

Module 4

BMPF7013

Working and Learning: An introduction to Work-Based Higher
Education

An overview of mental practice within the context of an application to
vocal pedagogy

Tanya Holt

2246139

Word count

Part 1: 3459 Part 2: 4190

Part 1	3
Introduction and Project Rationale	3
Programme of studies	4
Critical reflection	6
Part 2	10
Introduction	10
Scientific interest in the conscious and unconscious mind	11
Motor imagery (MI)	11
Auditory imagery	13
Kinaesthetic imagery	14
Visual imagery	14
PETTLEP - applying a framework for visualisation	14
Conclusion	17
References	19
Appendix 1	23
‘Developing a literature-based glossary and taxonomy for the study of mental practice in music performance’ (Mielke and Comeau, 2019)	23
Appendix 2 - Project Timeline	25

Part 1

Introduction and Project Rationale

My interest in the notion of 'mental practice' was initially piqued in 2004 by the chance reading of an article about a study undertaken at University College London's Institute of Cognitive Neuroscience (Haggard et al., 2004). The focus of the study was an examination of brain activity in dancers who imagined their choreography without physically engaging in dancing. The findings revealed that the brain can simulate a pre-learned motor skill without physical movement, thus providing the possibility for silent or static rehearsal for all types of physical activity along with the potential for remedial strategies for injury. As a long standing professional singer and dancer at the time, with a well-honed kinaesthetic awareness, this research resonated and self-legitimised my own practice of 'imagining' as a way of learning. Over the past few years I have developed a private singing practice, teaching predominantly adults on a one-to-one basis. Despite my positive personal experience, I have not encouraged or implemented any form of 'silent practice' in the teaching studio as I lack scholarly understanding of the term or its application within the context of vocal pedagogy. A lecture series on Motor Learning delivered by Heidi Moss-Erickson for the Voice Study Centre, touched on the potential value of silent learning, which has reinvigorated my interest. Ms. Moss-Erickson's exposition on the stages of speech acquisition in childhood highlighted the importance of silent practice and sub-vocalisation to speech development; subvocalisation refers to how we silently say words inside our heads, often engaging the motor mechanisms of the larynx and articulators (Moul, 2024). This suggested to me that there may be potential transferability to learning to sing. An initial overview of relevant academic research indicated that there may be sufficient literature to lend viability to the purpose of this paper; within the context of an application to music performance, there are evidenced benefits of silent practice on motor improvements and coordination, performance memory, pitch accuracy and rhythm mastery (Bernardi et al., 2013; Loimusalo, 2018; Monany, 2022). Therefore, through this academic opportunity, I will endeavour to deconstruct and synthesise a meaning of the term 'silent practice' that could add value to my practice.

I am aware that I am approaching this rapid, narrative review from a position of bias in favour of the potential benefits of this practice, based on hearsay and personal experience, and as such will actively seek research that questions or heeds its use in pedagogical settings. As a teacher, this broadening of my understanding may equip me to persuasively argue for, or perhaps against, the practice, using the literature to illustrate and support my position; it is my experience that the use of scientific evidence to support concepts is a persuasive tool in encouraging learning. My findings may reveal potential for the future development of teaching tools that might not only help students

in undertaking focussed, silent practice, but provide an opportunity for rehearsal when audible singing is not possible.

Programme of studies

Aims

- To fill a gap in my professional knowledge
- To become a more informed and better singing teacher
- To improve my academic skills in both writing and researching
- To continue to achieve my Masters degree in vocal pedagogy

Objectives/learning outcomes

- To acquire an in-depth, evidence-based understanding of the elements of mental practice through the implementation of a sound research methodology.
- To explore each of the elements of imagery in singing that are applied in mental practice; this includes visual, auditory, kinaesthetic and motor imagery (Mielke, 2019)
- To begin to actively identify elements of transferability to the professional practice
- To explore practical frameworks for the implementation of a visualisation script
- To become informed enough to begin considering strategies for the application of mental practice to singing students beyond the submission of this paper; this includes being able to guide individuals in devising a personal framework for visualisation that supports their learning objectives with due consideration to their current level of skill and their capacity for imagination
- To keep expanding my knowledge in this area by keeping up-to-date with research and by further reading, not made possible within the time-constraints of this rapid review

Project timeline

Please see appendix 2 (p25)

Literature Review Process

A video tutorial on using the University of Wales and Trinity Saint David's (UWTSD) library allowed me to structure an efficient first step in acquiring relevant literature. The research student is guided firstly in how to establish overall search terms and in using Boolean operators to begin narrowing the fields of interest. For example, an initial search using the term "mental imagery" could be narrowed to searches that might include AND "music or AND "singing". Up to date, peer-reviewed, 'white literature' is likely to present as more robust as it is subject to academic scrutiny prior to publication and would therefore be my first point of exploration. Furthermore, in order to find the most recent literature, a system of forward-citing from relevant, but older, information was

recommended. Almost as a matter of course, by following the librarian's suggestions, I began to develop an inclusion and exclusion criteria.

Inclusion and Exclusion Criteria

All literature needed to be as recent as possible, however, I felt disinclined to bind myself to a cut-off date of publication as this might exclude excellent source material that could lead to further papers via citations. Instead, if a particular literature search produced a wide choice of options, the most recent publications would be selected. To ensure quality, all white literature needed to be peer reviewed and preferably to have been cited by other researchers. I came to recognise particular sources as being dependable for quality, both in terms of content and in the authority of the writer; for example, *Frontiers in Human Neuroscience*, *Journal of Voice*, *Journal of Applied Sport Psychology* and *Science Direct* have all informed the content of this paper. Furthermore, reading the abstract section of selected papers helped determined relevance to the subject being explored, which further narrowed the selected corpus. Additionally, when approaching an academic review from a position of such limited knowledge, reading the abstract of a paper can be helpful in determining what is not relevant. For example, as a singing teacher I am less inclined to concern myself with research on the minutia of complex neural connectivity in imaging, when the outward manifestations of motor, kinaesthetic, visual and auditory imagery are of relevance to my practice and therefore a base understanding of such, is sufficient.

Adhering to this inclusion and exclusion criteria reduced the chances of being drawn into literature that was not specific to the research question, which, with the constraints of a tight university deadline, needed to be avoided. Furthermore, advice from the UWTSD librarians on finding connected articles further afield by linking my university library account to Google scholar, Connected Papers, Semantic Scholar and Research Rabbit, proved incredibly helpful. I had begun this research by using the term 'silent practice' rather than 'mental practice' however, an initial search of the phrase "silent practice" in University of Wales Trinity Saint David's (UWTSD) library, proved unproductive with 26-results on unrelated topics. However, the same term applied to Google Scholar was more fruitful with a study of the effects of 'mental practice' on pianists (Loimusalo et al., 2019), leading to a plethora of related articles. It occurred to me that in the UK, the word 'mental' is often used as slang or as a derogatory term for non-conformist behaviour (mentalhealth.org.uk), however, this initial Google search shows 'mental practice' as a commonly-used term internationally and as such is used throughout this paper. Using "mental practice" I quickly located a 'literature-based glossary and taxonomy for the study of mental practice in music performance' (Mielke et al., 2019). This peer-reviewed, transparent report proved invaluable, detailing an inventory of the search terms used to assimilate the corpus, such as "covert rehearsal", "mental imagery", "motor imagery", "silent rehearsal", "auditory imagery", and "aural imagery". Along with the listed corpus, the search terms and glossary provided a useful entry-point for my exploration. Using the search terms suggested by Mielke and co. (2019) along with Boolean operators to narrow the search to "singing", yielded a total of 19-results in the university library

(UWTSD), one of which was a chapter in the Oxford Handbook of Singing. I am aware that due to the lack of robust academic scrutiny, the use of grey literature is not encouraged until other sources have been exhausted, however, in this case the chapter provided a good overview of key scholastic articles and terminology. It is reassuring to discover that Kepes et al. (2012) argue for the value of including grey literature in academic research and propose a useful taxonomy which highlights inherent bias that may arise in different types of grey material. Subject-specific books or encyclopaedia can take considerable time to assimilate, resulting in articles often not being up to date by the time they are published, however, the quality and integrity of many of this sort of publication mean that they should not be overlooked out of hand. Additionally, such publications can prove to be a useful means of 'pearl growing' which describes using cited sources to locate further texts, in a chain effect, often delivering more up to date research (Boell, 2010). Recurring themes in a broad range of literature related to 'mental practice' suggested a narrowing of focus to specific fields of study: motor imagery, audiation, kinaesthetic imagery and visual imagery. As per the inclusion and exclusion criteria, I narrowed the number of selected texts down by acquainting myself with the abstract of an article to evaluate relevance, with due consideration to the authority of the authors and their positionality to the subject being explored.

Hermeneutics

By comparing, re-reading and interpreting, an overall, but by no means finite, understanding of the meaning of mental practice emerged. In essence, as the literature review progressed, I became more aware of what was most relevant to my research question; by examining the detail in the chosen texts and by drawing from several viewpoints I was able to create an overall impression. I also recognised that this process is open-ended and constantly in flux and that the acquisition of new information may change the perspective taken on earlier reading. This cyclical element of the research methodology highlights the ongoing nature of discovery and is known as hermeneutics (Boel, 2010). The Hermeneutic Circle is a theory expounded by the German philosopher Martin Heidegger (1927) who posited that without an understanding of the individual components of a text the reader is unlikely to gain the meaning as a whole. This approach has come naturally to me and has allowed me to begin to contextualise my own findings from broad fields of study into singing training, while appreciating the necessity to update myself on new research and be willing to consider novel ideas (Boel, 2010; George, 2021; Heidegger, 1927, 2010).

Critical reflection

Critical reflection is described as an ongoing, cyclical process that involves the acquisition, analysis, evaluation and subsequent application of knowledge (Boud et al., 1985; Jarvis, 1992; Lowery et al., 2019; Yensen, 2016). This could suggest that the acquisition of knowledge without reflection delivers little value to the learning process. Judging by the high number of publications dedicated to reflective thinking, this process of cyclical critical thinking is regarded as a vital part of

developing new knowledge. As my writing progressed, I was aware of how the element of 'reflection' is an ongoing process that occurs during the researching and writing process and not simply an overview of the project at the point of completion. As I reached the concluding part of my research, I recognised how exhausted I had become by the amount of reading and learning (I find academic reading requires elevated levels of concentration) and therefore determined to choose a model of reflection that felt manageable and straightforward in its framework; Borton's (1970) model of reflection offered an attractively accessible way forward that is structured around these three questions: What? So What? and Now What? In essence, these questions initiated a broad cycle of critical thinking that gauged the value of the learning in the following ways; by identifying the purpose of the learning, establishing what had been discovered both in terms of the research and the research methods and, in the same dualistic way, implementing what has been learned into my professional and scholarly practice both now and in the future.

What?

I had, for some time, been aware of the benefits of using mental practice for skills development in the training of both elite athletes and instrumentalists, but had very little understanding of what was meant by this term. Within the context of learning to play musical instruments, evidence suggests that mental imagery can result in improvements in motor skills and coordination, performance memory, pitch accuracy and rhythm mastery (Bernardi et al., 2013; Loimusalo, 2018; Monany, 2022). As a singing teacher, it is therefore natural that I should want to explore the potential that this presents for my practice, while also filling a gap in my professional knowledge. There appears to be a lack of literature specifically relating to mental practice in the field of singing training and therefore an assimilation of evidence drawn from other fields may begin to identify useful areas of transferability. Additionally, I was intrigued by the possibilities that mental practice could present to singers for whom audible practice is not always possible. The vocal mechanism is largely obscured from external examination, by this I mean that the shape of the larynx and the back of the tongue, both extremely important contributors to vocal timbre, cannot be overtly assessed by the teacher; therefore, exploring verbal, visual, auditory and gesticulatory descriptors to trigger kinaesthetic and motor responses in the vocal tract could have significant benefits in the training room.

As a researcher, previous modules have highlighted a skills deficit in locating up to date relevant literature. By adhering to a pre-planned, formalised research design with inclusion and exclusion criteria, I hoped to employ strategies that could make this area of the research process more efficient, in terms of academic robustness. Additionally, I hoped to improve on time-management by keeping the reading relevant.

So What?

Pinning down the exact research question when I had so little knowledge about the area being explored, provided a valuable opportunity for me to explore the benefits of scoping more broadly and trusting that the research process would refine and define the question being asked. Equally, I

discovered that it is difficult to commit to a review type (for example, narrative or scoping) without knowing the precise question. The initial question; “Exploring the benefits of silent practice within the context of vocal pedagogy” proved impossible to undertake without a broad understanding of what is meant by silent practice. In turn, I discovered that this could only be accomplished by an understanding of motor, kinaesthetic, visual and auditory imaging (Mielke et al., 2019).

Furthermore, identifying areas of transferability to vocal pedagogy required a wide range of cross referencing, that went beyond the remit of an originally intended scoping review. Therefore, with support provided by the librarians of University of Wales and Trinity Saint David (UWTSD), I was soon able to locate highly relevant literature drawn from clinical and empirical studies along with pedagogical texts from across a broad range of fields (Gates, 2021; Gordon, 2012, 1999; Holmes and Collins, 2001; Ruffino et al., 2017; Scott et al., 2022). These persuasively demonstrated the effective use of mental imagery in skills development. I discovered that the same areas of the brain are activated for imagined and actual movement and that imagined movement initiates muscular activation without the belly of the muscle contracting (Eaves et al., 2016; Meugnot, 2014; Mielke et al., 2019). Repetition of these imagined movements increases automaticity which can result in long term changes in neuroplasticity and, consequently, in long-term behavioural changes (Monany et al., 2022). This was precisely the material that I hoped to find to support the theme of the research and in turn, my professional practice. In terms of an audit of imagery types, I am now aware that visual and kinaesthetic imagery are intrinsically tied into motor-imagery (Blumer et al., 2024; Pearson, 2019). As there are proven benefits to auditory imaging, also known as audiation, in learning musical instruments and that subvocalisation activates the muscles of the vocal tract just by imagining singing, there is clearly the potential to use the combination of subvocalisation and audiation in silent practice for singers (Pfordresher et al., 2013, Greenspon, 2023; Moul, 2024). In other words, scientific evidence demonstrates that it could be possible to effectively practice motor aspects of singing without making sound (Pfordresher et al., 2013). From a professional standpoint, I considered these discoveries very worthwhile. Of equal importance is the existence of studies that warn that mental imagery can be harmful to people living with anxiety and other mental disorders (Holmes et al., 2005; Pearson, 2019; Zeman et al., 2015). Therefore, there needs to be judicious judgement in the way in which imagery is used on a person-to-person basis. In terms of limitations on the research in this area, I came to realise that the notion of mental practice is scientifically evidenced to be complex and subject to many fields of science with research still ongoing; these areas include neurology, physiology, psychology and biology. To add to this are the cultural and artistic considerations involved in the performance of music. This makes establishing a one-stop-fits-all protocol for imaging for singers impossible to achieve, however, Holmes et al’s (2005) PETTLEP model of visualisation stresses the importance of developing imagery in collaboration with the individual; this will allow the singer to identify their most efficient information processing model for specific skills acquisition.

Now What?

From an academic standpoint, I found myself overwhelmed by the seemingly infinite ways of presenting academic reviews, which made starting the essay overly time-consuming and frustrating. With this and previous modules, I have felt that academic writing skills seem to have taken precedence over the discussion of new knowledge pertinent to vocal pedagogy and, having begun the course with a thirst for new professional knowledge, I had begun to feel resentful about a perceived imbalance. For this module, I had a moment of insight that may have redressed this; having spent considerable time in learning about the hermeneutic circle and how I could demonstrate this knowledge in my presentation, I realised that my method of researching is already, unknowingly, underpinned by these principles. This moment suggested that I needed to trust my intuition more and in doing so I might unburden myself of the academic strictures that were confining me. Stepping back and taking a pragmatic overview reminded me of why I had undertaken the Masters in the first place and was very helpful in finding focus; securing a Masters reassures clients and employers that I have taken the time and trouble to gain a deep understanding of elements of my field of practice. Their interest is in the qualification and not in my skills as an academic writer. More importantly, perhaps, by filling gaps in my professional knowledge, I feel more self-confident as a teacher. I now feel that I have allowed myself to start enjoying the learning aspects of undertaking a professional Masters. I fully respect and appreciate the necessity for defined research protocols to create robustness in research, however, I am seeking a balance between these and reminding myself that my professional practice and my students are central to the purpose of the research. Going forward, university marking and feedback on this paper will reveal the suitability of this approach.

While undertaking this research, I became concerned that if I couldn't teach 'how' and 'what' to imagine, the knowledge would become redundant. I am therefore considering, for future research, the development of a scientifically underpinned 'image' vernacular relevant to singing training. At this stage I am not sure what form this would take, for example, 2D visual, spoken or written. Additionally, The PETTLEP Model (2005) along with Action Observation (AO) models, could provide the basis for visualisation protocols in singing training. Both could be used for developing image 'scripts' for students. This feels exciting and would add value to the research already undertaken.

In terms of fulfilling my personal goal of improved time efficiency, I felt that I was not fully successful in the early stages. This was mostly due to not refining my research question clearly enough and in taking considerable time to learn about research methodologies. In terms of identifying relevant literature, I was more successful and vastly more time-efficient than on previous modules and adhered to my proposed timeline. I hope that the efficiency in selecting literature continues to improve through the Masters.

Part 2

An overview of mental practice within the context of an application to vocal pedagogy

Introduction

A general definition of ‘mental practice’ as extracted by consensus from the corpus of literature assimilated for this paper, would describe it thus; the use of imagery, as opposed to the physical or motor skills used in physical practice, to develop and embed skills (APA Dictionary of Psychology, 2018; Mielke et al., 2019, Oxford Dictionary of Sports Science, 2007; Ruffino et al., 2021; Wakefield et al., 2013; Weiland et al., 2022). A number of studies demonstrate that elite performers often exhibit high-speed efficiency in information-processing and in motor coordination, which is variously attributed to a rigorous system of repetition and practice through the use of mental imagery (Monany et al., 2022; Ruffino et al., 2021). It is this enhanced neuro-processing and motor coordination that can often separate the expert practitioner from their novice counterpart, highlighting, perhaps, the need for incorporating mental practice into all fields of physical learning; this includes the author’s area of professional practice, singing training (Debarnot, 2014; Meng et al, 2019). The aim of this rapid review is not so much to expose the benefits of mental practice as it is to find depth in the meaning of the term from its historic, scientific roots to modern-day explorations and to identify elements of transferability to singing training. This element of transferability includes an examination of a framework for the practical application of visualisation that could be adapted to singing training (Holmes and Collins, 2005). The review will also examine the four areas of sensory input specifically related to singing imagery: motor, auditory, kinaesthetic and visual imagery (Mielke et al., 2019). As mental practice is dependent upon imagery and imagery per se, is subjective and unique to the individual experience, it can not be objectively evaluated by an outsider (Pearson, 2019). Therefore, to reduce the semantic ambiguity or vagueness that this might generate, this paper uses key terms provided in Mielke et al’s (2019) Glossary and Taxonomy on Mental Practice in Music Performance (appendix 1); a scrupulous, peer-reviewed document that draws from a wide-range of published articles to inform its content. Common search terms used for the purposes of this rapid review include “mental practice” along with “music”, “audiation”, “subvocalisation”, “motor imagery”, “kinaesthetic imagery”, “sport psychology” and “imagination”. The majority of the extracted literature includes peer-reviewed texts drawn from the domains of clinical psychology with some related pedagogical publications and, with a few exceptions, the literature is as recently published as possible. By way of summation, the author offers an actionable definition of the term ‘mental practice’ within the context of singing training, that is synthesised using a process of hermeneutics (Boel, 2010; Heidegger, 1927, 2010; George, 2021).

Within the context of an application to music performance, the evidenced benefits of mental practice include motor improvements and coordination, performance memory, pitch accuracy and rhythm mastery (Bernardi et al., 2013; Loimusalo, 2018; Monany, 2022).

Scientific interest in the conscious and unconscious mind

Scientific interest in the conscious and unconscious mind extends back to 1870s when psychology was presented as a new field of science. Some of the hypotheses suggested by our forebears are still upheld by modern-day scientific communities; of significance is Margaret Washburn's (1916) seminal text on Motor Theory of Consciousness which sought to explain the relationship between motor processes and the conscious and unconscious mind. Professor Washburn held with the school of Gestalt psychology that posited that the mind organises individual sensory inputs into 'wholes' rather than separate parts; in other words, the mind can undertake complex physical tasks more efficiently by 'overall' neural processing (Wagemans et al, 2012). In 1964, Fitts hypothesised that in the realms of cognitive psychology, repetition can result in cognitive processes evolving into automatic processing; by increasing automaticity in processing, effort levels are reduced and the process becomes more efficient, an important factor in expediting skill development (Milton et al., 2004; Ruffino, 2021; Scott et al., 2022; Shiffrin and Schneider, 1977; Willingham, 1998). Interestingly, it has been suggested that as people reach a level of automaticity that they find enjoyable and comfortable they fail to develop beyond the level of hobbyist, suggesting that automaticity is a false ceiling and not indicative of excellence (Ericsson, 2007). For over 70-years, scientists have posited that the more practice undertaken, the less conscious the act itself becomes. Although research in this field is ongoing, there is evidence that suggests that the consolidation and retention of skills developed through the use of imagery tends to be higher than those developed through the conventions of full physical embodiment (Bernardi et al., 2013; Ruffino, 2021). As singing is multi-sensory, the need for unconscious task-bearing, becomes essential to improvement and, as the Gestalt model hypothesises, efficiency of automaticity derives from being able to 'imagine' the overall task rather than the myriad individual component tasks. In other words, if we tried to simultaneously consider each of the complex motor and neural processes required for singing, the act itself could become almost impossible to execute, supporting the case for overall task imaging.

Motor imagery (MI)

The evolution of contemporary research methods and equipment, has enabled the modern-day scientist to verify some of the early theories posited by Washburn (1916) and Fitts (1964). Functional MRI (fMRI) of the brain, for example, can measure changes in blood flow correlating to brain activity when a pre-learned physical act is imagined (radiologyinfo.org). These mental representations of physical movement are defined as motor imagery and involve visual and kinaesthetic aspects of movement execution often with auditory imaging and other cues (Eaves et al., 2016; Meugnot, 2014; Mielke et al., 2019; Ruffino et al., 2021; Scott et al., 2022). fMRI used on professional dancers measured brain activity while imagining pre-learned choreography without physically engaging in dancing (Haggard et al., 2004). This study, along with more recent research,

revealed that the same areas of the brain that are activated for physical movement are also activated for imagined movement (Albers et al., 2013; Naselaris et al., 2015; Pearson, 2019). If the brain is activated in the same way for both forms of movement, this suggests value in silent or static rehearsal to embed skills for all types of physical activity. This includes remedial strategies for post injury or illness (Meugnot, 2014). Additionally, there may be benefits for singing students to practice when audible singing is not possible. In addition to fMRI studies, Transcranial Magnetic Stimulation (TMS) also provides quantifiable evidence of neural activity in the motor cortex of the brain when imagining pre-learned physical tasks (Monany et al., 2022). Advances in methods of non-invasive neuroimaging have allowed scientists to demonstrate that as behaviours and skills are developed and embedded, long-term changes can occur in neuroplasticity (Debarnot, 2014; Jäncke, 2009; Johansson, 2011; Monany et al, 2022). In other words, the brain can undergo physical modifications as the learning occurs. Debarnot (2014) sums this phenomenon up by highlighting that although the brain is the source of all human behaviour, it is possible that the behaviour itself can modify the brain, which, in turn, modifies the behaviour.

In addition to the neural observations occurring during MI, analyses of muscle activation provides a broader perspective; electromyography (EMG) has been used historically as a diagnostic tool in measuring electrical activity in muscles (Guillot et al, 2007; Aoyama et al., 2011). EMG can provide the subject with immediate visual and bio-feedback measurements, which can help in learning how to activate specific muscle sets (Weiland et al, 2022). However, EMG may not be a reliable method on its own for detecting the subliminal muscle activation or excitability occurring in the context of using MI (Guillot et al, 2005, Weiland et al, 2022). Tensionmyography (TMI) provides more detailed measurements of mechanical muscle reactions to stimuli and has been used in research to observe muscle activation in MI experiments. Controlled measuring of the activation of the bicep brachii muscle, for example, using TMI demonstrated muscle activation, but not full muscle belly contraction (Weiland et al., 2022). This example of overt action and imagined action being functionally similar, (i.e., when movement is felt using MI but the body remains static, as demonstrated by Professor Haggard's dancers) is described as Motor Simulation Theory (Frank et al., 2024). It is worth noting that MI depends on 'forward modelling' which describes how neural processes can predict a future sensorimotor state by mimicking a pre-learned physical process (Kilteni et al, 2018), thus highlighting that the 'choreography' needs to be learned before it can be imagined. To support this hypothesis, there is evidence to suggest that voluntary mental imagery (across all the senses) relies on memory retrieval; "We are combining different content that our senses have previously been exposed to and is stored in our memory" (Pearson, 2019, p2). This might suggest that omitting the use of MI would be sufficient for skill development, however, MI increases the efficiency and speed of neuro and motor processing and has been shown to be very effective in long-term behavioural modifications through changes in neuroplasticity (Lebon et al., 2010; Monany et al, 2022; Ranganathan et al.; 2004; Ruffino et al.; 2021; Yue et al.,1992). It should be noted that not all tasks benefit to the same degree, this includes physical tasks with less cognitive components, such as sit-ups (Ladda et al., 2021). Of further consideration, is that the

implementation of MI depends on the ability of an individual to imagine movement (Brown et al., 2013; Cumming et al., 2012; Weiland et al., 2022) and therefore, on a teacher's ability to direct the student in learning. Evidence suggests that for imagery to be effective, it must be personal, meaningful and relevant and developed by the individual, under the guidance of the mentor or teacher (Cumming et al., 2013; Holmes et al., 2005). However, it is important to note that not all humans are capable of imagination (a condition called aphantasia), and that imagery can be clinically disruptive to those living with disorders such as post-traumatic stress disorder (PTSD) depression, schizophrenia and Parkinson's disease (Holmes et al., 2005; Pearson, 2019; Zeman et al., 2015). In summary, the use of MI in the wider population has been shown to have a positive impact on motor training and as such may hold value in all forms of physical learning, including singing (Avanzino et al. 2015; Frank et al., 2022; Holmes and Collins, 2005; Ruffino et al., 2017; Scott et al., 2022).

Auditory imagery

There is a marked diversity of terminology used to describe representations of auditory imagery: inner singing, hearing eye, mind singing, audiation, subvocalisation, aural imagery (Gates, 2021). Collectively these suggest an introspective means of sound generation; such as composers orchestrating their work or musicians performing a memorised piece or silently studying a score (Gates et al., 2021; Gordon, 2012, 1999). Mielke et al's (2019) Glossary and Taxonomy on Mental Practice in Music Performance (appendix 1) defines it thus: "acoustic mental representation of objects or events". The acquisition of memory content through learning frequently occurring patterns and music schemata (common musical phrases) either implicitly or explicitly, are essential to the development of auditory imaging (Gates, 2021). These schemata are basic building blocks or sound structures, often acquired from early childhood and considered by some to be an important contributor to musical aptitude in later life (Choksy, 1974; Gordon, 2012). There is historic agreement that the developmental phases of speech acquisition in humans involves listening, auditory imaging and repetition; perhaps this suggests emphasis on listening and embedding schemata to expedite the learning process in singing training (Gordon, 1999; Moss Erickson, 2022). Unsurprisingly, perhaps, trained musicians have been found to have better music recall than their non-professional counterparts; this is accounted for by the multimodal advantage of imagery cueing techniques and memory retrieval through visual mapping of notation, statistical information, schemata and tactile pitch cueing (Gates, 2021). As singers do not have the advantage of multimodal, tactile pitch cueing, Gates (2021) suggests that learning to play the piano can aid sound-to-action pitch imaging and notation-to-pitch association. Perhaps further research should be devoted to devising strategies to develop pitch cueing skills for those singers who are unable to read music or with no access to a keyboard.

Subvocalisation is often used to describe how we say words inside our heads as we are reading them (Moul, 2024). The use of Electromyography (EMG) shows that subvocalisation activates the motor planning areas for speech as well as for planning laryngeal and articulatory movements for

the anticipation of a target pitch in singing (Greenspon, 2023; Pfordresher et al., 2013). Interestingly, it is this research that has allowed for the development of a silent-speech interface device used for post-laryngectomies (Deng et al., 2009). Essentially, in the same way that mentally rehearsing choreography can generate muscle activation, pitch imagery initiates laryngeal and articulatory muscle activity (Greenspon, 2023). This suggests that soundlessly rehearsing a song may have benefits for developing kinaesthetic awareness for pitching and for building musical memory. Additionally, there is the added benefit of a reduction in overloading or tension stress that can be present in undertaking physical tasks; for example, in the author's field of professional practice, sore throats from over-rehearsing (Ladda et al., 2021).

Kinaesthetic imagery

Kinaesthetic imagery is a sense that allows for perception of body movement and position, known as proprioception; the proprioceptors mediate sense and are found in muscles and tendons (Blumer et al., 2024). Kinaesthetic imagery is Intrinsically tied into motor imagery (MI) in that any sense of physical perception must, by its very nature, involve motor systems. As such, the combination of visual and kinaesthetic aspects of movement execution and sensation are incorporated into the MI model (Mielke et al., 2019; Ruffino et al., 2021; Scott et al., 2022). The neural connectivity between visual motor imagery and kinaesthetic imagery is not fully understood and is the subject of current research (Yang et al., 2021). As pitch-changing requires significant laryngeal movement in singing, as does vowel shaping and soft palate elevation, developing a sense of kinaesthetic feedback along with visual and auditory imaging, would seem to be significant in competent sound generation (Greenspon, 2023).

Visual imagery

As this paper has been concerned with perceptual visual imagery associated with MI, including kinaesthetic and auditory imaging, this section outlines the use of visual imagery objects to modify behaviours. Interestingly, the largest proportion of cortisol tissue in the human brain that is assigned to the five senses is that of processing visual information (Pearson, 2019). Behavioural studies suggest that visual imagery can have a functional effect, similar in form to visual perception, on sensory processing (Pearson et al., 2019). In other words, a person can experience sensory recall by associating a task with a seen image, thereby suggesting that visual stimuli can improve performance in perceptual tasks (Tartaglia et al., 2009). Beyond the remit of this paper, perhaps a 'glossary' of images to prompt particular sensory behaviours might be strategic in advancing singing training (Holmes et al., 2005). These might include visual images to depict vocal tract shaping, verbal metaphors to sum up overall sensations, auditory signals including tone triggers to develop emotional intention or narrative exposition.

PETTLEP - applying a framework for visualisation

In terms of a protocol for the application of imagery as a strategy in physical learning, the PETTLEP model offers a practical framework for visualisation that could be adapted to singing training (Frank et al., 2024; Kageyama, 2021; Ladda et al., 2021; Scott et al., 2020). It was originally developed by Holmes and Collins (2005) for sport psychologists to help athletes develop motor imagery skills, and is now widely used in broader fields of learning. The model incorporates the following components:

- **Physical** Adopting a stance, or movement, for example, or holding a relevant object to encourage task-specific kinaesthetic feedback, like a golf club or musical instrument (Frank et al., 2024; Scott et al., 2020).
- **Environment** Visual imagery such as photos, videos or audio of training grounds or competition and performance environments can facilitate the generation of vivid visual components of MI (Scott et al., 2020)
- **Task** Imagining the task, such as taking a penalty in football, or knocking the ball into the pocket in snooker, or performing a song
- **Timing** In order to reinforce the timing components of specific skills acquisition, Holmes and Collins (2005) suggest that movement execution is imaged in real-time, rather than in slow motion. In music, learning the rhythm and timing should be exact when imaging (Kageyama, 2021)
- **Learning:** MI content should be representative of the current level of learning and experience and should be updated as the individual's level of skill develops (Holmes and Collins, 2001).
- **Emotion** Feelings and emotions connected to movement execution can be a useful addition to the individual's MI stimulus (Scott et al., 2020). fMRI on professional singers has shown that parts of the emotional processing network, such as the amygdala and insula, is activated during performance, which suggests that emotional imagery may be helpful (Gates et al., 2021). Additionally, not directly related to the demands of the music, is the acknowledgment and acceptance of how the singer might feel under the pressure of performance (Kageyama, 2021)
- **Perspective:** This pertains to the visual perspective preferences of first or third person, which needs to be taken into account when implementing MI and should be decided by the individual and informed by the task being undertaken (Scott et al., 2020). Neurological patterns of activity are altered by changing modalities during imaging (so from first person to third person) which can affect the training outcome (Ladda et al., 2021)

This roadmap enables the individual to create an imagery 'script' to develop and enhance skills or prepare for a particular event, perhaps an audition or sung performance (Williams et al., 2013). Imagery scripts are widely used in therapeutic and clinical settings, including in music therapy or Cognitive Behavioural Therapy (CBT). It should be noted that not all PETTLEP elements apply to every person or circumstance (Kageyama, 2016, 2021; Scott et al., 2020). Additionally, due to the covert nature of imagery, there is no way of truly knowing how the individual is processing the imagery defined in the script (Pearson 2019; Wright et al., 2022). An illustrative example of

PETTLEP might be the golfer working on putting skills who imagines the hole, is able 'see' the ball and 'feel' the club and 'hear' the club head-ball-impact and the outcome (Frank et al., 2024). The hugely successful England footballer, Wayne Rooney describes using deliberate imagery in his big match preparation; knowing which kit he will be wearing allows him to imagine himself on the pitch, and visualising the potential challenges he might face helps prepare him for the necessary physical movement (www.fourfourtwo.com). When transposed to singing training, perhaps deliberate imaging of the costume along with a vivid visual reference of the performance space and interactions with other musicians on stage, might form part of a PETTLEP script (Ladda, 2021).

Since the introduction of the PETTLEP model in 2001, there has been an improved understanding of the neural processing of different image types. It has been suggested that designing a script requires rich verbal detail of the stimuli, sensations and actions to be imagined, along with visually-rich descriptive verbal instructions. However, the use of language and words risks depersonalising the cognitive control of movement, which is central to the PETTLEP philosophy (Scott et al, 2022). This is because neural processing for language requires activity in the ventral stream which is slower and more conscious than the dorsal stream which processes sensory information at an unconscious level (Wakefield et al., 2013). Action Observation (AO), both live and pre-recorded, has been shown to be an effective alternative for overcoming the dominance of the ventral stream (Wakefield and Smith, 2011). In essence, video footage or photographs of the athlete performing can help them recall vivid stimuli without the need for any verbal instructions. This suggests that singing students who are challenged by tone or pitch accuracy could use real-time spectrographic feedback to monitor the harmonic content of their voices (Ballantyne, 2021). In the same way that EMG can provide the subject with immediate visual and bio-feedback measurements, a visual perspective of 'in-tune' or 'out of tune' might allow the development of associated kinaesthetic and auditory feedback (Weiland et al, 2022). Learning to feel and identify the vocal-tract sensations for 'in-tune' may have long term learning benefits and provide rich descriptors for a PETTLEP model. AO and MI have been shown to use overlapping brain regions (Hardwick et al., 2018). As such, researchers have begun to successfully integrate AO and MI (AOMI) by delivering an AO experience prior to using the PETTLEP intervention which has the advantage of reducing the need to use language to define an image (Lu et al., 2020, Wright et al., 2022). Additionally, watching other people performing as part of the AOMI prescription, can also be successful in improving performance (Neuman & Gray, 2013). Imagining the feelings and sensations and postural changes observed in elite singers, may have benefits for their novice counterparts (Wright et al., 2022). Interestingly, some research indicates that participants learned new tasks more quickly when observing unskilled models also learning the task (Aoyama et al., 2020; Kawasaki et al, 2018). Perhaps an example of this might be vocal masterclasses, popular on social media platforms (Sir Thomas Allen, Cheryl Porter, Natalie Weiss and many others) allowing the bystander the opportunity to witness a highly skilled individual directing an unskilled or lesser skilled individual in exposing the 'right' way and 'wrong' way to undertake a task.

Conclusion

The literature examined for this paper supports the notion that mental practice can be described as the use of imagery to develop and embed physical and cognitive skills and is a process that can be applied to all forms of physical learning, including singing (APA Dictionary of Psychology, 2018; Mielke et al., 2019; Ruffino et al., 2021; Weiland et al., 2022). Empirical and clinical studies suggests that singers could develop high speed efficiency in information-processing and in motor coordination through a process of repetition supported by mental practice (Scott et al., 2022). Additionally, elevated levels of automaticity present as the major difference between the expert and the novice, which perhaps further highlights the value of repetition and mental practice in singing training (Debarnot, 2014; Meng et al, 2019, Ruffino, 2021; Scott et al, 2022). Historically, psychologists have posited that imaging the 'overall' task is likely to be more effective in expediting automaticity than a 'multi' tasking' approach (Fitts, 1964; Shiffrin and Schneider, 1977, Washburn 1916). As singing is a complex task, fusing a multitude of fields of science with art (Dicther et al., 2018; Herbst, 2016; Zhang, 2016), this 'overall' approach to task bearing, seems particularly apt. Although research in the study of the effects of imagery use is ongoing, observed behavioural modifications along with evidenced changes in neuroplasticity occurring through mental practice, currently suggests a more long-term embedding of skills than those associated with physical practice (Debarnot, 2014; Jäncke, 2009; Johansson, 2011; Monany et al, 2022). Imagining movement and engaging in movement have been shown to share the same motor and neural pathways, which, as singing is a physical activity, supports the value of undertaking mental practice (Albers et al., 2013; Haggard et al., 2005; Naselaris et al., 2015; Pearson, 2019); these include activating muscle sets without producing sound, thereby reducing muscular overloading or tension stress and providing opportunities to sing in environments where audible singing is not possible (Ladda et al., 2021). Additionally, subvocalisation can develop kinaesthetic feedback of laryngeal shaping and the use of audiation techniques can improve pitching, rhythm and the memorising of melodic patterns (Gordon, 2012; Greenspon, 2023; Ladda, 2021; Monany, 2022). In terms of an application for learning visualisation in a singing training setting, the Holmes and Collins (2001, 2005) PETTLEP model along with action observation (AO) may provide the groundwork for a model of visualisation for improving motor skills, developing kinaesthetic awareness, performance preparation, increased acquisition of memory objects, particularly for pitch and rhythm and better listening skills (Greenspon, 2023; Ladda, 2021; Neuman et al., 2013; Wright et al., 2022). However, it should be noted that not all people are capable of imagination and that there are some instances when triggering of images can be clinically disruptive, particularly to people living with anxiety disorders (Holmes et al., 2005; Pearson, 2019; Zeman et al., 2015). Overall, the empirical and clinical evidence explored for this paper supports the potential for mental imagery as an effective means of learning and embedding skills in singing training. As the notion of mental practice is evidenced as scientifically complex, including neurological, physiological and psychological phenomena, a one-stop-fits-all protocol for imaging for singers is unlikely to be

successful. Additionally, there are further cultural and artistic considerations involved in the performance of music. However, Holmes et al's (2005) reminder of the importance of developing imagery in collaboration with the individual is more likely to be affective in specific skills acquisition. Further research could consider a model of PETTLEP that combines AO that specifically targets singing training thus providing the basis upon which a singer can begin to devise their personal image 'script'.

References

Albers, A. M., Kok, P., Toni, I., Dijkerman, H. C., de Lange, F. P. (2013). 'Shared representations for working memory and mental imagery in early visual cortex'. *Curr. Biol.* 23, 1427–1431.

American Psychological Association [website] (Accessed: September 2024). <https://dictionary.apa.org/mental-practice> accessed 6/10/24

Aoyama, T., Kaneko, F., Kohno, Y. (2020). 'Motor imagery combined with action observation training optimized for individual motor skills further improves motor skills close to a plateau'. *Human Movement Science*, 73, Article 102683. doi:10.1016/j.humov.2020.102683

Arthur, C. (2018). 'A Perceptual Study of Scale-Degree Qualia in Context.' *Music Perception* 35 (3): 295–314. <https://doi.org/10.1525/mp.2018.35.3.295>.

Avanzino, L. *et al.*, (2015). 'Motor cortical plasticity induced by motor learning through mental practice'. *Front. Behav. Neurosci.* 9, 105.

Ballantyne, C. (2021). 'Application of Acoustic Vocal Pedagogy' [Recorded lecture]. Voice Study Centre. 12 October, 2023. Available at <https://voicestudycentre.com> (Accessed: August 2023).

Bernardi, N.F. *et al.* (2013). 'Mental practice promotes motor anticipation: evidence from skilled music performance', *Frontiers in human neuroscience*, 7, pp. 451–451. Available at: <https://doi.org/10.3389/fnhum.2013.00451>.

Blumer, R., Carrero-Rojas, G., de la Cruz, R., Streicher, J., Pastor, A. (2024). 'Extraocular Muscles: Proprioception and Proprioceptors. Reference Module in Neuroscience and Biobehavioral Psychology, Elsevier, ISBN 9780128093245, <https://doi.org/10.1016/B978-0-443-13820-1.00028-1> (<https://www.sciencedirect.com/science/article/pii/B9780443138201000281>).

Brown, P., Krakauer, J. (2009). 'Inside the brain of an elite athlete: the neural processes that support high achievement in sports'. *Nat Rev Neurosci* 10, 585–596. <https://doi.org/10.1038/nrn2672>

Brown, R.M., Palmer, C. (2013). 'Auditory and motor imagery modulate learning in music performance'. *Frontiers in human neuroscience*, 7, pp. 320–320. Available at: <https://doi.org/10.3389/fnhum.2013.00320>.

Cumming, J., Williams, S.E. (2013) 'Introducing the revised applied model of deliberate imagery use for sport, dance, exercise, and rehabilitation'. *Movement & sport sciences*, (82), pp. 69–81. Available at: <https://doi.org/10.1051/sm/2013098>.

Daneman, M., & Newson, M. (1992). Assessing the Importance of Subvocalization in Normal Silent Reading. *Reading and Writing: An Interdisciplinary Journal*, 4, 55-77

Debarnot U., Sperduti M., Di Rienzo F., Guillot A. (2014). 'Experts bodies, experts minds: How physical and mental training shape the brain'. *Frontiers in Human Neuroscience* VOL8 URL=<https://www.frontiersin.org/journals/human-neuroscience/articles/10.3389/fnhum.2014.00280> DOI=10.3389/fnhum.2014.00280 ISSN=1662-5161

Debarnot, U. (2014). Experts bodies, experts minds: How physical and mental training shape the brain. *Frontiers in human Neuroscience*

Deng Y., Patel R., Heaton J. T., Colby G., Gilmore L. D., Cabrera J., Roy S. H., De Luca C.J., Meltzner G. S. (2009). 'Disordered speech recognition using acoustic and sEMG signals'. In *INTERSPEECH-2009*, 644-647

Frank, C., Kraeutner, S., Rieger, M., Boe, S. (2023). 'Learning Motor actions via imagery - perceptual or motor learning?' *Psychological Research* 88. 1820 - 1832. <https://doi.org/10.1007/s00426-022-01787-4>

Greenspon, E.B. *et al.* (2023). 'Subvocalization during Preparatory and Non-preparatory Auditory Imagery'. *Auditory perception & cognition*, 6(1–2), pp. 108–127. Available at: <https://doi.org/10.1080/25742442.2022.2163582>.

Guillot, A. & Collet, C. *The Neurophysiological Foundations of Mental and Motor Imagery* (Oxford University Press, Oxford, 2010).

Guillot, A., Collet, C. (2005). 'Duration of mentally simulated movement: a review. *J. Mot. Behav.* 37, 10–20.

Hardwick, R. M., Caspers, S., Eickhoff, S. B., Swinnen, S. P. (2018). 'Neural correlates of action: Comparing meta-analyses of imagery, observation, and execution'. *Neuroscience & Biobehavioral Reviews*, 94, 31–44. doi:10.1016/j.neubiorev.2018.08.003.

Holmes, E. A. & Mathews (2005). 'A. Mental imagery and emotion: a special relationship?'. *Emotion* 5, 489–497

Holmes, P. S., & Collins, D. J. (2005). 'The PETTLEP Approach to Motor Imagery: A Functional Equivalence Model for Sport Psychologists'. *Journal of Applied Sport Psychology*, 13(1), 60–83. <https://doi.org/10.1080/10413200109339004>

<https://doi.org/10.1016/j.bandc.2021.105705>.

<https://www.fourfourtwo.com/performance/wayne-rooney>. [website: accessed October 2024]

Ishai, A. & Sagi, D. (1995). 'Common mechanisms of visual imagery and perception'. *Science* 268, 1772–1774.

Kageyama, N. (2016, 2021). 'Not Sure How to Do Mental Practice? Here's a 7-Point How-To Guide.' The Bulletproof Musician (podcast and newsletter) <https://bulletproofmusician.com/pettlep-a-7-point-how-to-guide-for-visualization/>

Kawasaki, T., Tozawa, R., Aramaki, H. (2018). Effectiveness of using an unskilled model in action observation combined with motor imagery training for early motor learning in elderly people: A preliminary study'. *Somatosensory & Motor Research*, 35(3–4), 204–211. doi:10.1080/08990220.2018.1527760.

Kepes, Sven & Banks, George & Mcdaniel, Michael & Whetzel, Deborah. (2012). Publication Bias in the Organizational Sciences. *Organizational Research Methods*. 15. 624–662. 10.1177/1094428112452760.

Kitago, T., Krakauer, J. (2013). 'Motor learning principles for neurorehabilitation. *Handb. Clin. Neurol.* 110, 93–103.

Ladda A., Lebon, F., Lotze, M. (2021). 'Using motor imagery practice for improving motor performance – A review'. *Brain and Cognition*, Volume 150, 105705, ISSN 0278-2626,

Lebon, F., Collet, C. & Guillot, A. (2010). 'Benefits of motor imagery training on muscle strength.' *J. Strength Cond. Res.* 24, 1680–1687.

Loimusalo, N.J. and Huovinen, E. (2018). 'Memorizing Silently to Perform Tonal and Non-tonal Notated Music: A Mixed-Methods Study With Pianists.' *Psychomusicology*, 28(4), pp. 222–239. Available at: <https://doi.org/10.1037/pmu0000227>.

Lowery, C., Jenlink, P. (eds) (2019). *The Handbook of Dewey's Educational Theory and Practice*. Leiden Boston: Brill .

Lu, F. J., Gill, D. L., Lee, Y. C., Chiu, Y. H., Liu, S., Liu, H. Y. (2020). 'Effects of visualized PETTLEP imagery on the basketball 3-point shot: A comparison of internal and external perspectives'. *Psychology of Sport and Exercise*, 51, Article 101765. doi:10.1016/j.psychsport.2020.101765.

Meng,F.,Li,A.,You,Y.,& Xie,C.(2019). 'Motor expertise modulates unconscious rather than conscious executive control. PeerJ,7,e6387.doi:10.7717/peerj.6387

[mentalhealth.org.uk](https://www.mentalhealth.org.uk) [Website: accessed September 2024]

Meugnot, A., Agbangla, N. F., Almecija, Y. & Toussaint, L. (2014). 'Motor imagery practice may compensate for the slowdown of sensorimotor processes induced by short-term upper-limb immobilization'. *Psychol. Res.* 79, 489–499.

Moss-Erickson, H. (2022). 'Vocal Learning and Songbirds: An Evolutionary Tale of Singing.' *Journal of Singing National Association of Teachers of Singing*. pp. 87-94 10.53830/xhji5745.

Naselaris, T., Olman, C. A., Stansbury, D. E., Ugurbil, K., Gallant, J. L. (2015). 'A voxel-wise encoding model for early visual areas decodes mental images of remembered scenes'. *Neuroimage* 105, 215–228.

Pearson, J. (2014). 'New directions in mental-imagery research: the binocular-rivalry technique and decoding fMRI patterns'. *Curr. Dir. Psychol. Sci.* 23, 178–183.

Pearson, J. (2019). 'The human imagination: the cognitive neuroscience of visual mental imagery'. *Nat Rev Neurosci* 20, 624–634. <https://doi.org/10.1038/s41583-019-0202-9>

Pearson, J., Clifford, C. W. G. & Tong, F. (2008). The functional impact of mental imagery on conscious perception. *Curr. Biol.* 18, 982–986.

Pearson, J., Naselaris, T., Holmes, E. A. & Kosslyn, S. M. (2015). 'Mental imagery: functional mechanisms and clinical applications'. *Trends Cogn. Sci.* 19, 590–602.

Pearson, J., Rademaker, R. L. & Tong, F. (2011). 'Evaluating the mind's eye: the metacognition of visual imagery'. *Psychol. Sci.* 22, 1535–1542.

Pearson, J., Westbrook, F. (2015). 'Phantom perception voluntary and involuntary non-retinal vision'. *Trends Cogn. Sci.* 19, 278–284.

Ranganathan, V. K., Siemionow, V., Liu, J. Z., Sahgal, V. & Yue, G. H. (2004). 'From mental power to muscle power - Gaining strength by using the mind.' *Neuropsychologia* 42, 944–956 (2004).

Rannaud, Monany, D., Lebon, F., Dupont, W., Papaxanthis, C. (2022). 'Mental practice modulates functional connectivity between the cerebellum and the primary motor cortex'. *iScience*, 25(6), 104397–104397. <https://doi.org/10.1016/j.isci.2022.104397>

Robertson, Edwin M. et al. (2004). 'Awareness modifies the skill-learning benefits of sleep.' *Current Biology : CB* vol. 14,3: 208-12. doi:10.1016/j.cub.2004.01.027

Ruffino, C., Papaxanthis, C. & Lebon, F. (2017). 'Neural plasticity during motor learning with motor imagery practice: Review and perspectives.' *Neuroscience* 341, 61–78.

Ruffino, C., Papaxanthis, C. & Lebon, F. (2017). 'Neural plasticity during motor learning with motor imagery practice: Review and perspectives'. *Neuroscience* 341, 61–78.

Ruffino, C., Truong, C., Dupont, W. (2021). Acquisition and consolidation processes following motor imagery practice. *Sci Rep* 11, 2295. <https://doi.org/10.1038/s41598-021-81994-y>

Scott, M., Wright, D., Smith, D., Holmes, P. (2022). 'Twenty years of PETTLEP imagery: An update and new direction for simulation-based training'. *Asian Journal of Sport and Exercise Psychology*, Volume 2, Issue 2, Pages 70-79, ISSN 2667-2391, <https://doi.org/10.1016/j.ajsep.2022.07.002>.

Tartaglia, E. M., Bamert, L., Mast, F. W. & Herzog, M. H. (2009). 'Human perceptual learning by mental imagery'. *Curr. Biol.* 19, 2081–2085.

Theodore, G. (2021). 'Hermeneutics'. The Stanford Encyclopedia of Philosophy (Winter 2021 Edition), Edward N. Zalta (ed.), URL = <<https://plato.stanford.edu/archives/win2021/entries/hermeneutics>>.

Wakefield, C., Smith, D. (2011). 'From strength to strength: A single-case design study of PETTLEP imagery frequency'. *The Sport Psychologist*, 25(3), 305–320, doi:10.1123/tsp.25.3.305

Wakefield, C., Smith, D., Moran, A. P., & Holmes, P. (2013). Functional equivalence or behavioural matching? A critical reflection on 15 years of research using the PETTLEP model of motor imagery. *International Review of Sport and Exercise Psychology*, 6(1), 105–121. doi:10.1080/1750984X.2012.724437.

Wakefield, C., Smith, D., Moran, A. P., Holmes, P. (2012). 'Functional equivalence or behavioural matching? A critical reflection on 15 years of research using the PETTLEP model of motor imagery'. *International Review of Sport and Exercise Psychology*, 6(1), 105–121. <https://doi.org/10.1080/1750984X.2012.724437>

Wieland, B., Behringer, M., Zentgraf, K. (2022). 'Motor imagery and the muscle system'. *International Journal of Psychophysiology*, 174, 57–65. <https://doi.org/10.1016/j.ijpsycho.2022.02.004>

Williams, S.E., Cooley, S.J., Newell, E., Weibull, F., Cumming, J. (2013). 'Seeing the difference: Developing effective imagery scripts for athletes'. *Journal of Sport Psychology in Action*, 4(2), 109–121. doi:10.1080/21520704.2013.781560.

Willingham, D. (1998). A neuropsychological theory of motor skill learning. *Psychol. Rev.* 105, 558–584.

Wright, D. J., Frank, C., Bruton, A. M. (2022). 'Recommendations for Combining Action Observation and Motor Imagery Interventions in Sport. *Journal of Sport Psychology in Action*, 13(3), 155–167. <https://doi.org/10.1080/21520704.2021.1971810>.

Yang, Y.J., Jeon, E.J., Kim, J.S. *et al.* (2021). 'Characterization of kinaesthetic motor imagery compared with visual motor imageries'. *Sci Rep* 11, 3751 (2021). <https://doi.org/10.1038/s41598-021-82241-0>

Yensen, J. (2016). 'Extracting Meaning in Support of Critical Thinking and Writing', *Online journal of nursing informatics*, 20(1).

Yue, G., Cole, K. J. (1992). 'Strength increases from the motor program: comparison of training with maximal voluntary and imagined muscle contractions. *J. Neurophysiol.* 67, 1114–1123 (1992).

Zeman, A., Dewar, M., Della Sala, S. (2015). 'Lives without imagery — congenital aphantasia'. *Cortex* 73, 378–380.

Appendix 1

‘Developing a literature-based glossary and taxonomy for the study of mental practice in music performance’ (Mielke and Comeau, 2019)

Glossary of terms

Auditory feedback: Instructive acoustic information received on the performance of a task (Highben & Palmer, 2004; “Acoustic”, 2016; “Feedback”, 2016). See also *feedback*.

Auditory image: Acoustic mental representation of an object or event (Holmes, 2005; “Acoustic”, 2016; “Image”, 2016). See also *image*.

Auditory imagery: Acoustic mental representations of objects or events (Cahn, 2008; “Imagery”, 2016; Thomas, 2014). See also *imagery*.

Auditory model: See **Model**.

Feedback: Instructive information received, on the performance of a task. This information may be specific: auditory (information heard as sound and/or music), kinesthetic (information felt in movement), motor (information about movement), and visual (information seen) (Highben & Palmer, 2004; “Feedback”, 2016). See also *auditory feedback*.

Image: Mental representation (auditory, kinesthetic, motor, and/or visual) of an object, event, or movement (Johnson, 2011; “Image”, 2016; Thomas, 2014). See also *auditory image*.

Imagery: Mental representations (auditory, kinesthetic, motor, and/or visual) of objects, events, or movements (“Imagery”, 2016; Thomas, 2014). See also *auditory imagery*, *kinesthetic imagery*, *motor imagery*, and *visual imagery*.

Imagery ability: Talent or skill in the use of mental representations of objects, events, or movements. See also *imagery* (“Ability”, 2016; “Imagery”, 2016; Thomas, 2014).

Imagery modality: Form of sensory perception (auditory, kinesthetic, motor, and/or visual) related to the mental representations of objects, events, or movements (“Modality”, 2016; “Imagery”, 2016; Thomas, 2014).

Kinesthetic imagery: Mental representations related to the feeling of movement without actual movement execution: a type of *motor imagery* (Kleber, Birbaumer, Veit, Trevorrow, & Lotze, 2007; “Imagery”, 2016; Thomas, 2014). See also *imagery*.

Mental practice: (noun) Use of imagery (auditory, kinesthetic, motor, visual) in the repeated cognitive execution of an activity in order to acquire or maintain proficiency on a musical instrument or the voice (“Mental practice”, 2007; Miksza, 2011; “Practice”, 2016)

(verb) To use imagery (auditory, kinesthetic, motor, visual) to repeatedly perform, cognitively, an activity in order to acquire or maintain proficiency on a musical instrument or the voice (“Mental practice”, 2007; Miksza, 2011; “Practice”, 2016).

Mental practice technique: Method of executing the repeated cognitive performance of an activity in order to acquire or maintain proficiency on a musical instrument or the voice. Techniques may include the use of *score analysis*, *imagery*, and *models* (Miksza, 2011; “Practice”, 2016; “Technique”, 2016).

Model/modeling: (noun) Live or recorded sound or music performance used as an example. (Cash et al., 2014; “Model”, 2016).

(verb) To provide or use a live or recorded sound or music performance as an example. (Cash et al., 2014; “Model”, 2016).

Motor feedback: See **Feedback**.

Motor imagery: Mental representations related to movement but without movement execution (“Imagery”, 2016; Thomas, 2014). See also *imagery*.

Music performance: Artistic act of presenting vocal and/or instrumental sounds (“Performance”, 2016).

Physical practice: (noun) Repeated performance of an activity in order to acquire or maintain proficiency on a musical instrument or the voice (Miksza, 2011; “Practice”, 2016).

(verb) To repeatedly perform an activity in order to acquire or maintain proficiency on a musical instrument or the voice (Miksza, 2011; “Practice”, 2016).

Practice: (noun) Repeated physical and/or mental performance of an activity in order to acquire or maintain proficiency on a musical instrument or the voice (Miksza, 2011; “Practice”, 2016).

(verb) To repeatedly perform, physically and/or mentally, an activity in order to acquire or maintain proficiency on a musical instrument or the voice (Miksza, 2011; “Practice”, 2016).

Practice strategy: Method, involving repeated physical and/or mental performance of an activity, used in order to achieve a long term music learning and/or performance goal (Miksza, 2011; “Practice”, 2016; “Strategy”, 2016).

Score analysis: Study of the elements and/or structure of a written or printed representation of a musical work (Fine et al., 2015; “Analysis”, 2016).

Visual imagery: Optical mental representations of objects, events, or movements (“Imagery”, 2016; Thomas, 2014). See also *imagery*.

Appendix 2 - Project Timeline

Module BMPF 7013 - Due by 2nd December 2023 ✓

Project Phases	Task	Completed by: date	Not started	On going	Completed
Phase 1 - Research	All lectures and seminars completed - introduction, research methodology, grey literature, reflective practice				✓
Choosing a research topic	Silent Practice				✓
Selecting literature	Reading and analysing literature based on criteria suggested in lectures. Approx 30 papers	16th September		✗	
Component 1 - Portfolio	Introduction and rationale	6th September		✗	✓
Programme of Studies	Learning and development aims	20th September		✗	✓
	Expected Learning Outcomes	20th September		✗	✓
	Activities to be undertaken	20th September		✗	✓
	Methods and Resources	20th September		✗	✓
	Literature review and methodology	20th September		✗	✓
	Timescale	7th September		✗	✓
	Contextualisation	20th September		✗	✓
	Critical Reflection	10th November		✗	✓
Compile Reference list		15th November		✗	✓
Component 2 - Written assignment	Introduction	19th September		✗	✓
	Main body	9th November		✗	✓
	Conclusion	14th November		✗	✓
Draft deadline		18th November			✓