

# Motor control and learning: The basics of skilled instrumental performance

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This paper introduces some concepts from the field of motor learning and their possible applications to the doublebass. Basic issues of motor performance and perceptual-motor integration form a proposal to enhance skilled instrumental performance. Posture and motion are analyzed under principal guidelines of human ergonomics. Movements used in doublebass performance are abridged to the concept of the pendulum motion. Three topics form a concluding part and give suggestions to enhance skilled instrumental performance. While this investigation is focused on issues of doublebass performance, it might be also extended to other instruments, especially those which require bi-manual movement production and acquisition.

*Keywords:* doublebass; motor learning; sensory learning; perceptual-motor integration; pendulum motion

Over the past decade, researchers have taken various approaches to studying how musicians acquire and refine their skills as performers. Results from studies have even suggested that the music studio could be used as a fascinating laboratory for the study of teaching and learning in general.

Most doublebass students are still advised to study from method books published in the nineteenth century as a single source for preparing their professional career. Whereas violin, viola, and violoncello methods show a more or less unified approach on how to hold and perform the instrument (e.g. Galamian 1962), doublebass methods reveal a larger variety of techniques and postures (e.g. Simandl 1905, Streicher 1974, Wolf 1991). Based on these different factors, there is a great deal of disagreement and contradiction in the study literature concerning techniques and methods of playing the instrument. While investigating in this field, I discovered that

findings from the field of human motor control and learning might well propose solutions to the many problems the doublebassist has to overcome in order to reach flawless performance, especially when performing as a soloist.

### **MAIN CONTRIBUTION**

This article aims to open up a new comprehension of movement production for a more effective development of technical elements which are indispensable to produce skilled action on the doublebass.

#### **Motor control and learning in instrumental performance**

What exactly is the nature of motor control and how broadly should the term be applied when describing the movements of a performer? Simply and general stated, motor control is the study of posture and motion and the mechanisms that underlie them (Rose 1997). In the course of learning to play an instrument, a vast amount of coordinated movements has to be controlled and strengthened with practice, forming then a motor program which is conceived as a hierarchical structure and that translates information into action (Davidson 1991).

Proctor and Dutta (1995) believe that three plans organize selection, coordination, and hierarchy: the “degree of freedom problem,” the “serial order problem,” and the “perceptual-motor problem.” First, the degree of freedom problem describes how a particular means for achieving a movement goal is selected from the numerous possible and alternative means. Second, the serial order problem deals with the sequences of movements in their hierarchy order and timing. Third, the perceptual-motor integration problem deals with the interrelations between perception and motor control.

When performing a simple action, like putting a key into a lock or placing the bow on the D-string of the doublebass, the limbs involved have the freedom to choose between a vast amount of movements the skeletal system has to offer. Sport science has long described posture and motion of the human body in three-dimensional axis (Ungerer 1977). By defining a similar concept for the doublebassist, the efficiency of movements, coordination, and an ergonomic posture can be easily related and efficiently improved. Figure 1 shows how a three dimensional working space might organize and put into relation movements of the left and right hand in doublebass performance.

The activity of the bow arm is defined by the setting of the four strings defining one dimension and the working space of all possible combinations (1a). The target of the left arm is defined by its fulcrum placed near the elbow. Incorporated in one pendulum movement are vibrato and shifting actions

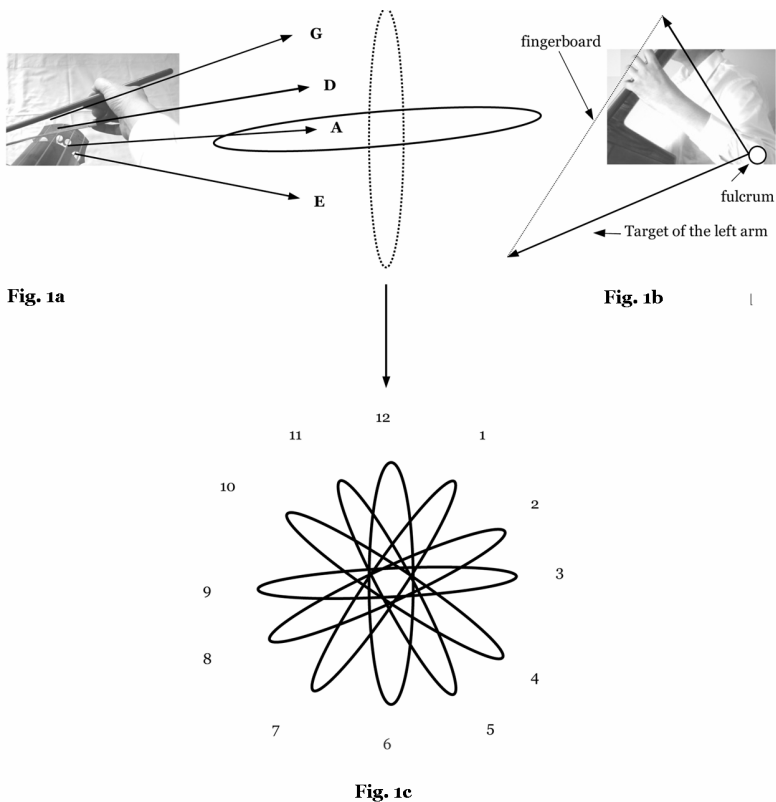


Figure 1. (a) Three dimensional space of the right arm. (b) Three dimensional space of the left arm. (c) A three dimensional working space for both hands.

with their underlying parameters (1b). In relating each movement to its possible “time zone” of an analogue watch placed in front of the hand like a mirror, it is possible to identify exactly the path of the arm and location (1c) (Wolf 1991). While the choice of movements might be applied to single motion, complexity arises when different kinds of movements have to be combined in hierarchical order. Lashley (1951) considers that movement sequences might involve sensory feedback in which one movement acts as the stimulus for the next in a series. Evidence suggestive of this hierarchical control has been obtained in studies using movement sequences that have some underlying structure. These underlying structures have been identified as important in building up hierarchical structures when forming motor

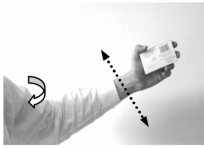


Fig. 2a



Fig. 2b



Fig. 2c

*Figure 2.* (a) Training the active and passive mode. (b) Exercise transferred to the instrument. Performance of the task.

programs in instrumental performance. When learning an instrument and then working on a specific piece of music, these programs will be built up. Wolf (1991) developed an analogical approach to sensory training to improve poorly established motor plans of doublebass students when learning, for example, vibrato, accurate finger-placing, shifting, or complex bow strokes. Wolf suggests that sensory training has to focus on the various types of simple and complex movements of the involved tasks in order to be effective. He also refers to the proprioceptive senses that are concerned with perceiving the body's own movement, its location, and the position of its limbs in space. A view that also has been highlighted in the design of sensory learning models in sports (Ungerer 1977) and ergonomics (Osborne 1987). Based on these concepts, the following exercise is suggested as a model to improve sensory ability when learning vibrato on the doublebass.

Shaking a matchbox (2a) in order to check the contents is a possible approach to experience the performance of active and passive mode. In this exercise, the hand that shakes the matchbox performs the active mode, whereas the rotational movement of the upper arm, as a result of the previous, is performed in a passive mode. The produced noise of the matches helps to orientate the motion in this stage. In a next step, the open hand will swing over the fingerboard, slowly closing it until the thumb and fingers slightly brush over the neck (2b). Now the size of the motion has to be gradually reduced to the size of the desired amplitude of motion. The movement adapts gradually to its working position (2c). When viewing the human body in action, it is evident that pendulum movements are predominant (Wolf 1991). A brief analysis of physical components provide some information about this system and in what type of activities might be used to enhance efficiency, coordination, and the economic use of muscular power (Pertzborn 2002).

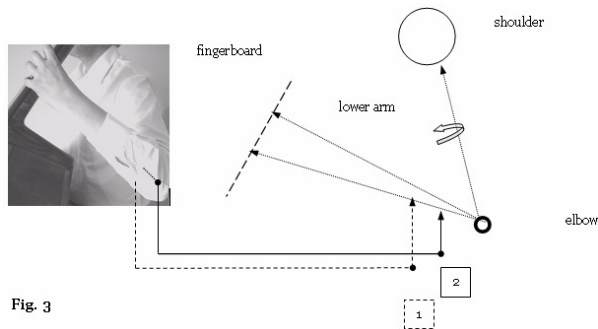


Fig. 3

*Figure 3.* The pendulum motion for the left hand.

### **One for all: The pendulum motion for doublebass technique**

Pendulum motions are most efficiently used in continuous performance skills. Figure 3 shows the position of the left hand when performing a continuous skill like vibrato. The motion of the hand, upper arm, and lower arm is transferred into the diagram connected to the photo. The frequency of the vibrato might be reduced or augmented through the placement of the fulcrum (o): the movement becomes larger and thus faster when the fulcrum is moved towards the middle of the arm (1), decreases and slows down when moving towards the elbow (2). The pendulum motion, viewed in a three-dimensional context, might well be considered as a possible overall concept for the effective production of movements. Muscular tension and limited movement control frequently arise when this concept remains unconsidered.

### **IMPLICATIONS**

With this paper, I have attempted to show that some concepts of motor control and learning might well form the basic guidelines to skilled performance:

1. The close relationship between posture and motion (Wolf 1991) can be confirmed as one of the essential elements of motor control.
2. Projecting the “degree of freedom” (Bernstein 1967) of movements to a three dimensional system is a viable way to define the location and spatial frame for both arms for the doublebass.
3. The pendulum-based movement is proposed as the integrative and most efficient movement to both posture and motion.

It is clear that investigation in this field is inherently complex and can only contribute to real life if training methods can be held simple and practical in order to meet musical goals. Further studies have to be undertaken in order to validate the present investigation. This could be done by observing the learning process of students and professionals. Movements could also be measured and related to the quality of their musical outcome.

Understanding and learning concepts from the area of human performance may help the learner to access unused potentials and surpass self imposed limits.

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