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Proposed methods for efficiently attaining the skills required for accurate time keeping In music.

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Proposed Methods For Efficiently Attaining The Skills Required For Accurate Time Keeping In Music.

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This dissertation is submitted for the degree of Bachelor of Music Honours
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ABSTRACT

This dissertation aims to provide exercises that will efficiently develop the skills necessary for accurate time keeping in music. Many contemporary industry-standard texts fail to provide specific methods to develop accurate time keeping in music. Most include instructions to use a metronome, but only as a dictator of tempo and not as a tool to improve one's own time keeping ability. This dissertation proposes to address that gap in contemporary music instructional literature. To enhance the understanding of the skills required for accurate time keeping in music, contemporary neurological literature pertaining to time keeping is investigated. A review of this literature reveals that temporal cognition and motor learning are two main factors influencing time keeping. Based on these findings, forty-eight exercises are developed that are designed to optimally input the cognitive and motor skills required to achieve the physical manifestation of accurate metronomic temporal intervals. The exercises focus primarily on heightening the awareness of the temporal partials (known in music as subdivisions) that are not being physically output by the individual, so that they may accurately quantify, perceive and physically manifest metronomically accurate notes or strokes. Through analysis of selected industry-standard music instructional literature, a format of presentation for the exercises is developed and employed. The devised format comprises of an introduction to the text, explanation of exercises, presentation of exercises in both written text and musical notation, and aural demonstrations of the exercises on an included compact disc. The exercises are then summarised and suggestions of extrapolations for exercises are discussed.

CONTENTS

INTRODUCTION

Quantifying temporal intervals, or judging time, occurs almost constantly in our daily lives. From estimating how many minutes have passed, to judging how hard to brake when a car in front slows down, to knowing when to move our arms, hands and fingers to catch a ball. Judging time is a necessary part of our functioning lives. For musicians, specialised forms of temporal judgement are paramount for successful tempo and rhythmic execution in music. These time keeping skills need to be highly precise and require training in order to become accurate. In the context of musical performance the ability to accurately judge time, in this case the finer timings of rhythmic accuracy, is crucial to a successful performance.

In the present day, the advent of drum machines, sampling, quantisation, and use of computers in music have greatly increased the level of tempo and rhythmic accuracy that the average listener of today is exposed to. A present day musician, who also qualifies as a present day listener, seeks the same level of tempo and rhythmic accuracy in their own abilities so they may replicate the music they are exposed to with the same temporally accurate intervals. So precise do these temporal intervals need to be, a musician will spend many an hour honing their timing skills alone.

This dissertation aims to answer the following research questions:

- What are the cognitive factors pertaining to the efficient training of time keeping in music?
- What are the motor learning factors pertaining to the efficient training of time

keeping in music?

- Is there an efficient method to optimally input the cognitive and motor skills required to physically produce accurate temporal intervals in the context of music?

RATIONALE

Contemporary instructional literature does not always address the specifics of how to hone accurate time keeping skills. The drumset instructional texts selected draw from a broad time span of publication, cover diverse topics, are industry-standard method books, and were developed by highly respected drum performers and educators. This selection highlights the lack of information in instructional literature that the proposed exercises attempt to address. These exercises aim to improve the efficient training methods for physical outputting of accurate temporal intervals for musicians.

Available research pertaining to this topic is predominantly made up of other musicians' accounts of procedures they undertook, or music theory or instructional texts. Generally, this material is primarily focused on the metric aspects of rhythm and not the 'accurate-events-in-time' aspect. Most, if not all, include instructions to use a metronome, but only as a dictator of tempo and not as a tool to improve one's own time keeping ability. For example, Ted Reed's book *Progressive Steps to Syncopation*, listed as one of the most popular drum books ever written, mentions only to '*devote some of your practice time to playing with a metronome.*'[1] Another example can be found in *It's Your Move: Motions and Emotions*, where regarding time keeping, Famularo instructs the use of a metronome, saying that '*it is a very effective tool for fine tuning your time feel'*[2]*,* but does not address specifically how the metronome is to be used to improve time keeping. There appears to be a distinct lack of definitive resources of methods for how best to go about learning how to play in time, let alone any that are substantiated with neurological information.

[1] Ted Reed, Progressive Steps to Syncopation for the Modern Drummer (Alfred Music Publishing, 1958).
[2] Dom Famularo, It's Your Move: Motions and Emotions (Faber Music Ltd, 2001).

Understanding the cognitive and motor learning processes of time keeping will arguably provide a greater understanding of how to effectively and efficiently input or develop the skills required for accurate time keeping. This information will be included only for this purpose and there will be no attempt in any way to contribute to the neuroscience community at large. This dissertation does not claim to be a definitive method for all individuals to learn how to achieve the physical manifestation of metronomically accurate temporal intervals, but rather, an informed starting point. The neurological information was obtained through searching databases; ProQuest Dissertation & Theses, ProQuest Psychology Journals, ProQuest Science Journals, PsycARTICLES and ScienceDirect Journals, through Google Books, and standard internet search engines.

This dissertation will be helpful for the music world as a whole, as the skills required for good time keeping in music are paramount in many present day styles and genres, as computer software is being used increasingly to achieve perfect consistencies in music; tempo, subdivisions, pattern repetition etc. The information in this dissertation could potentially save a great deal of time for musicians who wish or need to excel in time keeping ability such as drummers, bassists, pianists or any other rhythm section instrumentalists. Of course, all musicians can benefit from this information too.

METHODOLOGY

Neurological studies pertaining to temporal cognition and motor learning will be analysed. The information will be used to formulate and validate the exercises. This will provide background information as to how and why the exercises will improve an individual's ability to physically manifest accurate temporal intervals.

Music instructional literature, notably percussive instructional literature will be analysed. This information will provide two functions:

- To expose the absence of information pertaining to the efficient training of physically outputting accurate temporal intervals. This will be discussed in the literature review.
- To be used to develop a format for the proposed exercises to follow. This will be discussed in Chapter 3.

The criteria for selecting music instructional literature for analysis was as follows:

- Texts from a broad time span of publication were to be included.
- Diversity in topic of music instruction was to be included.
- Texts with obvious logical formats were to be included.
- Texts from highly prominent authors were to be included.

To supply diversity among disciplines, supplementary texts were selected for analysis of format of presentation.

Following introductory material, this dissertation will be constructed of six chapters:

- Preliminary readings suggested that certain neurological factors, particularly temporal cognition and motor learning, are likely to influence the physical manifestation of accurate time keeping in music. In **Chapter 1**, these factors will be further investigated through a review of current scientific literature. Their effects will be determined and summarised.

- **Chapter 2** will discuss common inadequacies in the practice of time keeping. Exercises, substantiated by the findings of Chapter 1, will be developed to address these shortcomings.

- The format of presentation of industry-standard music instructional literature will be analysed in **Chapter 3**. From the analyses, the most salient methods of presentation will be compiled to develop a format of presentation for the proposed exercises.

- **Chapter 4** will present a complete set of exercises based on those outlined in Chapter 2 according to the format of presentation developed in Chapter 3.

- In **Chapter 5** the substantiation of presented exercises with neurological information will be summarised. Possible further extrapolations of the exercises are discussed.

- **Chapter 6** will consist of a conclusion, summarising the results of this dissertation and providing personal reflection from the author.

GLOSSARY

Time keeping or to ‘keep time’ is defined in this dissertation as the act of physically producing accurate intervals in time, in the context of music.

In this dissertation, the term ‘**burying the click**’ is defined as the phenomenon of an individual achieving absolute synchronisation with a metronome so as the metronome can no longer be heard.

Metronome ‘**click**’ or ‘**clicks**’ refers to the sound produced from a metronome.

Quantisation is defined in this dissertation as the process of using software to precisely reposition recorded material according to a particular subdivision.

In this dissertation **play along tracks** are defined as a recorded accompaniment for a student to practice with. These tracks exclude the recorded material of the chosen instrument so that the students can perform the part themselves.

BPM is an abbreviation of beats per minute: the system of measurement for tempo.

LITERATURE REVIEW

Neurological Literature

Stein's book The Genius Engine explores the functions of the prefrontal cortex of the human brain. Published in 2007, the information is up to date and relevant, and will be used to discuss cognitive factors of time keeping. Stein states that, “The PFC owns time... To organize your actions, you need a neural mechanism to integrate them across time.”[3] These quotes are pertinent to the review of the cognitive factors of time keeping and will be discussed in Chapter 1.1

2011 *New Ideas in Psychology* journal article, *The intrinsic link between motor behaviour and temporal cognition* by Cassenti, proposes that motor behaviours aid timing by offering an array or processes that consistently take a certain amount of time to accomplish.[4] This article is useful as it outlines the two main view points on what form the internal time keeper of the human brain takes, and introduces a new perspective that is based on motor behaviour. This will be integrated in Chapter 1.1. The exercises developed in this dissertation are compliant to all three mentioned models of the internal timekeeper in the human brain.

From the Journal of Experimental Psychology: Human Perception and Performance 2005, Krampe, Mayr and Kliegl's *Timing, Sequencing, and Executive Control in Repetitive Movement Production,* demonstrates that the timing and sequencing of target durations

[3] K. Stein, *The Genius Engine* (John Wiley & Sons, Inc., 2007).
[4] Daniel N. Cassenti, “The intrinsic link between motor behaviour and temporal cognition,” *New Ideas In Psychology* 29 (2011): 72-79.

require low-level timing and executive control.[5] This article contains a useful quote with regards to the cognitive factors of time keeping discussed in Chapter 1.1:

> *Complex rhythm production requires the precise timing of intervals, such that their absolute and relative durations as well as their adequate sequencing are respected.*[6]

Shadmehr and Holcomb's *Neural Correlates of Motor Memory Consolidation* (1997), uses functional imaging of the brain to demonstrate that '*within 6 hours after completion of practice, while performance remains unchanged, the brain engages new regions to perform the task'* and that '…*this shift is specific to recall of an established motor skill and suggests that with the passage of time, there is a change in the neural representation of the internal model and that this change may underlie its increased functional stability'.*[7] This information is discussed in Chapter 1.1 to highlight the importance of long-term practice of motor skills.

Consolidation of motor memory (2006), by Krakauer and Shadmehr, reviews whether motor memory consolidates in a manner analogous to declarative memory.[8] This article contains valuable up to date information on how muscle memory functions and will be used to highlight the importance of inputting physical tasks correctly from the first instance. This will be discussed in Chapter 1.2

A 2004 Canadian Journal of Experimental Psychology article, *Benefits and Limits of Explicit Counting for Discriminating Temporal Intervals,* states that segmenting temporal

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[5] Ralf Th. Krampe, Ulrich Mayr and Reinhold Kleigl, "Timing, Sequencing and Executive Control in Repetitive Movement Production," *Journal of Experimental Psychology: Human Perception and Performance* 31, no. 3 (2005): 379-397.
[6] Ibid.
[7] Reza Shadmehr and Henry H. Holcomb, "Neural Correlates of Motor Memory Consolidation," *Science* 227, no. 5327 (1997): 821-825.
[8] John W. Krakauer and Reza Shadmehr, "Consolidation of Motor Memory," *TRENDS in Neurosciences* 29, no. 1 (2006): 58-64.

information into smaller parts helps to process it.[9] The authors, Grondin, Ouellet and Roussel compare the benefits of explicit counting in temporal discrimination tasks and show the limits of that strategy. The results of the experiments are evidence of the need to quantify the space between timed events in order to accurately judge them. The author of this dissertation proposes that the more accurate and consistent one's own form of 'counting' is, the more accurate and consistent one will be with judging the greater interval durations.

Daniel Levitin's international bestseller *This Is Your Brain On Music* is a 2006 publication that discusses how the human brain is functioning when an individual is experiencing music.[10] Formerly a session musician, sound engineer, and record producer, Levitin now holds the James McGill Chair at the Laboratory for Musical Perception, Cognition, and Expertise at McGill University. This two hundred and seventy six page publication is a prime example of literature that connects the neuroscience and music fields of expertise.

Brown's 1997 *Perception & Psychophysics* journal article, *Attentional resources in timing: Interference effects in concurrent temporal and nontemporal working memory tasks,* determines the following:

> *Time perception is probably handled by general purpose processing resources. These are the same resources used by an executive mechanism to integrate information, coordinate actions, and oversee multitask processing.*[11]

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[9] Simon Grondin, Bastien Ouellet and Marie-Eve Roussel, "Benefits and Limits of Explicit Counting for Discriminating Temporal Intervals," *Canadian Journal of Experimental Psychology* 58, no. 1 (2004): 1-12.
[10] D. Levitan, *This Is Your Brain On Music* (Atlantic Books, 2006).
[11] Scott W. Brown, "Attentional resources in timing: Interferences effects in concurrent temporal and nontemporal working memory

Timing is very sensitive to cognitive demands…Timing is also affected by even relatively light processing loads… This susceptibility to cognitive workload occurs because any nonautomatized task probably taps into general-level resources to some degree.[12]

Timing disrupts concurrent nontemporal task performance to the extent that the nontemporal task uses the same general executive resources used by timing.[13]

Temporal interval production and processing in working memory, a 1995 journal article by Fortin and Breton, includes a significant quote with regards to temporal cognition: *'…interference between processing in working memory and time estimation suggests that working memory, defined as a works space for active processing of current information, contributes to time estimation.'*[14]

Magill and Hall's 1990 *Human Movement Science* article *A Review of The Contextual Interference Effect in Motor Skill Acquisition* contains relevant information with regards to motor learning. The contextual interference effect is explained as '…*a learning phenomenon where interference during practice is beneficial to skill learning'.*[15] In the context of an instructional setting the authors state that *'Results of research supporting this effect indicate that the way in which an instructor organizes the practice sessions will*

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tasks," *Perception & Psychopysics* 59, no. 7 (1997): 1118-1140.
[12] Ibid.
[13] Ibid.
[14] Claudette Fortin and Richard Breton, "Temporal Interval Production and Processing in Working Memory," *Perception & Psychopysics* 57, no. 2 (1995): 203-215.
[15] Ricahrd A. Magill and Kellie G. Hall, "A Review of the Contextual Interference Effect in Motor Skill Acquisition," *Human Movement Science* 9 (1990): 241-289.

influence the degree of skill learning that will result from practice.'[16] It is then made clear that while suggestions can be made in regards to instructional applications based on the contextual interference effect, more information about the task and student boundary limits are required so that instructors can be given more specific guidelines of how to take advantage of the contextual interference effect.[17]

2002 *Steven's Handbook of Experimental Psychology* article *Music Perception and Cognition,* written by Timothy Justus, is a review of the major findings in the music perception and cognition field of cognitive psychology. Justus defines music perception and cognition as an, '…*area of cognitive psychology devoted to determining the mental mechanisms underlying our appreciation of music'.*[18] Included in this article is useful information about rhythm. Justus makes the following claims:

> *85 to 90 percent of the notated durations in a typical musical piece are of two categories in a ratio of either 2:1 or 3:1 with each other.*[19]
>
> *The limitation of durations to two main categories may result from a cognitive limitation; even musically trained subjects have difficulty distinguishing more than two or three duration categories in the range below two seconds.*[20]
>
> *Listeners distort near-integer ratios towards integers when repeating rhythms, and musicians have difficulty reproducing rhythms that cannot be represented as approximations of simple ratios.*[21]

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[16] Ibid., 11
[17] Ibid.
[18] Timothy C Justus and Jamshed J. Bharucha, "Music Perception and Cognition," *Steven's Handbook of Experimental Psychology* 1, no. 3 (2002): 453-492.
[19] Ibid.
[20] Ibid.
[21] Ibid.

Repp's 2010 *Music Perception* article, *Self-Generated Interval Subdivision Reduces Variability of Synchronisation With a Very Slow Metronome*, highlights some important information regarding subdividing. An important finding in this article is that anti-phase tapping, tapping only at the bisection of a temporal interval, is less variable than in-phase tapping and depend less on the immediately preceding taps.[22] This finding substantiates the proposed exercise in this dissertation strongly.

A filled duration illusion in music: Effects of metrical subdivision on the perception and production of beat tempo, a 2009 study by Repp and Bruttomesso replicates and extends previous findings suggesting that metrical subdivision slows the perceived beat tempo.[23] This is evidence of the existence of present day research pertaining to subdivisional studies.

1997 *Annual Review of Psychology* article, *Music Performance* by Caroline Palmer, includes relevant information pertaining to the research topics of this dissertation:

> *Research on the planning of musical sequences for production is reviewed, including hierarchical and associative retrieval, style-specific syntactic influences, and constraints on the range of planning.*[24]
>
> *The fine motor control evidenced in music performance is discussed in terms*

[22] Bruno H. Repp, "Self-Generated Interval Subdivision Reduces Variability of Synchronization With a Very Slow Metronome," *Music Perception* 27, no. 5 (2010): 389-397.
[23] Bruno H. Repp and Meijin Bruttomesso, "A filled duration illusion in music: Effects of metrical subdivisions on the perception and production of beat tempo," *Adv Cog Psychol* 5 (2009): 114-134.
[24] C. Palmer, "Music Performance," *Annual Review of Psychology* 48 (1997): 115-138.

of internal timekeeper models, motor programs, and kinematic models.[25]

Music Instructional Literature

John Riley's *The Art of Bop Drumming* is a contemporary industry-standard text for developing bebop drumming skills. Although first published in 1994, this method book is still widely used in the present day. This text will serve two functions in this dissertation. Firstly, it will contribute to establishing that many current music instructional literatures do not describe specific ways to learn to keep good time. Secondly, the format that the instructional information is delivered in will be analysed and used to form a model of presentation for the proposed exercises. This will be present in Chapter 3.

John Riley has performed with jazz icons such as Stan Getz, Milt Jackson, Miles Davis, Dizzy Gillespie, John Scofield, Bob Mintzer, Gary Peacock, Mike Stern, Joe Lovano, John Patitucci, Bob Berg, and performed in large groups such as the Vanguard Jazz Orchestra, and the Carnegie Hall Jazz Band. Riley holds a Bachelor of Music degree in jazz education, and a Master of Music in jazz studies. He is on the faculty of Manhattan School of Music, The New School, and SUNY Purchase, and is an Artist in Residence at Amsterdam Conservatory, Holland.

Progressive Steps To Syncopation by Ted Reed was first published in 1958 and in its foreword it is listed as one of the most popular drum books ever written. Designed specifically to address syncopation in music, the text fails to mention any method for improving timing of syncopated rhythms other than to '*devote some of your practice time to*

[25] Ibid., 13

playing with a metronome.' (Castiglioni 2011) This helps to strengthen the argument that industry-standard music instructional texts rarely address specific methods for improving accuracy in time keeping.

Clayton Cameron's *Brushworks,* a 2003 instructional text on brush playing in jazz drumming will be analysed in Chapter 3 to contribute to the formation of a model of presentation for the proposed exercises. It is important to note that although this is an instructional text for drummers, there is no mention of specifically how to execute the exercises with accurate timing other than tempo markings at the beginning of each exercise. Popular drumming website Drummerworld says the following about Cameron:

> *Called "genius" by legendary drummer Max Roach, Clayton Cameron has compiled, written and illustrated the most comprehensive material on the subject ever devised. It is the first book to develop a system of notation for brushstrokes and brush-effects that stays within the traditional system and is easy to comprehend.*[26]

Gary Chester's industry standard text *The New Breed* is an instructional publication for drummers, that focuses on reading, coordination, time, feel, and concentration level. Published in 1985, this text is widely used in the international drumming community to the present day. The format of the exercises in this text will be analysed and used to help formulate a model of presentation for the proposed exercises in this dissertation. This is present in Chapter 3. On the topic of timing, Chester covers some important factors, but without great detail or explanation. Chester states that,

[26] Bernhard Castiglioni, *Drummer World: Clayton Cameron*, 18 11 2011, http://www.drummerworld.com (accessed 11 17, 2011).

The most important thing for a drummer is understanding time. This occurs with experience and dedicated practice. There are three basic time feels: on top, in the middle, and behind. You have to find out which time feel works in a particular situation.[27]

With regards to his exercises Chester states that the individual 'should practice with a click track, because in the studio you must be able to work with it'. And that 'practicing the systems with a click will help develop a good sense of time, and will help develop the feel of working with a click.'[28]

This vague depiction of how to develop accurate timing is pertinent example of how industry-standard drumming instructional texts can lack specific methods for developing the skills for accurate time keeping.

Discussing the life of Gary Chester, Drummerworld provides the following quote:

If the subject is great studio drummers, this man's name inevitably comes up, and Gary Chester can also take credit for both writing and co-writing a pair of books that are acknowledged masterworks of drum instruction.[29]

Rhythm and Meter Patterns by Gary Chaffee, is one of four publications under the PATTERNS series. This 1976 publication covers odd rhythms, mixed meters, metric modulation and polyrhythms and is still widely used to this day. Beyond having metronome markings for the exercises, this text does not address how to execute any of the concepts

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[27] Gary Chester, *The New Breed* (New Jersey: Modern Drummer Publications, 1985).
[28] Ibid.
[29] Bernhard Castiglioni, *Drummer World: Clayton Cameron*, 18 11 2011, http://www.drummerworld.com (accessed 11 17, 2011).

with accurate timing. This is another music instructional text that in Chapter 3 will have its format analysed, which will contribute to formulating a method of presentation of the exercises in this dissertation.

Gary Chaffee has performed with music icons such as Pat Metheny, Dave Samuels, Abe Laboriel, Jaco Pastorius, Mike Stern, Steve Swallow, Mick Goodrick, John Abercrombie, Bill Frisell, Palle Danielsson, and Tom Harrell. He was Chairman of the Percussion Department at Berklee College of Music 1972 to 1976. A number of Chaffee's students have gone on to become prominent figures in the contemporary drumming scene in their own right. These include Vinnie Colaiuta, Steve Smith, Jonathon Mover, JR Robinson, Casey Scheuerell, Kenwood Dennard, Joey Kramer and David Beal.

Louie Bellson and Gil Breines'1963 publication *Modern Reading Text in 4/*4, is a text designed to develop accuracy and speed in sight reading through specially designed syncopation studies. This text makes no mention of an approach or method for the student to develop accurate time keeping, it does not suggest the use of a metronome, and does not include tempo settings for the exercises. It advises the student not to move on from an exercise until they are '*able to read the entire study smoothly with equal volume throughout and in strict tempo'*[30]*,* without including how a strict tempo is to be attained.

Bellson has recorded on approximately two hundred albums[31], working with such music legends as Duke Ellington, Count Basie, Benny Goodman, Tommy Dorsey, Woody Herman, Benny Carter, Sarah Vaughan, Ella Fitzgerald, Oscar Peterson, Art Tatum, Dizzy Gillespie, Gerry Mulligan, Stan Getz, Hank Jones, Sonny Stitt, Milt Jackson, Clark Terry, Louie Armstrong, Lionel Hampton, Shelly Manne, Billy Cobham, James Brown, Sammy

[30] Louis Bellson and and Gil Breines, *Modern Reading Text in 4/4* (Alfred Music Publishing, 1963).
[31] Bernhard Castiglioni, *Drummer World: Clayton Cameron*, 18 11 2011, http://www.drummerworld.com (accessed 11 17, 2011).

Davis, Jr., Tony Bennett, Mel Torme, Joe Williams and Wayne Newton.

It's Your Move: Motions and Emotions, written by Dom Famularo and published in 2001 includes a pertinent section on 'practice tips'. Famularo includes poignant tips related to many of the principles discussed in this dissertation. He mentions '*true practice is a re-programming process*'[32] referring to the principle of breaking down old habits and building up new ones. This can be seen as explanation of having to address incorrect muscle memory input. He discusses the necessity of good attention, stating that '*effective practice requires total concentration*'[33], and that '*Staying focused solely on the practice material is the only way to master these techniques.'* Regarding time keeping he instructs to use a metronome, saying that '*it is a very effective tool for fine tuning your time feel.*'[34] Although these concepts are mentioned, Famularo does not provide explicit methods to address these ideas, he only acknowledges they exist.

Dom Famularo is a master drum clinician, having presented masterclasses and clinics all over the world. Some countries include Hong Kong, Japan, Israel, England, Ireland, Scotland, France, Germany, Portugal, Belgium, Italy, Austria, Holland, Switzerland, Sweden, Norway, Turkey, Malaysia, Singapore, Phillipines, Indonesia, New Zealand, Australia, Mexico, Canada, and the United States.[35]

Analysis of Contemporary Drumming, written by Graham Morgan and published in 1999, is a drum set instructional text covering a multitude of topics comprised of 20 sections. Under the title of 'A modern physical and conceptual approach', the last sentence of the introduction to the text reads, '*Apart from your desire to improve learn and work on hand*

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[32] Dom Famularo, *It's Your Move: Motions and Emotions* (Faber Music Ltd, 2001).
[33] Ibid.
[34] Ibid.
[35] Bernhard Castiglioni, *Drummer World: Clayton Cameron*, 18 11 2011, http://www.drummerworld.com (accessed 11 17, 2011).

control, (sic) two important aids for this first section are a clock and a metronome.'[36] Beyond tempo markings for selected exercises, there is no mention of any procedure to address the student's time keeping.

Graham Morgan held the position of staff drummer for Australian television station GTV-9 for over twenty years. He has performed with internationally reputable artists such as John Farnham, Dame Kiri Te Kanawa, Clark Terry, Carmen McRae, Freddie Hubbard, and the Melbourne Symphony Orchestra. Morgan has performed on hundreds of television commercials, radio commercials and film scores during the 1960's to 1990's.[37]

Two Drummers Collective Series publications, *Brazilian Rhythms For Drumset* (1991)*,* and *Afro-Cuban Rhythms For Drumset* (1990), written by Duduka Da Fonseca & Bob Weiner, and Frank Malabe & Bob Weiner respectively, are industry-standard texts pertaining to world music. There is no mention of metronome use in either publication, and therefore methods for training students in metronomically accurate time keeping do not exist.

The Drummers Collective was founded in New York City in 1977 by a small group of professional musicians and was accredited by the National Association of Schools of Music in 2006. The Drummers Collective was the birthplace of the world-famous DCI Music Video Company. Some Alumni include Billy Martin, Anton Fig, Shawn Pelton, Zach Danziger, Wil Calhoun, Tal Wilkenfeld, and Chris Coleman.[38]

The examined drumset texts, drawn from a range of dates and covering diverse styles, are all industry-standard method books developed by highly respected drum performers and

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[36] Graham Morgan, *Analysis Of Contemporary Drumming* (Melbourne: Musos Publications, 1999).
[37] Ibid.
[38] The Collective, *The Collective*, 18 11 2011, http://www.drummerscollective.com (accessed 11 16, 2011).

educators, and form a reasonable cross-section of the available instructional material. As such, the noticeable lack of information in this literature detailing specific processes for the training of accurate time-keeping can be considered indicative of a wider deficiency in this area.

The following two texts have been included to supplement diversity to the format or presentation model.

Franz Simandl's *New Method For The Double Bass,* revised by Frederick Zimmerman, is a method book for the double bass. Published in 1984, this fourth edition text has been widely used in the international double bass community, being published in multiple languages. In Chapter 3 the format of the instructional literature will be analysed and used to formulate a method of presentation for the exercises proposed in this dissertation.

The Art of Comping by Jim NcNeely, is a instructional method book for developing piano comping in a jazz setting. Published since 1992, this text is widely used in the international jazz piano community. It too will have its format of instructional information analysed in Chapter 3 to compile a model for presenting the proposed exercises.

Popular performance psychology publication *The Inner Game of Music* (1987) includes information on teaching and learning that is relevant to the presentation of the proposed exercises. In Chapter 10 of the publication, Green discusses the negative factors of 'do this' instructions and the positive factors of 'awareness' instructions, and includes ways of transforming 'do this' instructions into 'awareness' instructions. This information will be summarised in Chapter 3.1 and used as a template for the written format of the proposed exercises.

Chapter 1: Review of the relevant neurological information pertaining to accurate time keeping

1.1 Cognitive mechanisms

The cognitive mechanisms behind human temporal processing have been debated for decades without an explicit resolution. Temporal cognition is a skill set that mentally computes time intervals. The term encompasses tasks including temporal production: behaviourally marking a time interval, or temporal estimation: communicating the perceived length of an interval by itself or in comparison with other intervals. Researchers of temporal cognition agree there is an internal time keeper, but disagree with the form this time keeper takes. Two common models are expressed. One, the timekeeper is a set of oscillators with each producing a unique beat. The beats are arranged in a multitude of different combinations to reproduce one interval, and error within each oscillating mechanism contributes to the overall error in the estimation of duration. Two, the timekeeper is more like a clock, having a single small unit of time that can reproduce any interval larger than one of these individual units. Error in duration estimation results from random beat interval errors from the clock.[39] Cassenti offers a recently developed third model, proposing that motor behaviours aid timing by offering an array or processes that consistently take a certain amount of time to accomplish. This model will be discussed in Chapter 1.2.1.

For an individual to be successful at physically producing accurate intervals in time, they need to be successful with accurately measuring intervals or durations in time. Intricate rhythm production demands the explicit timing of intervals, such that their absolute

[39] Daniel N. Cassenti, "The intrinsic link between motor behaviour and temporal cognition," *New Ideas In Psychology* 29 (2011): 72-79.

durations, relative durations, and their sufficient sequencing are respected.[40] The prefrontal cortex (PFC) is the area of the brain generally understood to process higher level cognition, with functions including monitoring execution of motor behaviour for errors, which includes sequencing and timing.[41] When time keeping, while physically outputting successive actions, our brains are monitoring our past actions and predicting the future actions, all in the space of now. This multitasking is a unique ability of the PFC and falls under the general category of 'working memory'.[42]

Oxford Dictionary describes working memory as 'the part of short-term memory which is concerned with immediate conscious perceptual and linguistic processing'. Working memory plays a role in the estimation of time.[43] Stein claims that working memory comprises the mind's central operating system for thinking-in-time, and quotes Fuster as saying that it is essential for the "execution of successive acts in a structure of behaviour over time".[44] This is a fitting description of the act of time keeping itself.

Another function of the prefrontal cortex, and an important factor of time keeping, is the role of attention over time. Attention comes in three forms:

1) Focus; attention as keeping a representation of a sensory percept zeroed in over short time periods.

2) Effortful attention; dedication, perseverance, maintenance of discipline. This form is unavoidably connected to motivation, will, desire.

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[40] Ralf Th. Krampe, Ulrich Mayr and Reinhold Kleigl, "Timing, Sequencing and Executive Control in Repetitive Movement Production," *Journal of Experimental Psychology: Human Perception and Performance* 31, no. 3 (2005): 379-397.
[41] Daniel N. Cassenti, "The intrinsic link between motor behaviour and temporal cognition," *New Ideas In Psychology* 29 (2011): 72-79.
[42] K. Stein, *The Genius Engine* (John Wiley & Sons, Inc., 2007).
[43] Claudette Fortin and Richard Breton, "Temporal Interval Production and Processing in Working Memory," *Perception & Psychopysics* 57, no. 2 (1995): 203-215.
[44] K. Stein, *The Genius Engine* (John Wiley & Sons, Inc., 2007).

3) Exclusionary, inhibitory attention; repels the ceaseless stream of sensory information that the brain is exposed to, and runs interference against distracting thoughts.[45]

These three forms of attention are vital to efficient practice. The first form to monitor what we are doing is correct, the second form for daily repetition and regular practice, and the third for being able to stay on task while practicing.

Like any function of the brain, working memory and the performance of the PFC, varies between each individual. Stein recalls Goldman-Rakic as saying,

> *Everyone person has delay cells in his prefrontal cortex...but some people may have wonderful cells that fire for fifteen seconds, during which time that person could integrate volumes of information... Whereas in another person those same cells will only do it for three seconds... If there is a bell curve for intelligence, there is probably one for working memory capacity.*[46]

An individual's ability to efficiently, accurately and correctly input the skills required to physically manifest accurate temporal intervals, and indeed their success with the output of the skills, will be governed by the capability of their PFC and therefore their working memory capacity.

[45] Ibid., 22
[46] Ibid.

1.1.1 Subdividing

Research shows that segmenting temporal information into smaller parts helps to process it.[47] The same is true in music performance, where subdividing the beat into smaller fractions can improve the temporal accuracy as the margin for error is decreased. Although subdividing does indeed improve variability of synchronisation with a metronome[48], without an already accurate time keeping ability our own subdividing must also be inherently flawed.

1.2 Motor learning

A vital piece of information to consider, when exploring the *physical manifestation* of accurate temporal intervals, is regarding motor learning, or, how we learn physically. What we input, through practice, is what will be output during performance of the task. Motor memory is consolidated through savings in performance over several trials. Consolidation is defined as a set of processes whereby a long-term memory becomes more stable with the passage of time. 'Savings' refers to relearning at a more rapid rate and complete form than in comparison to the rate of initial learning.[49] With this in mind, it is extremely important that the skills are correctly input from the first instance, versus attempting to edit the ingoing information as the practice continues. This information, when put to good use, leads to *results* driven practice and not *intent* driven practice.

Research shows that within six hours after completing practice of a task, the performance

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[47] Simon Grondin, Bastien Ouellet and Marie-Eve Roussel, "Benefits and Limits of Explicit Counting for Discriminating Temporal Intervals," *Canadian Journal of Experimental Psychology* 58, no. 1 (2004): 1-12.
[48] Bruno H. Repp, "Self-Generated Interval Subdivision Reduces Variability of Synchronization With a Very Slow Metronome," *Music Perception* 27, no. 5 (2010): 389-397.
[49] John W. Krakauer and Reza Shadmehr, "Consolidation of Motor Memory," *TRENDS in Neurosciences* 29, no. 1 (2006): 58-64.

of the task remains unaltered, while new regions of the brain are engaged to perform the task. The shift in regions is specific to recall of an already established motor skill, and suggests that through time the neural representation of the internal model changes, and that this change underlies its increased functional stability.[50] This information substantiates the need for ongoing or daily repetition in successfully learning a new motor skill, as the passage of time is a part of the process in being able to recall the skills more efficiently.

1.2.1 Motor behaviour and temporal cognition

Cassenti, in his article *The intrinsic link between motor behaviour and temporal cognition*, presents the idea that motor behaviours, or sequences of motor behaviours, provide a means of reproducing time intervals. This differs from the aforementioned traditional viewpoints of temporal cognition. Evidence for this theory includes tapping strategies, counting strategies, and neuropsychological results of motor areas activating during temporal cognitive tasks. It is proposed that motor behaviours help timing by offering an array of processes that consistently take a set amount if time to accomplish. Motor behaviours also allow partitioning of larger intervals into smaller intervals, becoming easier to estimate.[51]

If Cassenti's theory is true then a set of exercises that input metronomically accurate muscle memory will aid timing as the motor mechanisms themselves will be what the intervals of time are judged from. This heavily reinforces the need for the correct muscle memory to be input in the first instance, because if the ingoing muscle memory information is inconsistent or constantly changing, there is a chance that the individual's judgement of

[50] Reza Shadmehr and Henry H. Holcomb, "Neural Correlates of Motor Memory Consolidation," *Science* 227, no. 5327 (1997): 821-825.
[51] Daniel N. Cassenti, "The intrinsic link between motor behaviour and temporal cognition," *New Ideas In Psychology* 29 (2011): 72-79.

time will reflect this.

1.3 Summary of neurological factors influencing time keeping

Researchers of temporal cognition agree there is an internal time keeper, but disagree with the form this time keeper takes. The two commonly accepted models are:

1) The timekeeper is a set of oscillators with each producing a unique beat. The beats are arranged in a multitude of different combinations to reproduce one interval.

2) The timekeeper is more like a clock, having a single small unit of time that can reproduce any interval larger than one of these individual units.

For an individual to be successful at physically producing accurate intervals in time, they need to be successful with accurately measuring intervals or durations in time. The prefrontal cortex (PFC) is the area of the brain generally understood to process higher level cognition, with functions including monitoring execution of motor behaviour for errors, which includes sequencing and timing.

An individual's ability to accurately and correctly input the skills required to physically manifest accurate temporal intervals, and their success in outputting the skills, is governed by the capability of their PFC and therefore their working memory capacity. This includes their strength in the three forms of attention:

1) Focus; attention as keeping a representation of a sensory percept zeroed

in over short time periods.

2) Effortful attention; dedication, perseverance, maintenance of discipline. This form is unavoidably connected to motivation, will, desire.

3) Exclusionary, inhibitory attention; repels the ceaseless stream of sensory information that the brain is exposed to, and runs interference against distracting thoughts.[52]

Muscle memory consolidates through savings in performance over multiple repetitions. This means that whatever is input through practice is what will be output in performance. This information highlights the importance of inputting muscle memory correctly from the first instance, rather than editing incorrect muscle memory habits. This can be seen as analogous to 'treating the cause and not the symptoms'. The passage of time can be seen to play a part in the improved recall of a new motor skill, which would suggest that practice over the long term is required to increase the stability of the motor skill.

[52] K. Stein, *The Genius Engine* (John Wiley & Sons, Inc., 2007).

Chapter 2: Development of proposed exercises through analysis of neurological information

A common prescription to improve time keeping is to simply practice with a metronome, and to subdivide the beat. A typical exercise includes setting a metronome on quarter notes and asking the individual play simple rhythms against it for a number of minutes. These usually comprise of a constant rate of quarter notes, eighth notes and sixteenth notes. The intent is to subdivide the space between the quarter notes from the metronome, and in turn learn to measure each different subdivision. Success is deemed when, if accurate, the individual will no longer hear the metronome, a term often called 'burying the click'.

There are a number of problems with this kind of approach:

- As mentioned in Chapter 1.1.1, while subdividing improves variability of synchronisation with a metronome[53], without an already accurate time keeping ability our own subdividing must also be inherently flawed.

- If successful, the individual is already able to play in time, making the exercise unnecessary.

- If unsuccessful, that is if the metronome can still be heard, the individual is at some point or at many points not keeping accurate time. As mentioned in chapter 1.2,

[53] Bruno H. Repp, "Self-Generated Interval Subdivision Reduces Variability of Synchronization With a Very Slow Metronome," *Music Perception* 27, no. 5 (2010): 389-397.

what is input through practice is what will be output in performance. With this understanding it could be seen as counterproductive to pursue this method, as the information being input is not conducive to the desired output. The physical manifestation of accurate temporal intervals is not taking place, and therefore is not being input into the muscle memory of the individual, and rather, an inaccurate approximation of precise time keeping is being input instead. The individual is intending to play in time but not actually accomplishing it.

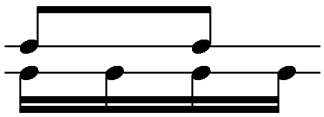
- The indicator of success is when the metronome can no longer be heard. When the individual is attempting to tap in synchronisation to the quarter note, the only feedback is after each tap. There is no feed back of how accurate the tap is about to be before it takes place. There is only one of two results; correct- the metronome click was not heard, or incorrect- the metronome could still be heard. This response of right or wrong does not give any scope on how to improve the individual's accuracy, beyond whether they have tapped slightly before or after the metronome.

A more efficient method is to have feed back at a more frequent rate; an indicator of success with synchronisation and an indicator of success with subdividing. A simple way for an individual to achieve this is as follows:

Example Exercise A

- Set a metronome to 60 BPM with the sixteenth note subdivisions on.
- Clap or play, if a percussive instrument, at an eighth note rate.

Note that the claps are written as the top line of notation.



1 e & ah

The indicator of success is when the only audible 'clicks' from the metronome are on the 'e' and 'ah' counts. The individual should hear, clap-click-clap-click etc. This exercise is a more efficient method than the previously mentioned exercise because of the following:

- There is instant and constant feedback from the metronome as to the placement of the desired eighth note rate.

- Because the metronome is at a rate of twice what the individual is clapping, the 'clicks' on the 'e' and 'ah' are exact bisections of the space between where the individual is intending to place their claps. This extra reference point lets the individual judge more precisely where the claps should be placed, as they are now being exposed to the accurate subdivisions of the beat.

In order for individuals to eventually be able to keep accurate time of their own accord, a process of weaning from the metronome must begin. Research shows that anti-phase tapping, that is tapping in between metronome 'clicks', is more accurate than in-phase tapping.[54] Another piece of information to consider is the motor learning fundamental of repetition. As mentioned in chapter 1.2, muscle memory is consolidated through repetition of a task. Therefore a logical next step would be to keep the muscle memory consistent, clapping at the same rate and rhythm, and have the metronome click only on the 'e' and

[54] Ibid., 28

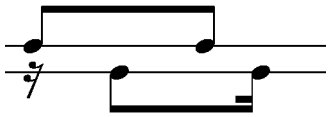
'ah'. The procedure would be as follows:

Example Exercise B

- Set a metronome to 60 BPM with the eighth note subdivisions on.

- Perceive the metronome 'clicks' to be falling on the 'e' and 'ah' counts.

- Clap or play at an eighth note rate, starting on the ‘1’.



1 e & ah

When accurate, this exercise will sound identical to the previous one: clap-click-clap-click etc. Familiarity and success with exercise A is crucial, as whether or not B sounds identical is the prime indicator of success in this exercise. The individual can also record themself practicing to assess their accuracy objectively.

This weaning process would continue, removing another metronome reference point, while keeping the muscle memory consistent. The procedure would now be as follows, with two variations to cover both possible metronome placements:

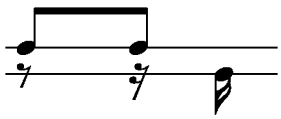
Example Exercise C

A)

- Set a metronome to quarter notes at 60 BPM.

- Perceive the metronome 'click' to be falling on the 'ah' count.

- Clap or play at an eighth note rate, starting on the ‘1’.



1 e & ah

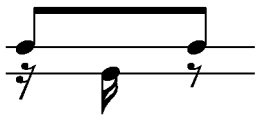
When accurate, the individual should hear clap-REST-clap-click.

B)

- Set a metronome to quarter notes at 60 BPM.

- Perceive the metronome 'click' to be falling on the 'e' count.

- Clap or play at an eighth note rate, starting on the ‘1’.



1 e & ah

When accurate, the individual should hear clap-click-clap-REST.

These two exercises are still taking advantage of the anti-phase tapping principle.

To summarise, the procedure begins with the metronome outputting not only what the individual is aiming to play but also the subdivisions in between, then the exercises enter into a process of weening from the metronome, utilising anti-phase tapping where applicable. This procedure will be applied to a number of different rates: 8^{th} notes, single 16^{th} notes, groups of two 16^{th} notes, groups of three 16^{th} notes, single triplet notes, and groups of two triplet notes. The exercises introduce the physical manifestation of accurate timekeeping as short cyclic rhythms or as a consistent rate, of which more elaborate rhythms can then be created from.

Another factor to address in developing an efficient practice method is the duration of the exercises. As mentioned in Chapter 1.1, attention is vital to successful practice. If an individual's mechanism for monitoring whether or not they are executing the correct procedure isn't functioning properly, there is a great chance the muscle memory will be input incorrectly or inconsistently. With this in mind, a logical method would be to only practice each exercise for as long as the desired result can be achieved. Many students make the mistake of persevering with an exercise for extended periods of time with the intent of improving errors that begin to occur, when their attention has lapsed early on and they are potentially undoing the few minutes of correct muscle memory that was input initially. To combat this, specific duration goals for each exercise are defined:

- Four bars of accurate time keeping.
- Eight bars of accurate time keeping.
- Sixteen bars of accurate time keeping.

Then onto longer, timed durations:

- Thirty seconds of accurate time keeping.
- One minute of accurate time keeping.

Once the previous time frame is achieved the individual can progress to the next duration. Once all durations are complete the individual can increase the tempo and begin the process again.

Chapter 3: Analysis of industry-standard music instructional literature and formulation of presentation for proposed exercises

3.1 Analysis of format of presentation

John Riley's *The Art Of Bop Drumming* presents its musical instruction in a logical, sequential manner. It first offers an introduction to the text. This is followed with explanations of the forthcoming techniques and exercises using written text and musical notation. Then, accompanying the various techniques and exercises are demonstrations by the author via a compact disc included with the publication. Riley substantiates his concepts and techniques by including relevant quotes throughout the publication from leading drummers of the Bop eras. Finally, the student can participate in employing the learned techniques and concepts via six play along tracks included in the aforementioned compact disc.

Summary of the format of presentation for *The Art Of Bop Drumming*:

- Introduction to the publication.
- Explanation of techniques/exercises.
- Presentation of exercises.
- Demonstration of techniques/exercises by author.
- Substantiation of techniques using quotes from leading Bop drummers throughout publication.

- Participation of techniques/exercises by student via six play along tracks, minus drums.

The Art Of Comping by Jim NcNeely trains students in the various techniques of jazz piano comping. There are six pieces to practice with which are available via an included compact disc. There are two versions of each piece; one with the author playing the piano part, and one without the piano so the student can participate using the techniques and concepts covered in the publication. The format of presentation of instructional material is methodical and simple to follow. After a written introduction of the text, NcNeely instructs the student to listen to the complete piece, focusing in on the piano comping, then presents a written explanation of the form and feel for the specific piece. Then he follows a written analysis of his playing, specifically his comping, in said piece. Then, the musical notation of the piece with suggested exercises are presented. The exercises are both in written text and musical notation. The student is then invited to begin employing these techniques by playing along to the version of the piece that has no piano included. This format repeats for the six pieces presented in this publication.

Summary of the format of presentation for *The Art Of Comping*:

- Introduction to the publication.
- Demonstration of techniques by author via CD recording.
- Explanation of piece.
- Analysis of author's demonstration of techniques.
- Explanation of suggested exercises to develop such techniques.
- Participation of techniques/exercises by student via play along tracks, minus piano.

An analysis of the format of presentation for Clayton Cameron's *Brushworks*, runs parallel to Riley's *The Art Of Bop Drumming,* with it too following a logical format. Firstly there is a written introduction of the text. Then techniques and concepts are discussed, followed by an explanation and presentation of exercises in both written text and musical notation. Included are demonstrations by Cameron via a comprehensive ninety nine track compact disc, which culminates in a play along track for the student to practice the newly developed skills with.

Summary of the format of presentation for *Brushworks*:

- Introduction of publication.
- Explanation of techniques/exercises.
- Presentation of exercises.
- Demonstration of techniques/exercises by author.
- Participation of techniques/exercises by student via a play along track, minus drums.

Gary Chester's *The New Breed* uses a simple format of presentation. There is first a written text introduction, covering the various concepts and ideas behind Chester's exercises. This includes methods for how to go about practicing the exercises. The exercises themselves are then presented using musical notation. After the initial volumes of exercises are presented, there is a second written explanation for the following volume of exercises. This publication does not include demonstrations by the author of any kind.

Summary of the format of presentation for *The New Breed*:

- Introduction to publication.
- Explanation of techniques/exercises.
- Presentation of exercises.
- A second explanation of techniques/exercises.
- A second presentation of exercises.

Rhythm & Meter Patterns by Gary Chaffee follows a similar format of presentation that Riley's *The Art Of Bop Drumming*, and Cameron's *Brushworks* employ. It begins with a written introduction to the techniques and concepts that are covered. It then moves on to the presentation of exercises using both written text and musical notation. The significant difference with this publication compared to the previously mentioned titles, is the demonstration of exercises by Chaffee via included compact disc. Not only does Chaffee demonstrate the exercises, he provides spoken instruction of greater length and detail than the written forms in the publication.

Summary of format of presentation for *Rhythm & Meter Patterns*:

- Introduction to publication.
- Explanation of techniques/exercises.
- Presentation of exercises.
- Demonstration of techniques/exercises by the author, including more detailed spoken instructions/concepts pertaining to exercises.

The format of presentation for *New Method For The Double Bass* by Franz Simandl follows a simple logical approach. There is first a written introduction to the publication, including 'supplementary possibilities' for how to use the text. Following this are written

instructions of the exercises and the exercises themselves in musical notation. This approach of presentation of written instructions and exercises in musical notation is repeated over the five chapters that make up the publication. There are no demonstrations of exercises/techniques by the author.

Summary of format of presentation for *New Method For Double Bass*:

- Introduction to publication.
- Explanation of techniques/exercises.
- Presentation of exercises.
- Process repeated over 5 chapters.

3.1.2 Summary of instructional concepts in Green's *The Inner Game Of Music*

In chapter 10 of Green's *The Inner Game of Music*[55], Green describes the problem with 'do this' instructions is that they ask the student accomplish particular results that the student may not necessarily believe they can achieve: '*Make sure you don't slow down*', *'Play up on the beat', 'Make sure it grooves'.*

Green lists ways in which the student may be unable to translate the instruction into a physical action:

- They may not comprehend what is required of themselves; 'What is up on the beat?', 'What does groove mean?'.

[55] Barry Green, *The Inner Game Of Music* (Pan Books , 1987).

- The student may understand the instruction but not understand how to achieve the desired result physically; 'I can't seem to keep the beat steady'. Self-doubt may also occur when the student's body doesn't seem able to produce the result their teacher is asking of them.

- The student may understand the instruction, but lack the physical facility to execute the task; 'I can't play that fast'.

- At times the instructions are inaccurate, or contradict the student's own experience; 'That doesn't look right to me', 'Mr Smith told me not to do that'.

- The instructions may be accurate and the student may be able to achieve the desired physical results, but when too many instructions are given to the student in succession, it may overload the student's mind; 'I'm confused, how can I slow down if I'm up on the beat?'

- The student may be perfectly able to follow the instructions, but not retain them at a later date.

- There may be times when the student simply doesn't agree with the instruction, and their attention is partly preoccupied trying to find other ways to solve the problem.

Green goes on to explain that instructions that include the phrase, 'try to...' are also likely to cause problems, as the suggestion of 'trying' creates doubt in out ability to succeed.

Green explains that 'awareness instructions' can change how a student thinks about the situation. They draw upon the student's personal experience; their ability to learn by noticing what is happening. They don't involve 'correct' or 'incorrect' procedures, nor do they involve complex systems of steps that could be easily confused or forgotten. They do not ask more of the body than it is capable of producing, nor do they create doubt. Because of these factors, awareness instructions liberate students from doubt, confusion, frustration and discouragement. Awareness instructions, or exercises, ask only for the conscious mind to pay attention to what is happening, not to what is correct or incorrect.

Green lists some examples of signals that a 'do this' instruction is about to be given. They include:

- *Do such and such.*
- *This is difficult, but...*
- *Play it this way.*
- *Make it better.*
- *Please try harder.*
- *Now relax.*
- *Let's get it right this time.*

He then lists examples of alternate phrases that emphasise the student's awareness and experience. They include:

- *Be aware of...*
- *Listen for...*
- *How does it feel when...*
- *Tell me the difference you notice between...*

- *What do you hear when...*
- *Pay attention to the...*
- Let's see if...
- Notice the feeling you get when...

3.2 Summary of analysis, and devised presentation for proposed exercises

By compiling the analyses of the selected music instructional texts, the following three consistencies can be seen:

- The author provides an introduction to the text.
- The author gives a written explanation of the techniques/material to be learned.
- The author presents the exercises using both written text instructions and musical notation.

The proposed exercises in this dissertation will follow this format and will also include demonstrations of exercises via compact disc, as performed by the author. This method of presentation is evident in the majority of the analyses of the selected music instructional texts. The written text instructions will be formatted as 'awareness' instructions and not 'do this' instructions, as modelled from chapter 10 of Green's *The Inner Game of Music.* The exercises will be notated with standard music notation.

Chapter 4: Presentation of exercises

4.1 Introduction

This instructional text is designed to provide musicians with a new and efficient approach to time keeping. The following forty-eight exercises involve a process of exposing the student to precisely where an intended rhythm is placed through acknowledging the subdivisions that are not being played by the student. The exercises then gradually ween the student from reliance on the metronome so that they may keep accurate time of their own accord. Being able to attain synchronisation with a metronome is important but true time keeping must be a skill of an individual alone, without any devices or external reference points.

4.2 Explanation of exercises

The exercises included in this text are designed to efficiently develop the student's time keeping ability in the following ways:

- By heightening the awareness and accuracy of the subdivisions of the beat, particularly the subdivisions that are not being played by the student.
- By inputting the correct, temporally accurate, muscle memory required for accurate time keeping.
- By putting a time limit on exercises so as to combat ingraining incorrect muscle

memory due to the student's concentration lapsing.

The following exercises all require the use of a metronome. The author suggests that the use of sequencing software or a drum machine is the ideal choice of metronome, as most standard metronomes do not offer the following features:

- Specific rhythms or groupings of subdivisions that can be programmed in.
- Specific sounds can be used, ideally high-pitched sounds with as short a length as possible.
- High rates of tempo or subdivisions can exist without pitch differences or accents.

These features are necessary for the exercises included in this instructional text.

Each exercise is listed as starting at 60 BPM. Once each of the following time frames is achieved, the tempo can increase and the exercises can be addressed at the new tempo. The author suggests increments of 10 BPM, or 5 BPM if the change in tempo is too big a challenge.

The exercises are all notated as being one beat in duration, but are designed to be repeated continuously to so as to be able to attain the following durations in 4/4 time signature:

- Four bars of accurate time keeping.
- Eight bars of accurate time keeping.
- Sixteen bars of accurate time keeping.

Then on to longer, timed durations:

- Thirty seconds of accurate time keeping.
- One minute of accurate time keeping.

During a single practice session, the student should practice these exercises for only as long as they can remain correct. If the student finds their concentration is lapsing, they should move on to something else. Repeating the exercises with the intent to improve errors that have began to occur, runs the risk of undoing the few minutes of correct muscle memory that was input at the beginning of the practice session. Like any new skill, these exercises take time and repetition to develop, and daily practice is strongly recommended.

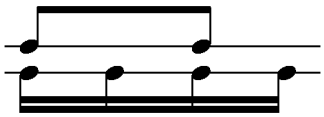
4.3 Presentation of Exercises

Group 1 – 8th note rate

Exercise 1

A) – Track 1

- Set a metronome to 60 BPM with the sixteenth note subdivisions on.
- Clap or play, if your instrument is percussive, at an eighth note rate, beginning on the ‘1’ count.



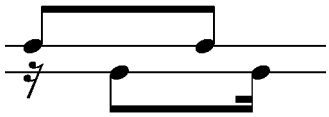
1 e & ah

Be aware of when the metronome should be heard by itself; when accurate, the only audible ‘clicks’ from the metronome should be in between the claps, on the ‘e’ and ‘ah’ counts. You should hear, clap-click-clap-click etc.

This is instant and constant feedback as to the successful placement of the desired eighth note rate. When successful, there are metronomically accurate, physical manifestations of temporal intervals taking place. The focus of this exercise is the phenomenon of only hearing the ‘e’ and ‘ah’ from the metronome.

B) – Track 2

- Set a metronome to 60 BPM with the eighth note subdivisions on.
- In your mind, perceive the metronome ‘clicks’ to be falling on the ‘e’ and ‘ah’ subdivisions. Counting out loud can help establish this.
- Clap at an eighth not rate that begins on the ‘1’.

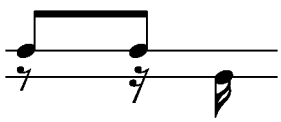


1 e & ah

Listen for where the metronome should be placed; when successful you should hear, clap-click-clap-click etc. The difference is now the ‘e’ and ‘ah’ can only be heard from the metronome regardless of where the claps fall. The goal then becomes to place the claps accurately so that this exercise is audibly identical to exercise 1. Success with this exercise will depend on the level of familiarity with the previous exercise.

C) – Track 3

- Set a metronome to 60 BPM with the quarter note subdivision on.
- In your mind, perceive the metronome ‘clicks’ to be falling on the ‘ah’ count.
- Clap at an eighth note rate that begins on the ‘1’.

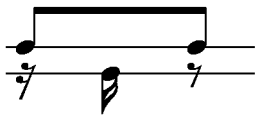


1 e & ah

Be aware of where the metronome will be heard; you should hear, clap-REST-clap-click etc. Again, the temporal placement of the claps are to be referenced by the awareness of where the metronome ‘click’ should be falling, and familiarity and success with the previous two exercises is paramount.

D) – Track 4

- Using the same metronome rate, perceive the metronome ‘clicks’ to be falling on the ‘e’ count.
- Clap at an eighth not rate that begins on the ’1’.



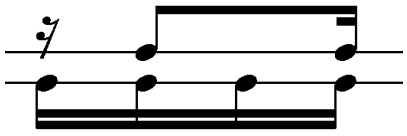
1 e & ah

Now you should hear, clap-click-clap-REST etc. Again, the temporal placement of the claps are to be referenced by the awareness of where the metronome ‘click’ is falling on the 'e' count. Familiarity, and success, with the previous two exercises is paramount.

Exercise 2

A) – Track 5

- Set a metronome to 60 BPM with the sixteenth note subdivisions on.
- Clap or play at an eighth note rate, falling on the 'e' and 'ah' counts.

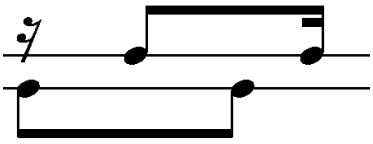


1 e & ah

When successful you will only hear the ‘1’ and the '&' from the metronome. You should hear click-clap-click-clap. Remember to be aware of where the metronome 'clicks' will be heard in regards to the claps.

B) – Track 6

- Set a metronome to 60 BPM with the eighth note subdivisions on.
- Clap or play at an eighth note rate, falling on the 'e' and 'ah' counts.



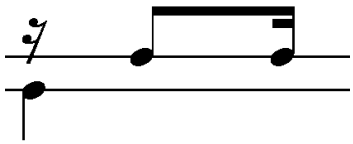
1 e & ah

Now the ‘1’ and the '&' count can only be heard from the metronome regardless of where the claps fall. The goal then becomes to place the claps accurately so that this exercise is audibly identical to exercise A). Success with this exercise will depend on the level of

familiarity with the previous exercise.

C) – Track 7

- Set a metronome to 60 BPM with the quarter note subdivision on.
- Clap or play at an eighth note rate, falling on the 'e' and 'ah' counts.

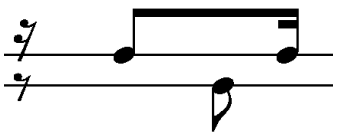


1 e & ah

Now you should hear, click-clap-REST-clap etc. Again, the temporal placement of the claps are to be referenced by the awareness of where the metronome ‘click’ should be falling, on the ‘1’, and familiarity and success with the previous two exercises is paramount.

D) – Track 8

- Using the same metronome rate, perceive the metronome ‘clicks’ to be falling on the ‘&’ count.
- Clap or play on the 'e' and 'ah'.



1 e & ah

Now you should hear, REST-clap-click-clap etc. The temporal placement of the claps are

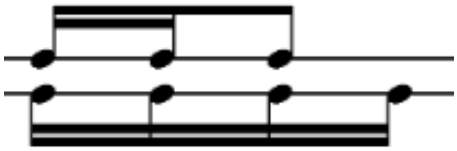
to be referenced by the awareness of where the metronome ‘click’ should be falling, on the '&' count. Familiarity, and success, with the previous two exercises is paramount.

Group 2 – Groups of three 16th notes

Exercise 1

A) – Track 9

- Set a metronome to 60 BPM with the sixteenth note subdivisions on.
- Clap or play three consecutive 16th notes, starting on the ‘1’.



1 e & ah

Be aware that the only 'click' that you should here from the metronome is falling on the 'ah' count. You should be hearing clap-clap-clap-click etc.

B) – Track 10

- Set a metronome to 60 BPM with the eighth note subdivisions on.
- In your mind, perceive the metronome ‘clicks’ to be falling on the 'e' and ‘ah’ counts.
- Clap or play three consecutive 16th notes, starting on the ‘1’.

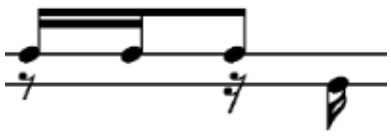
1 e & ah

Listen out for the where the metronome is falling; when accurate you should still only hear it on the 'ah' count, even though it is also falling on the 'e' too. It should sound identical to

the previous exercise, clap-clap-clap-click etc.

C) – Track 11

- Set a metronome to 60 BPM with the quarter note subdivision on.
- In your mind, perceive the metronome ‘clicks’ to be falling on the ‘ah’ counts.
- Clap or play three consecutive 16th notes, starting on the ‘1’.



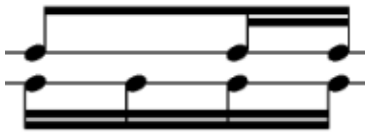
1 e & ah

Again be aware of the placement of the metronome 'click'. When accurate you should hear clap-clap-clap-click etc., and it will sound identical to the previous two exercises.

Exercise 2

A) – Track 12

- Set a metronome to 60 BPM with the sixteenth note subdivisions on.
- Clap or play three 16th notes, falling on the ‘1’, the '&' and the 'ah' count.

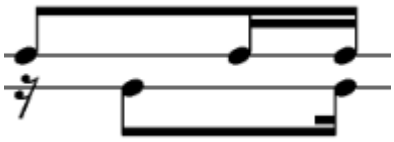


1 e & ah

Be aware that only 'click' that you should hear from the metronome is falling on the 'e' count. You should be hearing clap-click-clap-clap etc.

B) – Track 13

- Set a metronome to 60 BPM with the eighth note subdivisions on.
- In your mind, perceive the metronome ‘clicks’ to be falling on the 'e' and ‘ah’ counts.
- Clap or play three 16th notes, falling on the ‘1’, the '&' and the 'ah' count.

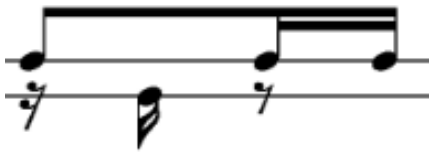


1 e & ah

Listen out for the where the metronome is falling; when accurate you should still only hear it on the 'e' count, even though it is also falling on the 'ah' too. It should sound identical to the previous exercise, clap-click-clap-clap etc.

C) – Track 14

- Set a metronome to 60 BPM with the quarter note subdivision on.
- In your mind, perceive the metronome ‘clicks’ to be falling on the ‘e’ counts.
- Clap or play three 16th notes, falling on the ‘1’, the '&' and the 'ah' count.



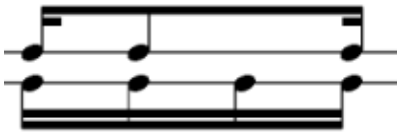
1 e & ah

Again be aware of the placement of the metronome 'click'. When accurate you should hear clap-click-clap-clap etc., and it will sound identical to the previous two exercises.

Exercise 3

A) – Track 15

- Set a metronome to 60 BPM with the sixteenth note subdivisions on.
- Clap or play three 16th notes, falling on the ‘1’, the 'e' and the 'ah' count.

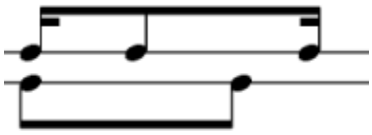


1 e & ah

Be aware that only 'click' that you should hear from the metronome is falling on the '&' count. You should be hearing clap-clap-click-clap etc.

B) – Track 16

- Set a metronome to 60 BPM with the eighth note subdivisions on.
- Clap or play three 16th notes, falling on the ‘1’, the 'e' and the 'ah' count.

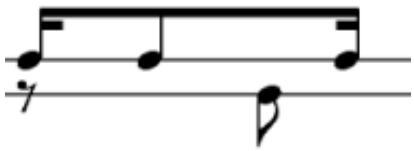


1 e & ah

Listen out for the where the metronome is falling; when accurate you should still only hear it on the '&' count, even though it is also falling on the ‘1’ too. It should sound identical to the previous exercise, clap-clap-click-clap etc.

C) – Track 17

- Set a metronome to 60 BPM with the quarter note subdivision on.
- In your mind, perceive the metronome ‘clicks’ to be falling on the ‘&’ counts.
- Clap or play three 16th notes, falling on the ‘1’, the 'e' and the 'ah' count.



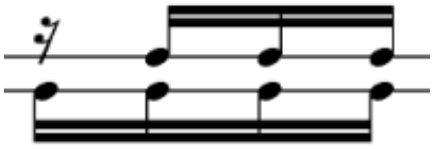
1 e & ah

Again be aware of the placement of the metronome 'click'. When accurate you should hear clap-clap-click-clap etc., and it will sound identical to the previous two exercises.

Exercise 4

A) – Track 18

- Set a metronome to 60 BPM with the sixteenth note subdivisions on.
- Clap or play three consecutive 16th notes, starting on the 'e' count.

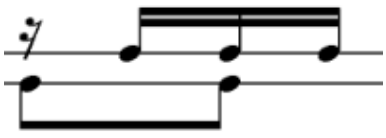


1 e & ah

Be aware that only 'click' that you should hear from the metronome is falling on the ‘1’. You should be hearing click-clap-clap-clap etc.

B) – Track 19

- Set a metronome to 60 BPM with the eighth note subdivisions on.
- Clap or play three consecutive 16th notes, starting on the 'e' count.

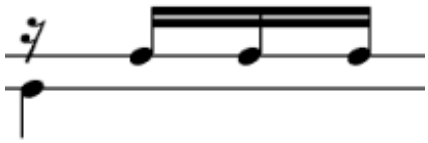


1 e & ah

Listen out for the where the metronome is falling; when accurate you should still only hear it on the '&' count, even though it is also falling on the ‘1’ too. It should sound identical to the previous exercise, click-clap-clap-clap etc.

C) – Track 20

- Set a metronome to 60 BPM with the quarter note subdivision on.
- Clap or play three 16th notes, falling on the ‘1’, the '&' and the 'ah' count.



1 e & ah

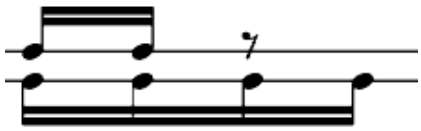
Again be aware of the placement of the metronome 'click'. When accurate you should hear click-clap-clap-clap etc., and it will sound identical to the previous two exercises.

Group 3 – Groups of two 16th notes

Exercise 1

A) – Track 21

- Set a metronome to 60 BPM with the sixteenth note subdivisions on.
- Clap or play two consecutive 16th notes, starting on the ‘1’.

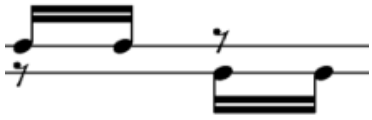


1 e & ah

Be aware that the only 'clicks' that you should here from the metronome is falling on the '&' and 'ah' counts. You should be hearing clap-clap-click-click etc.

B) – Track 22

- Set a metronome to 60 BPM with two consecutive sixteenth note subdivisions on.
- In your mind, perceive these 'clicks' to be falling on the '&' and 'ah' counts.
- Clap or play two consecutive 16th notes, starting on the ‘1’.



1 e & ah

Listen out for the where the metronome is falling; when accurate it should sound identical

to the previous exercise, clap-clap-click-click etc. Familiarity with the previous exercise is crucial.

Exercise 2

A) – Track 23

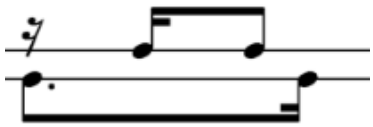
- Set a metronome to 60 BPM with the sixteenth note subdivisions on.
- Clap or play two consecutive 16th notes, starting on the 'e' count.

1 e & ah

Be aware that the only 'clicks' that you should here from the metronome are falling on the ‘1’ and 'ah' counts. You should be hearing click-clap-clap-click etc.

B) – Track 24

- Set a metronome to 60 BPM with two consecutive sixteenth note subdivisions on.
- In your mind, perceive these 'clicks' to be falling on the ‘1’ and 'ah' counts.
- Clap or play two consecutive 16th notes, starting on the 'e' count.



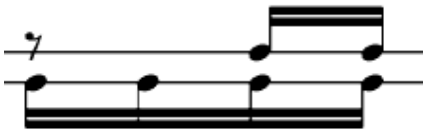
1 e & ah

Listen out for the where the metronome is falling; when accurate it should sound identical to the previous exercise, click-clap-clap-click etc. Familiarity with the previous exercise is crucial.

Exercise 3

A) – Track 25

- Set a metronome to 60 BPM with the sixteenth note subdivisions on.
- Clap or play two consecutive 16th notes, starting on the '&' count.

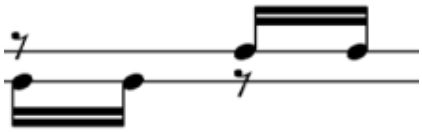


1 e & ah

Be aware that the only 'clicks' that you should here from the metronome is falling on the ‘1’ and 'e' counts. You should be hearing click-click-clap-clap etc.

B) – Track 26

- Set a metronome to 60 BPM with two consecutive sixteenth note subdivisions on.
- In your mind, perceive these 'clicks' to be falling on the ‘1’ and 'e' counts.
- Clap or play two consecutive 16th notes, starting on the '&' count.



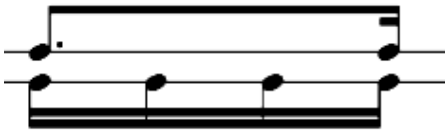
1 e & ah

Listen out for the where the metronome is falling; when accurate it should sound identical to the previous exercise, click-click-clap-clap etc. Familiarity with the previous exercise is crucial.

Exercise 4

A) – Track 27

- Set a metronome to 60 BPM with the sixteenth note subdivisions on.
- Clap or play two 16th notes falling on the ‘1’ and the 'ah' count.

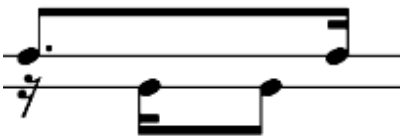


1 e & ah

Be aware that the only 'clicks' that you should here from the metronome is falling on the '&' and 'ah' counts. You should be hearing clap-click-click-clap etc.

B) – Track 28

- Set a metronome to 60 BPM with two consecutive sixteenth note subdivisions on.
- In your mind, perceive these 'clicks' to be falling on the 'e' and '&' counts.
- Clap or play two 16th notes falling on the ‘1’ and the 'ah' count.



1 e & ah

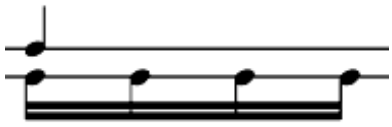
Listen out for the where the metronome is falling; when accurate it should sound identical to the previous exercise, clap-click-click-clap etc. You will still hear the metronome falling only the 'e' and '&' counts, even if you are unsuccessful. Familiarity with the previous exercise is crucial.

Group 4 – Quarter note rate/ single sixteenth notes

Exercise 1

A) – Track 29

- Set a metronome to 60 BPM with the sixteenth note subdivisions on.
- Clap or play at a quarter note rate starting on the ‘1’.

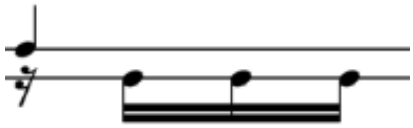


1 e & ah

Be aware that the only 'clicks' that you should here from the metronome are falling on the 'e', '&' and 'ah' counts. You should be hearing clap-click-click-click etc.

B) – Track 30

- Set a metronome to 60 BPM with three consecutive sixteenth notes falling on the 'e', '&' and 'ah' counts.
- Clap or play at a quarter note rate starting on the ‘1’.



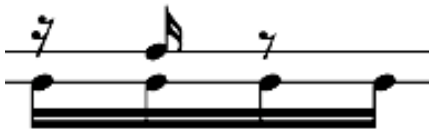
1 e & ah

Listen out for the where the metronome is falling; when accurate it should sound identical to the previous exercise, clap-click-click-click etc. Familiarity with the previous exercise is crucial.

Exercise 2

A) – Track 31

- Set a metronome to 60 BPM with the sixteenth note subdivisions on.
- Clap or play at a quarter note rate starting on the 'e' count.

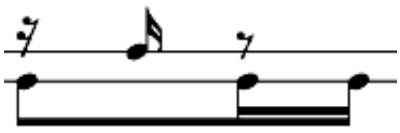


1 e & ah

Be aware that the only 'clicks' that you should here from the metronome are falling on the ‘1’, '&' and 'ah' counts. You should be hearing click-clap-click-click etc.

B) – Track 32

- Set a metronome to 60 BPM with three consecutive sixteenth notes falling on the ‘1’, '&' and 'ah' counts.
- Clap or play at a quarter note rate starting on the 'e' count.



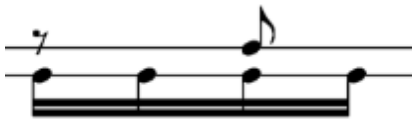
1 e & ah

Listen out for the where the metronome is falling; when accurate it should sound identical to the previous exercise, click-clap-click-click etc. Familiarity with the previous exercise is crucial.

Exercise 3

A) – Track 33

- Set a metronome to 60 BPM with the sixteenth note subdivisions on.
- Clap or play at a quarter note rate starting on the '&' count.

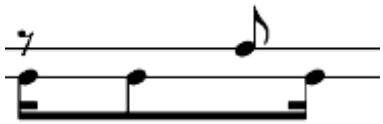


1 e & ah

Be aware that the only 'clicks' that you should here from the metronome are falling on the ‘1’, 'e', and 'ah' counts. You should be hearing click-click-clap-click etc.

B) – Track 34

- Set a metronome to 60 BPM with three consecutive sixteenth notes falling on the ‘1’, 'e', and 'ah' counts.
- Clap or play at a quarter note rate starting on the '&' count.



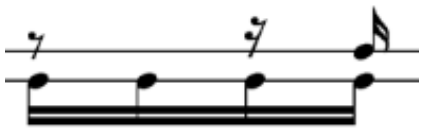
1 e & ah

Listen out for the where the metronome is falling; when accurate it should sound identical to the previous exercise, click-click-clap-click etc. Familiarity with the previous exercise is crucial.

Exercise 4

A) – Track 35

- Set a metronome to 60 BPM with the sixteenth note subdivisions on.
- Clap or play at a quarter note rate starting on the 'ah' count.

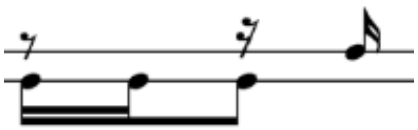


1 e & ah

Be aware that the only 'clicks' that you should here from the metronome are falling on the ‘1’, 'e', and '&' counts. You should be hearing click-click-click-clap etc.

B) – Track 36

- Set a metronome to 60 BPM with three consecutive sixteenth notes falling on the ‘1’, 'e', and '&' counts.
- Clap or play at a quarter note rate starting on the 'ah' count.



1 e & ah

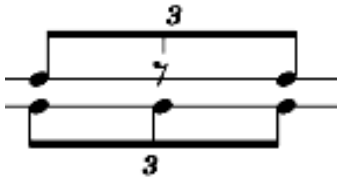
Listen out for the where the metronome is falling; when accurate it should sound identical to the previous exercise, click-click-click-clap etc. Familiarity with the previous exercise is crucial.

Group 5 – Groups of two triplet notes

Exercise 1

A) – Track 37

- Set a metronome to 60 BPM with the triplet subdivisions on.
- Clap or play two triplet notes falling on the ‘1’ and the 'let' count.

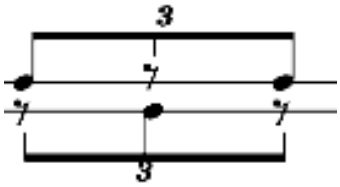


1 trip let

Be aware of where you should be hearing the metronome fall in between the claps on the 'trip' count; when accurate you will hear clap-click-clap etc.

B) – Track 38

- Set a metronome to 60 BPM with the quarter note subdivision on.
- In your mind, perceive the 'clicks' to be falling on the 'trip' count of a triplet.
- Clap or play two triplet notes falling on the ‘1’ and the 'let' count.



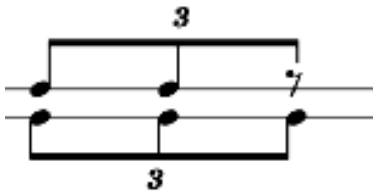
1 trip let

Listen out for the where the metronome is falling; when accurate it should sound identical to the previous exercise, clap-click-clap etc. Familiarity with the previous exercise is paramount.

Exercise 2

A) – Track 39

- Set a metronome to 60 BPM with the triplet subdivisions on.
- Clap or play two consecutive triplet notes starting on the ‘1’.

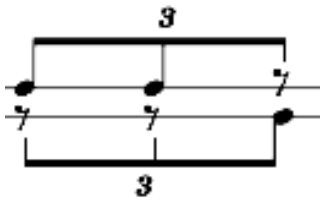


1 trip let

Be aware of where you should be hearing the metronome fall in between the claps on the 'let' count; when accurate you will hear clap-clap-click etc.

B) – Track 40

- Set a metronome to 60 BPM with the quarter note subdivision on.
- In your mind, perceive the 'clicks' to be falling on the 'let' count of a triplet.
- Clap or play two consecutive triplet notes starting on the ‘1’.



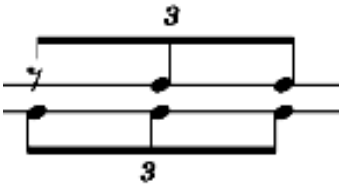
1 trip let

Listen out for the where the metronome is falling; when accurate it should sound identical to the previous exercise, clap-click-clap etc. Familiarity with the previous exercise is paramount.

Exercise 3

A) – Track 41

- Set a metronome to 60 BPM with the triplet subdivisions on.
- Clap or play two consecutive triplet notes starting on the 'trip' count.

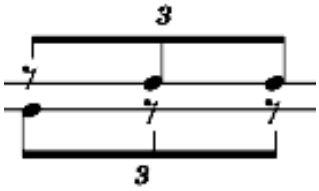


1 trip let

Be aware of where you should be hearing the metronome fall in between the claps on the ‘1’; when accurate you will hear click-clap-clap etc.

B) – Track 42

- Set a metronome to 60 BPM with the quarter note subdivision on.
- Clap or play two consecutive triplet notes starting on the 'trip' count.



1 trip let

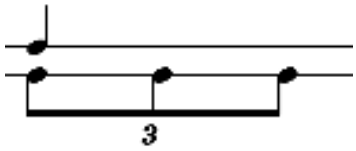
Listen out for the where the metronome is falling; when accurate it should sound identical to the previous exercise, click-clap-clap etc. Familiarity with the previous exercise is paramount.

Group 6 – Quarter note rate/ single triplet notes

Exercise 1

A) – Track 43

- Set a metronome to 60 BPM with the triplet subdivisions on.
- Clap or play at a quarter note rate starting on the ‘1’.

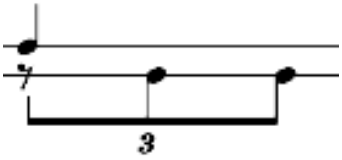


1 trip let

Be aware of where you should be hearing the metronome fall in between the claps on the 'trip' and 'let' counts; when accurate you will hear clap-click-click etc.

B) – Track 44

- Set a metronome to 60 BPM with two consecutive triplet notes on, falling in the 'trip' and 'let' counts.
- Clap or play at a quarter note rate starting on the ‘1’.



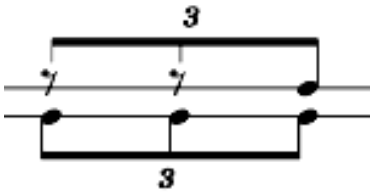
1 trip let

Listen out for the where the metronome is falling; when accurate it should sound identical to the previous exercise, clap-click-click etc. Familiarity with the previous exercise is paramount.

Exercise 2

A) – Track 45

- Set a metronome to 60 BPM with the triplet subdivisions on.
- Clap or play at a quarter note rate starting on the 'let' count.

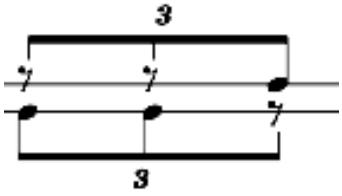


1 trip let

Be aware of where you should be hearing the metronome fall in between the claps on the ‘1’ and 'trip' counts; when accurate you will hear click-click-clap etc.

B) – Track 46

- Set a metronome to 60 BPM with two consecutive triplet notes falling on the ‘1’ and 'trip' counts.
- Clap or play at a quarter note rate starting on the 'let' count.



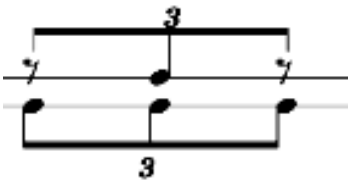
1 trip let

Listen out for the where the metronome is falling; when accurate it should sound identical to the previous exercise, click-click-clap etc. Familiarity with the previous exercise is paramount.

Exercise 3

A) –Track 47

- Set a metronome to 60 BPM with the triplet subdivisions on.
- Clap or play at a quarter note rate starting on the 'trip' count.

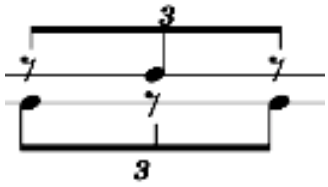


1 trip let

Be aware of where you should be hearing the metronome fall in between the claps on the ‘1’ and 'let' counts; when accurate you will hear click-clap-click etc.

B) – Track 48

- Set a metronome to 60 BPM with two consecutive triplet notes falling on the ‘1’ and the 'let' counts.
- Clap or play at a quarter note rate starting on the 'trip' count.



1 trip let

Listen out for the where the metronome is falling; when accurate it should sound identical to the previous exercise, click-clap-click etc. Familiarity with the previous exercise is paramount.

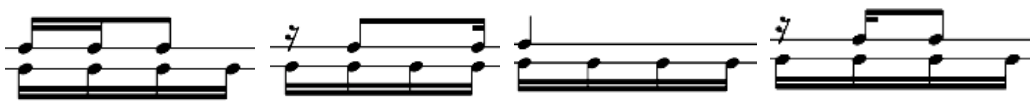
4.4 Demonstration of Exercises

The included compact disc contains an example of every exercise, including spoken instructions by the author.

Chapter 5: Summary of exercises and potential extrapolations

The exercises presented in Chapter 4 provide an efficient method for the optimal input of the cognitive and motor skills required to physically produce accurate temporal intervals in the context of music. They address the neurological factors influencing accurate time keeping in music, including attention over time, accurate subdividing, and the input of metronomically accurate muscle memory.

The exercises can be extrapolated further to develop beyond what is presented in Chapter 4. For example, as each exercise is only a single beat long, these exercises can be played one after another to form rhythms of any desired length. This means an individual can potentially work on any rhythm, of any length, with the same level of accuracy.



Another possibility is to play through a page of rhythms from a sight reading book or other such publication, using a metronome set to a rate of double that of what is being played, or the same rate as what is being played. This is employing the same method as the exercises in Chapter 4; having an indicator of success with synchronisation and an indicator of success with subdividing.

Chapter 6: Conclusion/Discussion

6.1 Summary of dissertation

This dissertation has provided exercises that are specifically designed to efficiently develop the skills necessary for accurate time keeping in music. This dissertation proposes to have contributed to addressing the void in contemporary music instructional literature whereby how to attain accurate time keeping is not explained explicitly. Through investigation of contemporary neurological literature, a greater understanding of the mitigating factors of time keeping has been harboured. Exercises were then developed from an analysis of the temporal cognition and motor learning factors pertaining to accurate time keeping. Through analysis of selected industry-standard music instructional literature, a format of presentation for the exercises was developed and employed. This format of presentation comprised of an introduction to the text, an explanation of exercises, a presentation of exercises in both written text and musical notation, and aural demonstrations of the exercises on an included compact disc. The exercises were then summarised and suggestions of extrapolations for exercises were discussed.

6.2 Summary of research questions

The results of the research questions are as follows:

What are the cognitive factors pertaining to the efficient training of time keeping in music?

Research into temporal cognition showed that neuroscientists agree there is an internal time-keeper of the human brain, but disagree with the form that it takes. There are two commonly accepted models:

1) The timekeeper is a set of oscillators with each producing a unique beat. The beats are arranged in a multitude of different combinations to reproduce one interval.

2) The timekeeper is similar to a clock, having a single small unit of time that can reproduce any interval larger than one of these individual units.

For an individual to be successful at physically producing accurate intervals in time, they need to be successful with accurately measuring intervals or durations in time. The prefrontal cortex (PFC) is the region of the brain understood to be responsible for processing higher level cognition. This includes functions such as monitoring execution of motor behaviour for errors, which includes sequencing and timing.

An individual's success with correctly inputting the motor skills required to physically manifest accurate temporal intervals, and their success in outputting these skills, is determined by the capability of their PFC and therefore their working memory capacity. This includes their strength in the three forms of attention:

1) Focus; attention as keeping a representation of a sensory percept zeroed in over short time periods.

2) Effortful attention; dedication, perseverance, maintenance of discipline.

This form is unavoidably connected to motivation, will, desire.

3) Exclusionary, inhibitory attention; repels the ceaseless stream of sensory information that the brain is exposed to, and runs interference against distracting thoughts.

If an individual's mechanism for monitoring whether or not they are executing the correct procedure isn't functioning properly, there is a great chance the muscle memory will be input incorrectly or inconsistently.

What are the motor learning factors pertaining to the efficient training of time keeping in music?

Research into human motor learning found that muscle memory consolidates through savings in performance over multiple repetitions. Once the brain is exposed to a new motor skill, it stores a form of the information, an internal model, making relearning stronger and faster than initial learning. This means that the motor skills that are input during practice of a task are the skills that will be output in performance. This information highlights the efficiency, and importance, of inputting muscle memory correctly from the first instance, rather than editing incorrect muscle memory habits. The passage of time was seen to play a part in the improved recall of a new motor skill, which serves to highlight that regular practice over the long term is required to increase the stability of the motor skill.

Is there an efficient method to optimally input the cognitive and motor skills

required to physically produce accurate temporal intervals in the context of music?

After analysing the cognitive and motor learning factors pertaining to the efficient training of time keeping in music, forty-eight exercises were developed that specifically address these factors. The exercises provide an efficient method of developing accurate time keeping in music for the following reasons:

- The need for an individual to be successful with accurately *measuring* intervals in time in order to be successful with accurately *physically producing* intervals in time, is addressed. The exercises achieve this by exposing the individual to precisely where an intended rhythm is placed in time, through being aware of the precise placement of the subdivisions that are not being played by the individual. This utilises the research pertaining to subdividing, that shows anti-phase tapping, tapping in between the beat, is more accurate than attempted synchronised tapping with the beat.

- The importance of attention in practice is highlighted, and measures are taken to combat mental fatigue by issuing specific time frames of successful repetition to aim for. These time frames proceed logically from small to large.

- Consistent muscle memory is input efficiently. The exercises are designed so that the newly forming motor skill stays at a constant rate while the placement of the highlighted subdivisions changes. This maximises the length of time that the correct muscle memory is input for, and satisfies the research into motor learning that reveals what is input through practice is what will be output through performance.

- The importance of daily repetition is illustrated, in compliance with the research explaining that the passage of time can be seen to play a part in the improved recall of a new motor skill.

6.3 Personal reflection

The author's own interest in the research topic of this dissertation is that of a personal one. Having been a student of the drumset for the past sixteen years, the ability to perform music inside the parameters of strict metronomic accuracy is of utmost importance. Having personally spent many an hour seeking accurate time keeping, the author felt there was a deficiency in the prevalent instructional texts. This lead to an investigation into devising a method to improve his own time-keeping. As an experienced educator, the author hopes this dissertation will provide future generations of musicians with a more explicit, efficient method for attaining accurate time keeping in music.

The author is satisfied with the findings of this dissertation, although without personally holding any qualifications in the field of science, recognises there is potentially a great wealth more knowledge to be obtained in the research of temporal cognition. The collected literature reflects that there is an increasing partnership between the neuroscience and music communities and this, in the author's opinion, is what will ultimately lead music education into the future.

APPENDIX

- An included compact disc containing aural examples of the exercises presented in Chapter 4.

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