

# Characterization as a Motor Skill of a Right-hand Stroke on the Classical Guitar Technique

## Regulatory Conditions and Action Goals

José Rui Fernandes Pedroso<sup>1</sup> and Maria Bernardete Castelan Póvoas<sup>2</sup>

<sup>1</sup> PPGMUS, UDESC, Brazil; CAL, UFSM, Brazil;

<sup>2</sup> PPGMUS, UDESC, Brazil

<sup>1</sup>jfernandespedroso@gmail.com, <sup>2</sup>bernardetecastelan@gmail.com

### Abstract

In this paper, we propose a characterization of an isolated right-hand stroke in the classical guitar technique as a motor skill in terms of its goals and regulatory conditions. The choice of this element is important due to the constitution of the produced sound characteristics in the moment of string release. Thus, we conducted an exploratory investigation within a bibliographic framework, establishing connections between the fields of motor learning and guitar technique (Carlevaro, 1979), focusing on the physical parameters of finger-string interaction during the stroke. Initially, we resorted to a distinction between the movements that make up a given action and the motor skill being performed (Magill & Anderson, 2017) through the concepts of action goals and regulatory conditions. Then we considered parameters of interaction between the finger and the string (Pavlidou, 1997), seeking to strengthen our characterization with a physics background. We hope to contribute to a better understanding of this technical component and to offer the instrumentalists a conceptual framework that allows them to evaluate the motor aspects of his technique, regardless of the technical school practice. In this sense, the concepts of regulatory conditions and action goals allow us to contextualize the parameters of interaction within the elements of the instrumental technique, which can serve as a meaningful reference to consider the movements available at a given stroke.

**Keywords:** classical guitar, motor learning, instrumental action, right-hand technique

### Introduction

This paper presents a characterization of an isolated right-hand stroke as a motor skill in terms of its action goals and regulatory conditions. The choice of this technical element is related to the importance that the instant of string release has for the constitution of the sound characteristics produced. This work is derived from an investigation into Abel Carlevaro's instrumental theory for the classical

guitar (1979), specifically his system for right-hand strokes and the use of joint fixations (*fijaciones*). To better understand this technical resource and the other propositions made by Carlevaro, a theoretical framework was developed through interdisciplinary, bibliographical research. The characterization presented here is a part of this theoretical study, which comprised three main phases.

Firstly, a literature review was conducted focusing on the classical guitar technique, highlighting right-hand actions and the reception of Carlevaro's ideas in academic research. Interdisciplinary research papers that focused on the classical guitar were also considered, even if they did not directly approach musical performance. The relevance of his work in the field of instrumental technique and its development is presented, given that his proposals are constantly considered in research such as Walt (1996), Barros (2008), Roos (2009), Cardoso (2015), and Tsai (2018). Although Carlevaro's precepts have been considered in more recent works, the use of fixations in the right-hand technique was assimilated in perspective to the use of the five-stroke system and associated with definitions such as the simultaneous work of extensor and flexor muscles (Fernández, 2000). In general, the utilization of this system is seen as the five described strokes for the right-hand technique, although it was made clear that there is no delimitation, but a spectrum starting with free strokes and incrementing the muscles recruited to the task (Carlevaro, 1979, p. 51). The concepts of fixations were studied directly by Abeijón (2020), focusing on its precedents and reception by the guitar community. Considering the interdisciplinary research reviews in the first stage, such as Simões (2019), Centeio (2019), and Rabaioli (2020), although related to bimanual coordination on the classical guitar, a characterization of a single right-hand stroke, in terms of its regulatory conditions, was not carried out.

In the second phase, to address the research gap concerning the applicability and comprehension of

these concepts, we brought together topics from the fields of structural kinesiology, motor control and learning, as well as theoretical aspects of the interaction between the finger and string in the right-hand technique. From the combination of these aspects, we were able to propose a characterization of an isolated right-hand stroke as a motor skill. In the final stage, we analysed Carlevaro's instrumental theory based on the literature review conducted in the first phase and the theoretical framework developed in the second. Understanding of a guitar stroke through concepts such as regulatory conditions and action goals allowed for a broader comprehension of Carlevaro's theories and the interlocking between other Carlevarian concepts with fixations, such as muscular aggregates and restraining momentum. Those results and kinesiological aspects of the theoretical framework developed for this investigation were not covered in this paper and will be addressed in future publications.

The approach presented here aims to offer a complementary perspective on the practical knowledge of the right-hand technique, while also connecting with the field of motor learning. In this sense, the understanding of movements as components of the skill in question, as the assessment of technical elements in terms of regulatory conditions and goals, favours a renewed approach to instrumental practice, which can serve as a theoretical framework for the development of new practice strategies or the evaluation of the utilized means to achieve the intended artistic goals.

Characteristics and components of a motor skill

The concept of motor skill is usually associated with "activities or tasks that require voluntary control over the movements of the joints and body segments to achieve a certain goal" (Magill & Anderson, 2017, p. 3). The coordinated use of movements, which are components of these skills, is the means through which the action is carried out or even the way in which its goals are achieved. The purpose of a motor skill is to cause some type of change in the environment or in the person's relation to the environment. The ability to play the piano could be taken as an example, since it involves the goal of striking the correct keys in the proper sequence and at the right time, and it requires control over posture and finger and hand movements to achieve that goal (Magill & Anderson, 2017, p. 6).

Although instrumental action appears as an example of motor skill, some of its elements may remain without proper characterization. It

is a challenge faced by a musician who turns to interdisciplinary research involving the study of movements, which does not affect the merit of these theoretical structures and the applicability in the context of instrumental practice. In this context, four properties necessary for the characterization of a motor skill are established:

- 1) a goal to be achieved;
- 2) voluntary execution;
- 3) movement of the joints and body segments required to achieve the goal; and
- 4) necessity of learning or relearning. (Magill & Anderson, 2017, p. 7).

As components of motor skills (actions), we will consider movements as "specific patterns of motion among joints and body segments" (Magill & Anderson, 2017, p. 7). From this perspective, we are considering three levels of study for the acquisition of motor skills: 1) the skill (action) itself; 2) the movements used to achieve the action goals; and 3) the neuromotor processes involved. In the context of guitaristic action, given its interaction properties, it is necessary to clearly define its goals. Guitaristic action is adapted from the concept of pianistic action, developed within a theoretical framework that establishes an interconnection between body movements, the written music, and the desired musical results in piano performance (Póvoas, 1999, p. 80). That is a conceptual background through which the technical aspects of classical guitar technique and its analogous movements can be approached in relation to artistic goals (Pedroso, 2022, p. 38). In consideration of the movements that are fundamental to the realization of a motor skill, Magill & Anderson (2017) note that "too often, practitioners ignore this hierarchy of priorities and *introduce skills as movement patterns to be learned rather than as action goals to accomplish*. Learners are less actively involved in the learning process when this happens and are less likely to develop the problem-solving skills needed to become independent learners." (p. 9, italics ours)

The problem of presenting the skill as the probable movement pattern for its execution is contextualized in sports practice, and it is plausible that this mistake manifests itself in the context of instrumental teaching and learning as well. Considering the differences between sports and musical practices, it is worth remembering the congruence present between the means through which their actions are performed: motor skills, constituted by movements and controlled by neuromotor processes. In this context, it is pointed out that "the second reason

to distinguish the different levels of study is that not all people can accomplish the action goal using the same movement pattern or perform the same movement using the same neuromotor processes” (Magill & Anderson, 2017, p. 9).

In this sense, the lack of clarity between motor skill and the “movement pattern” used can lead to inhibition of the search for new motor solutions. This distinction between the skills that constitute instrumental action and the movements that compose it becomes especially relevant if we consider that the development of instrumental technique should focus more on expanding the resources available for musical interpretation than on adequately reproducing a discrete sequence of movements.

In the next section, concepts from Gentile’s taxonomy for motor skills classification are discussed. Centeio (2019) demonstrated the applicability of this system by contextualizing the guitaristic action, and we will start from this point of view to expand the understanding of the action goals and the regulatory conditions of a right-hand stroke.

### Guitaristic action and Gentile’s taxonomy

Gentile’s two-dimensional taxonomy expanded the one-dimensional approach to motor skills by considering two general characteristics: 1) the environmental context in which the skill is performed and 2) the function of the action that characterizes the skill. By subdividing these two characteristics, this expansive taxonomy produces sixteen categories (Magill & Anderson, 2017, p. 14). The environmental context dimension has two basic characteristics: regulatory conditions and intertrial variability. According to the authors:

“The term regulatory conditions refer to those features of the environmental context to which movements must conform if they are to achieve the action goal. They regulate spatial and temporal characteristics of the movement as well as the forces that underlie these characteristics. [...] It is important to note that regulatory conditions do not refer to characteristics of a person’s movements but only to characteristics in the environmental context in which a skill is performed.” (Magill & Anderson, 2017, p. 16)

Intertrial variability, in turn, refers to the maintenance of regulatory conditions across different attempts to perform a given skill (Magill & Anderson, 2017, p. 17). A motor skill can be distinguished by the presence or absence of intertrial

variability. Some characteristics of the environment, referred to by Gentile as “non-regulatory conditions”, can influence the way a skill is performed. The presence of an audience, the temperature of the environment during the performance of the action, whether the skill is being performed during the day or night; all these are characteristics that can affect the outcome of the execution, but not as directly as the regulatory conditions (Magill & Anderson, 2017). Ideally, the regulatory conditions for guitaristic action are maintained, as the instrument’s physical characteristics do not change significantly during performance. Even if errors or inaccuracies occur during a performance, they are not related to intertrial variability, as they concern the movements that make up a motor skill, rather than the regulatory conditions under which it is performed.

The second dimension on which Gentile’s taxonomy is based concerns the action’s function. This can be determined by considering whether the result of executing the skill involves the movement of the body from one location to another, or whether it involves the manipulation or use of an object. In this taxonomy, body orientation refers to the maintenance or change of body location, and two of these orientations are of interest for classifying motor skills: body stability, which refers to skills that do not involve changing the location of the body, and body transport, which implies displacements, such as walking and swimming (Magill & Anderson, 2017).

Considering the manipulation of objects as a function of action, the taxonomy describes it as “maintaining or changing the position of an object, such as a ball, a tool.” (Magill & Anderson, 2017, p. 20). Another way to express this function is to hold or use the object. Skills that require object manipulation are more difficult to perform than skills that do not, since “the person must do two things at once. First, the person must manipulate the object correctly, and second, he or she must adjust body posture to accommodate for the imbalance created by the object” (Magill & Anderson, 2017, p. 21, italics ours).

Overall, the guitaristic action, characterized as a motor skill, fits in category 2B in Gentile’s classification because it involves manipulation of an object (the instrument) and not bodily transport; furthermore, regulatory conditions are static and there is no variability between the attempts to perform the action, since the physical characteristics of the instrument are ideally preserved during the instrumental performance.

This taxonomy offers a valuable resource for assessing the possibilities and limitations of movements, as well as a tool for selecting a progression of actions that are functionally appropriate for overcoming motor difficulties or increasing performance capacity (Magill & Anderson, 2017, p. 23). The classification of guitaristic action also sets up a conceptual background to investigate elements of instrumental technique in a contextualized manner within the field of motor learning.

**Regulatory conditions of a right-hand stroke**

As discussed, the regulatory conditions will be related to the environmental characteristics in which the motor action is performed, rather than to the movements that constitute it. In the context of a right-hand stroke, they will be linked to the physical characteristics of the guitar considered relevant to the interaction between the finger and the string immediately prior to its release. These parameters are related to the direction of the displacements made, the friction between the finger and the string during the stroke, and the instrument’s characteristics and physical dimensions (Pavlidou, 1997).

It is also important to consider the influence that the longitudinal location of the stroke exerts on the intensity and sound quality of the guitar, as exemplified by Taylor (1978, p. 24). The possibility of pulsing the string in different regions is a well-established resource recognized by theorists of the instrument and widely used by guitarists.

Recognizing that the modification of the longitudinal point of contact with the string has implications on the force required to obtain the same level of sound power, we will take the resistance performed by the string as opposed to the movement of the finger as the main regulatory condition for the isolated performance of a stroke on the guitar. The resistance exerted by the string is proportional to the displacement occurring in the direction opposite to the movement of the finger and needs to be accommodated by the action at the moment when the stroke is performed.

All the actions described are being considered on the same region of the string, close to the sound hole, corresponding to the natural position described by Carlevaro (1979, p. 22). In the same sense, we will use the division of digital stroke into the agonist phase, referring to the contact of the finger with the string, and antagonist phase, referring to the beginning of the release of the string and replacing the finger for the next stroke (Carlevaro, 1979, p. 52).

The second regulatory condition is related to the material constraints on the vibration of the string without contact against the instrument or other strings. This condition can also be linked to the length and diameter of the string being played, but, in general, its proximity to the scale is the main factor limiting the maximum vibration amplitude. The lateral distance between the strings is the third regulatory condition considered for the action in question, since this property limits the possible trajectories that the finger can develop to start the stroke. Recognizing that the material and diameter of the strings used are relevant factors for the interaction with the finger, we chose not to count these characteristics as regulatory conditions in this elaboration. Since the characterization carried out aims to describe the skill to perform an isolated stroke, the condition referring to the resistance offered by the string already includes the possibility of differences in the interaction caused by the diameter of the string and the material that constitutes it. These differences are more relevant when combined actions are considered, which is beyond the scope of this paper. The following table (Table 1) lists the regulatory conditions considered in the characterization conducted here.

**Table 1: Regulatory conditions: right-hand stroke**

Regulatory conditions:	Notes:
String resistance exerted by the string in each stroke;	Proportional to the displacement and in the opposite direction to the movement;
String’s maximum amplitude of vibration;	Limited by the proximity of the string to the frets;
Lateral distance between strings.	Constrains finger approach trajectories.

**Action goals characterization for an isolated right-hand stroke**

A given motor skill needs, among other elements, a goal to be achieved. As highlighted, the most important moment in a right-hand stroke as a motor skill is the instant immediately prior the string’s release. It is the moment in which the guitarist can establish the parameters that define the characteristics of the sound (Rabaioli, 2020, p. 79). Understanding the goals to be achieved by a motor skill is a crucial element to enable the search for strategies to achieve it (Magill & Anderson, 2017), especially in musical practices, where the anthropometric characteristics of each instrumentalist substantially alter the viability of some techniques.

Once again, the importance of distinguishing the goal of a motor skill to be performed from the pattern of movements used is reinforced. Although the same motor action performed by different individuals shares similar goals, the motor availability (Pedroso, 2022, p. 48, 97) of each instrumentalist guides the choice of the pattern to be used to achieve them. In the same sense, the action will be guided by the environmental context in which it is carried out, as represented by the regulatory conditions described in the previous section.

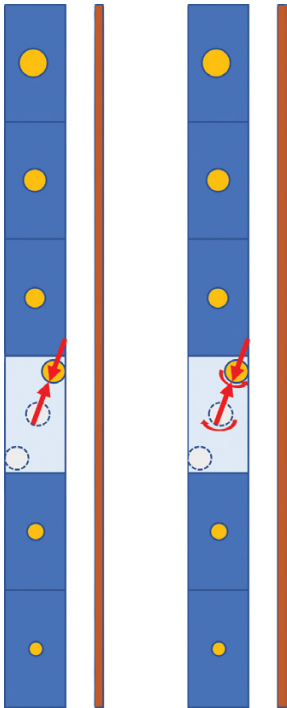
The primary goal of the action of the right hand in guitar technique is then related to the control over the parameters of interaction with the string available for sound emission (Pavlidou, 1997). Based on Taylor (1978), Pavlidou highlighted the importance of the angle of string release from the two most widespread ways of pulsing the string for the guitar technique: the free and rest strokes. The author points out that the difference between the two approaches is the angle of string release, and that this variance in the release of the string, from perpendicular to parallel, can be exploited according to the desired musical effect. Due to its physical characteristics, specifically the soundboard, the guitar is more prone to react to perpendicular than

to parallel forces, since the transfer of energy to the top is more efficient (Pavlidou, 1997, p. 9). Another contribution of Pavlidou's theoretical model worth considering is the friction between the finger and the string at the moment of the stroke. A restorative force arising from the friction between the finger and the string at initial contact can, by rotating the string on its own axis, alter the initial vibration parameters at the instant of release.

In Figure 1, we have presented the side view of the guitar strings highlighting the displacements and forces involved in a right-hand stroke. In this example, the third string is moved obliquely towards the soundboard. The red arrows denote the opposing reaction of the string in relation to the stroke, including the rotation of the string on its own axis as a function of friction with the finger. This characteristic can also be related to the material difference between strokes with or without nails.

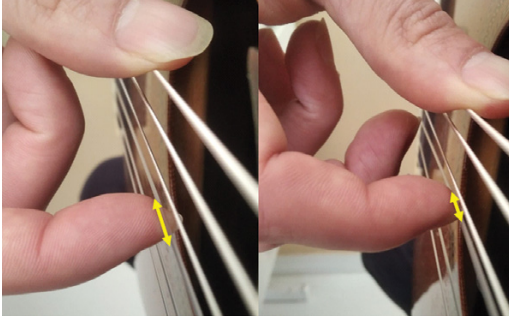
Without nails, the moment of string release is marked by contact only with the surface of the finger, which can lead to a sound with little definition and amplitude, especially on the three highest strings. A stroke performed with a fingernail, in turn, has more defined and controllable characteristics since the point of contact has a more regular surface and a lower coefficient of friction with the string than using only the digital surface. In the same sense, the width of the area of interaction between the finger and the string plays a significant role, as it influences the number of vibrational modes activated in each stroke. The author explains that "The number of harmonics that exist in the sound spectrum of an ideal string are theoretically infinite. However, in the sound spectrum of a real string there is always a frequency above which higher partials are almost absent. The cut-off frequency is created and modified by two mechanisms, (i) the stiffness of the string mentioned above, and (ii) the width  $\omega$  of the spectrum that excites the string. [...] While playing, the guitarist adjusts the cut-off frequency in order to alter the sound quality, by changing the angle of attacking the string" (Pavlidou, 1997, p. 21).

In addition to the direction of the displacement applied to the string, the guitarist also has the possibility of controlling the area of the point of contact with the string to obtain variations in the characteristics of the sound produced. Figure 2 illustrates the possibility of changing the width of the contact area between the finger and the string at the time of touch. On the left side of Figure 2, it can be observed that the index finger develops a



**Figure 1: Break down of the acting forces on a right-hand stroke based on Pavlidou (1997)**

trajectory perpendicular to the string, resulting in a larger contact area. On the right side, an oblique trajectory is used, which results in a smaller contact area. We emphasize that the contact area which influences the characteristics of the sound emitted will be the area in contact with the string at the time of the release.



**Figure 2. Different contact width for a right-hand stroke**

Another interaction parameter considered by Pavlidou refers to the response of the finger to the displacement of the string at the moment of release: “The interaction process is also strongly influenced by the response of the finger-muscle. The model showed that the string trajectory and release conditions are very sensitive to any alterations in the function which describes the relation between the muscle expansion and the restoring muscle force. [...] The importance of the finger-muscle response in the sound quality points out the need for an experimental evaluation of its form. It is very likely that finger-muscle responses differ among individual players” (Pavlidou, 1997, p. 178).

Returning to Gentile’s taxonomy, we highlight the function of action linked to the manipulation of objects, in which it is necessary to accommodate the imbalance created by the object in the skills with this characteristic. This aspect can be related to the establishment of the guitarist’s posture, which plays a crucial role in the technical conception of the right hand.

In the agonist phase of the stroke, the finger moves the string to the desired position, which, in turn, exerts a force on the finger proportional to this displacement. Considering these conditions, it is possible for an imbalance in the disposition of the hand to occur, because at the beginning of the antagonist phase, the finger will no longer balance the load carried out by the string immediately

before release. Ideally, the string should be released preserving the parameters established by the guitarist while keeping the postural stability of the right hand. Thus, we can consider four goals of the action for a given touch of the right hand, listed in the following table (Table 2).

**Table 2: Right-hand stroke: characteristics and action goals**

Action Goals	Notes:
String displacement	Amount and direction of the displacement imposed on the string;
Contact area	Width of the contact area with the string at the moment of release;
Keeping the parameters	Conservation of the established parameters at instant of string’s release;
Postural balance	Accommodation of the postural disruption caused by the stroke.

## Conclusion

Within the scope of this article, we presented a theoretical framework favouring a comprehension of right-hand strokes in the classical guitar technique as a motor skill. We emphasized the difference between the movements that constitute a given action and the skill being performed (Magill & Anderson, 2017). This distinction is pertinent in the teaching and learning of instrumental technique, considering the risk of describing motor skills only as patterns of movements to be performed without considering the goals to be achieved through action.

Regulatory conditions, as described in Gentile’s taxonomy, are related to the physical properties of the instrument, as they are the material constraints for the performance of the action. The action goals are in turn linked to the interaction parameters that influence sound production the most and that can be considered during the conception of a right-hand stroke. The action goals and regulatory conditions were derived from the parameters of interaction between the finger and the string (Pavlidou, 1997). In this sense, it was possible to identify a relationship between the postural disturbances generated by each stroke and the possible implications for the conception of hand positioning.

Through this elaboration, we hope to contribute to a better understanding of this component of guitaristic action and offer guitarists a conceptual structure that allows them to evaluate the motor aspects of their technique, regardless of the orientation or technical school practiced. In this

sense, the concepts of regulatory conditions and action goals allow us to contextualize the interaction parameters with elements of instrumental technique, which can serve as a reference to consider the movements available at a given stroke of the right hand. Although this theoretical approach was developed to understand premises of the technical paradigm proposed by Abel Carlevaro, this framework has the potential to be applied in any instrumental setting mediated by motor skills.

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