. The participants' actual number of responses are reflected in Table 4.2, comparing the nature of the skill. The skill with the most responses is found in row one, while rows six and seven contain the skill least taught.

Table 4.2: Disposition of concepts

		Rhythm	Melody	Harmony
Highest Response	1	▪ Active listening	▪ Active listening	▪ Active listening
	2	▪ Listening skills ▪ Reading skills	▪ Memory	▪ Listening skills
	3	▪ Perception ▪ Error detection ▪ Audiation	▪ Listening skills ▪ Reading skills ▪ Perception ▪ Error detection ▪ Performance skill ▪ Dictation ▪ Ensemble	▪ Audiation ▪ Memory ▪ Ensemble ▪ Concepts
	4	▪ Memory ▪ Performance skill ▪ Dictation ▪ Ensemble	▪ Audiation ▪ Cognition	▪ Perception ▪ Cognition
	5	▪ Concepts ▪ Reflection on performance	▪ Concepts	▪ Reading skills ▪ Error detection ▪ Performance skill ▪ Dictation
	6	▪ Cognition	▪ Reflection on performance	▪ Reflection on performance ▪ Passive listening
Lowest Response	7	▪ Passive listening		

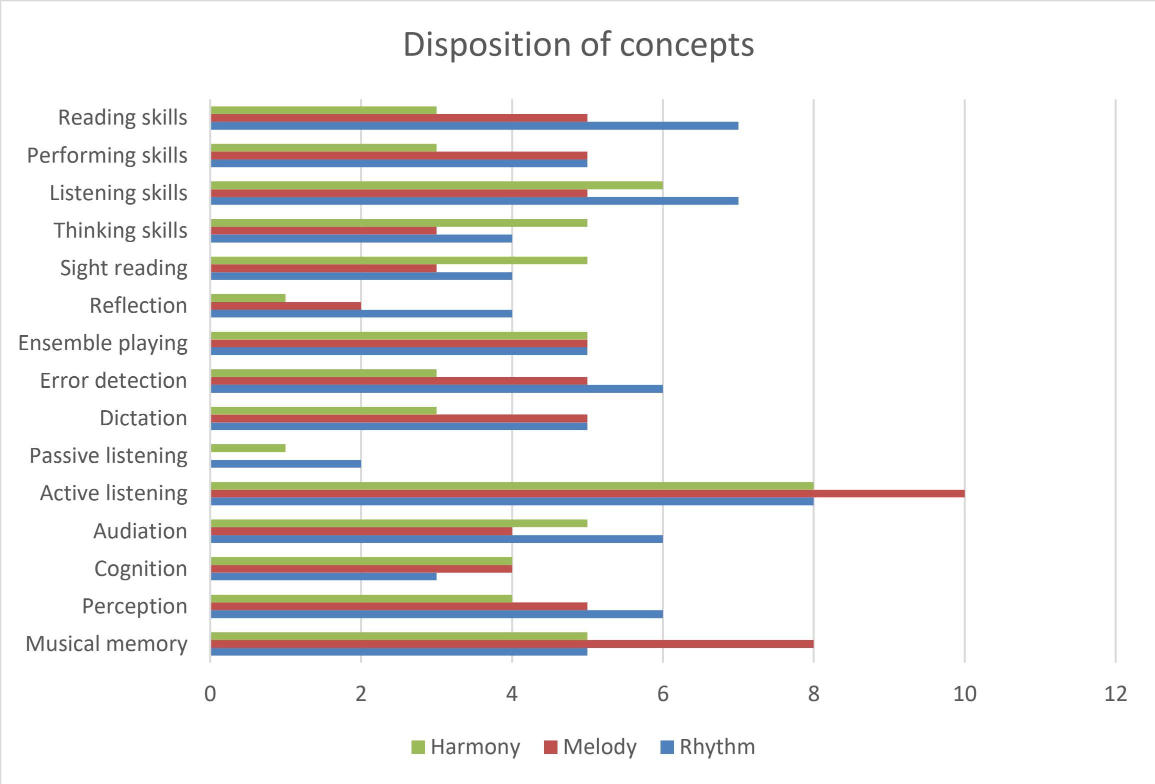


Figure 4.9: Disposition of concepts

Figure 4.9 juxtaposes the results of the last three mentioned questions' responses. The graph measures each skill's use in each concept. Again, the expectation was that the participants would have selected most of the skills for each concept. The graph juxtaposes the frequency with which a skill is taught for each concept, thus showing which concept is taught the most overall. Knowing that the expectation was not met, the comparison brings forth interesting results. The defence and arguments against and for the results is similar to that discussed in the previous three sections.

The most selected skill is active listening in the concept of melody. Most participants also listed active listening as the most important listening skill (Figure 5.4). Listening skills were also ranked as the most important aural skill (Figure 5.6). If the result of the previous questions were taken into consideration, the result is to be anticipated. The second-highest selected skill is active listening in both rhythm and harmony, but also melodic memory in melody. Again, active listening was anticipated, in line with the results of Figures 5.4 and 5.6. Melodic memory was the highest ranked thinking skill together with dictation (Figure 5.3). Thinking skills were ranked the second-most important aural skill (Figure 5.6). The absence of dictation in this list is questionable. The aggregate listing of dictation (Figure 5.11) is rated low.

Passive listening is not rated as a skill taught in melody. The result is anticipated as passive listening is ranked lowest important listening skill (Figure 5.4). The second-lowest rated skill is passive listening in rhythm and harmony – which is also anticipated – and reflection in melody and harmony. Reflection is not rated as low in rhythm, where it is rated as higher than cognition. Reflection is ranked as almost the highest skill in performance skills (Figure 5.5). Performance skills are ranked second-lowest aural skill (Figure5.6).

4.4.5 Aggregation of concepts

Figure 4.10 below is composed from the responses to the same three questions as discussed in 5.2.1, 5.2.2 and 5.2.3. The participants did not answer a separate question to derive at the data in this section.

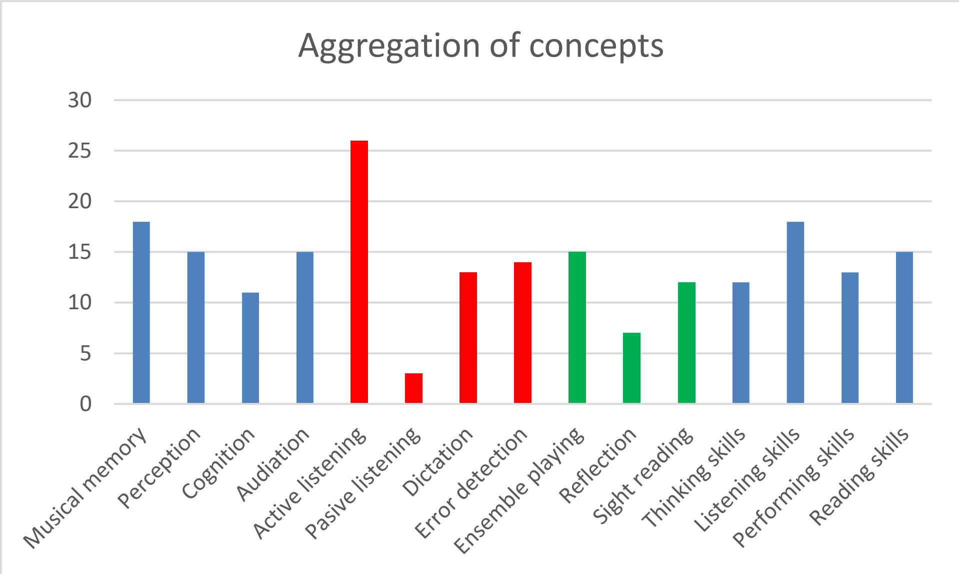


Figure 4.10: Aggregation of all skills taught for concepts: rhythm, melody, and harmony

Figure 4.10 displays the participants' responses to rhythm, melody, and harmony to each skill as aggregates. The first four (coloured blue) are thinking skills. The next four (coloured red) are listening skills. The following three (coloured green) are performing skills. The last four (coloured blue) are a culmination of the groupings and called aural skills.

The expected skill to be most selected by the participants to train students aurally is active listening skills. Melodic memory and listening skills are rated second. Rated third is ensemble playing, audiation and reading skills. Besides creating a list of the most taught aural training skills, it is interesting to note that the list contains one element from each section (colour). There one aspect of each skill was ranked as most important overall. Passive listening and reflection skills are taught least of the available list.

4.5 STRING-SPECIFIC SKILLS

The last question required from the participants was whether they taught any string-specific skills in the lessons they present. The question was not forced in any way; participants could skip the question if they wanted to. Eleven of the participants responded to the question. It should be noted that only one of the participants is a string instrumentalist.

Table 4.3: Responses to string-specific education

Yes	No
2	9

Two of the eleven indicated that string-specific aural training elements are included in their teaching. The participants were asked to list the elements. One participant commented: “Playing [by] memory, playing in the total darkness when one cannot stare at the fingerboard.” The participant indicated that memory (not just melodic) is used in the teaching of her string students. The total darkness usually abolishes visual distractions. In string-specific literature (Chapter 2.4) kinaesthetic studies are encourage by researchers and pedagogues.

Another participant lists three elements that assist with intonation: “I teach them to listen and to sing and to imagine the intervals before they play.” The participant addresses string-specific listening skills found in the literature (Chapter 2.4.2). Singing is usually a reflection or comparison for intonation. This element is discussed under thinking skills (2.4.1). The third activity on the list is supposed to be before singing. Imagery or audiation are both thinking skills (as mentioned before), but also pertinent as a performing skill (Chapter 2.4.4) and for expressive performance practices. The literature supports what both participants use as string-specific elements.

4.6 CONCLUSIONS

This section will discuss the conclusions drawn from the comparison between the survey and the academic literature pertaining to basic concepts (rhythm, melody, and harmony) and aural skills (thinking skills, listening, reading, and performance skills).

The most important concept identified by this study is rhythm. Both the literature and the survey support this finding, and it is also the most-taught concept in the classroom. The most important skill identified is active listening. The most-taught aural skills are active listening, listening skills, melodic memory, ensemble performance, audiation and reading. The least-taught and valued aural skills are performance reflection and passive listening. Performance reflection is the ability of the students to judge their own performance and work independently from the teacher. It is not clear why a lecturer would not teach the skill of independence to a student. Listening skills and thinking skills form an important part of aural skill training. Passive listening is not valued as much in the classroom as it is in the literature.

Thinking skills training are not opposite to reading skills training, but reading skill training is often found juxtaposed to listening skills as in the battle of rote or note learning for beginner’s methods. Rote learning still forms an integral part of tertiary students’ education. In fact, both rote and note methods are present at the same time. The battle should be renamed as which should be taught first, as opposed to the only method used.

Ensemble performance is an important skill in aural training. Both the survey and the academic literature support this, but aural ensemble skills are not offered to students in most of the tertiary institutions of the regions studied. The students are expected to participate in ensemble groups without having been trained in the necessary skills. The study also found that no training is offered (methodology class) to potential aural skill pedagogues in any institution in the regions studied.

Many pedagogues still do not consider aural training an interdisciplinary skill. Dictation is considered a difficult skill, but it is restricted to the aural classroom, while it should be embraced as a part of audiation. This echoes the introduction of this thesis, where researchers believe that skills are not transferred from one lesson to another. It is no surprise, because pedagogues expect students to memorise elements before understanding the concepts. The details of the findings will be discussed in chapter 5.

CHAPTER 5

Conclusion

5.1 THE RESEARCH TOPIC

The topic of string-specific aural training arose from my interest in string playing and my experiences with receiving and presenting aural training. I was exposed to the aural training methods from Russia, Bulgaria and Italia. I experienced these methods as being significantly different to those presented by the South African teachers. Through my teaching experience I observed that the aural skills of students of a specific instrument were stronger than that of other instrumentalists. The question that arose from this experience was how to assist the different instrumentalists' aural training. Not finding the answers available inspired the need to conduct research on the topic of string-specific aural training.

I wanted to discover what should be included in the aural training of a prospective musician, specifically the string player. A large body of existing research on general aural training was found, as well as evidence that string-specific aural training is necessary. However, literature addressing the practical application of aural training for the string player was unsatisfactory. I set out exploring the general aspects of aural training available in this field of research, and then found what was needed specifically by the developing string student. In the research I wanted to discover whether different countries had different approaches to string players' aural needs.

The literature review was used to assess the necessary aural skills. A survey was constructed based on the needs identified by the literature review, and sent to participants identified as persons responsible for the tertiary training of string students. These participants included teachers of practical lessons, theory lessons, ensemble and orchestra lessons, and aural training lessons. The survey was loaded onto an on-line host to which potential participants were sent invitations. The data were analysed statistically and presented in this thesis.

A large body of existing research is available in the field of aural training. Limitations on space of this thesis forced me to reduce some of these research areas to either footnotes or just to mention the area without presenting the research. The research focused on finding:

1. Aural skills needed by the music student in general.
2. Aural skills necessary for the string student.
3. The application of string-specific aural training within three regions (UK, USA and Scandinavia).

5.2 FINDINGS OF THIS RESEARCH

The aural skills required by the general music student were found in the vast body of academic literature, from which only three basic concepts of music were investigated (rhythm, melody, and harmony). Defining these concepts proved to be complex, for several researchers have completely different philosophies as to the exact meaning of each concept. The main defining aspects of each concept were explored and presented, as well as the different interpretations of each by the researchers. A recurring theme in research on rhythm is anticipation and predictability of the beat and pulse. The anticipation is important due to rhythm not being stable. This becomes a factor for both ensemble player and listener. Anticipation is also a factor in melody, as pitches are changed with the use of temperaments. I found that absolute pitch is not an inborn ability, but a latent skill that can be taught to persons at a very young age. The importance of memory is highlighted with the technique of chunking. Acculturalisation plays an important part in the tonality identification. Harmony deals with consonance and dissonance that is established through the process of acculturalisation.

Four aural skills are identified by a leading researcher in the field, G. Karpinski (2000), are: thinking skills, listening skills, reading skills, and performing skills. The aural skills each have subsections structured in hierarchical order. The basic concepts were measured in each subsection of each aural skill. The information on each of these is vast, and representative information was noted in the literature review of this thesis. In thinking skills, I found that the brain of different instrumentalists' functions differently and therefore also looks different. Audiation is an important skill to acquire as a musician, but cannot be assessed. The remarkable ability of the brain to focus on one melodic line in a cluster of sound leads to active and passive listening skills. Both are important for musicians: active listening, for own performance and passive listening during ensemble participation. Dictation is found only in the aural training classroom. Reading skills are linked to both audiation and performance reflection. The cognitive processes involved are not linear, but recur several times.

The string-specific aural needs were investigated by reviewing academic literature. Many similarities were found between the aural skills required by the string player and those of the general music student. The string student's specific aural needs were investigated under the categories of thinking, listening, reading, and performing. The most significant difference was found between the cognitive processes of the general music student (mostly pianists) and the string student. The differences between pianists and string students are highlighted, because the prominent instrument used in the aural classroom is a piano. An important physical difference between the piano and string instrument is the use of tuning systems and intonation. While the piano tuning is identified as representative equal temperament (extreme upper and lower registers are tuned slightly sharper and flatter respectively), the string instrumentalist use different temperaments and expressive intonation while performing. The string student should therefore be prepared for the correct use of temperament and what to do in ensemble situations. Elements that influence the choice of tuning system are the date of the composition, the texture of the ensemble, the instrumentation of the ensemble and the role in the ensemble. Timbre has a very specific role in the performance by the string player, influencing instrument specific techniques (such as col legno) and the use of vibrato (rapid altering of pitch). The aural training of the string player cannot be the sole responsibility of the instrumental teachers, as the focus of their lessons is solo performance. Srting student education should involve a more interdisciplinary method.

The application of aural training in specific regions was discovered in literature and by the survey. Due to respondent numbers, this study can not be regarded as a representative of the regions, although valuable findings emerged from the little data. The latter assessed the attitude of the lecturer toward aural skill needs and what is included in their lessons to enhance the basic concepts (as discussed in the literature). By comparing the needs of the string player to the findings of the survey, conclusions were made about the aural skill training aimed at the string student. It was not assessed if the string player was separated from the general music student. It was found that the academic literature still does not inform the aural training of students, and that some lecturers are unaware of the complexities involved in the field of aural training. This is surprising, for pertinent literature is almost two centuries old. It is also interesting to note that the interdisciplinary nature of music is not practiced.

Secondary findings that emerged were that there is not a methodology class that prepares a potential aural trainer for the important interdisciplinary work that is needed. The aural trainer is left to find his or her way through teaching experience, memory of what is taught to him or her as a student, own research, and external sources like symposiums. Not one of the countries in this study has a course for potential aural trainers. Aural pedagogues are expected to structure the lesson around the needs of the current group of students presented to them. From the survey and lack of survey participation it is evident that the aural trainer is not as well-equipped as might be expected.

5.3 WHAT THE RESEARCH MEANS TO US

Most of the evidence from which conclusions were drawn was based on the literature review. This considered research from several time periods and areas of the world. The depth of the literature review can be gathered from the number of bibliography entries. The combination of aural training and performance in research is not a new topic, although the topic has not been exhausted. This research of string-specific aural training is an attempt to bring the topic into the English-speaking research world, for it receives much more attention in other languages, such as Russian and Norwegian. I wish for due attention to be given to the field of instrument-specific aural training, a new dynamic to aural training. The underlying aim of the research is to improve education. I hope to open discussions on the training of the trainer and the real needs of the aural student.

Recommendations for further research in the field is:

- Training the string player's ear (with a different method)
  A quallitative investigation can be conducted in order to understand the different approaches to string specific (as well as instrument specific) aural training.
- Reflective practice in aural training so that the individual needs of the student can be assessed and addressed.
- The role of active and passive listening, specially in performance anxieties and error detection
  Passive listening is sometimes regarded as non-essential, but in the literature it is clear that this is a valuable skill in ensemble performance.
- Ensemble-based aural training
  The "what" is adequately addressed in the literature, but the lesson structure and curriculum should be investigated.
- Training the aural Trainer
  In general, not much attention is given to training the aural trainer. With the specific needs of the instrumental groups in mind, training the aural teacher need much more consideration.
- Communication between educators
  Holistic and interdisciplinary approaches should receive considerable attention in music institutions so that theory is reflected in practice and practice inform theory.
- Aural training in South Africa.
  A study of the current status of aural training in South African institutions can be undertaken.

The research developed from questions that occurred to me as an aural trainer. The lack of answers in the literature available to me in English, German, Afrikaans or Dutch encouraged the desire to produce such literature. It was a journey of discovery covering old and almost forgotten research and new, emerging fields of research. A fascinating discovery was the uniting nature of the aural training field: not only of the different music fields (theory, history, practical and ensemble) but also of different disciplines of the academic world, like neuroscience, psychology, and biology.

Reference list

Adderley, C., Schneider, C. & Kirkland, N. 2006. Elementary music teacher preparation in US colleges and universities relative to the National Standards-Goals. http://www-usr.rider.edu/~vrme/v7n1/visions/Adderley%20Music%20Teacher%20Preparation.pdf Date access 22 October 2017.

Adorno, T.W. 2014. Towards a theory of musical reproduction: Notes a draft and two schemata. Cambridge: John Wiley & Sons.

Altenmüller, E., Wiesendanger, M., & Kesselring, J. eds. 2006. Music motor control and the brain. Oxford, UK: Oxford University Press.

Alvarez, M. 1980. A comparison of scalar and root harmonic aural perception techniques. *Journal of Research in Music Education*, 28 (4): 229 – 235. http://www.jstor.org/stable/3345032?seq=1&cid=pdf-reference#references_tab_contents Date of access 30 April 2017.

Ambrazevičius, R. & Wiśniewska, I. 2008. Chromaticisms or performance rules? Evidence from traditional singing. *Journal of interdisciplinary music studies*, 2 (1-2): 19 – 31. https://www.researchgate.net/publication/228351279 Date accessed 17 June 2016.

Árpád, S. 1992. Gordonka-ABC a hangszeres előkészítő osztály tanulóinak. Budapest: Editio Musica Budapest.

Babbie, E. & Mouton, J. 2001. The Practice of Social research. South Africa: Oxford University Press.

Babbie, E. 2014. The Practice of Social research edition 14. Canada: Cengage learning.

Bachem, A. 1950 Tone height and tone chroma as two different pitch qualities. Holland: Acta Psychologica.

Baehr, R. 2013. The Effects of Timbral Cues on Pitch Perception. Barnard: College of Columbia University. (Thesis – PhD)

Bangert, M. & Schlaug, G. 2006. Specialization of the specialized in features of external human brain morphology. *European Journal of Neuroscience*, 24 (6): 1832 - 1834. http://onlinelibrary.wiley.com/doi/10.1111/j.1460-9568.2006.05031.x/full Date access 22 October 2017.

Benward, B. & Kolosick, J.T. 2010. Ear training: a technique for listening. Boston: McGraw-Hill.

Barbieri, P. & Mangsen, S. 1991. Violin intonation: a historical survey. *Early music*, 19 (1): 69 – 88. http://www.jstor.org/stable/3127954 Date access 24 October 2015.

Barbour, J.M. 1951. Tuning and Temperament. Michigan: State college press.

Beckman, A.A. 2011. Aural skills pedagogy: From academic research to the everyday classroom. https://digital.library.txstate.edu/handle/10877/3305 Date access 22 October 2017.

Bezuidenhout, R.M. & Cronjé, F. 2014. Qualitative data analysis (I*n* Du Plooy-Cilliers, F, Davis, C & Bezuidenhout, R. *eds*. Research Matters. Cape Town: Juta and company. P.228-251).

Bharucha, J.J. 1987. Music cognition and perceptual facilitation: A connectionist framework *Music Perception: An Interdisciplinary Journal*,5 (1): 1 – 30 http://mp.ucpress.edu/content/5/1/1 Date access 22 September 2017.

Bharucha, J. & Krumhansl, C.L. 1983. The representation of harmonic structure in music: Hierarchies of stability as a function of context. *Cognition*, 13 (1): 63 - 102. https://doi.org/10.1016/0010-0277(83)90003-3 Date access29 March 2017.

Bigand, E. & Poulin-Charronnat, B. 2006. Are we "experienced listeners"? A review of the musical capacities that do not depend on formal musical training. *Cognition*, 100 (1): 100 - 130. https://doi.org/10.1016/j.cognition.2005.11.007 Date access 30 April 2017.

Blum, D. 1987. The art of quartet playing: The Guarneri Quartet in conversation with David Blum., New York: Cornell University Press.

Böhmová, Z., Grünfeldová, A. & Sarauer, A. 2002. Klavírní škola pro začátečníky. 1. vyd. Praha: Nakladatelství. Kassel, Germany: Editio Bärenreiter.

Boltz, M.G. 1993. The generation of temporal and melodic expectancies during musical listening. *Attention, Perception, and Psychophysics*, 53 (6): 585 – 600. https://link.springer.com/article/10.3758%2FBF03211736?LI=true Date access 23 March 2017.

Bones, O. & Plack, C.J. 2015. Subcortical representation of musical dyads: individual differences and neural generators. *Hearing research*, 323: 9 – 21. https://doi.org/10.1016/j.heares.2015.01.009 Date accessed 23 August 2017.

Boomsliter, P. C. & Creel, W. 1963. Extended Reference: An Unrecongnized Dynamic in Melody. *Journal of Music Theory*, 7 (1): 2 – 22. http://www.jstor.org/stable/843020 Date access 22 October 2015.

Brubacher, J.S. & Rudy, W. 2017. Higher education in transition: A history of American colleges and universities. 4th ed. New Jersey: Transaction Publishers.

Buonviri, N.O. 2014. An exploration of undergraduate music majors' melodic dictation strategies. Update: Applications of Research in Music Education. *National Association for music education*, 33 (1): 21 – 30. https://doi.org/10.1177/8755123314521036 Date access 8 February 2015.

Butler, D. 1989. Describing the perception of tonality in music: A critique of the tonal hierarchy theory and a proposal for a theory of intervallic rivalry. *Music Perception: An Interdisciplinary Journal*, 6 (3): 219 – 241. http://www.jstor.org/stable/40285588 Date access 29 March 2017.

Butler, D. 1997. Why the Gulf between Music Perception Research and Aural Training? *Bulletin of the Council for Research in Music Education*, 132: 38 – 48. http://www.jstor.org/stable/40375331 Date access 14 October 2015.

Byo, J.L. 1997. The effects of texture and number of parts on the ability of music majors to detect performance errors. *Journal of Research in Music Education*, 45 (1): 51 - 66. http://www.jstor.org/stable/3345465 Date access 7 October 2015.

Cambouropoulos, E. 2006. Musical parallelism and melodic segmentation. *Music Perception: An Interdisciplinary Journal*,23 (3): 249 - 268. http://www.jstor.org/stable/10.1525/mp.2006.23.3.249 Date accessed 30 April 2017.

Cavitt, M.E. 2003. A descryiptive analysis of error correction in instrumental music rehearsals. *Journal of Research in Music Education*, 51 (3): 218 - 230. https://doi.org/10.2307/3345375 Date access 14April 2015.

Cazden, N. 1945. Musical consonance and dissonance: A cultural criterion. *The Journal of Aesthetics and Art Criticism*, 4 (1): 3 - 11. http://www.jstor.org/stable/426253 Date access 13 September 2017.

Chappell, V. C. 1962. The Philosophy of Mind. Englewood Cliff, N.J: Prentice-Hall.

Chau, C.J., Wu, B. & Horner, A. 2015. The Effects of Early-Release on Emotion Characteristics and Timbre in Non-Sustaining Musical Instrument Tones. Conference paper September 2015 ICMC, United States of America: CEMI, University of North Texas.

Chittum, D. 1969. A different approach to harmonic dictation. *Music Educators Journal*, 55 (7): 65 – 66. https://doi.org/10.2307/339246 Date access 29 August 2016.

Chrisman, R. 1971. Identification and correlation of pitch-sets. *Journal of Music Theory*, 15 (1-2): 58 – 83. http://www.jstor.org/stable/842896 Date access 22 October 2017.

Coffey, E.B., Colagrosso, E.M., Lehmann, A., Schönwiesner, M. & Zatorre, R.J. 2016. Individual differences in the frequency-following response: relation to pitch perception. *PloS one*, 11 (3): p.e 0152374. https://doi.org/10.1371/journal.pone.0152374 Date access 21 September 2017.

Cook, N.D., & Fujisawa, T.X. 2006. The psychophysics of harmony perception: Harmony is a three-tone phenomenon. *Empirical Musicology Review*, 1 (2). https://kb.osu.edu/dspace/bitstream/handle/1811/24080/EMR000008a-..?sequence=1 Date access 16 July 2014.

Cooke, D., 1959. The language of music. https://philpapers.org/rec/COOTLO-5/ Date Access 22 October 2017.

Corrigall, K.A., Schellenberg, E.G., & Misura, N.M. 2013. Music training, cognition, and personality. *Frontiers in psychology*, 4: 1 – 10. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3639373/ Date access 23 May 2017.

Creswell, J.W. 2003. Research design: Quantitative, qualitative and mixed methods approach. Thousand Oaks, California: Sage Publications.

Crowder, R.G., Reznick, J.S., & Rosenkrantz, S.L. 1991. Perception of the major/minor distinction: V. Preferences among infants. *Bulletin of the Psychonomic Society*, 29 (3): 187 – 188. https://link.springer.com/article/10.3758/BF03342673 Date access 22 October 2017.

Crowe, B.J. 2004. Music and soulmaking: Toward a new theory of music therapy. Toronto: Scarecrow Press.

Cuddy, L.L., & Cohen, A.J. 1976. Recognition of transposed melodic sequences. *The Quarterly Journal of Experimental Psychology*, 28 (2): 255 – 270. http://dx.doi.org/10.1080/14640747608400555 Date access 21 June 2016.

Dalby, B. 1999. Teaching Audiation in Instrumental Classes An incremental approach allows teachers new to Gordon's music learning theory to gradually introduce audiation-based instruction to their students. *Music educators journal*, 85 (6): 22 – 46. http://www.jstor.org/stable/3399517 Date access 5 March 2015.

Dalby, B. 2005. Toward an effective pedagogy for teaching rhythm: Gordon and beyond. *Music Educators Journal*, 92 (1): 54 – 60. http://www.jstor.org/stable/3400228 Date access 4 October 2015.

David, D., Wade-Woolley, L., Kirby, J.R., & Smithrim, K. 2007. Rhythm and reading development in schoolage children: a longitudinal study. *Journal of Research in Reading*, 2: 169 – 183. http://onlinelibrary.wiley.com/doi/10.1111/j.1467-9817.2006.00323.x/full Date access 13 October 2016.

Deutsch, D. 2013. Organizational processes in music. (*In*: Clynes, M. Ed. Music, Mind, and Brain: the neuropsychology of music. Boston; Springer. P. 503 – 522)

Deutsch, D., & Feroe, J. 1981. The internal representation of pitch sequences in tonal music. *Psychological review*, 88 (6): 503. http://deutsch.ucsd.edu/pdf/Psych_Rev-1981_88_503-522.pdf Date access 17 October 2015.

Devaney, J., Ellis, D.P. 2008. An empirical approach to studying intonation tendencies in polyphonic vocal performances. *Journal of Interdisciplinary Music Studies*, 2 (1-2): 141 – 156. http://www-gewi.uni-graz.at/cim07/ Date access 4 March 2015.

Deyoe, N., & Guyver, R. 2006. Ear Training: A Critical and Practical Approach. *Recuperado de* http://www.Nicholasdeyoe.com/pdfs/Practicum% 20outline% 20copy. Pdf Date access 18 June 2016.

Dickey, M.R. 1991. A comparison of verbal instruction and nonverbal teacher-student modelling in instrumental ensembles. *Journal of Research in Music Education,* 39 (2): 132 – 142. http://www.jstor.org/stable/3344693 Date access 4 March 2015.

Dirkse, S. 2011. Encouraging empirical research: Findings from the music appreciation classroom. *Journal of Music History Pedagogy*, 2 (1): 25 – 35. https://dspace.library.uu.nl/bitstream/handle/1874/35241/HaasISMIR09cameraReady.pdf?sequence=1 Date access 21 March 2017.

Doğantan-Dack, M. 2012. The art of research in live music performance. *Music Performance Research*, 5: 34 – 48. http://mpr-online.net/Issues/Dogantan-Dack%20FINAL%20120311.pdf Date access 28 October 2016.

Dowling, W.J., & Fujitani, D.S. 1971. Contour, interval, and pitch recognition in memory for melodies. *The Journal of the Acoustical Society of America*, 49 (2B): 524 – 531. http://dx.doi.org/10.1121/1.1912382 Date access 12 October 2015.

Dowling, W.J., & Bartlett, J.C. 1981. The importance of interval information in long-term memory for melodies. *Psychomusicology: A Journal of Research in Music Cognition*, 1 (1): 30. http://dx.doi.org/10.1037/h0094275 Date access 10 December 2015.

Dowling, W. 2001. Perception of Music in blackwell handbook of sensations and perception. Edited by Bruce Goldstein. Victori: Blackwell publishing.

Drai-Zerbib, V., Baccino, T., & Bigand, E. 2012. Sight-reading expertise: Cross-modality integration investigated using eye tracking. *Psychology of Music*, 40 (2); 216-235. https://doi.org/10.1177/0305735610394710 Date access 2 October 2017.

Drake, C., Palmer, C. 2000. Skill acquisition in music performance: relations between planning and temporal control. *Cognition*, 74 (1): 1 – 32. https://doi.org/10.1016/S0010-0277(99)00061-X Date access 13 March 2017.

Du Plooy-Cilliers, F. 2014. Research paradigms and traditions. (*In* Du Plooy-Cilliers, F, Davis, C & Bezuidenhout, R. *eds*. Research Matters. Cape Town: Juta and company. P. 18 - 35)

Du Plooy-Cilliers, F., & Cronjé J. 2014. Quantitative data collection. (*In* Du Plooy-Cilliers, F, Davis, C & Bezuidenhout, R. *eds*. Research Matters. Cape Town: Juta and company. P. 147 - 173)

Duțică, L. 2016. Didactic Strategies for the Development of Professional Musical Hearing. *Review of Artistic Education,* 11-12: 42-52. https://doi.org/10.1515/rae-2016-0005 Date access March 2017.

Edlund, L. 1963. Modus novus: Studies in reading atonal melodies. Stockholm:. Nordiska.

Edworthy, J. 1985. Interval and contour in melody processing. *Music Perception: An Interdisciplinary Journal,* 2 (3): 375 – 388. http://www.jstor.org/stable/40285305 Date access 30 April 2017.

Eerola, T., Ferrer, R., & Alluri, V. 2012. Timbre and affect dimensions: evidence from affect and similarity ratings and acoustic correlates of isolated instrument sounds. *Music Perception: An Interdisciplinary Journal*, 30 (1): 49 – 70. https://doi.org/10.1525/mp.2012.30.1.49 Date access 13 March 2016.

Elliott, D.J. 1995. Music Matters: a new philosophy of music education. New York: Oxford University Press.

Epstein, D. 1995. Shaping time: Music, the brain, and performance. California. Wadsworth Publishing.

Ericson, K.A. 2014. The road to excellence: The acquisition of expert performance in the arts and sciences, sports, and games. Florida. Psychology Press.

Everest, F.A. 2001. Master handbook of acoustics. 4th ED. *The Journal of the Acoustical Society of America*, 110(4): 1714 – 1716. https://doi.org/10.1121/1.1398048 Date access22 October 2017.

Fetherston, M.D. 2011. Building Memory Structures to Foster Musicianship in the Cello Studio. Columbu: Ohio State University (Dissertation – PhD).

Fitch, W.T. 2006. The biology and evolution of music: A comparative perspective. *Cognition*, *100*(1): 173 - 215. http://www.sciencedirect.com/science/article/pii/S0010027705002258 Date access 22 October 2017.

Fletcher, N.H. 2002. Harmonic? Anharmonic? Inharmonic?. *American Journal of Physics*, 70 (12): 1205 – 1207. http://dx.doi.org/10.1119/1.1509419 Date access 22 October 2017.

Forsythe, J.L., Kinney, D.W. & Braun, E.L. 2007. Opinions of music teacher educators and preservice music students on the National Association of Schools of Music standards for teacher education. *Journal of Music Teacher Education, 16*(2): 19 - 33.

http://journals.sagepub.com/doi/pdf/10.1177/10570837070160020104 Date access 22 October 2017.

Foulkes-Levy, L. 1997. Tonal markers, melodic patterns, and musicianship training: Part I: Rhythm reduction. *Journal of Music Theory Pedagogy*, *11*:1-24.

Fourie, E. 2016. Sight-reading and sight-reading in practice. Refresher course presented at Hugo Lambrecht 28 &29 January 2016.Cape Town.

Francès, R., & Dowling, W.J. 2014. The perception of music. New York: Psychology Press.

Fyk, J. 1995. Melodic intonation, psychoacoustics and the violin. *An Interdisciplinary Journal*, 14 [4]: 477 – 485. http://www.jstor.org/stable/40285734 Date access 22 October 2017.

Gabrielsson, A. 2003. Music performance research at the millennium. *Psychology of music*, 31 (3): 221 – 272. https://doi.org/10.1177/03057356030313002 Date access 2 October 2017.

Galamian, I., & Thomas, S. 2013. Principles of violin playing and teaching. New York. Dover Publication.

Gardner, H. 1991. The unschooled mind. New York, Basic Books.

Gault, B. 2005. Music learning through all the channels: Combining aural, visual, and kinaesthetic strategies to develop musical understanding. *General Music Today*. 19 (1): 7 – 9. https://doi.org/10.1177/10483713050190010103 Date access 9 October 2017.

Geringer, J.M., MacLeod, R.B., & Ellis, J.C. 2014. Two studies of pitch in string instrument vibrato: Perception and pitch matching responses of university and high school string players *International Journal of Music Education*, 32 (1);.19-30. https://doi.org/10.1177/0255761411433728 Date access 24 October 2015.

Geringer, J.M., MacLeod, R.B., & Allen, M.L. 2010. Perceived pitch of violin and cello vibrato tones among music majors. *Journal of Research in Music Education*, 57 (4): 351 – 363. https://doi.org/10.1017/S0265051700003739 Date access 31 January 2017.

Godwin, J. 1993. The Harmony of the Spheres a Sourcebook of the Pythagorean Tradition in Music. New York. Simon and Schuster.

Gonzo, C.L. 1971. An analysis of factors related to choral teachers' ability to detect pitch errors while reading the score. *Journal of Research in Music Education*, 19 (3): 259 – 271. http://www.jstor.org/stable/3343762 Date access 7 December 2016.

Gooding, L., & Standley, J.M. 2011. Musical development and learning characteristics of students: A compilation of key points from the research literature organized by age. *Applications of Research* *in Music Education*, 30 (1): 32-45. https://doi.org/10.1177/8755123311418481 Date access 28 June 2016.

Gordon, E. 1974. Toward the development of a taxonomy of tonal patterns and rhythm patterns: Evidence of difficulty level and growth rate. *Experimental research in the psychology of music: Studies in the psychology of music*, 9: 39 - 232. http://library.sc.edu/music/gordon/331.pdf Date access 16 June 2015.

Gordon, E.E. 1989. Audiation, imitation and notation: Musical thought and thought about music Audiation, imitation and notation: Musical thought and thought about music. *American Music Teacher*, 38 (5): 15 - 59. http://www.jstor.org/stable/43543904 Date access 7 December 2016.

Gordon, E.E. 1999. All about audiation and music aptitudes: Edwin E. Gordon discusses using audiation and music aptitudes as teaching tools to allow students to reach their full music potential. *Music Educators Journal*, 86 (2): 41-44. https://doi.org/10.2307/3399589 Date access 7 December 2016.

Gordon, E.E. 2011a. Untying Gordian knots. South Carolina: GIA Publications.

Gordon, E.E. 2011b. Roots of music learning theory and audiation. *University of South Carolina Scholar Commons.* http://scholarcommons.sc.edu/cgi/viewcontent.cgi?article=1000&context=gordon_articles Date access 15 September 2015.

Gotham, M. 2014. Meter Metrics: Characterizing Relationships Among, Mixed, Metrical Structures. *Music Theory*, 21 (2). http://www.mtosmt.org/issues/mto.15.21.2/mto.15.21.2.gotham.php Date access 19 March 2017.

Grutzmacher: A. 1987. The effect of tonal pattern training on the aural perception, reading recognition, and melodic sight-reading achievement of first-year instrumental music students. *Journal of Research in Music Education*, 35 (3): 171-181. http://www.jstor.org/stable/3344959 Date access 24 February 2016.

Gurung, R.A., Chick, N.L., & Haynie, A. 2009. Exploring signature pedagogies: Approaches to teaching disciplinary habits of mind. Virginia: Stylus Publishing.

Halevi, T., Memon, N. & Nov, O. 2015. Spear-phishing in the wild: A real-world study of personality, phishing self-efficacy and vulnerability to spear-phishing attacks. http://ssrn.com/abstract=2544742 Date access 27 October 2017.

Hannon, E.E., & Trainor, L.J. 2007. Music acquisition: effects of enculturation and formal training on development., *Trends in cognitive sciences*, 11 (11): 466-472. https://doi.org/10.1016/j.tics.2007.08.008 Date access 3 March 2015.

Harris, C.A. 1918. The war between the fixed and movable doh. *The Musical Quarterly*, 4 (2): 184 - 195. http://www.jstor.org/stable/738052 Date access 3 May 2015.

Hasegawa, R. 2013. New Approaches to Tonal Theory. *Music and Letters*, 93 (4): 574-593. https://academic.oup.com/ml/article-abstract/93/4/574/1018120 Date access 22 October 2017.

Hashi, H., & Rochde, A. 2017. Measuring Effects Of Music And Healing Energy Using A Seed Germination Bioassay. *[Pengukuran Musik Dan Penyembuhan Energi Menggunakan Bioasay Perkecambahan Benih] Agritrop: Jurnal Ilmu-Ilmu Pertanian (Journal of Agricultural Science), 12*(2).12 (2). http://jurnal.unmuhjember.ac.id/index.php/AGRITROP/article/view/724 Date access 22 October 2017.

Hasty, C.F. 1981. Rhythm in Post-Tonal Music: Preliminary Questions of Duration and Motion. *Journal of Music Theory*, 25 (2): 183-216. http://www.jstor.org/stable/843649 Date access 22 October 2017.

Hasty, C. 1997. Meter as rhythm. New York: Oxford University Press.

Hasty, C. 1999. Just in Time for More Dichotomies--A Hasty Response. *Music Theory Spectrum*, 21 (2): 275 - 293. http://www.jstor.org/stable/745865 Date access 19 March 2017.

Hayes, J.R. 1985. Three problems in teaching general skills. (*In* Chipman, J. W. Segal, & Glaser, R. eds Thinking and learning skills: volume 2. New Jersey: Routledge. P 391-405)

Heaton, P. 2005. Interval and contour processing in autism. *Journal of autism and developmental disorders*, 35 (6): 787. https://link.springer.com/article/10.1007/s10803-005-0024-7 Date access 22 October 2017.

Herrmann, N. 1995. The creative brain. 2nd Ed. USA: Quebecor printing book group.

Hewitt, M.P. 2015. Self-efficacy, self-evaluation, and music performance of secondary-level band students. *Journal of Research in Music Education,* 63 (3): 298-313. https://doi.org/10.1177/0022429415595611 Date access 22 October 2017.

Hiatt, J.S., & Cross, S. 2006. Teaching and using audiation in classroom instruction and applied lessons with advanced students. *Music educators journal*, 92 (5): 46-49. http://www.jstor.org/stable/3878502 Date access 28 June 2016.

Hofmann-Engl, L. 2010. Consonance/Dissonance-A Historical Perspective. Proceedings of the 11th International Conference on Music Perception and Cognition Croydon Family Groups – United Kingdom. http://www.chameleongroup.org.uk/research/ICMPC11.pdf Date access 13 September 2017.

Holzapfel, A., Krebs, F., & Srinivasamurthy, A. 2014. Tracking the "odd": Meter inference in a culturally diverse music corpus (In ISMIR-International Conference on Music Information Retrieval. p. 425-430. ISMIR.)

Honingh, A. 2007. Intonation and Temperament: A Special Orchestral Rehearsal. *Research Gate*. https://www.researchgate.net/profile/Aline_Honingh/publication/251344414_INTONATION_AND_TEMPERAMENT_A_SPECIAL_ORCHESTRAL_REHEARSAL/links/56a7328008ae997e22bbc701.pdf Date access 17 June 2017.

Horvath, K. 1999. Effect of aural or visual-aural models on string students' ear training proficiency. *Southeastern journal of music education*, 11: 35. https://musi.franklin.uga.edu/sites/default/files/wp_import/2013/11/SEJoME-V11.pdf#page=41 Date access 22 October 2017.

Hubbard, T.L. 2010. Auditory imagery: empirical findings. *Psychological bulletin*, 136 (2): 302, https://doi.org/DOI: 10.1037/a0018436 Date access 14 March 2015.

Hung, J.L. 2012. An investigation of the influence of fixed-do and movable-do solfège systems on sight-singing pitch accuracy for various levels of diatonic and chromatic complexity. San Francisco: University of San Francisco. (Dissertation – PhD).

Huron, D. 1989. Voice denumerability in polyphonic music of homogeneous timbre. *Music Perception: An Interdisciplinary Journal*, 6 (4): 361-382. http://www.jstor.org/stable/40285438 Date access 10 June 2015.

Huron, D. 2011. Why is sad music pleasurable? A possible role for prolactin. *Musicae Scientiae*, 15(2): 146 - 158. http://doi.org/10.1177/1029864911401171 Date access 27 March 2017.

Isotalo, J. 2001. Basics of statistics. Finland, University of Tampere.

James, J. 1995. The music of the spheres: music, science, and the natural order of the universe. New York: Springer science and business media, LLC.

Jensen, E. 2000. Music with the brain in mind. San Diego: Brain Store.

Jerde, T.A., Childs, S.K., Handy, S.T., Nagode, J.C., & Pardo, J.V. 2011. Dissociable systems of working memory for rhythm and melody. *Neuroimage*, 57(4): 1572 - 1579. http://doi.org/10.1016/j.neuroimage.2011.05.061 Date access 22 June 2016.

Jerold, B. 2015. Diderot (Part II)—Temperament and Expressive Intonation. *Music Theory and Analysis (MTA)*, 2(1): 70 - 94. https://doi.org/10.11116/MTA.2.1.3 Date access 24 October 2015.

Jessop, S. 2017. The Historical Connection of Fourier analysis to Music. *The Mathematics Enthusiast*, 14(1-3): 77. https://search.proquest.com/openview/627842df3d6814cc0786da7901931543/1?pq-origsite=gscholar&cbl=2030106 Date access 27 September 2017.

Johnson, E. 2013. Practical Tools to Foster Harmonic Understanding. *Music Educators Journal*, 99(3): 63 - 68. https://doi.org/10.1177/0027432112469539 Date access 22 October 2017.

Johnson, V.V. 2014. The Relevance of Music Theory Concepts and Skills as Perceived by In-Service Music Educators. *Visions of Research in Music Education*, 25(7). http://www.rider.edu/~vrme Date access 30 September 2017.

Johnson-Laird: N., Kang, O.E., & Leong, Y.C. (2012) On musical dissonance. *Music Perception: An Interdisciplinary Journal*, 30(1): 19 - 35. https://doi.org/10.1525/mp.2012.30.1.19 Date access 22 October 2017.

Jonides, J., Lewis R.L., Nee, D. E., Listig, C.A., Berman M.G., & Moore, K. S. 2008. The Mind and Brain of Short-Term Memory. *Annual review of Psychology*, 59: 193-224. doi: 10.1146/annurev.psych.59.103006.093615 Date access 22 October 2017.

Jones, M.R., Johnston, H.M., & Puente, J. (2006) Effects of auditory pattern structure on anticipatory and reactive attending. *Cognitive psychology*, 53(1): 59-96. https://doi.org/10.1016/j.cogpsych.2006.01.003 Date access 29 March 2017.

Juslin: N. 2003. Five facets of musical expression: A psychologist's perspective on music performance., *Psychology of Music*, 31(3): 273 - 302. http://pom.sagepub.com/content/early/2013/08/22/0305735613484548 Date access 27 May 2015.

Kagan, J., & Zentner, M. 1996. Early childhood predictors of adult psychopathology. *Harvard Review of Psychiatry* 3 (6): 341 - 350.. http://www.tandfonline.com/doi/abs/10.3109/10673229609017202 Date access 22 October 2017.

Kalkandjiev, Z.S., & Weinzierl, S. 2013. Room acoustics viewed from the stage: Solo performers' adjustments to the acoustical environment. International Symposium on Room Acoustics., Toronto, Canada.

Karpinski, G.S. 2000. Aural skills acquisition: the development of listening, reading. and performing skills in college-level musicians. New York: Oxford University Press.

Keller, P.eE. 2001. Attentional Resource Allocation in Musical Ensemble Performance *Psychology of Music*, 29(1):20-38.

Keller: E. 2014. Ensemble performance: Interpersonal alignment of musical expression. (*In Fabian, D., Timmers, R. & Schubert E. Eds.* Expressiveness in music performance: Empirical approaches across styles and cultures. Oxford: Oxford University Press. P. 260-282.)

Khan, R. 2014. Quantitative data analysis (I*n* Du Plooy-Cilliers, F, Davis, C & Bezuidenhout, R. *eds*. Research Matters. Cape Town: Juta and company. P. 204 - 227).

Kimber, M. 1974. Intonation Variables in the Performance of Twelve-tone Music. Washington: Catholic University of America. (Dissertation – DMA)

Kinney, D.W., & Forsythe, J.L. 2012. Does Melody Assist in the Reproduction of Novel Rhythm Patterns? *Contributions to Music Education*, 39 p.69 - 85. http://www.jstor.org/stable/24127245 Date access 10 December 2015.

Klonoski, E. 2006. Improving dictation as an aural-skills instructional tool. *Music Educators Journal*, 93(1): 54 - 59. http://www.jstor.org/stable/3693431 Date access 25 March 2017.

Koelsch, S., Rohrmeier, M., Torrecuso, R., & Jentschke, S.I. 2013. Processing of hierarchical syntactic structure in music. *Proceedings of the National Academy of Sciences*, 110 (38): 15443-15448. http://doi.org/10.1073/pnas.1300272110 Date access 21 September 2017.

Konečni, V.J. 2008. Does music induce emotion? A theoretical and methodological analysis. *Psychology of Aesthetics, Creativity, and the Arts*, 2 (2): 115. http://dx.doi.org/10.1037/1931-3896.2.2.115 Date access 22 October 2017.

Koonin, K . 2014. *Validity and reliability* (I*n* Du Plooy-Cilliers, F, Davis, C & Bezuidenhout, R. *eds*. Research Matters. Cape Town: Juta and company. P 252 - 261)

Kopiez, R. In Lee, J. 2008. Towards a general model of skills involved in sight-reading music. *Music education research*, 10(1): 41 - 62. http://doi.org/10.1080/14613800701871363 Date access 1 October 2017.

Krumhansl, C.L. 1979. The psychological representation of musical pitch in a tonal context. *Cognitive psychology,* 11 (3): 346-374. https://doi.org/10.1016/0010-0285(79)90016-1 Date access 29 March 2017.

Krumhansl, C.L. 1990. Tonal hierarchies and rare intervals in music cognition. *Music Perception: An Interdisciplinary Journal*, 7 (3): 309-324. https://doi.org/10.2307/40285467 Date access 22 October 2017.

Krumhansl, C.L. 2000. Rhythm and pitch in music cognition. *Psychological bulletin*, 126(1): 159. http://dx.doi.org/10.1037/0033-2909.126.1.159 Date access 7 October 2015.

Krumhansl, C.L. 2004. The cognition of tonality–as we know it today. *Journal of New Music Research*, 33 (3): 253-268. http://www.tandfonline.com/doi/abs/10.1080/0929821042000317831 Date access 22 October 2017.

Kurth, R. 1996. Dis-Regarding Schoenberg's Twelve-Tone Rows: An Alternative Approach to Listening and Analysis for Twelve-Tone Music. *Theory and Practice*, 21: 79-122. http://www.jstor.org/stable/41054292 Date access 25 March 2017.

Lahav, A., Boulanger, A., Schlaug, G. A, Saltzman, E. 2005. The Power of Listening: Auditory?Motor Interactions in Musical Training. *Annals of the New York Academy of Sciences*, 1060(1): 189-194. http://onlinelibrary.wiley.com/doi/10.1196/annals.1360.042/full Date access 28 Augustus 2016.

Langer, S.K. 1953. Feeling and Form: a theory of art developed from philosophy in a new key. Cambridge: Harvard University press.

Langner, J. A, & Goebl, W. 2003. Visualizing Expressive Performance in Tempo—Loudness Space. *Computer Music Journal,* 27 (4): 69-83. http://www.mitpressjournals.org/doi/abs/10.1162/014892603322730514?journalCode=comj Date access 3 October 2017.

Large, E.W. 2008. Resonating to musical rhythm: theory and experiment. (*In:* Grondin, S. Ed. The psychology of time. UK, Emerald group publishing limited. P. 189 – 227)

Lee, Y.S., Janata , Frost, C., Martinez, Z. A, & Granger, R. 2014. Melody recognition revisited: influence of melodic Gestalt on the encoding of relational pitch information. *Psychonomic bulletin & review*, 22(1): 163-169. http://doi.org/10.3758/s13423-014-0653-y Date access 10 December 2015.

Lehman, B. 2005a. Johann Sebastian Bach's tuning. http://www.larips.com/ Date access 15 May 2016.

Lehman, B. 2005b Unequal Temperaments. http://www.vdgs.org.uk/files/VdGSJournal/Vol-03-2.pdf Date access 29 May 2016.

Lerdahl, F., & Jackendoff, R. 1983. An overview of hierarchical structure in music. *Music Perception: An Interdisciplinary Journal,* 1(2): 229-252. http://www.jstor.org/stable/40285257 Date access 30 March 2017.

Lerdahl, F., Krumhansl, C.L. 2007. Modelling tonal tension. *Music Perception: An Interdisciplinary Journal,* 24 (4); 329-366. http://www.jstor.org/stable/10.1525/mp.2007.24.4.329 Date access 4 March 2015.

Levitin, D. J., & Rogers, S.E. 2005. Absolute pitch: perception, coding, and controversies. *TRENDS in Cognitive Sciences*, 9 (1). https://doi.org/10.1016/j.tics.2004.11.007 Date access 16 November 2014.

Lewis, P. 1998. Understanding Temperaments. http://leware.net/temper/temper.htm#_nr_273 Date access 10 June 2017.

Liebhaber, B. 2001. Steps toward Successful Dictation. *Teaching music*. https://eric.ed.gov/?id=EJ648101 Date access 25 March 2017.

Loh, C.S. 2005. Guitar vs. Piano: The Effects of Instrument Sound in Web-Based Ear Training. Proceedings of the Conference of American Educational Research Association (AERA 2005), Montreal, Canada.

London, J. 1993. Loud rests and other metric phenomina. (or, meter as heard). *A journal of the Society for Music Theory*, 2: 1-7-. http://www.mtosmt.org/issues/mto.93.0.2/mto.93.0.2.london.php Date access 6 December 2016.

London, J. 1995. Some examples of complex meters and their implications for models of metric perception. *Music Perception: An Interdisciplinary Journal*, 13 (1): 59-77. http://www.jstor.org/stable/40285685 Date access 6 December 2016.

London, J. 1999. Hasty's dichotomy. *Music Theory Spectrum*, 21 (2): 260-274. http://www.jstor.org/stable/745864 Date access 6 December 2016.

London, J. 2002. Cognitive constraints on metric systems: Some observations and hypotheses. *Music Perception: An Interdisciplinary Journal*, 19 (4): 529-550. http://www.jstor.org/stable/10.1525/mp.2002.19.4.529 Date access 6 December 2016.

London, J. 2012. Hearing in time: psychological aspects of musical meter. Ed 2. UK: Oxford University Press.

Loosen, F. 1992. Intonation of solo violin performance with reference to equally tempered Pythagorean, and just intonation. New York: AIP Publishing LLC.

MacLeod, R.B. 2008. Influences of dynamic level and pitch height on the vibrato rates and widths of violin and viola players. http://www.jstor.org/stable/40343711 Date access 14 June 2016.

Madsen, C.K., Duke, R.A., Geringer, J.M. 1986. The effect of speed alterations on tempo note selection. *Journal of Research in Music Education* 34 (2): 101-110. https://doi.org/10.2307/3344738 Date access 22 October 2017.

Martins, M.D., Gingras, B., Puig-Waldmueller, E., FitchW.T. 2017. Cognitive representation of "musical fractals": Processing hierarchy and recursion in the auditory domain. *Cognition*, 161 p.31-45. https://doi.org/10.1016/j.cognition.2017.01.001 Date access 21 September 2017.

Matthews, T. 2014. The Impact of Specialized Musical Training on Rhythm Abilities: Comparing Drummers, Pianists, Singers and String Players. Montreal: Concordia University. (Dissertation – PhD)

May, W.V., & Elliott, C.A. 1980. Relationships among Ensemble Participation, Private Instruction, and Aural Skill Development. *Journal of Research in Music Education* 28 (3): 155-161. http://www.jstor.org/stable/3345232 Date access 19 June 2016.

McCaleb, J.M. 2017. Embodied knowledge in ensemble performance. Proceedings of the Conference on Performance Studies (PERFORMA'11), Routledge.

McClung, A. C. 2000. Extramusical skill in the music classroom. *Music Educators Journal*, 86 (5). http://www.jstor.org/stable/40204930 Date access 30 April 2017.

McCulloch, S., 2006. Creative Interpretation and Cello Technique: A Pedagogical Handbook in the Tradition of Michael Goldschlager and Bernard Greenhouse. Joondalup *Austrailia: Edith Cowan University*. *(Dissertation* - Bachelor of Performing Arts Honours)

McDermott, H.J. 2004. Music perception with cochlear implants: a review. *Trends in amplification.* University of Melbourne. https://doi.org/10.1177/108471380400800203 Date access 22 October 2017.

McDermott, H. J., Hauser, M. 2005. The origins of music: Innateness, uniqueness, and evolution. *Music Perception: An Interdisciplinary Journal*, 23 (1): 29-59. http://doi.org/10.1525/mp.2005.23.1.29 Date access 22 October 2017.

McDermott, H.J., Lehr, A. J., & Oxenham, A. J. 2010. Individual differnces Reveal the Basis of Consonance. *Current Biology*, 20, 1035–1041. http://doi.org/10.1016/j.cub.2010.04.019 Date access 19 March 2017.

McNeil, A.F. 2000. Aural skills and the performing musician: function, training and assessment. Huddersfield: University of Huddersfield (Dissertation – PhD)

McPherson, G.E. 1995. Five aspects of musical performance and their correlates. *Bulletin of the council for research in music education*, 115-121. http://www.jstor.org/stable/40318774 Date access 10 January 2017.

McPherson, G.E., & Renwick, J.M. 2011. Self-regulation and mastery of musical skills. (*In:* Handbook of self-regulation of learning and performance. North Carolina: University of North Carolina. P. 234-248).

Merritt, J. & Castro, D., 2016. Comprehensive Aural Skills: A Flexible Approach to Rhythm, Melody, and Harmony. Oxford: Routledge.

Meyer, L.B. 1959. Some remarks on value and greatness in music. *The Journal of Aesthetics and Art Criticism*, 17 (4): 486-500. http://links.jstor.org/sici?sici=0021-8529%28195906%2917%3A4%3C486%3ASROVAG%3E2.0.CO%3B2-E Date access 4 April 2017.

Micheyl, C., Delhommeau, K., Perrot, X., & Oxenham, A.J. 2006. Influence of musical and psychoacoustical training on pitch discrimination. *Hearing research*, 219 (1): 36-47. https://doi.org/10.1016/j.heares.2006.05.004 Date access 26 April 2015.

Midorikawa, A., Kawamura, M., & Kezuka, M. 2003. Musical Alexia for Rhythm Notation: A Discrepancy Between Pitch and Rhythm. *Neurocase*, 9 (3): 232–238. http://www.tandfonline.com/doi/abs/10.1076/neur.9.3.232.15558 Date access 20 January 2017.

Miksza, P. 2015. The effect of self-regulation instruction on the performance achievement, musical self-efficacy, and practicing of advanced wind players. *Psychology of Music*, 43 (2): 219-243. http://doi.org/10.1177/0305735613500832 Date access 3 October 2017.

Milne, A.J., Sethares, W.A., Laney, R., & Sharp, 2011. Modelling the similarity of pitch collections with expectation tensors. Journal *of Mathematics and Music*, 5 (1): 1-20. http://dx.doi.org/10.1080/17459737.2011.573678 Date access 8 October 2017.

Mishra, J. 2000. Q & A: Research Related to the Teaching of String Technique. *Journal of String Research*, 1: 9-36. http://www.cfa.arizona.edu/jsr/jsrmishra/jsrmishra%20main%20frame.htm Date access 26 December 2015.

Mishra, J. 2014. Factors related to sight-reading accuracy: A meta-analysis. Journal of research in Music Education, 61 (4): 452-465. http://doi.org/10.1177/0022429413508585 Date access 10 October 2017.

Moor, C. 2010. Music and Politics, Performance, and the Paradigm of Historical Contextualism. Michigan: University of Michigan publishing.

Moustakas, C.E. 1994. Phenomenological Research Method. Thousand oaks: Sage Publications.

Müllensiefen, D., & Wiggins, G. 2011. Polynomial functions as a representation of melodic phrase contour.

http://www.doc.gold.ac.uk/~mas03dm/papers/Muellensiefen_Wiggins_PolynomialContour_2011.pdf Date access 22 October 2017.

Nakata, T., & Trehub, S.E. 2004. Infants' responsiveness to maternal speech and singing. *Infant Behaviour and Development*, 27 (4): 455-464. https://doi.org/10.1016/j.infbeh.2004.03.002 Date access 22 October 2017.

Orman, E.K. 2002. Discrimination of Rhythmic Displacement by High School, Undergraduate and Graduate Music Students. *Research Studies in Music Education*, 18 (1): .38-45. https://doi.org/10.1177/1321103X020180010501 Date access 22 October 2017.

Oxenham, A.J., & Micheyl, C. 2013. Pitch perception: dissociating frequency from fundamental-frequency discrimination. (*In:* Moore, B.C., Patterson R.D., Winter, IM., Caryon, R.P. & Gockel, HE. Eds. Basic Aspects of Hearing. Advances in Experimental Medicine and Biology, 787. New York Springer. P. 137-145)

Øye, I.F. 2013. Music analysis. A bridge between performing and aural training?. https://brage.bibsys.no/xmlui/handle/11250/274224 Date access 22 October 2017.

Paney, A.S. 2007. Directing attention in melodic dictation. Texas: Texas Tech University. (Dissertation – PhD

Paney, A.S., & Buonviri, N.O. 2014. Teaching melodic dictation in Advanced Placement music theory. *Journal of Research in Music Education*, 61 (4): 396-414. http://doi.org/10.1177/0022429413508411 Date access 17 June 2016.

Papiotis: , Marchini, M., Perez-Carrillo, A., & Maestre, E. 2014. Measuring ensemble interdependence in a string quartet through analysis of multidimensional performance data. *Frontiers in* psychology, 5: 963-963. http://doi.org/10.3389/fpsyg.2014.00963 Date access 24 October 2015.

Parncutt, R. 2012. Harmony: A psychoacoustical approach. Berlin, Sringer Verlag.

Pembrook, R.G. 1987. The effect of vocalization on melodic memory conservation. *Journal of Research in Music Education*,35 (3): 155-169. https://doi.org/10.2307/3344958 Date access 22 October 2017.

Pembrook, R.G. & Riggins, H.L. 1990. Send help!": Aural skills instruction in US colleges and universities. *Journal of Music Theory Pedagogy*, *4*(2): 231-242.

Penttinen, M. 2013. Skill Development in Music Reading. The Eye-Movement Approach. Finland: University of Turku. (Dissertation – PhD)

Peretz, I. & Zatorre, R.J. 2005. Brain organization for music processing., *Annual Review of Psychology*, 56: 89-114. http://dx.doi.org/10.1146/annurev.psych.56.091103.070225 Date access 5 May 2017.

Peterson, J. 1925. A functional view of consonance. *Psychological Review*, 32 (1): 17-33. http://dx.doi.org/10.1037/h0074190 Date access 22 October 2017.

Pitcher, A. C. 2008. Mastering Musicianship: An Integrated Approach to String Pedagogy. *Australian Kodály Bulletin.*. http://kodaly.org.au/assets/Australian_Kodaly_Bulletin_2008_LR.pdf#page=39 Date access22 October 2017.

Plack, C.J. 2010. Musical consonance: The importance of harmonicity. Current Biology, 20(11): R476. https://doi.org/10.1016/j.cub.2010.03.044 Date access 9 November 2017.

Plomp, R. 2002. The intelligent ear. On the nature of sound perception. London, lawrence Erlbaum and Associates Publishers.

Polonenko, M.J., Giannantonio, S., Papsin, B.C., Marsella: , Gordon, K.A. 2017. Music perception improves in children with bilateral cochlear implants or bimodal devices. *The Journal of the Acoustical Society of America*, 141 (6): 4494-4507. http://dx.doi.org/10.1121/1.4985123 Date access 22 October 2017.

Price, H.E. 1992. Transferring teaching concepts from methods course to studio instruction. *Contributions to Music Education*, 19: 75-86. http://www.jstor.org/stable/24127398 Date access 22 October 2017.

Prince, J.B., Schmuckler, M.A., & Thompson, W.F. 2009. The effect of task and pitch structure on pitch-time interactions in music. *Memory and cognition*, 37 (3): 368-381. http://dx.doi.org/10.1037/a0038010 Date access 19 June 2017.

Purves, D., Augustine, G.J., Fitzpatrick, D., C Katz, L. C., La Mantia,A., O McNamara, J., & Williams, S. M., 2001. Circuits within the basal ganglia system. Neuroscience, 2nd edition. Sunderland: Sinauer Associates.

Rameau, J.P. 1971. Treatise on harmony; translated from Italian Philip Gossett. New York: Dover Publications.

Randel, D.M. ed. 2001, The Harvard dictionary of music. Uk: Harvard University Press.

Rankin, S.K., Fink: W., & Large, E.W. 2014. Fractal structure enables temporal prediction in music. *The Journal of the Acoustical Society of America*, 136 (4): EL256-EL262. http://asa.scitation.org/toc/jas/136/4 Date access 2 February 2017.

Rasch, R. 2008. How Equal Temperament Ruined Harmony, and Why You Should Care," by Ross Duffin., *Performance Practice Review*, 13 (1): 12. http://doi.org/10.5642/perfpr.200813.01.12 Date access 28 January 2016.

Rasmussen, M., Santurette, S., & MacDonald, E. 2014. Consonance perception of complex-tone dyads and chords. *7th Forum Acusticum.*, Technical University of Denmark.

Ravignani, A., Honing, H., & Kotz, S.A. 2017. The evolution of rhythm cognition: Timing in music and speech. *Frontiers in human neuroscience*, 11. http://doi.org/10.3389/fnhum.2017.00303 Date access 19 June 2017.

Reitan, I.E. 2009. Students' attitudes to aural training in an academy of music. *Nordic research in music education;* 11, Norges musikkhøgskole. http://hdl.handle.net/11250/172191 Date access 26 June 2016.

Rimsky-Korsakov, N. 1964. Principles of orchestration. edited Maximilian Steinberg translation Edward Agate. New York; Dover Publications.

Rink, J. 2005. The practice of performance: Studies in musical interpretation. Cambridge; Cambridge University Press.

Robinson, M.H. 2012. Varying Degrees of Difficulty in Melodic Dictation Examples According to Intervallic Content. Knoxville: University of Tennessee. (Dissertation – Master)

Rogers, M. 2013. Aural dictation affects high achievement in sight-singing, performance and composition skills. *Australian Journal of Music Education*, 1:.34. https://search.proquest.com/openview/344a8247f14a45ebca2408034d5151ef/1?pq-origsite=gscholar&cbl=426756 Date access 22 October 2017.

Rolland, P. 1974. Action Studies: Developmental and Remedial Techniques: Violin and Viola. Illinois; Boosey & Hawkes.

Rosemann, S., Altenmüller, E., & Fahle, M. 2016. The art of sight-reading: Influence of practice, playing tempo, complexity and cognitive skills on the eye–hand span in pianists. *Psychology of Music*, 44 (4): 658-673. http://doi.org/10.1177/0305735615585398 Date access 1 October 2017.

Royal, M.S. 1999. Music Cognition and Aural Skills: A Review Essay on George Pratt's" Aural Awareness". *Music Perception: An Interdisciplinary Journal*, 17(1): 127-144. http://www.jstor.org/stable/40285815 Date access 23 November 2015.

Saeedi, N.E., Blamey: J., Burkitt, A.N., & Grayden, D.B. 2016. Learning Pitch with STDP: A Computational Model of Place and Temporal Pitch Perception Using Spiking Neural Networks., *PLoS computational biology*, 12 (4): e1004860. https://doi.org/10.1371/journal.pcbi.1004860 Date access 21 September 2017.

Salamon, J., & Gómez, E. 2012. Melody extraction from polyphonic music signals using pitch contour characteristics. *IEEE Transactions on Audio, Speech, and Language Processing*, 20 (6): 1759-1770. http://ieeexplore.ieee.org/abstract/document/6155601/ Date access 30 April 2017.

Sánchez, M. 2006. The expressive intonation in violin performance. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.626.9059&rep=rep1&type=pdf Date access October 2017.

Schellenberg, E.G., & Habashi. 2015. Remembering the melody and timbr, forgetting the key and tempo. *Memory and cognition,* 43 (7): 1021-1031. http://doi.org/10.3758/s13421-015-0519-1 Date access 4 June 2017.

Schmuckler, M.A. 2011. Components of melodic. *(In*: Hallam, S., Cross, I. &l Thaut, M. Oxford handbook of music psychology, Oxford; Oxford university Press. p.93.)

Schmuckler, M.A. 2016. Tonality and Contour in Melodic Processing. *(In*: Hallam, S., Cross, I. &l Thaut, M. Oxford handbook of music psychology, Oxford; Oxford university Press. P.143-166.)

Schulze, K., Dowling, W.J., Tillmann, B. 2012. Working memory for tonal and atonal sequences during a forward and a backward recognition task. *Music Perception: An Interdisciplinary Journal*, 29 (3): 255-267. http://doi.org/10.1525/mp.2012.29.3.255 Date access 10 December 2015.

Seesjärvi, E., Särkämö, T., Vuoksimaa, E., Tervaniemi, M., Peretz, I., & Kaprio, J. 2016 The nature and nurture of melody: a twin study of musical pitch and rhythm perception. *Behaviour genetics*, 46 (4): 506-515. http://doi.org/10.1007/s10519-015-9774-y Date access13 August 2017.

Serafine, S., Young, D. 2002. *Bowed string physical model validation through use of a bow controller and examination of bow strokes.,* In Procedures:. Stockholm Musical Acoustics Meeting. https://www.researchgate.net/profile/Stefania_Serafin/publication/229010218_Bowed_string_physical_model_validation_through_use_of_a_bow_controller_and_examination_of_bow_strokes/links/00b49520d1fc89a9b1000000.pdf Date access 19 June 2016.

Serafine, M.L. 1988. Music As Cognition: The Development of Thought in Sound. New York: Columbia University Press.

Serafine, M.L. 2010. Music as cognition. New York: Columbia University Press.

Serafine, M.L. 2013. Music as cognition: The development of thought in sound. Columbia; Columbia University Press.

Shackford, C.R. 1956. Intonation in ensemble string performance. *The Journal of the Acoustical Society of America*, 28 (1): 150-150. http://dx.doi.org/10.1121/1.1918058 Date access 22 October 2017.

Shuker, R. 2005. Popular Music: the key concepts. 2 Ed. London; Routledge.

Siljestam, S. 2013. Just Intonation compared to Pythagorean Tuning and Equal temperament. http://www.soundfromtheheart.com/2013/10/pythagorean-tuning-compared-to.html Date access 22 October 2017.

Singh, Y.K. 2006. Fundamental of research methodology and statistics. India; New Age International.

Sisley, B.A. 2008. A comparative study of approaches to teaching melodic dictation. Ohio: Kent State University. (Dissertation - Masters)

Skowron, Z. 2012. On Zofia Lissa's ,1908–1980, Musical and Aesthetic Explorations. *Musicology Today*. http://bazhum.muzhp.pl/media/files/Musicology_Today/Musicology_Today-r2012-t9/Musicology_Today-r2012-t9-s132-153/Musicology_Today-r2012-t9-s132-153.pdf Date access 28 June 2016.

Slette, A.L. 2014. Aural awareness in ensemble rehearsals. A qualitative case study of three undergraduate chamber music ensembles playing Western classical music. Oslo: Norges musikkhøgskole (Dissertation – PhD)

Sloboda, J., & Edworthy, J. 1981. Attending To Two Melodies At Once: the of Key Relatedness. *Psychology of Music*, *9*(1): 39-43. https://doi.org/10.1177/03057356810090010701 Date access 22 October 2017.

Smagorinsky, P.H. 2007. The Culture of Vygotsky. *Reading Research Quarterly*, *44*(1): 85-95. http://onlinelibrary.wiley.com/doi/10.1598/RRQ.44.1.4/full Date access 22 October 2017

Smagorinsky, P.H. 2008) The method section as conceptual epicentre in constructing social science research reports. *Written Communication*, *25*(3): 389-411. http://wcx.sagepub.com/cgi/content/abstract/25/3/389 Date access 18 March 2015.

Snyder, J.L, 1980. Harmonic dualism and the origin of the minor triad. *Indiana Theory Review*, 4(1): 45-78. http://www.jstor.org/stable/24044496 Date access 22 October 2017

Snyder, B. 2000. Music and memory: An introduction. *Indiana Theory Review*. http://www.jstor.org/stable/24044496 Date access 13 September 2017.

Stabley, N.C. 2001. Creative activities for string students: Activities focused on improvisation, creativity, and movement can help beginning string students understand basic music concepts. *Music Educators Journal*, 88 (2): 29-57. https://doi.org/10.2307/3399739 Date access 22 October 2017.

Steinschaden, B. & Zehetmair, H., 1982. *Hören und Geigen nach Suzuki: eine Anleitung aus europäischer Sicht* (Vol. 25). Germany; Heinrichshofen.

Stevens, C.J., Keller: E., & Tyler, M.D. 2011. Tonal language background and detecting pitch contour in spoken and musical items. *Psychology of Music*, 41 (1): 59-74. http://doi.org/10.1177/0305735611415749 Date access 30 March 2017.

Sukamolson, S. 2007. Fundamentals of quantitative research Suphat Sukamolson. Bangkok: Chulalongkorn University. (Dissertation – PhD)

Tavakol, M., & Dennick, R. 2011. Making sense of Cronbach's alpha. *International journal of medical education*, 2: 53. http://doi.org/10.5116/ijme.4dfb.8dfd Date access 15 October 2017.

Temperley, D. 1999. What 's Key for Key? The Krumhansl-Schmuckler Key-Finding Algorithm Reconsidered. *Music Perception: An Interdisciplinary Journal*, 17 (1): 65-100. http://www.jstor.org/stable/40285812 Date access 28 March 2017.

Temperley, D. 2004. The cognition of basic musical structures. *Music Perception: An Interdisciplinary Journal*, Vol. 17(1): 65-100 17. http://www.jstor.org/stable/40285812 Date access 22 October 2017.

Terhardt, E. 1973. Pitch, consonance, and harmony. *The Journal of the Acoustical Society of America*, 55 (5): 1061-1069. DOI: 10.2307/40285261 Date access 22 October 2017.

Thaut, M.H. 2005. Rhythm, music, and the brain: Scientific foundations and clinical applications., New York: Routledge.

Thompson, W.F. 2013. Intervals and scales. (*In*: Deutsch, D. Ed. The psychology of music. 3rd Ed. Amsterdam: Academic Press Publication. P. 107-140)

Tillmann, B., Bharucha, J.J., & Bigand, E. 2000. Implicit learning of tonality: a self-organizing approach, *Psychological review*, 107 (4): 885. http://doi.org/10.1037//0033-295X.107.4.885 Date access 28 May 2017.

Tirovolas, A.K., & Levitin, D.J. 2011. Music perception and cognition research from 1983 to 2010: A categorical and bibliometric analysis of empirical articles in Music Perception. *Music Perception: An Interdisciplinary Journal*, 29 (1): 23-36. http://mp.ucpress.edu/content/29/1/23 Date access 22 October 2017.

Toch, E. 1977. The shaping forces in music: an inquiry into the nature of harmony, melody, counterpoint, form. Courier Corporation. New York, Dover Publications.

Trainor, L.J., & Heinmiller, B.M. 1998. The development of evaluative responses to music: infants prefer to listen to consonance over dissonance. *Infant Behaviour and Development*, 21 (1): 77-88. https://doi.org/10.1016/S0163-6383(98)90055-8 Date access 22 October 2017.

Trainor, L. J., Tsang, C.D., & Cheung, V.H. 2002. *Preference for sensory consonance in 2-and 4-month-old infants. Music Perception: An Interdisciplinary Journal*, 20 (2): 187-194. https://doi:10.1525/mp.2002.20.2.187 Date access 22 October 2017.

Trehub, S.E. 2000. Human processing predispositions and musical universals. (*In:* Lennart, N. Björn, W. Merker, S.B. Eds. The origins of music. London; MIT Press. P. .427-448.)

Tymoczko, D. 2011. Dualism and the Beholder's Eye: Inversional Symmetry in Chromatic Tonal Music. (*In*: Gollin, A. & Rehding, A. The Oxford Handbook of Neo-Riemannian Music Theories, Oxford University Press. P. 165 -269)

Vitouch, O. 2003. Absolutist models of absolute pitch are absolutely misleading. *Music Perception: An Interdisciplinary Journal*, 21(1): 111-117 http://doi.org/10.1525/mp.2003.21.1.111 Date access 21 April 2015.

Vurma, A., Raju, M., & Kuuda, A. 2011. Does timbre affect pitch?: Estimations by musicians and non-musicians. *Psychology of Music*, 39 (3): 291-306. http://doi.org/10.1177/0305735610373602 Date access 22 October 2015.

Vuvan, D.T., Podolak, O.M., & Schmuckler, M.A. (2014) Memory for musical tones: the impact of tonality and the creation of false memories. *Frontiers in psychology*, 5: 582. http://doi.org/10.3389/fpsyg.2014.00582 Date access 30 April 2017.

Vygotsky, L.S., 1987. Thinking and speech: (*In:* Vygotsky, L.S. The collected works of LS Vygotsky, vol. 1. New York: Plenum Press.p.113-114.)

Wachter, M.I. 2014. Effects of sight-singing using moveable-do solmization on the transposition performance of undergraduate group piano students. University of South Carolina Scholar Commons.

Wagner, E. 2014. Cognitive Models of Tonal Tension. *Academia education.* https://s3.amazonaws.com/academia.edu.documents/37213899/Modeling_Musical_Tension.pdf?AWSAccessKeyId=AKIAIWOWYYGZ2Y53UL3A&Expires=1508885842&Signature=cRNpVxCSwIatGK4jQ00jjT3JZZ4%3D&response-content-disposition=inline%3B%20filename%3DCognitive_Models_of_T Date access 22 October 2017.

Walker, C.A. 2010. Intonation in the aural-skills classroom. Massachusetts: University of Massachusetts - Amherst. (Dissertation – Master)

Waters, A.J., Townsend, E., & Underwood, G. 1998. Expertise in musical sight-reading: A study of pianists. *British Journal of Psychology*, 89 (1): 123-149. http://onlinelibrary.wiley.com/doi/10.1111/j.2044-8295.1998.tb02676.x/full Date access 22 October 2017.

Wayland, R., Herrera, E., & Kaan, E. 2010. Effects of musical experience and training on pitch contour perception. *Journal of Phonetics*, 38 (4): 654-662. https://doi.org/10.1016/j.wocn.2010.10.001 Date access 22 October 2017.

Wedin, E. N. 2015. Playing Music with the Whole Body, eurythmics and motor development. Stockholm; Germans Musikförslag AB.

Wei, T. Y. J. 2013. An Alternative Approach to Collegiate Beginner Violin Lessons: Collaborative Learning. Eugene :University of Oregon. (Disserttation – PhD)

Weiss, M.W., Trehub, S.E., & Schellenberg, E.G. 2012. Something in the way she sings: Enhanced memory for vocal melodies. *Psychological Science*, 23(10): 1074-1078. http://doi.org/10.1177/0956797612442552 Date access 22 June 2016.

White, D. 2007. Potential Mathematical Models for the Western Musical Scale: A Historical and Empirical Comparison. http://www. skytopia. com/music/theory/scaledissertation.html# intro Date access 24 October 2015.

Widmer, G., & Goebl, W. 2004. Computational models of expressive music performance: The state of the art. *Journal of New Music Research*, 33 (3): 203-216. http://www.tandfonline.com/loi/nnmr20 Date access 24 February 2016.

Windsor, W.L., & De Bézenac, C. 2012. Music and affordances. *Musicae scientiae*, 16 (1): 102-120. https://doi.org/10.1177/1029864911435734 Date access 22 October 2017.

Wohlman, K.J., 2013. Ear-tudes: an ear training method for the collegiate tubist. Iowa: University of Iowa. (Dissertation – PhD)

Wolf, A., & Kopiez, R. 2014. Do grades reflect the development of excellence in music students? The prognostic validity of entrance exams at universities of music. *Musicae Scientiae*, 18 (2): 232-248. http://doi.org/10.1177/1029864914530394 Date access 21 April 2015.

Woodruff, A.D. 1970. How Music Concepts Are Develop. *Music Educators Journal*, 56 (6): 51-54. https://doi.org/10.2307/3392717 Date access 22 October 2017.

Wöllner, C., & Cañal-Bruland, R. 2010. Keeping an eye on the violinist: motor experts show superior timing consistency in a visual perception task. *Psychological research*,74 (6): 579-585. http://doi.org/10.1007/s00426-010-0280-9 Date access 15 March 2016.

Zanoni, M., Setragno, F., & Sarti, A. 2014. The violin ontology. Proceedings of the 9th Conference on Interdisciplinary Musicology – CIM14. Berlin, Germany 2014. http://home.deib.polimi.it/setragno/files/CIM2014.pdf Date access 13 March 2016.

Zavadska, G., & Davidova, J. 2015. The Development of Prospective Music Teachers' Harmonic Hearing at Higher Education Establishments. *Pedagogika*, 117 (1). https://www.ceeol.com/search/article-detail?id=341748 Date access 29 August 2016.

Zimmerman, B.J., & Schunk, D.H. 2011. Motivational sources and outcomes of self-regulated learning and performance. *(In:* Dale H. Schunk, Zimmerman, B.Eds. Handbook of self-regulation of learning and performance New York, Routledge.P. 49 - 64)

Zwolinska, E. 2013. Music education through audiation teaches aesthetically. *Polskie Forum Psychologiczne*, 18 (2): 143-156. http://psjd.icm.edu.pl/psjd/element/bwmeta1.element.psjd-8331ac60-6d2f-430b-84fe-a537360f1ae1;jsessionid=6E51DCAB57A46BBB7D5726EFF7002CC9 Date access 22 October 2017.

Žabka, M. 2014. Dancing with the Scales Subchromatic Generated Tone Systems. *Journal of Music Theory*, 58 (2): 179-233. http://doi.org/10.1215/00222909-2781769 Date access 25 October 2015.

Addenda

Addendum A

UNIVERSITEIT
STELLENBOSCH
UNIVERSITY

NOTICE OF APPROVAL

REC Humanities New Application Form

11 October 2017

Project number: MUS-2017-1169

Project Title: Training the string player's ear: a comparative study.

Dear Ms Hester Fischer

Your REC Humanities New Application Form submitted on 14 September 2017 was reviewed and approved by the REC: Humanities.

Please note the following about your approved submission:

Ethics approval period: 11 October 2017 - 10 October 2020

Addendum B

CONSENT TO PARTICIPATE IN RESEARCH
Dear prospective participant, My name is Hester Fischer, a student at the music department of Stellenbosch University (South Africa). I would like to invite you to take part in a survey, the results of which will contribute to a research project in order to complete my Master degree course. Please take some time to read the information presented here, which will explain the details of this project. Your participation is entirely voluntary and you are free to decline to participate. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw from the study at any point, even if you agreed to take part. The purpose of this study is to compare approaches to aural training as presented to string students by their lecturers. Comparisons will be drawn between different geographical regions and subjects or modules offered to the string student. The questionnaire will take less than 10 minutes to complete and will contain a combination of questions covering the ranking of aural skills needed in order of importance. The questionnaire contains 9 questions.
RIGHTS OF RESEARCH PARTICIPANTS: You have the right to decline answering any questions and you can exit the survey at any time without giving a reason. You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have questions regarding your rights as a research participant, contact Mrs Maléne Fouché [mfouche@sun.ac.za; 021 808 4622] at the Division for Research Development.
Your information and response to the survey will be protected for complete anonymity. The questions and answers will be hosted by an on–line host that does not record or provide me with the details of any participants. Furthermore, the questionnaire contains no identifying questions. If you have any questions or concerns about the research, please feel free to contact the researcher Hester Fischer via e-mail at hester.vanwy5@gmail.com and/or the Supervisor, Danell Herbst at danellherbst@sun.ac.za. To save a copy of this text, download the attachment. Please confirm acceptance of this information on the survey. To start the survey, open the following link: http://acweb.co.za/survey

	YES	NO
I confirm that I have read and understood the information provided for the current study.	☐	☐
I agree to take part in this survey.	☐	☐

Addendum C

Training the String Players' Ear

View Edit Webform Results

Submitted by Hester on Wed, 09/20/2017 - 23:54

Start Pg 1 Pg 2 Pg 3 Pg 4 Pg 5 Pg 6 Pg 7 Pg 8 Pg 9 Pg 10 Pg 11 Pg 12 Pg 13 Pg 14 Pg 15 Complete

Page 1 of 17

• I confirm that I have read and understood the information provided for the current study.

- Yes
- No

Next Page >

Training the String Players' Ear

View Edit Webform Results

Submitted by Hester on Wed, 09/20/2017 - 23:54

Start Pg 1 Pg 2 Pg 3 Pg 4 Pg 5 Pg 6 Pg 7 Pg 8 Pg 9 Pg 10 Pg 11 Pg 12 Pg 13 Pg 14 Pg 15 Complete

Page 2 of 17

Current region of teaching

- UK
- USA
- Scandinavia

< Previous Page Next Page >

Training the String Players' Ear

View Edit Webform Results

Submitted by Hester on Wed, 09/20/2017 - 23:54

Start Pg 1 Pg 2 Pg 3 Pg 4 Pg 5 Pg 6 Pg 7 Pg 8 Pg 9 Pg 10 Pg 11 Pg 12 Pg 13 Pg 14 Pg 15 Complete

Page 4 of 17

Years of teaching experience

< Previous Page Next Page >

Training the String Players' Ear

View Edit Webform Results

Submitted by Hester on Wed, 09/20/2017 - 23:54

Start Pg 1 Pg 2 Pg 3 Pg 4 Pg 5 Pg 6 Pg 7 Pg 8 Pg 9 Pg 10 Pg 11 Pg 12 Pg 13 Pg 14 Pg 15 Complete

Page 5 of 17

Gender ?

- Male
- Female
- Other...

< Previous Page Next Page >

Copyright ACWEB 2017

Training the String Players' Ear

View Edit Webform Results

Submitted by Hester on Wed, 09/20/2017 - 23:54

Start Pg 1 Pg 2 Pg 3 Pg 4 Pg 5 Pg 6 Pg 7 Pg 8 Pg 9 Pg 10 Pg 11 Pg 12 Pg 13 Pg 14 Pg 15 Complete

Page 6 of 17

Please rank the following concepts in order of importance.1 Highest -> 3 Lowest

	1	2	3
Rhythm	○	○	○
Melody	○	○	○
Harmony	○	○	○

< Previous Page Next Page >

Training the String Players' Ear

View Edit Webform Results

Submitted by Hester on Wed, 09/20/2017 - 23:54

Start Pg 1 Pg 2 Pg 3 Pg 4 Pg 5 Pg 6 Pg 7 Pg 8 Pg 9 Pg 10 Pg 11 Pg 12 Pg 13 Pg 14 Pg 15 Complete

Page 7 of 17

What is your first instrument?

- None -

What is your Second instrument?

- None -

< Previous Page Next Page >

Training the String Players' Ear

View Edit Webform Results

Submitted by Hester on Wed, 09/20/2017 - 23:54

Start Pg 1 Pg 2 Pg 3 Pg 4 Pg 5 Pg 6 Pg 7 Pg 8 Pg 9 Pg 10 Pg 11 Pg 12 Pg 13 Pg 14 Pg 15 Complete

Page 8 of 17

Please rank the following thinking skills in order of importance 1 Highest

	1	2	3	4
Musical memory	○	○	○	○
Perception	○	○	○	○
Cognition	○	○	○	○
Audiation	○	○	○	○

Give a reason for your answer.

< Previous Page Next Page >

Training the String Players' Ear

View Edit Webform Results

Submitted by Hester on Wed, 09/20/2017 - 23:54

Start Pg 1 Pg 2 Pg 3 Pg 4 Pg 5 Pg 6 Pg 7 Pg 8 Pg 9 Pg 10 Pg 11 Pg 12 Pg 13 Pg 14 Pg 15 Complete

Page 9 of 17

Please rank the following listening skills in order of importance

	1	2	3	4
Active listening	○	○	○	○
Passive listening	○	○	○	○
Dictation	○	○	○	○
Error detection	○	○	○	○

Give a reason for your answer.

< Previous Page Next Page >

Training the String Players' Ear

View Edit Webform Results

Submitted by Hester on Wed, 09/20/2017 - 23:54

Start Pg 1 Pg 2 Pg 3 Pg 4 Pg 5 Pg 6 Pg 7 Pg 8 Pg 9 Pg 10 Pg 11 Pg 12 Pg 13 Pg 14 Pg 15 Complete

Page 10 of 17

Please rank the following performance skills in order of importance

	1	2	3
Ensemble playing	○	○	○
Reflection in performance	○	○	○
Sight reading	○	○	○

Give a reason for your answer.

< Previous Page Next Page >

Training the String Players' Ear

View Edit Webform Results

Submitted by Hester on Wed, 09/20/2017 - 23:54

Start Pg 1 Pg 2 Pg 3 Pg 4 Pg 5 Pg 6 Pg 7 Pg 8 Pg 9 Pg 10 Pg 11 Pg 12 Pg 13 Pg 14 Pg 15 Complete

Page 11 of 17

Please rank the following aural skills in order of importance

	1	2	3	4
Thinking skills	○	○	○	○
Listening skills	○	○	○	○
Performance skills	○	○	○	○
Reading skills	○	○	○	○

Give a reason for your answer.

< Previous Page Next Page >

Training the String Players' Ear

View | Edit | Webform | Results

Submitted by Hester on Wed, 09/20/2017 - 23:54

Start Pg 1 Pg 2 Pg 3 Pg 4 Pg 5 Pg 6 Pg 7 Pg 8 Pg 9 Pg 10 Pg 11 Pg 12 Pg 13 Pg 14 Pg 15 Complete

Page 12 of 17

Please indicate what is taught to string students to enhance their Rhythm (mark all applicable).

- ☐ Musical memory
- ☐ Perception
- ☐ Cognition
- ☐ Audiation
- ☐ Active listening
- ☐ Passive listening
- ☐ Dictation
- ☐ Error detection
- ☐ Ensemble playing
- ☐ Reflection on performance
- ☐ Concepts
- ☐ Thinking skills
- ☐ Listening skills
- ☐ Performance skills
- ☐ Reading skills

Give a reason for your answer.

< Previous Page | Next Page >

Training the String Players' Ear

View | Edit | Webform | Results

Submitted by Hester on Wed, 09/20/2017 - 23:54

Start Pg 1 Pg 2 Pg 3 Pg 4 Pg 5 Pg 6 Pg 7 Pg 8 Pg 9 Pg 10 Pg 11 Pg 12 Pg 13 Pg 14 Pg 15 Complete

Page 13 of 17

Please indicate what is taught to string students to enhance their Melody (mark all applicable).

- ☐ Musical memory
- ☐ Perception
- ☐ Cognition
- ☐ Audiation
- ☐ Active listening
- ☐ Passive listening
- ☐ Dictation
- ☐ Error detection
- ☐ Ensemble playing
- ☐ Reflection on performance
- ☐ Concepts
- ☐ Thinking skills
- ☐ Listening skills
- ☐ Performance skills
- ☐ Reading skills

Give a reason for your answer.

< Previous Page | Next Page >

Training the String Players' Ear

View | Edit | Webform | Results

Submitted by Hester on Wed, 09/20/2017 - 23:54

Start | Pg 1 | Pg 2 | Pg 3 | Pg 4 | Pg 5 | Pg 6 | Pg 7 | Pg 8 | Pg 9 | Pg 10 | Pg 11 | Pg 12 | Pg 13 | Pg 14 | Pg 15 | Complete

Page 14 of 17

Please indicate what is taught to string students to enhance their Harmony (mark all applicable).

- Musical memory
- Perception
- Cognition
- Audiation
- Active listening
- Passive listening
- Dictation
- Error detection
- Ensemble playing
- Reflection on performance
- Concepts
- Thinking skills
- Listening skills
- Performance skills
- Reading skills

Give a reason for your answer.

< Previous Page | Next Page >