Finding focus : using external focus of attention for practicing and performing music

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Learning Motor Skills

As playing music requires motor skills it is useful to understand the principles and theories of motor control and motor learning in order to know how to train a musician well. It is not within the scope of this dissertation to undertake a detailed review and critique of all motor control and motor learning theories, though aspects that have relevance for an inquiry into external focus will be discussed in detail. A brief summary of the relevant theories to this research is presented below, beginning with defining what type of motor skill playing music is.

What Kind of Skill is Music-making?

Playing an instrument involves different types of motor skills. Schmidt and Wrisberg (2008) describe categories of skills within sports that can be directly applied to music-making. The skill categories can be visualised as a tree-diagram (Figure 1.1). The top of the diagram shows that skill can be subdivided in motor and cognitive skill (each containing procedural and declarative knowledge). Cognitive in this context refers to conscious cognition[10] - skills requiring conscious thinking and decision making, whereas motor skill refers to a task involving movement and little or no decision-making.[11]

Motor skills can be divided first of all as open or closed skills. Open skills are those for which the environment is constantly or perhaps unpredictably changing (e.g. during a football match). Closed skills are skills for which the environment is predictable and stable (e.g. shooting an arrow at a predetermined unmoving target) (Schmidt & Lee, 2005). Music-making is generally a closed skill as the environment is relatively predictable and a piece of music is usually rehearsed and prepared in advance with the understanding of how it needs to sound for the concert (and the way the instrument responds can be, in general, considered stable). The last set of categories describes how movements can either be discrete, serial or continuous. Music performance would be categorised a “serial” skill, because it involves the connecting of many discrete movements (a discrete movement – with a discernible beginning and end – would be a single note or a fragment of music consisting of a short group of notes). As a piece of music contains many notes/fragments connected together, it would be categorised as a serial motor skill (Schmidt & Wrisberg, 2008).[12]

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[10] Cognition also involves unconscious processes, for instance the processing of perception, memory, learning, thought, and language without being aware of it.
[11] Cognition is a highly complex subject. An elaborate discussion of cognitive skills is outside the scope of this discussion.
[12] An exception to this definition would be improvisation – which could be considered a continuous movement – or even an open skill. Playing jazz would require a combination of open and serial skills.

Figure 1.1 Categories of Skill

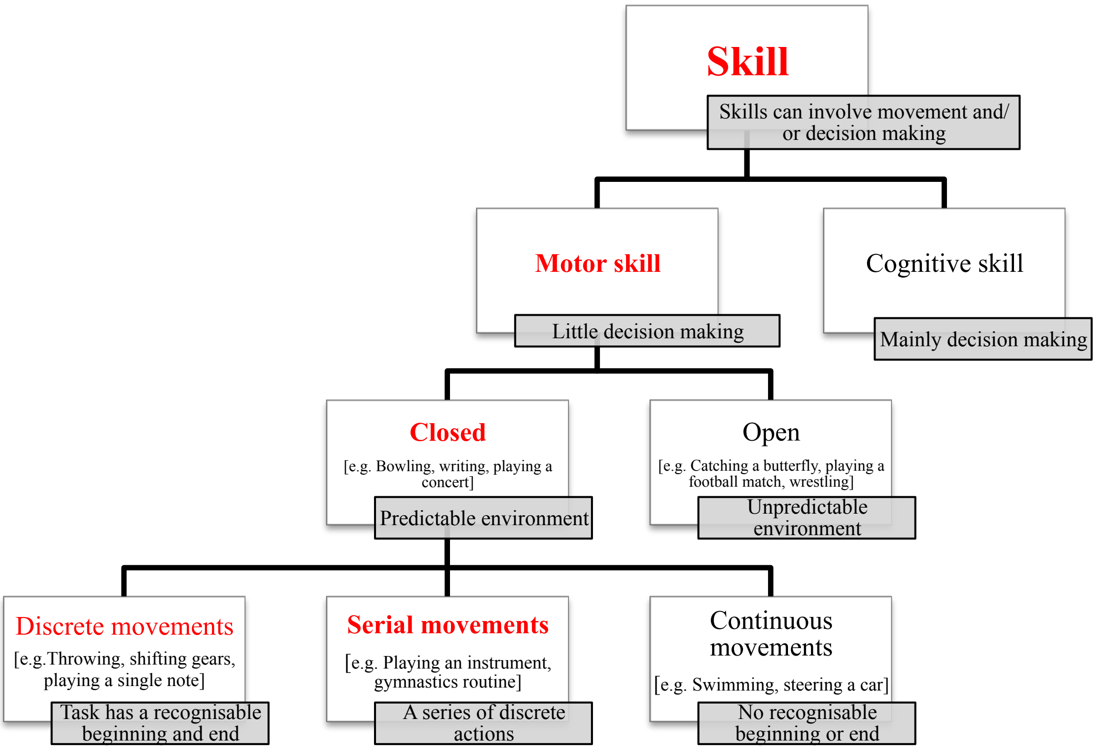

Figure 1.1 illustrates categories of skill, highlighting the types of skills and movements used for playing music (formulated from information from Schmidt & Wrisberg, 2008, pp. 3-8). The red, bold categories describe the skills needed for music-making. Discrete movements are connected to make serial movements.[13]

Now that the type of motor skills for performing music have for the most part been defined as *closed skills, involving discrete and serial movements*, the following section investigates the question "How do musicians learn and perform these skills?"

Current Theories on Motor Control and Motor Learning

What are the current theories that can explain how we learn complex movements and how can these theories help musicians know how to approach the way they practice and perform? The following section describes the two main streams of thinking on motor learning: Motor Program Theory and Dynamic Pattern Theory (Schmidt & Wrisberg, 2008).

Motor Program Theory

Motor Program Theory is probably the most accepted explanation at present for how we learn complex movements. The main concepts within the theory are outlined here and include an explanation of a "closed loop" system and an "open loop" system, and finally "Schema Theory".

[13] Motor Skills do involve cognition – in the form of attention (rather than thinking about strategies and making decisions).

In 1971, Jack Adams introduced the idea that learning a movement involves a "closed loop" process. The process involves four components: 1. Executive – making executive decisions about how to perform the movement; 2. Effector – carrying out the actions; 3. Feedback – getting feedback that provides information; and 4. Comparator – detecting error and comparing the feedback to what was desired (Schmidt & Wrisberg, 2008).

Music example: If we were to apply the closed loop system to describe a musician's learning process it would look as follows:

1. Executive: The player would decide how to play a phrase or fragment of music – this may involve things like what it needs to sound and/or feel like, how to control the body, and what to focus on.
2. Effector: Play the section of music.
3. Feedback: Notice how it sounded, what it felt like.
4. Comparator: Compare the played version with the desired version and detect the errors (leading back to 1. deciding how to play it again).

A closed loop way of processing an action demands a great deal of attention and takes some time to process information during the learning process (Adams, 1971; Schmidt & Lee, 2005; Schmidt & Wrisberg, 2008). This can be useful when learning a new skill, learning certain types of movements (e.g. continuous movements such as swimming, or holding a certain posture), or during early stages of learning (e.g. learning a new piece of music). According to this theory, errors are to be avoided as they are retained in the memory.

Complex short discrete movements (like those involved in performing music) are, however, too demanding on the attention to use a closed loop model (Schmidt, 1975). The open loop system was proposed by Schmidt to explain how one learns and performs skills that require fast reactions. Schmidt introduced the idea that whilst feedback can be available when one is performing an action (as in the closed loop model): "Most types of motor behaviour represent a complex blend of both open- and closed- loop control operations" (Schmidt & Wrisberg, 2008, p. 110). When a complex movement requires fast reaction time, there is no time for processing feedback, and is therefore referred to as an "open loop".

Movements are learned by the development of a motor program. Schmidt explains that the motor program relies on building up a *schema* or set of rules that allow the person to perform new variations of the movement – implying that one does not need to have a new motor program for every skill. Building up the schema involves practicing the movement in various ways. The schema theory presumes that errors are part of the process of collecting information about how to perform.

Music example: Learning to play tones on the natural trumpet could involve playing a few of the easier tones separately and then varying the dynamics, note duration, order of the tones and articulation. The collected information forms the schema that can then allow the player to be able to play other tones and patterns than the ones practiced.

Dynamic Pattern Theory

> *"Practicing (music) can be considered as a self-organizing process, which frequently starts with uneconomical activation of large neuronal pools in the sensory-motor brain regions."* (Altenmüller & Schneider, 2008, p. 341)

A newer theory – the Dynamic Pattern Theory (Kelso & Schöner, 1988; Newel, 1991; 2003) – states that there are no "rules" generated by movements but rather that they occur and are learned by a system involving "self-organisation" and continual adaptation to the environment through sensory feedback. This theory is very compelling, as it takes into account the complexity of the interaction between the person and their environment. The view that Dynamic Pattern Theory is now the dominant view of the underlying mechanisms of motor learning is also reflected in a recent overview of this research area (Hommel, Brown & Nattkemper, 2016).

Music example: To allow a holistic self-regulating process to occur, a musician could explore a segment of music using variation, improvisation and involving sensory awareness – e.g. focussing on touch and sound, and by focussing on the desired outcome without analysing, comparing or consciously correcting the movements.[14]

Degrees of freedom

There are many possible combinations of muscle and joint activity that can produce a specific action, and there are variations to every movement (e.g. trajectory and form). This is referred to as the "degrees of freedom-problem" (Schmidt & Wrisberg, 2008), as it is very hard to predict specific movement parameters or decide on the optimal movement. Learning how to deal with the many degrees of freedom is a central problem in motor control, and involves the balancing of allowing certain muscles and joints to move during an action, and preventing or "freezing" others (Schmidt & Wrisberg, 2008). In the case of a piano player, for example, this would involve the player freeing (or freezing) the freedom in the wrist, hand and fingers. One of the major roles of motor programs would be, therefore, to "coordinate the many degrees of freedom needed to produce an effective & efficient action". The question remains – to what extent is it important to understand and consciously steer the movements, or is it better to focus on something else and allow a self-organisation to take place? For both sports and

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[14] An example of this kind of approach to practicing music can be found in 'Practicing in Flow' by Andreas Burzik (Burzik: Flowskills, http://www.flowskills.com) and also the 'Flow Music Method' created by Eve Newsome (http://www.flowmusicmethod.com.au)

music-making it is the outcome that matters and not how you get there. The dynamic pattern theory suggests that the optimal balancing of the degrees of freedom are found during an unconscious "self-organising" process. Practicing can therefore be considered as a self-organising process.

To sum up: a motor program consists of pre-structured sets of motor commands that are constructed at the highest cortical levels and then conveyed to the lowest centres in the hierarchy responsible for executing the movement. Unlike the motor program theory, in the Dynamic Patterns Theory, there are no hierarchies in contrast to a command-based centre. It seems likely that different theories or combinations of theories discussed above may best explain different types of movement – depending on the type of task, the environment and the skill level of the player (Schmidt & Wrisberg, 2008). Another factor that could be relevant is whether the skill is new – in an early stage of learning – or in an advanced stage of learning. The next section will look in detail at the different stages of learning motor skills.

Stages of Learning Motor Skills and the Role of Attention

It is widely accepted amongst experts in motor learning that learning occurs in stages – each of which has certain characteristics. A description of each stage of learning, its characteristics and the role of attentional focus in each stage is described in the following section. One of the most referred to paradigms was put forward by Fitts and Posner (1973) and describes three consecutive stages of learning that they call **cognitive, associative and autonomous** stages. Although there is general consensus about the stages of learning amongst experts, there is some contention about the role of attention during each stage. A description of each stage follows.

Early stage (cognitive stage)

In the early stage of learning, a skill involving complex movements is characterised by being halting, slow and rigid, and containing inconsistencies and errors. The player is exploring different ways to achieve the goal; getting an idea of the movement, using a step-by-step approach (Gentile, 1972; Schmidt & Wrisberg, 2008; Schmidt & Lee, 2005; Wulf, 2007) or by understanding the patterns involved (Newell, 1985).

Progress in the early stage tends to occur rapidly. For musicians the early stage could refer to first learning to play an instrument, or learning a new skill or piece of repertoire, and would be characterised by frequent wrong notes, halting speed and rhythm and lack of details such as dynamics and articulation. This stage is also called "verbal stage" (Adams, 1971) or "declarative stage" (Hattie & Yates, 2014), as it is generally believed that verbal conscious cognitive processes should be involved during the early stage. Proponents of implicit motor learning, however, believe that declarative processes are not necessary – or even degrade the learning process (Masters, 2012; Wulf, 2007). This will be discussed in more depth in the following section on explicit and implicit motor learning.

Middle stage (associative stage)

During this part of the learning process, the movements become more efficient, fluent, confident, decisive and adaptable, as well as reliable (Schmidt & Wrisberg, 2008; Wulf, 2007). Progress is usually slower than in the first stage of learning as the player is making subtle adjustments to the movements. A musician's playing would begin to sound more fluid, feel more relaxed, and there would be fewer incorrect notes and more details in the execution. The middle stage is also referred to as the "motor stage" (Adams, 1971).

Later stage (autonomous stage)

In the later stage of learning, the person's movements become more automatic and exhibit more consistency, efficiency and confidence. Execution is smooth, effortless and automatic as well as accurate and adaptable. At this stage, reliable performance is possible (Schmidt & Wrisberg, 2008; Wulf, 2007). In the case of musicians, the music would feel more effortless, sound fluent, have nuances and be (virtually) free of wrong notes.

Overlearning

It is worth mentioning here that sometimes a skill can be "overlearned" and starts to degrade as a result of too much practice (Altenmüller, 2006). A performance would revert back to a more halting rendition, be less fluid and have more errors. Reliable performance is possible only when the autonomous stage has been reached. Although automaticity is the goal of practice, it also has its downside. Learning requires not only repetition, but also deliberate practice involving concentration and attention to structured goal setting in order for control to become more automatic (Ericsson, 2008). Paradoxically, once automaticity is achieved and the player is able to shift attention elsewhere, improvement can stop and development of bad habits or even degradation can occur (Altenmüller, 2006, 2012; Hattie & Yates, 2014).

The Role of Attention During the Stages of Learning

Of importance to this thesis is the question of where a player's attention should be during a particular stage of learning. During learning, cognitive demands gradually decrease as the task becomes more automatic. The person's attention is at first often on controlling the movements by breaking them up into parts. Later the parts are joined, and there is more room for attention to details or to the overall musical and expressive goals as the movements themselves are controlled more automatically (Wulf, 2007).

The general assumption, then, is that in the first stage of learning there is a need for more conscious attention as well as verbal instruction and feedback. As the attentional and cognitive load lessens during the middle and later stages, the player is able to focus on things not related to carrying out the task, or on a higher level of task focus, i.e. by focussing on expression. Many musicians approach the (learning) process by first learning technical skills and later focussing on musical and expressive aspects.

In Table 1.1, the stages of motor learning are outlined, the mechanisms are described, and the role of attention is highlighted. The table was composed by the author, and is the result of a compilation of the following sources: Altenmüller & Grün, 2002; Altenmüller, 2006; 2012; Hattie & Yates, 2014; Schmidt & Lee, 2005; Schmidt & Wrisberg, 2008; Squire & Kandel, 2009. Major research on motor learning referred to by the above sources includes: Adams, 1971; Fitts & Posner, 1967; Gentile, 1972; and Singer, 1993. Nomenclature differs amongst researchers, and some of the more common and descriptive examples are included in the table.

Table 1.1 Stages of Learning

Stage of Learning	Mechanisms	Attention
Early Stage **(Cognitive stage)**	Information is initially stored in the immediate (ultra-short-term) memory and moves to the short-term memory due to repetitive practice (no anatomical change) (Squire & Kandell, 2009). Translating declarative knowledge into procedural knowledge.	Use of language and words to direct action. Attention is on how the movement is performed: exploring, analysing and directing the body's movements (Adams, 1971; Schmidt & Lee, 2005). Memory load is heavy (Hattie & Yates, 2014).
Middle Stage **(Associative stage)**	Information shifts from short-term to long-term memory, causing long-term changes in synaptic connectivity – an anatomical change (Squire & Kandell, 2009). Consolidation occurs due to the strengthening of synaptic patterns between sensory and motor neurons. Memory load is reduced. A bigger shift from declarative to procedural knowledge.	The performer's concentration is more on patterns of movement and refinement of the skill (Newell, 1985). Attention shifts from directing movements to checking if the result fits the desired outcome.
Later Stage **(Autonomous stage)**	Consolidation is complete. Actions are well organised, reliable and involve large-sized chunks. Memory load is low as recognition is being activated.	Movements are produced with little or no conscious attention. Attention is on strategy or movement form or style (Schmidt & Lee, 2005).

Table 1.1 illustrates the stages of learning, the mechanisms involved and the role of attention.

It is generally believed that the early stage of learning involves verbal, declarative processing of information. In the middle stage, declarative knowledge is shifted to procedural knowledge as small movement skills are strung together. In the final stage, the movement occurs largely automatically (Adams 1971; Schmidt & Lee, 2005). In the following sections an alternative view about the role of attention during the learning of motor skills is presented. Contrary to mainstream beliefs (both in research and in music practice) is the idea that motor learning is best learned implicitly (Masters, 2012) and using external focus (Wulf, 2007).

How important are declarative processes to learning complex movements? Should people first understand what they are doing in a verbal cognitive way in order to achieve automaticity? The next section investigates this question by discussing and comparing explicit and implicit approaches to motor learning.

Explicit and Implicit Motor Learning

Explicit motor learning is defined as "learning which generates verbal knowledge of movement performance (e.g. facts and rules), involves cognitive stages within the learning process and is dependent on working memory involvement", whereas implicit learning is "learning which progresses with no or minimal increase in verbal knowledge of movement performance (e.g. facts and rules) and without awareness" (Kleynen et al., 2015, p. 2). As explained earlier in *stages of learning*, the cognitive load when learning something new is heavier than when the movement becomes more automatic. Questions arise concerning how much instruction and declarative knowledge to give a learner, and when it is appropriate to use explicit or implicit learning strategies. The main strategies used in sports and rehabilitation training include discovery learning, analogy learning, errorless learning, observational learning, dual task learning, trial and error learning, and movement imagery[15] (Kleynen et al., 2015)[16]. These are all strategies that are familiar to musicians; an added strategy would be auditory imagery.

Explicit learning involves conscious thinking and use of the working memory, and is usually operationalised by giving rules and instructions or by instructing the learners to find rules and instructions for themselves, and can be promoted by using various types of feedback. Implicit learning is better promoted by restricting feedback, by using an external focus of attention and by practicing the entire skill (Kleynen et al., 2015). Implicit learning (also called tacit learning) is a term coined by Arthur Reber in 1965. Reber claimed that implicit processes are more effective than explicit ones because they existed before the evolution of the cerebral cortex and consciousness. From an evolutionary perspective, long before people learned to talk they were still able to move effectively, and the implicit unconscious mechanisms that evolved were the most effective for survival. The development of verbal conscious functions and working memory meant that the necessity of the implicit mechanisms was not as great. Man has been described as being more reliant on conscious thinking processes (Reber, 1989;

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[15] Discovery learning would involve allowing learners to discover the rules themselves; analogy learning would involve presenting an analogy (e.g. image) to focus on; errorless learning involves learning in a way that no errors occur during practice (e.g. playing very slowly); observational learning means learning by observing someone else; dual task learning involves focussing on something else (e.g. counting backwards) whilst performing the skill; trial and error learning focuses on repeating the task, and noticing and responding to what works and what doesn't work; movement imagery involves imagining how the movement would look or feel.

[16] An interdisciplinary study about explicit and implicit motor learning.

1992). The questions that remain are: when, how and why should implicit learning be used instead of explicit learning, or can one use a combination?

The main considerations to be taken into account when deciding whether an explicit or implicit approach is appropriate are the type and difficulty of the task, whether the individual is a novice or expert, and the stage of learning. Many scientists and coaches believe that an explicit declarative stage is important for early stages of learning or with novices (as suggested by stages of learning models, e.g. by Fitts & Posner (1967) and by Schneider & Shiffrin (1977). Others claim that novices learn better with implicit methods and experts learn better when using rules and instructions (explicit methods). Schlapkohl & Raab (2016) described several studies on novices and expert athletes using both explicit and implicit approaches – the implicit approach used analogies (e.g. in a study involving table tennis players, the players were instructed to: "Try to move the arm as if you were throwing a discus"), and the explicit approach involved a set of instructions. The conclusions were that expert athletes benefit from rule-based instructions, whereas novices and pupils should be instructed implicitly (Schlapkohl & Raab, 2016, p. 39). Robert Singer is an example of those who believe that explicit methods are needed before and after making the movement, but that during the movement, an implicit approach is better. His 'five step approach' consists of: Readying, Imaging, Focussing, Executing and Evaluating (Singer, 1988). A more radical view has been taken by Richard Masters, who claims that it is important not to think about the movement while executing it, that instructions should be kept to a minimum, and that explicit learning is generally detrimental (Maxwell, Masters & Eves, 2000; Masters, 2012; Wulf, 2007). Since many of the views of Masters are in line with research on external focus, a review of Masters' implicit learning theory and his research follows here.

Masters' Implicit Learning Theory

Richard Masters claims that conscious thought can interfere with the automatic execution of a movement, and that motor learning should be primarily implicit in order to be efficient and to be reliable under pressure. His theory aligns with Reber's view that the older implicit processes lead to better learning and performance: "Implicit processes are embedded in neuroanatomical brain structures that phylogenetically are older and more sophisticated than explicit processes" (Masters & Poolton, 2012, p. 68, citing Reber, 1992). MacMahon & Masters (2002) describe explicit motor learning as a conscious process involving 'hypothesis testing': comparing internal thoughts with external facts and evaluating the success of the solution according to the movement-related feedback. The result is an accumulation of explicit knowledge in the form of rules and facts, which are stored in the long-term memory. According to Masters (2012), this form of learning is not only inefficient on the neural level, but also susceptible to error when the person is under stress. The phenomenon of referring back to declarative knowledge after automaticity is achieved is termed by Masters as "reinvestment". Most sportspeople (and musicians) will recognise that thinking about how to do a movement during performance disrupts the flow and execution of that movement. Although verbal-analytical aspects of working memory activity may be gradually withdrawn during learning, the declarative knowledge that has been collected still remains available for retrieval, manipulation and application by the working memory (Zhu et al., 2012). Masters and Maxwell (2004) describe the Theory of Reinvestment as the retrieval and application of declarative knowledge during performance and cite wide-ranging empirical research that reveals that reinvestment is detrimental to performance (e.g. Baumeister, 1984; Bliss, 1895; Boder, 1935; Borkovec, 1976; Henry & Rogers, 1960; Reason & Mycielska, 1982; Weinberg & Hunt, 1976; Wulf et al., 2001). Masters' research reveals several causes for reinvestment, including the fact that some personality types are more prone to 'overthinking', psychological pressure, injury or fatigue, the availability for too much time for movement preparation, as well as unexpected events before or during a performance (Zhu et al., 2012).

Research on Implicit Learning

Most research on implicit motor learning has been carried out since 1992, and in many fields, including rehabilitation, child development and surgery, as well as sports (Masters & Poolton, 2012). Researchers have explored several ways to induce implicit motor learning: using secondary tasks, errorless learning, analogy learning, and marginal perception. Details of each of these and some results of the research are given below.

Using secondary tasks: the learner is thinking about something unrelated to the movement (e.g. counting backwards from 1000) whilst playing. The secondary task uses up a large proportion of the working memory (thus hampering hypothesis testing), leaving the main task to be carried out unconsciously.

Masters' early research on implicit motor learning in 1992 used a complex secondary task with novice golfers. Participants reported that they putted 'intuitively' (showing implicit learning). They performed better under real-life pressure situations than the other two groups (explicit learners and discovery learners) (Masters, 1992). This kind of dual task experiment has been replicated repeatedly with positive results (for an overview, see Masters & Poolton, 2012, p. 60). One disadvantage was that dual task learning was slower than the other two types of learning (explicit and discovery). When a simpler kind of dual task learning was tried (MacMahon & Masters, 2002), the results showed that hypothesis testing was not halted. The dilemma remained of how to have a secondary task that is complex enough to halt hypothesis testing without slowing down learning.

Errorless learning: the task is designed in such a way that the learner doesn't make mistakes (e.g. by starting on a very easy level and gradually getting harder). The assumption behind errorless learning is that if mistakes are never experienced, they cannot become ingrained or familiar, and therefore not later retainable from the memory. An experiment involving beginner golfers and putting from very short distances, then gradually lengthening the distances, showed that they were more accurate (over a full range of distances) in a delayed retention test than a group that learned by first practicing over larger distances, and a control group (Masters, Kerr & Wheedon, 2001; Maxwell et al., 2001). In another study, when explicit instruction was added after the initial implicit learning phase, the players' performance remained stable (Poolton, Masters & Maxwell, 2005). More recently, there has been a great deal of research and interest in implicit motor learning using errorless learning techniques in rehabilitation and surgery (for details, see Masters & Poolton, 2012, p. 64).

Analogy learning: instead of giving verbal explanations, presenting a mental model of a new concept that is familiar to the learner (e.g. imagine the phrase 'cascading like a waterfall'). Analogies allow the individual to make inferences about concepts with little awareness of the rules that underlie the concepts (Donnelly & McDaniel, 1993). A great deal of research related to implicit learning has been carried out using analogies, with mostly positive results when compared to explicit learning. Studies on not only golf putting, but also tennis, table tennis basketball and other sports have shown that using analogies promotes implicit learning (e.g. Liao & Masters, 2001; Poolton, Masters & Maxwell, 2007; Koedijker, Oudejans & Beek, 2011). One problem with using analogies is that an analogy coming from a trainer may not always make sense to any particular individual – or be the most descriptive for the task. A solution could be to search for the most powerful/accurate analogy together with the learner.

Marginal perception: the information is presented to the learner so quickly that he/she doesn't consciously notice it, and yet it influences the behaviour (changes movements or posture without the subject being aware of learning). *Change blindness* is another form of marginal perception, where the task is made very gradually different (e.g. more difficult) without the learner realising. In experiments using marginal perception, feedback is withheld – often visual feedback, so that the player does not know the outcome and is forced to rely on unconscious awareness to detect feedback. An example of marginal perception and change blindness is as follows: a coach who wants to teach a volleyball player to learn to 'spike' normally brings the player's attention to trying to jump higher. Instead the coach could raise the net very slightly so that the player is not aware and is forced to jump higher without realising it. Then the net is raised a little more. Similar tactics could be used with musicians – for instance by slightly varying tempo or pitch (without telling the student) in order to stretch the musician's abilities without them 'knowing'. Other examples can be found in a study by Masters, Maxwell and Eves (2009) on (novice) golf putting. Similar studies have been done with tennis players.

Conclusions about research on implicit motor learning

Most of the studies on implicit learning that have been done on novices, in the field of sports, involve short timeframes and discrete movements (relevant for music, as music-making also involves discrete movements). More longitudinal studies are needed, as well as studies involving experts. The reason for the experimental designs that have been used is probably that it is easier to obtain clear quantitative results. Testing experts, testing field situations and testing musicians would be complex and involve many subjective elements. It is important to note that although many of the findings show that implicit learning leads to less performance decline when under stress (e.g. during a difficult performance), they don't show that the performance itself is better than that of explicit learners (Wulf, 2007).

Whilst it may seem logical to many that we need to mix explicit and implicit approaches and methods for learning and performing, depending on the nature of the task, the learner's abilities and the stage of motor learning (Kleynen et al., 2005), from the evidence of Masters and colleagues, it also seems likely that implicit learning could play a greater role in training motor skills. Apart from marginal perception, the above implicit learning strategies tested by Masters and colleagues are fairly common in teaching musicians. For instance, taking a slow tempo and learning short fragments (errorless learning), and using analogies and metaphors. Some musicians watch television while training with technical exercises (secondary task).

A key to the question of what approach is more appropriate in any given situation could lie in a deeper understanding of how cognitive load and task focus influence learning and performance. It would be important to look at the specific domain to be more sure about which approach is optimal, to adapt the concept of implicit learning to that field (design methods and strategies) and investigate its effect with longitudinal studies. In the case of music, this has not yet been done.

One important conclusion of the above research on implicit motor learning is that the mind should not be overloaded with declarative information – nor should it be overloaded with task irrelevant information. When the mind is not busy at all and the individual has too much time to prepare a movement, the result is not always optimal (Zhu et al., 2012). Therefore it seems that attention should be task-related and demanding but not based on rules and instructions or verbal-analytical processes. Gabriele Wulf proposes an elegant solution to finding complex task-related non-declarative focus – the use of external focus of attention. A recent theory by Gabriele Wulf and Rebecca Lewthwaite points out the importance of external focus to the debate of how to engage the conscious mind during motor learning.

The OPTIMAL Theory of Motor Learning

Wulf and Lewthwaite's OPTIMAL (Optimising Performance Through Intrinsic Motivation and Attention for Learning) theory of motor learning (Wulf & Lewthwaite, 2016) proposes that there are three keys to optimal performance, and that the combination of all three is the best approach to motor learning and performance.

Three Keys to Optimal Performance

In the OPTIMAL theory of motor learning, there are three conditions of practice that promote learning and performance (adapted for music pedagogy from Wulf & Lewthwaite, 2016):

- **Autonomy:** This means that the student should have choices. Rather than passively receiving instructions, a student needs to develop a sense of agency. Even small or incidental choices (e.g. what piece would you like to start with?) can have a positive effect on learning.
- **Enhanced Expectancies:** A musician's own beliefs and expectancies should be positive in order to learn or perform well. Mindset and self-efficacy play a part, as do success with challenging tasks and positive feedback.
- **External focus:** Instructions and feedback need to focus attention on the desired effect of the movements – i.e. musical intention (the expression that the musician wants to convey, including how it should sound). The result of this type of practice is that a musician is more focussed on the task itself – i.e. making music and expression. There is less focus on the self.

Wulf and Lewthwaite's theory suggests that autonomy, enhanced expectancies and external focus can each promote optimal learning, and that a combination of the three is even more effective. Together these three aspects can cause a "goal-action coupling" that results in less focus on the self, more focus on the task goal, and better learning and performance.

Figure 1.2 Schematic of the OPTIMAL Theory (Wulf & Lewthwaite, 2016)

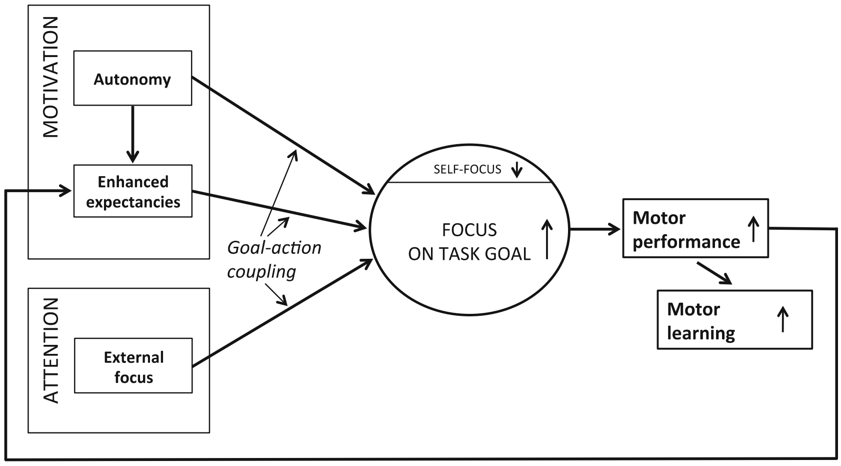

Figure 1.2 shows that the combination of autonomy, enhanced expectancies and external focus contributes to focussing on the task goal, and enhances performance and learning. The experience of a successful performance causes the player to expect further successes (enhanced expectancies), thus feeding back into the loop.

One of the significant things about Wulf & Lewthwaite's theory is the inclusion of motivation in a theory of motor learning, thus reflecting and implying how complex, multifaceted and holistic motor learning really is. The main significance and particular relevance to this research is the importance and influence of an external focus of attention. Masters' theories and research make clear that directing attention to co-ordinating one's movements (in a verbal-analytical way) is not optimal, and also that diverting the mind into secondary tasks (to prevent hypothesis testing) also creates problems for learning. Wulf proposes that the solution would be to direct attention to the intended goal of one's movements – which she calls external focus. According to Wulf, not only does external focus avoid the use of declarative processes, it also engages the player in a task-related focus, resulting in enhanced learning. External focus will be discussed in detail in the next chapter.

Motor Learning and Motor Performance for Music-making

As discussed in the introduction of the current thesis, musicians and their teachers use a wide range of teaching methods and strategies, but do not necessarily know much about how or why they work or don't work. Much of what goes on in the teaching and practice room is not monitored. General knowledge about how motor learning works is essential for the development of pedagogy – not only for young students but also in the conservatoire level, where musicians are being taught by experts with very individual approaches based largely on tacit knowledge, and little to no pedagogical training. Musicians spend many hours in the practice room, struggle with issues connected with motivation, confidence, and even injury. Performance is often accompanied by stressful feelings and performance anxiety. A better understanding of motor learning can bring not only more efficient and effective results, but also more confidence and joy in the process of learning. It is essential to know how to train the mind i.e. when verbal-analytical processes are useful, and when and how to use implicit training methods.

If we apply the concept of implicit learning to musicians' motor learning we can argue that musicians need to rely less on analysing and directing their movements during learning (even in early stages), and certainly during performance. Proponents of the implicit learning theory do not advocate that learning and performance should occur without cognition. Conscious cognition can be useful and is required for planning strategies, choosing appropriate goals and monitoring the environment as well as reacting to unexpected events and communicating with the other players (e.g. in an ensemble). "Finding the right balance of consciousness during performance can be a constant challenge for performers. […] However, conscious control is often conspicuous by its absence when performers surpass their best" (Masters, 2012, p. 139).

Every performing musician has experienced moments, during a performance that is going well and fluently, when thoughts about *how* to play the next note or phrase have caused errors to occur. By thinking about what he is doing, the musician is no longer allowing implicit mechanisms to be in control. Implicit learning is enabled by using external focus and also by practicing the entire skill (i.e. not breaking it into components) (Kleynen et al., 2005). The question for a musician in the practice room or on stage: "What should I be consciously focussing on?" can now be addressed by investigating attentional focus and, in particular, external focus of attention.