Application of Finger Gymnastics for Retraining and Refining Piano Technique

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APPLICATION OF FINGER GYMNASTICS FOR RETRAINING AND REFINING PIANO TECHNIQUE

By

P. David Encalada León

A DOCTORAL ESSAY

Submitted to the Faculty of the University of Miami in partial fulfillment of the requirements for the degree of Doctor of Musical Arts

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A doctoral essay submitted in partial fulfillment of
the requirements for the degree of
Doctor of Musical Arts

APPLICATION OF FINGER GYMNASICS FOR RETRAINING AND REFINING
PIANO TECHNIQUE

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Application of Finger Gymnastics for Retraining and Refining Piano Technique.

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The purpose of this study is to offer a conceptual basis and physical actions to retrain specific physiological settings, which are: 1) excessive and/or permanent stress of fingers at the flexor/extensor muscles, and 2) under development and thumb’s functionality and coordination, both common causes of rigidity and stagnation of fingers while playing the piano. Exercises and actions selected to fulfill this purpose belong to several authors that have designed gymnastic exercises and routines for hand and fingers, as well as those created by myself and this research’s advisor Dr. Naoko Takao. The exercises are sequenced following specific targeted outcomes, complemented with additional clarification of the purpose, goals, and proper usage, within the specific application parameters of this study.
ACKNOWLEDGMENTS

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I would also like to extend my highest recognition to the Government of Ecuador and to the Universidad de Cuenca, for funding my doctoral studies, and for believing in my commitment to contribute in the development of Ecuadorian educative and musical scenes.

With earnest appreciation, I also thank my parents (Luciano and Valentina), close family, and true friends, for their unconditional care and support along this tough but incredibly rewarding period of my life.
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CHAPTER ONE
INTRODUCTION

Background

The artistic act of performing a musical instrument comprises two essential aspects: 1) the mental act of developing an aesthetic intention, and 2) the physical act of representing it. During the processes of practicing and learning repertoire, pianists need to find the appropriate kinesthetic and physiological means to purposefully produce sound in correlation to the music and the interpretation. Although such process may be natural to some individuals, others may need to follow an exhaustive analysis of their technical approach in order to find the actions that need to be accomplished.

During the complex process of learning how to convey musical intentions through physical action, pianists face the risk of acquiring inconvenient psychomotor practices which could not only challenge but inhibit representing the intended aesthetic purposes. The psychomotor nature of such practices implies that all physical actions are nonetheless controlled by the brain, the consolidation of which involves uniquely individual mixtures of mental processes. This is especially true in music performance, as the musical context and individual’s understanding of it is integral to the learning process. As such, it needs to be kept in mind that physiological conditioning, whether ideal or not, does not exist in isolation from the mental processes. Such physiological conditioning, rather than suggesting an acquisition of particular muscular size or strength, denotes a finely-tuned muscular response to nervous system’s commands. It is to produce and differentiate
physical motions with adequate suppleness and equivalence in terms of speed, precision, and timing to suit the intended musical outcome.

When erroneous psychomotor practices do occur, they could become pervasive habits and sometimes even evolve into physiological conditions or injuries. While the avoidance of such adverse circumstances should be of primary interest to all pianists, overriding faulty physiological conditioning requires pianists to find strategies to acquire another set of technical means through a process of retraining. Such retraining process and its subsequent technical resetting may offer another perspective to the popular perception that dexterity can only be acquired during early stages of life.

While the risk of developing incorrect habit is well recognized, a solution to the problem is often not offered among the majority of existing literature. In *A Symposium for Pianists and Teachers: Strategies to Develop the Mind and Body for Optimal Performance*, edited by Kris Kropff, the authors state that the process of technical retraining could be frustrating and painful, and so they maintain that instructing correct habits from the very beginning of the instrumental learning process is essential.¹ Certainly these considerations are universally accepted as sound, but undesirable physiological habits can nevertheless develop even under the best of intentions. In reality, most pianists, at some stage of their careers, encounter the necessity to improve and rethink certain psychomotor aspects so that it would allow them to more efficiently represent what piano repertoire demands.

Modifying physiological settings acquired and automatized after many years of instrumental training could be a long and demanding process, requiring focused attention

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on the resetting and refinement of the muscular usage and coordination. In reality such process is somewhat different than learning a skill from scratch since it implies that automatized aspects of a skill must be discarded in order to obtain new habits and physiological conditions. Also, as L. Sian Beilock et al. states, such process is uncertain in duration and could initially be detrimental to the general performance capacities, in this case, of the pianist.

Regardless of the intricacy and uncertainty of such transformational path, medical studies show that certain psychomotor aspects can be improved over time based on a selection and combination of routines and exercises performed on a frequent basis. Considering that the psychomotor aspect of piano performance, at least at the level of general technical orientation, is learned and automatized after years of conceptualization and constant repetition, gaining new habitual settings requires a similar, gradual process, if not longer.

Since the second half of the nineteenth century, some piano pedagogues and theorists have offered practical exercises known as finger and hand gymnastics, with the purpose of acquiring or retraining piano technique. Although such treatises vary on several aspects of their scope and approach, they share the purpose of developing physiological and psychomotor matters related to the upper apparatus. Some of them also


4 Ibid.

5 Ibid.
sustain that this gymnastic practice could produce a much faster improvement than hours at the keyboard destined to mechanical exercises and studies, thus avoiding unnecessary fatigue and friction. Such conception is also founded on the notion that exercising at the keyboard does not necessarily embrace the training of all muscles required in piano playing, which could be better achieved by physiologically-informed gymnastics.6

Understanding the Basics of Muscular Mechanics and the Development of Maladaptive Physiological Habits

Before considering the process of retraining, the comprehension of how movement functions in human body is essential. In this context, Otto Ortmann states that: “the fact remains that the units of the body with which we play the piano are essentially levers of the third class and obey laws pertaining to their structure and their attachments to the skeletal parts.”7

In an essence, our body movement is achieved when adjoining bones are moved into position by the coordinated contraction and release of their attached muscles. Muscles connect with tendons producing force only during contraction. A muscle contraction is capable of producing movement in only one direction: movement to the opposite direction could only be achieved by the contraction of the opposing muscle.

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Both opposite muscles should work in coordinated contraction-releasing alternation, in order to prevent a conflict of forces called co-contraction.\(^8\) Since muscles work by momentary contraction, the absence of tension release could also produce obstruction of free and agile movements, tightening of joints, inhibition of adjacent muscles, and possible injuries due to extra stress on tendons.\(^9\)

In the specific case of piano playing, the lack of tension release in arm’s musculature constitutes a significant barrier to moving with ductility, precision, and freedom. This is also a common cause for developing conditions such as tendinitis, cubital or carpal tunnel syndromes, as well as other medical diagnoses.\(^10\)\(^11\) Such an unhealthy state of tension may become habitual, resulting in an excessive and continuous contraction of finger muscles without the knowledge of the pianist. Consequently, co-contraction at the finger level is likely to produce an unnaturally “curled” or “stretched out” fingers, depending on the predominance of tension residing in flexors or extensors respectively.\(^12\)\(^13\) Anxiety, intense work, and constant stress are also influential factors for developing medical conditions in pianists and other music professionals. One of such


\(^9\) Ibid, 105-107.


\(^11\) Mark.

\(^12\) Ibid.

\(^13\) Flexor muscles are located on the ventral (palm) side of the forearm and are in charge of bending fingers towards the hand. Extensor muscles are located on the dorsal side of the forearm and are in charge of straighten and lifting them away. When one of these opposite muscles is in action, the other set should release tension in order to allow free motion. Mark, 105-106.
disorders, surprisingly common, is focal dystonia which is characterized by the partial or
total loss of psychomotor control of the hand in extensively trained movements.\textsuperscript{14}

Piano playing is an activity with very specific psychomotor components, dissimilar
to even other instrumental performance. One of the reasons for this difference relates to
the role of the thumb in terms of trajectory and support. Unlike performance of other
instruments, the thumb’s usual role, of pulling toward the hand with the purpose of
gripping and holding, is never applied at the piano.\textsuperscript{15, 16} Due to the square shape of the
keyboard and its straight and parallel positioning in respect to the floor, the thumb must
exert force in the same trajectory as the other fingers trace. Although all pianists must
train to overcome the natural tendency of the thumb, some may need extra muscular
training to fully conquer it. Such training also allows for a stronger bridge to be built to
support the hand and fingers, in turn aiding to use the arm weight appropriately.\textsuperscript{17}

Such muscular training or development is essentially dependent on repetition of
physical action, and it could be completed away or at the instrument depending on their
nature and purpose. These hand and finger exercises, often referred to as “finger
gymnastics,” have been sometimes criticized as being antiquated and ineffective for
developing piano technique, at least by itself. In its defense, no philosophy is completely

\begin{flushleft}
\textsuperscript{15} Richard Drake, Wayne Vogl, Adam W. M. Mitchell, Gray’s Basic Anatomy (London: Elsevier
10th, 2016).
\textsuperscript{16} Paolo Steinberg Grikis, “The Pianist’s Support: the Development of the Palm of the Hand and its
Relation to Fingers, Wrist, and Arm,” (Doctoral Essay, Indiana University, 2005), 18.
\textsuperscript{17} Ibid.
\end{flushleft}
unfavorable or beneficial in itself. An innovative way of thinking, by its very impetus being that of correcting what was inadequately addressed before, has the tendency to disregard precepts of previous theories. In piano pedagogy, “finger” school as well as “anatomical-physiological” school have been superseded by the “weight” school and more modern philosophies of piano technique that integrate the mental and neurological considerations. Along the way, as it is often the case with any type of development through history, many useful precepts from past pianistic methodologies have been categorically labeled as ineffective. But precepts of all schools and approaches could be valuable from certain perspective or another, all depending on their application. For example, aspects of the “finger” school could complement a pianist lacking in clear articulation within the application of “weight” school concepts, or understanding anatomical-physiological principles could indeed serve to prevent injuries.

George Kochevitsky was a prominent proponent of the “psycho-technical” pedagogical school, conceiving the nervous system as an important source for developing piano technique. He associates finger-gymnastic practice with the old school of piano pedagogy and states that “such practice later proved to be useless and even harmful.” Unfortunately, there is no detailed explanation of how this could be declared so emphatically. Contrary to this latter perception, the present research proposes that finger gymnastics can be used as a positive and practical tool with the purpose of physiological reconditioning.

From a historical perspective, finger gymnastics were already mentioned in Francois Couperin’s *L’art de toucher le clavecin* (1716), but the first substantial

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A published work dedicated to finger gymnastics was a book entitled *Finger and Wrist Gymnastics* written by Edwin W. Jackson (1865). Jozsef Gát states that by the same time that Jackson’s work appeared, Franz Liszt also praised and used sets of hand gymnastics invented by Joseph Fischer M.D, after seeing his student Anna Lukács-Schuk successfully modifying her technique with their practice.

Later, in 1908, Tobias Matthay published his *Relaxation Studies in the Muscular Discriminations Required for Touch, Agility and Expression in Pianoforte Playing*, offering a series of practical exercises to be executed away from the keyboard to combat constant muscle stress, some of them focalizing at the finger level. What is novel in Matthay’s approach is that he focuses on releasing unnecessary muscular tension instead of the more usual approach among similar exercises, at or away from the keyboard, of developing strength or elasticity.

A few years later, David F. Kempf published *Automatic Finger Control*. This work, at first glance, appears to be a purely gymnastic treatise, but upon closer examination, it becomes apparent that its pursuit is on the development of speedy coordination of physical action using the characteristics of the cognitive process. Kochevitsky maintains that “the laws [at] work of the central nervous system, which directs our motor activity, exclude any possibility of making the calculations [of selecting

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20 Ibid.

21 Anna Lukács-Schuk published her book *Reform of Piano Technique* in 1897. Unfortunately, the author only recounts Liszt’s appraisal of the exercises she practiced, neglecting to describe the exercises.

22 Myra Hess, preface to *The Visible and Invisible in Pianoforte Technique* by Tobias Matthay (New York: Oxford University Press, 1947), x.

23 David F. Kempf was a Faculty member of the U.S. Music School in New York. This institution sponsored and published the seventh edition of his book in 1921.
what muscles precisely to use each moment] while playing, and limit the ability to control muscle work while practicing…although muscles need regulation, this has to be achieved in a quite different way.”

In this context, Kempf’s book could be seen as a practical method in which to obtain such an automatic (we could also say unconscious) muscular control of the hand when carefully applied.

More recently, in 2005, Paolo Steinberg synthetized central aspects of pianist Evelyne Brancart’s conceptions related to physiological reconditioning of the support of the palm of the hand. At age thirty one, this Belgium pianist decided to improve her technical approach at the keyboard, and thus she developed sets of exercises and routines oriented towards the physiological transformation of the muscles required to play the piano. The findings led her to successfully retrain several aspects of her skills. The physiological reconditioning of the thumb function is central and unique to Brancart’s personal research although the importance of this part of the hand has been generally acknowledged in piano pedagogical treatises.

The mentioned works stand as some examples of treatises concerning or including gymnastic exercises for the hand and fingers. Such volumes as well as other works will be closely examined in Chapter Two.

**Goals of the Study**

The goal of the current study, after a comprehensive review of existing finger gymnastic routines away from the keyboard, is to select and sequence specific exercises

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24 Kochevitsky, 10.

25 (Evelyne Brancart, February 24, 2015, conversation with the author)
to address two of the most common physiological habits of pianists requiring reconditioning. Namely, these maladaptive physiological habits, frequently manifested in rigidity and stagnation, are: the excessive and continuous contraction of finger-controlling muscles and the misuse of the thumb. These exercises, in their original sources, are not necessarily appropriate to be presented in the progression as given for treating the habits under discussion, and in some cases, contain exercises not directly relevant for the purpose. Instead of the trial-and-error approach in the selection and sequencing of the exercises, it is posited that the reconditioning process would be much more efficient when: 1) the materials used are carefully selected and sequenced with the targeted outcomes in mind; and 2) such process is undertaken with the proper understanding of the underlying principles of musculature involved in piano playing.

The present research was motivated by a desire to search for the means to override inconvenient physical conditions or habits that impeded the author from performing agilely at the keyboard. Its aim is to offer an alternative practical manner in which to retrain specific physiological aspects as a basis for subsequent technical reorientation. By no means, it proposes to develop piano technique by finger gymnastics alone nor suggests that such exercises encompass all aspects of the physiological reconditioning sought. Instead, it is intended as an auxiliary aid for any individuals who seek a path to reconsider their skills at the keyboard at any stage of their career: similar physiological retraining process may complement any technical adjustments being sought by other means.
CHAPTER TWO

LITERATURE REVIEW

Existing literature related to the subject of the current study may be broadly divided into several categories as follows: 1) prognosis and expectations of physiological rehabilitation; 2) physiological reconditioning from the medical perspective; 3) biomechanical and physiological considerations of piano playing; and 4) anatomical-physiological approaches to piano training, including finger gymnastics.

Prognosis and Expectations of Physiological Rehabilitation

When considering a process of psychomotor and physiological retraining, empirical studies in the field of medical rehabilitation could offer valuable evidence. Although such research does not necessarily relate to music or piano playing, it could scientifically support the notion that transformation in these aspects is possible. During the last decade, the advancement of medical science has reached a point where a partial or even total recovery of severe conditions such as dystonia or paralysis after a stroke is possible.

Research related to rehabilitation could be exemplified by the study by Patrice Berque et al., “A Combination of Constraint-Induced Therapy and Motor Control Retraining in the Treatment of Focal Hand Dystonia in Musicians.” In it she determines the effects of applying behavioral therapy to treat Focal Hand Dystonia (FHD), a disorder characterized by the involuntary loss of control of finger movement.26 FHD disorder

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manifests in involuntary spasm, cramping sensations, abnormal hand posture, and finger curling, and in piano playing, by the loss of coordination in specific fingerings, fingers sticking, and irregularities in rhythm and *tempi*. It usually affects third, fourth, and fifth fingers, and is presumably resultant of excessive practice of rapid, alternating, and precise finger-movement patterns.\(^{27}\) The therapy applied by Berque et al. was constraint-induced in nature, focusing on the motor control at slow speed.\(^{28}\) Results of this study, along with those of Elbert et al.,\(^{29}\) Altenmuller et al.,\(^{30}\) and Pantev et al.,\(^{31}\) show that it is possible to restore normal sensory and fine motor control of the hand.\(^{32}\)

Berque et al. propose learning-based sensorimotor training (LBST) as another method to treat FHD. Such method consists of the redefinition of “spatial and temporal processing capacities in the sensory and motor cortices in order to restore task-specific skills.”\(^{33}\) Such process features an initial distinction of large objects or the performance of big movements, with a progressive increasing of difficulty after mastery is reached.

Considering rehabilitation of muscular control, Jeehyun Yoo, in the article, “The Role of Therapeutic Instrumental Music Performance in Hemiparetic Arm Rehabilitation,” informs about upper extremity weakness rehabilitation, focusing on the

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\(^{27}\) Berque et al., 149.

\(^{28}\) Process based on the partial immobilization of certain parts of the motor apparatus.


\(^{30}\) Eckart Altenmüller and Hans-Christian Jabusch, “Focal Dystonia in Musicians: Phenomenology, Pathophysiology, Triggering Factors, and Treatment.”


\(^{32}\) Berque et al., 160.

\(^{33}\) Altenmüller and Jabusch, 7.
recovery of muscle tone, muscle strength, range of motion, and posture and control of movements with patients in post-stroke condition. Yoo reports that clinical rehabilitation was applied to three patients suffering from lack of control in upper-extremity movement. The use of music as means for this specific example of rehabilitation is irrelevant for the present paper.

Yoo’s research confirms that muscular control can be rehabilitated and improved even in post-stroke conditions, due to its process being essentially neurological. It is also informative in offering a review of related data, proving that upper extremities are more likely to recover than lower extremities, and that their weakness reverses over time with periodic exercise. Such reconditioning of arm functioning is even possible after four years of stroke occurrence.

**Physiological Reconditioning from the Medical Perspective**

Studying physiological reconditioning from the medical perspective stands as a support for understanding the possible causes of maladaptive aspects of the hand and finger movement. Determining such causality could be fundamental in addressing physiological conditioning at its root cause for the sake of preventing any reoccurrence. It could also add empirical evidence related to the prognosis of physiological retraining

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35 Ibid.

36 Ibid.

37 Ibid.

38 Ibid.
processes, which, despite its being not always specifically music related, nonetheless provide potential strategies and principles to be applied in the neuro-muscular retraining process of fingers and hand with the aim of improving piano technique.

Sonia Ranelli, in her study, “Playing-Related Musculoskeletal Problems in Children Learning Instrumental Music: The Association between Problem Location and Gender, Age, and Music Exposure Factors,” states that her aim is to determine symptoms and disorders in children and adolescents by connoting gender, age, and music exposure as well as type and number of instruments and playing time. For her, such understanding is crucial for the purpose of clarifying the possible risk factors for developing playing-related musculoskeletal problems in order to prevent them. Such examination, she proposes, would allow an earlier detection of symptoms and the prevention of developing more disorders.

After offering a review of medical studies applied to musicians suffering from all kinds of physiological pains and conditions, she declares that the evidence of studies applied to children and adolescents is limited. For this purpose, Ranelli surveyed 731 children aged seven to seventeen studying instrumental music in public schools in Australia.

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40 Ibid, 124.

41 Ibid.

42 Ibid.

43 Ibid.
Ranelli’s study is particularly enlightening for clarifying that, although playing-related musculoskeletal problems appear mostly during adulthood, they may originate before. The cause for this phenomenon could be based on the fact that musicians, unlike other occupations, typically start their careers at an early age.\textsuperscript{44} This implies the accumulation of repetitions and the years of habitual instrumental practice, with the latter often done over prolonged periods of time with the same posture without variation.\textsuperscript{45} Thus, musculoskeletal problems are more likely to appear in adults because wrong physiological habits have been already practiced for years since childhood or adolescence.\textsuperscript{46} This tendency could also be seen as a product of the increased likelihood of adult pianists to engage in longer periods of potentially injury-prone practice habits. She adds that this is more likely to happen in piano practice than with any other instrument, which could be explained by the complexity of repertoire and the memorization necessity.\textsuperscript{47}

Ranelli classifies playing-related musculoskeletal problems in adult musicians into two broad categories: “1) mild aches and pains, experienced during and following playing, that may or may not affect performance, and 2) pain, weakness, lack of control, numbness, tingling, or other symptoms that interfere with the ability to play the instrument as usual.”\textsuperscript{48} Within the second category and in the specific case of professional pianists or adult piano students, she states that the right hand is more susceptible to

\begin{itemize}
\item \textsuperscript{44} Ranelli, 123.
\item \textsuperscript{45} Ibid.
\item \textsuperscript{46} Ibid.
\item \textsuperscript{47} Ibid.
\item \textsuperscript{48} Ibid, 124.
\end{itemize}
developing such problems. Some of the reasons for this tendency relate to practice habits, difficulty or type of repertoire, and duration and frequency of practice sessions. Important factors that contribute to the development of such conditions are the excessive repetition of specific technical practices as well as the excessive force applied to the keys.

In the doctoral dissertation “The Influences of Physical Attributes, Perceived Exertion, and Time Spent Playing the Piano on Hand Discomfort, and the Relationship of Hand Discomfort with Hand Function Status among Piano Students: An Exploratory Study,” Siaw Chui Chai evaluates the influences of physical attributes, perceived exertion, and time spent playing the piano on recalled hand discomfort, as well as the relationship of hand discomfort and hand-function status. She defines hand discomfort as “self-report” experiencing of pain, aching, numbness, tingling, muscle spasm, swelling, fatigue, tension, tightness, stiffness, weakness, or clumsiness in the hand or arm.

Chai explains that playing the piano requires “continuous, repetitive, and precise use of hands for lengthy periods of time in a well-coordinated and highly specific manner for successful musical assembly.” Although piano playing demands low-impact loads not exceeding physiological limits, there exist a risk of overexerting structures due to

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49 Ranelli, 134.
50 Ibid.
51 Ibid, 136.
53 Ibid, 2.
54 Ibid, 1.
repeated depressing and releasing of piano keys without adequate rests.55 Additionally, such risk could be exacerbated by unbalanced muscular settings, incrementing chances to develop inconvenient physiological conditions, hand discomfort, or injuries.

She states that piano students are more vulnerable to feel hand discomfort due to longer duration of practice sessions and shorter periods of rest.56 Hand discomfort may be influential in damaging hand functions needed for piano playing, possibly provoking early termination of professional careers.

Considering that mechanical degradation of physical structures may be produced by recurrent exposure to stress and that rest may beneficiate its recovery, Chai highlights the importance of documenting the time spent playing the piano. She asserts that there exist evidence of both positive and negative associations between amount of piano practicing and the age of starting piano practice in relation to hand discomfort.57 Chai’s study is especially enlightening in offering statistical evidence and valuable argumentation for the understanding of the causality and variables of hand discomfort, including stiffness, rigidity, and lack of muscular control.

Naotaka Sakai, in his study “Hand Pain Attributed to Overuse among Professional Pianists: A Study of 200 Cases,” informs about his diagnostic and treatment experiences with professional and student pianists suffering from pain related to hand overuse. He defines overuse as one which occurs when: 1) symptoms occurred during or just after practicing; 2) there is no specific medical condition; 3) symptoms recur frequently while playing; and 4) patients noticed that practice was hard enough to develop the
symptom. Pianists considered for his study were mostly women and the diagnostics include tendinitis, enthesopathy, muscle pain, neurological disturbance, joint pain, and neck or scapular pain. He declares that hand motions of musicians are quiet specific and that medical problems in pianists are related to practicing specific piano techniques.

Sakai relates that few studies on hand overuse existed in the nineteenth century at the time when the instrument evolved to the present technology and that only since 1977, literature related to this topic has become more frequently researched. He specifically recounts a study by Lederman and Calabrese (1986) who classified overuse injuries in instrumentalists into: “1) those involving bones, joints, and bursae, 2) disorders of the musculotendinous unit, 3) primary muscular pain and cramp, 4) nerve entrapment, and 5) a poorly characterized group.” Sakai maintains that treatment of such hand overuse conditions should focus on their original cause in order to achieve full recovery, thus avoiding any eventual recurrence.

To exemplify the relationship between specific piano techniques and conditions due to overuse, Sakai addresses the excessive practice of octaves and chords. He maintains

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58 Sakai, 178.


60 Sakai.

61 Ibid.

62 Ibid, 179.


64 Sakai, 180.

65 Ibid.
that the prolonged hyperabduction of thumb and little finger plus the constant tension of abductor and extensor pollicis applied under long periods of practice of this technique (octaves and chords) could produce condition of overuse in the first compartment of the wrist or in the lateral epicondyle. He also treats extensor tendinitis and interosseous muscle pain as overuse injuries caused by the frequent extension and flexion at the metacarpo-phalangeal joint (the joint we often refer to as the “bridge”) for striking the keys with each finger overly arched. His findings are specifically informative in understanding that the excessive practice of specific kinesthetic patterns of hands and fingers could eventually become the cause of overuse injuries or additional neural-signal complications.

Expanding on Sakai’s due classification of focal dystonia as a neurological disturbance related to overuse, Eckart Altenmuller and Hans-Christian Jabusch, explain that this condition occurs without pain and that this characteristic “distinguishes it from repetitive-strain injuries and occupational fatigue syndromes.” In their study “Focal Dystonia in Musicians: Phenomenology, Pathophysiology, Triggering Factors, and Treatment,” Altenmuller and Jabusch define this condition as a task-specific movement disorder which appears as “muscular incoordination or loss of voluntary motor control of extensively trained movements while a musician is playing the instrument.”

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66 Epicondyle: any of several prominences on the distal part of a long bone serving for the attachment of muscles and ligaments. Drake, Vogl, and Mitchell.

67 Sakai, 180.

68 Interosseous: situated between the bones. Drake, Vogl, and Mitchell.

69 Sakai, 180.

70 Altenmüller and Jabusch, 3.

71 Ibid, 2.
authors assert that such loss of muscular coordination is normally escorted by co-contraction of antagonistic muscle groups.\textsuperscript{72} Focal dystonia’s risk appearance is higher in musicians than in any other occupational group, male classical musicians in the mid-30s being the most preponderant group; keyboard and plucked-instrument musicians are primarily affected in the right hand.\textsuperscript{73}

Altenmüller and Jabusch’s study is particularly helpful in clarifying, besides a genetic predisposition, specific psychological conditions such as anxiety, extreme perfectionism, and intense working behavior, combined with the pressure and stress of classical music profession, are certainly definitive factors conducive to developing focal dystonia or similar conditions.\textsuperscript{74} These stress-induced processes are rare in improvisational musicians or similar music cultures, since movements applied in those practices normally obey personal biomechanical approaches.\textsuperscript{75} This study also addresses the idea that co-contraction of antagonistic muscle groups is associated with \textit{focal dystonia}, suggesting the hypothetical reasoning that maladaptive muscular co-contraction regulation could contribute to preventing the development of \textit{focal dystonia}.

In relation to biomechanical considerations, Christoph Wagner, in his study “Musician’s Hand Problems: Looking at Individuality: A Review of Points of Departure,” states that “piano playing is achieved by the interaction of different biomechanical

\textsuperscript{72} Altenmüller and Jabusch, 3.
\textsuperscript{73} Ibid, 4.
\textsuperscript{74} Ibid.
\textsuperscript{75} Ibid.
elements.” His approach focuses on understanding which of these elements may be supportive or limiting for the purpose of playing. Thus, he stresses the importance of qualitative analysis on each individual case.

In his study, Wagner divides the biomechanical background of the individual into three aspects: 1) size and shape of body parts involved; 2) level of resistance of joints involved; and 3) available muscle strength acting on the joints. Wagner proposes to clearly distinguish biomechanical conditions of every musician and advocates to pay special attention to this matter along the instrumental educative process, accepting individual differences as a natural characteristic rather than searching for universal anatomical standards.

Although it is true that every individual can only rely on their specific anatomical characteristics to form a personal biomechanically sound core technique as Wagner suggests, piano playing demands specific basic conditions in the psychomotor and physiological fields. Some examples of those specific conditions are the muscular coordination and control of fingers, the coordination of mind and movement, and the functioning of the thumb. Answers to the proper conditioning of these aspects can best be found among physiologically-informed treatises written by pianists, as discussed in the subsequent section.

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77 Ibid, 57.

78 Ibid, 64.
Biomechanical and Physiological Considerations of Piano Playing

The present study finds essential roots in the biomechanical approach of piano playing, which seeks how best to use the body to play effectively using the empirical knowledge of anatomy and kinesiology.79 Although this approach exists alongside the history of keyboard performance, its most prominent advance started during the last quarter of the nineteenth century, around the same time the instrument reached its modern form and technology.80

Dylan Savage, in his contribution to *A Symposium for Pianists and Teachers: Strategies to Develop the Mind and Body for Optimal Performance* (2002), offers a review of the history and evolution of the biomechanical awareness in piano performance and pedagogy. He positions Ludwig Deppe and Rudolf Breithaupt as two of the most prominent researchers in this approach and attributes to them the initiation of a specific trend known as the “physiological and anatomical” pedagogical school.81 Savage highlights Deppe’s conception of tone production which is based on the coordinated action of all parts of the arm rather than on the isolated finger technique.82 Similarly, this author explains Breithaupt’s physiological understanding for the production of full-toned *legato* using the weight of the upper arm rather than the finger alone.83

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80 Wagner.

81 Ibid, 7.

82 Savage.

83 Ibid.
Savage supports his argument recalling Kochevitsky, who recognizes the significance of Deppe and Breithaupt for being pioneers in considering perception and conscious training as valid substitutes of pure mechanical exercises. Both authors have total conviction on the accuracy of science, especially when considering that understanding muscular action and function is an essential step for solving technical difficulties.\(^{84}\)

Savage continues his overview of biomechanical approach by reviewing Otto Ortmann’s work, whose intention was to search for physiologically correct positioning of piano-playing mechanism.\(^{85}\) Savage also highlights Ortmann’s contribution to the understanding that muscular work is based on different levels of contraction and tension, thus denying any benefit of aiming for total relaxation.\(^{86}\) Savage then presents Abby Whiteside’s insight that technical control is only possible without the interference of the muscles not involved in a particular action.\(^{87}\)

Savage also cites Arnold Shultz’s precept that velocity in piano playing is achieved when fingers’ flexor muscles overcome extensor’s minimal outgoing contraction, which assures the lifting of the fingers when flexor muscles have released.\(^{88}\) He then emphasizes Tobias Matthay’s view that muscular coordination is fundamental to all technical means.\(^{89}\) About József Gát, Savage points out the notion that correct methods of piano

\(^{84}\) Kochevitsky, 10.
\(^{85}\) Savage, 8.
\(^{86}\) Ibid, 9.
\(^{87}\) Ibid.
\(^{88}\) Ibid, 10.
\(^{89}\) Ibid.
playing should rely on physics and anatomical principles, verified by physiology and contrasted to those coming solely from pedagogical and performance experience.\textsuperscript{90} In his chapter, Savage also refers to other interdisciplinary approaches to music performance, such as medicine and wellness, sport training techniques, and technological applications. Although a detailed understanding of each of the authors mentioned in Savage’s chapter can only be obtained by close examination of their respective publications or teachings, this overview is indispensable for obtaining an overall notion of the history of the biomechanical approach.

In his book \textit{The Physiological Mechanics of Piano Technique} (1929), Otto Ortmann introduces a radically scientific study on piano playing, empirically measuring the most “efficient and physiologically correct” positions used during piano playing.\textsuperscript{91} Ortmann’s research is based on data analysis of multiple experiments held at Peabody Conservatory. With the purpose of determining the nature of movements and actions applied when playing the piano, he used various scientific equipment to capture expert pianists’ movements while playing.

Ortmann explains that his work has a three-fold value: 1) the general theoretical understanding of the accurate muscular operation during the act of piano playing; 2) the practical approach on specific problems of piano technique with pedagogical purposes; and 3) the physiological implications of the technical problem.\textsuperscript{92} The mentioned perspectives are respectively contained in the sections of his book: “The Physiological Mechanics of Piano Technique.”

\textsuperscript{90} Savage, 12.

\textsuperscript{91} Ibid, 8.

Organism,” “General Aspects of Physiological Movement,” and “The Touch-Forms of Piano Technique.” One of the most important of his contributions consists of the analysis offered of every technical gesture based on an empirical methodology, completed with several kinds of scientific equipment. Ortmann’s work is fundamental in understanding that minimal and precise muscular contraction is indispensable for tone production, thus rejecting the misguided aim for total relaxation.

Approaching the art of piano playing from a scientific point of view has been criticized and resisted by artists and pedagogues alike, not surprising considering the intrinsic dichotomy of the disciplines. Nevertheless, results of such analysis may facilitate the comprehension of physiological characteristics of this musical activity, thus preventing mechanical faults that could generate inadequate technical settings.

Brenda Wristen, in her doctoral dissertation, “Overuse Injuries and Piano Technique: A Biomechanical Approach,” states that this is “the first study to approach combined motions comprising specific pianistic tasks.” For this purpose she considers environmental, anatomic, and biomechanical constraints, and details the kinesiology of the playing apparatus. She also offers biomechanical norms for seven pianistic tasks including scales, arpeggios, octaves, among other.

In her study, Wristen also describes mechanical factors of muscles and tendons and their response to force application. She also discusses common types of injuries

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93 Savage.


95 Ibid.

96 Ibid.
suffered by pianists and advices on their prevention using medical, biomechanical, and ergonomic data.\textsuperscript{97} Wristen also suggest instructions for analyzing a determined pianistic task following a qualitative biomechanical approach.\textsuperscript{98}

Wristen concedes that research related to the prevention of injuries and to the correlation of injury and piano technique is historically under explored.\textsuperscript{99} She also refers to a pedagogical debate on the appropriateness of using technical exercises and etudes, taking the side of the argument that the misuse of such exercises is usual and could lead to injury.\textsuperscript{100}

She states that the interest in finding ways to accomplish certain activity with minimal amounts of strain upon structures has grown considerably, promoting the increase of studies examining the motions employed at the piano from a biomechanical approach.\textsuperscript{101} Nevertheless, she maintains that such approach responds more to a purely scientific interest, rather than from a practical perspective of pianists.\textsuperscript{102}

Wristen differentiates skills used in piano playing from those used in sports, saying that although both are goal-directed the former is much more complicated by added

\begin{flushleft}
\textsuperscript{97} Wristen.
\textsuperscript{98} Ibid.
\textsuperscript{99} Ibid, 1.
\textsuperscript{100} Ibid.
\textsuperscript{101} Ibid, 3.
\textsuperscript{102} Ibid.
\end{flushleft}
elements such as musical expression, tonal and dynamic effects, among others.\textsuperscript{103} Thus, in piano playing, the means to achieve the goal is equally important than the goal itself.\textsuperscript{104}

Considering these aesthetic variables, Wristen suggests that quantifying a definite manner to execute specific motions is impossible.\textsuperscript{105} Nevertheless, she maintains that establishing general biomechanical norms for given motions may be possible, considering biological tolerances of anatomical parts common in all individuals.\textsuperscript{106} She adds that all healthy individuals have the same basic construction of bones, muscles, ligaments, tendons, and joints, and that surpassing their biological tolerances could produce injuries or specific conditions.\textsuperscript{107} Although Wristen does not take into account the cognitive side of the psychomotor aspects of piano practice, a separate examination of biomechanical factors may have its own merit in the consideration of physiological retraining.

Pianist Thomas Mark published \textit{What Every Pianist Needs to Know about the Body} in 2003 as a product of his extensive research on body mapping,\textsuperscript{108} kinesthesis, and quality of movement. In this book, the author studies extensively not only the upper apparatus but the whole human body from a pure anatomical perspective as well as from its functional application in piano performance. He also dedicates independent chapters for biomechanical concepts, structural balance, breathing, injuries, and retraining.

\textsuperscript{103} Wristen, 4.
\textsuperscript{104} Ibid.
\textsuperscript{105} Ibid.
\textsuperscript{106} Ibid.
\textsuperscript{107} Ibid.
Mark’s book is an in-depth study of anatomical and kinesthetic aspects of the whole body in relation to the act of playing the piano. It includes an analysis of the skeletal and muscular structure, principals of balance, influence of breathing, and the possible acquisition of injuries due to erroneous muscular control. It stands as an up-to-date accessible source for understanding the physiological functioning of the body, and provides specific examples of co-contraction of finger muscles. This information is helpful in determining the causality of finger rigidity in piano playing.

In the section treating muscular mapping, he explicitly treats the tendency of “curled fingers” as a product of antagonistic contraction between flexor and extensor finger muscles. After explaining the necessity of tension-release coordination between opposite muscles, he sustains that the propensity for keeping fingers more pronouncedly bent than the “natural curve” is a consequence of unending contraction of flexor muscles. Conversely, the predominance of constant tension in extensor muscles may produce a pushed-out positioning of fingers. Both physiological predispositions stand as obstacles for the active and responsive action of fingers. Jackson labels these tendencies as “a peculiar kind of paralysis,” and attributes their cause to constant muscular over-exertion.

In the specific case of the thumb, Paolo Steinberg Griks in his doctoral essay maintains that the specific function of this finger, when playing the piano, demands a particular muscular usage. Since the trajectory of the thumb should run parallel to the

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109 Mark, 107.

110 Ibid.


112 Mark, 107.
other fingers, thumb’s flexor’s contraction with the purpose of adduction is rarely applied at the keyboard. For this purpose, training to keep the thumb more separated at the carpometacarpal (CMC) and metacarpophalangeal (MCP)\(^{113}\) joints would facilitate a freer thumb’s vertical descent on the keyboard while simultaneously building a stronger support for the hand.

For this purpose, Grikis, referring to Brancart, suggests stretching the *adductor pollicis*, a bifurcated muscle located between the thumb and the middle finger, whose function is to pull (flex) the thumb towards the palm.\(^{114}\) Since this role has no practical purpose in key stroke, training it to remain open would facilitate a freer thumb’s vertical descent in an abducted position on the keyboard, while simultaneously building a stronger support for the hand.\(^{115}\) This thumb’s repositioning would be well reinforced by the exercising of thumb’s *extensor pollicis longus*,\(^{116}\) a skeletal muscle which functions to achieve full interphalangeal hyperextension of the finger (which means the complete extension of the thumb including its last phalange).\(^{117}\) This repositioning and training does not imply the constant engagement of muscles through tension, but merely developing a more abducted default new positioning of the thumb.

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\(^{113}\) The *carpometacarpal* joint (CMC) links the thumb with the wrist; the *metacarpophalangeal* (MCP) joint links the thumb to the palm (thumb’s knuckle).

\(^{114}\) Drake, Vogl, and Mitchell.

\(^{115}\) Grikis, 8.

\(^{116}\) The *Pollicis longus* is a skeletal muscle that begins at the dorsal surface of the *ulna* (long bone located between elbow and wrist) and ends at the distal phalange (last skeletal section) of the thumb.

\(^{117}\) Drake, Vogl, and Mitchell.
Anatomical-Physiological Approaches to Piano Training, Including Finger Gymnastics

With the aim of selecting and sequencing finger exercises for the purpose of this study, treatises and pedagogical works containing gymnastic practices were surveyed and analyzed. This section of the literature review follows a chronological progression in order to understand the historical development of this approach.

In 1865, a German author Edwin Jackson published his *Finger Gymnastics*, a system of exercises after several experimentations, with an endorsement from “the highest anatomical, musical and gymnastic authorities of Germany.”\(^{118}\) He maintains that his intention is to offer an alternate methodology to render joints of fingers and hands strong and flexible, in a much faster, less exhausting and more effective way than the “finger school” approach at the piano.\(^{119}\) Nevertheless, he clarifies that his method is intended to be used not only by pianists but by instrumentalists in general.

He then recounts his own experience using his system on a daily basis, stating that he noticed an increase of agility in his fingers and wrists, as an effect of setting the muscles free.\(^{120}\) Along his justifications, Jackson makes clear that evading and preventing fatigue is one of his most important concerns, suggesting that this condition may be a product of inadequate muscular usage or a consequence of muscular weakness, since fingers are the least exercised parts of human body.\(^{121}\)

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\(^{118}\) Jackson, vi.

\(^{119}\) Ibid, 2-3.

\(^{120}\) Ibid.

\(^{121}\) Ibid, 6-7.
The author proposes that after properly and gymnastically exercising muscles and stretching ligaments and tendons, fingers would move fluently and easily over the keyboard.\footnote{Jackson, 6-7.} He synthetizes his intentions in offering a careful training method: to grant fingers flexibility and agility, to shorten time of study, and to assist the labor of both student and teacher.\footnote{Ibid, 13.}

A central aspect of this method consists of focusing on the transversal and longitudinal exercising of hand’s ligaments with the purpose of setting them loose, thus allowing for a less restricted muscular activity in fingers.\footnote{Ibid, 10-11.} Jackson’s fundamental principle is that flexibility, ability, and strength can only be acquired through regular exercise of the muscles, and that agility and quickness are produced by strength and power.\footnote{Ibid.}

In 1893 Ridley Prentice published *Hand Gymnastics: for the Scientific Development of the Muscles used in Playing the Pianoforte*. In the preface he praises Jackson’s work as one of the chief training treatises up to date.\footnote{Prentice, preface.} In contrast to Jackson, Prentice focuses on the development of extensor muscles rather than on transversal ligaments.\footnote{Ibid.}

Unlike Jackson, Prentice focuses on the muscular development specifically for pianists and asserts that he avoids using any exercises that are subject to possible
confusion or misinterpretation.\textsuperscript{128} He also suggests that gymnastics should be done away from the keyboard, explaining that the keyboard does not offer the ideal conditions for exercising all muscles needed to play the piano.\textsuperscript{129} For him, exercising only at the keyboard produces considerable fatigue and unnecessary friction: the keyboard is not meant to be “a gymnastic apparatus suitable for this scientific training.”\textsuperscript{130}

Similarly to Jackson, Prentice maintains that fingers are the least trained parts of the human body, and that even the more developed hands generally lack muscular controlling power.\textsuperscript{131} Also from his perspective, to play studies and exercises mechanically would produce no constructive results. Instead, he proposes that combining gymnastic training with studies and exercises could offer remarkable physiological settings to gain agility.\textsuperscript{132} Prentice sustains that practicing gymnastics produces much faster results than hours playing exercises and studies.\textsuperscript{133} He then conveys that combining both systems would result in more than double the effect of keyboard exercise alone.\textsuperscript{134}

Prentice warns that his method should be practiced intelligently and thoroughly, with firm and unwavering attention to the completion of the task as instructed: he states that “mere mechanical motion of the hand or of the finger will effect nothing.”\textsuperscript{135}

\textsuperscript{128} Prentice, preface.
\textsuperscript{129} Ibid, 11.
\textsuperscript{130} Ibid.
\textsuperscript{131} Ibid.
\textsuperscript{132} Ibid, 8.
\textsuperscript{133} Ibid.
\textsuperscript{134} Ibid.
\textsuperscript{135} Ibid, 10.
synthesizes the objectives of his method in gaining strength, agility, and control, stating that the latter can only be achieved through the development of all sets of muscles of the hand.\textsuperscript{136} This process, he continues, can only be completed away from the instrument, since at the keyboard the pianist mostly trains the flexor muscles of the fingers.\textsuperscript{137}

Prentice refers to the balance of the opposite muscle sets as the natural condition of positions and movements for all limbs, including the state of rest.\textsuperscript{138} He clarifies that if one of the sets is overly strengthened the other set becomes weak and cannot fulfill its function.\textsuperscript{139} For him, it is clear that the pianist needs to develop flexor and extensor muscles equally, but he asserts that the act of piano playing nurtures mostly the flexor muscle set, attributing the latter to the fact that: 1) they have more work to do, and 2) more attention is devoted to their action during key stroke.\textsuperscript{140}

Prentice’s work contains one of the earliest gymnastic methods exclusively devoted to pianists. His aim for developing both sets of flexors and extensors to be in balance could aid in regulating any state of muscular unbalance at the single finger level, such as co-contraction.

Another highly influential figure active in the first half of the twentieth century is Tobias Matthay, a prolific writer-theorist-pedagogue whose ideas and precepts have not completely escaped criticism. Matthay faithfully believes in the importance of comprehending the nature of correct physical actions in order to determine the causes of

\begin{itemize}
  \item \textsuperscript{136} Prentice, 10.
  \item \textsuperscript{137} Ibid, 12.
  \item \textsuperscript{138} Ibid, 11.
  \item \textsuperscript{139} Ibid.
  \item \textsuperscript{140} Ibid, 12.
\end{itemize}
difficulty during the study of actual repertoire. He conceives that successful piano playing depends on a multitude of variables, as he states:

“Habits of proficiency and accuracy in inducing the required muscular actions and inactions...[implying] the acquisition of mental-muscular discriminations in a number of very definite directions, and primarily, in the elision of all unnecessary exertions.”

He synthetizes the most important muscular discriminations in piano playing into three categories: 1) timely relaxation of the arm-supporting muscles (to allow the use of weight); 2) elimination of all “contrary” exertions; and 3) exactness in timing to end the required exertions (elimination of all unnecessary and detrimental exertions). The essence of his teaching could be summarized in: 1) the precise distinction between arm and finger stroke, 2) the use of weight as a support for digital action, and 3) the use of rotation almost constantly associated with digital activity.

In his book Relaxation Studies in the Muscular Discriminations Required for Touch, Agility and Expression in Pianoforte Playing (1908), Matthay explains that the exercises contained in this method are designed for attaining the correct execution of any technical aspect and that they can be combined with any other set of studies or exercises away or at the piano.

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142 Ibid, 1.

143 Ibid, IV.

144 Luca Chiantore, Historia de la técnica pianística (Madrid: Alianza Editorial, 2001).

145 This volume by Matthay is a complement to his well-known Act of Touch and First Principles of Piano Playing.

146 Matthay.
His method is divided into categories with different functions, which are 1) preparation, 2) special purposes, and 3) daily practice (during the whole career of the pianist).\textsuperscript{147} He asserts that their practice would save hours of practice time and would allow the pianist to accurately recall the required mental-muscular discriminations before the musical act.\textsuperscript{148}

Matthay also categorizes his exercises by considering if they should be practiced away or at the instrument.\textsuperscript{149} He postulates that those to be completed away from the piano are especially valuable in treating acquired erroneous habits related to muscular actions and inactions.\textsuperscript{150} He bases this assertion on the notion that when seeing the keyboard, the performer instantly recalls the accustomed wrong muscular conditions, impeding to dismiss them.\textsuperscript{151} He consequently states that “the harder task to accomplish is the first weakening of long-formed bad habits.”\textsuperscript{152}

Contrary to other gymnastic methods reviewed, Matthay proposes that the order of his exercises must be determined by each case, depending on the specific necessities of the individual.\textsuperscript{153} Nevertheless, he advises to firstly master the simpler notions before

\begin{enumerate}
\item Matthy, I.
\item Ibid, III.
\item Ibid, IV.
\item Ibid.
\item Ibid.
\item Ibid, IV.
\item Ibid, V.
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attempting complex combinations, as well as to delay the practice of the exercises for finger individualization until control of the larger muscles is fully mastered.\textsuperscript{154}

Matthay’s advice for individualized sequencing is perceptive and crucial. Accordingly, when presenting the selection of exercises in the present study, commentary will be added to clarify their respective purpose, thus informing how to properly sequence them to suit each individual case.

Matthay’s \textit{Relaxation Studies} is not only significant in providing actual exercises with the purpose of controlling finger muscle exertions, but also in describing in detail their practice, implications, and aims. It also offers practical advises for the specific process of retraining and transforming psychomotor habits.

Adopting a similar approach, David F. Kempff, in the preface to the second edition of his \textit{Automatic Finger Control} (1921), describes his method as advanced, intensely practical, and time saving.\textsuperscript{155} He not only mentions the importance of its habitual practice, but also stresses that it should be performed twice per day, specifically, immediately after waking up and just before sleeping.\textsuperscript{156} He asserts that if practiced in this way with full thought and attention, actions and movements implied in the exercises would be promptly assimilated and remembered.\textsuperscript{157} Kempff states that the mind works best under certain definite circumstances, thus favoring the attentional level required for embracing his

\textsuperscript{154} Matthay.

\textsuperscript{155} David F. Kempff, \textit{Automatic Finger Control}, 7\textsuperscript{th} ed. (New York: U. S. School of Music, 1921), preface.

\textsuperscript{156} Ibid.

\textsuperscript{157} Ibid.
method. As a result, practicing his exercises at a definite time every day would habituate the mind to respond more readily and actively to the process.

The aforementioned argument will be prominently advocated when recommending how to schedule the practice of the exercises selected in this study. Such metacognitive planning will contemplate the importance of mental predisposition to fully engage in the training, and the connotation of creating a habitual routine for its practice.

He stresses that movement exercises must be brisk, with the intention of executing complete contractions of the muscles involved. He also specifies that the work should be done one hand at a time and that close mental attention is essential, especially while performing exercises which require one muscle working in opposition to another. This principle of exercising one hand at a time would be the prescription for the practical phase of the current study. This is beneficial for the sake of clarity of neural feedback and for achieving a stronger attentional engagement.

The main principle of Kempff’s method is the acquisition of coordination between muscles and brain rather than the development of strength or suppleness of fingers: “the main idea is…training the muscles so as to overcome the tendency of the fingers to move more slowly than the mind.” After complete muscular training is accomplished thus, he affirms that the control achieved would derive in perfect technique and touch, while also

158 Kempff.
159 Ibid.
160 Ibid, introduction.
161 Ibid.
162 Kochevitsky, 12.
163 Kempff, introduction.
helping to overcome nervousness, to gain a velvety touch, and to improve sight-reading skills.\textsuperscript{164}

Thomas Fielden writes \textit{The Science of Pianoforte Technique} (1927) at a time when the theoretical analysis of piano technique was markedly centered on anatomic and physiological principles.\textsuperscript{165} A confessed follower of Breithaupt, he considers that knowing the properties of muscular movements would allow its adequate application and would be decisive in solving technical difficulties.\textsuperscript{166} He suggests that, for example, at the moment of trying to master a difficulty, a pianist, unaware of the proper muscular process implied in the specific difficulty, could erroneously use muscles that have nothing to do with the movement required.\textsuperscript{167} This lack of mental direction performed in prolonged sessions of mechanical practice may create automatic (involuntary) reflexes, which could be of controlled or uncontrolled nature.\textsuperscript{168} Nevertheless, performing in slow motion would allow for conditioning such reflexes in detail, allowing technical certainty and swiftness.\textsuperscript{169} Fielden argues that fingers are controlled by individual nervous impulses and that each nerve connection controls a section of the large comprehensive muscle.\textsuperscript{170}

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\footnotesize
\textsuperscript{164} Kempff.
\textsuperscript{165} Chiantore.
\textsuperscript{166} Thomas Fielden, vii.
\textsuperscript{167} Ibid, 12.
\textsuperscript{168} Ibid.
\textsuperscript{169} Ibid.
\textsuperscript{170} Ibid.
\end{flushright}
He also assures that nervous control can be developed by proper inhibition and relaxation of unnecessary forces, both important aspects in his conception.\textsuperscript{171}

Fielden states that “old” (stiff-fingered) pedagogical methods give attention to physiological laws in terms of muscular movement of fingers, but they do not consider the implications of how to properly apply scientific laws to piano technique.\textsuperscript{172} To counteract this, in his book Fielden includes a technical method based on a gymnastic approach, which deals with both muscular training and its kinesthetic application at the keyboard.

Fielden also states that practicing exercises with stereotyped hand positions have only certain validity, beyond which only the great (talented) players progress.\textsuperscript{173} He explains this phenomenon by considering imagination and inspiration as appropriate tools to find physical movements that could appropriately convey aesthetic expressions.\textsuperscript{174}

In his book, Fielden dedicates a chapter to the “Technical Training by Gymnastics,” in which he tackles the individual exercise of several parts of the body, giving special attention to muscular co-ordination. He divides his approach into two categories: 1) muscular training (in great extent to be performed away from the keyboard) and 2) applied movement at the keyboard. He explains that in general, the aim of gymnastics is to achieve the “ability to control and call swiftly into action the muscle or combination of muscles necessary for the performance of any technical difficulty,”\textsuperscript{175} and that unless “the

\begin{footnotes}
\footnote{Fielden, 13.}
\footnote{Ibid, 10.}
\footnote{Ibid, 3.}
\footnote{Ibid.}
\footnote{Ibid, 36.}
\end{footnotes}
student practices his exercise with knowledge, he is likely to become merely mechanical and automatic.”176

Fielden maintains that the ability to control fingers resides initially in the big muscles of the arm. 177 Similarly to Matthay, who recommend delaying the practice of the exercises for finger individualization, Fielden suggests that the process of developing control should start at the shoulder level and not at its opposite end.178 When it comes to gymnastics for fingers, Fielden states that the question should be to consider not only how to develop muscular strength but also elasticity of the ligaments, in order to allow more resilience of tendons.179 Similarly to Jackson, he states there is no case of stiffness in hands that cannot be improved though exercise and massage.180

He focuses his approach on the fact that every muscular action has its reciprocal movement, thus dividing his exercises according to three progressive stages: 1) the alternation of contraction and relaxation of the same muscles; 2) the contraction of a set of muscles, while relaxing them and setting up the contraction of the reciprocal set; and 3) the relaxation of one set of muscles and the gradual contraction (in the same degree) of the reciprocal set, through a slow and steady movement, avoiding stiff and spasmodic effort.181 Fielden considers that the process for physiological training with the purpose of enriching piano technique should logically start at the shoulder and end at the finger

176 Fielden, 36.
177 Ibid, 34.
178 Ibid.
179 Ibid, 40.
180 Ibid, 41.
181 Ibid.
level. Fielden’s exercises may benefit the development of coordinated muscular contraction and relaxation of the opposing set of muscles.

Similarly to other authors, he believes that exercises should be practiced with full concentration keeping track of the nervous co-ordination and the sought intention. Fielden (who, like Kochevitsky, correctly places the nervous system as the origin for any muscular action), suggests that muscles must be in good condition in order for the nerves to operate them efficiently. Such good condition implies adequate suppleness rather than abnormal size or strength, thus allowing muscles to respond to nervous messages with equivalent speed and adequate precision.

Fielden is cautious in presenting gymnastics as a methodology that, by itself, could develop technique. Rather, he suggests practicing his sets as a supplementary strategy with the purpose of shortening long periods of technical studies, and at the same time judiciously comprehending the application of physical actions on the keyboard. He believes that “only by knowing his technique physiologically and mentally will [the student] establish the condition of permanence which is the criterion of achievement on any musical instrument.”

Fielden’s precepts regarding the importance of practicing gymnastics with full concentration and of understanding its functioning physiologically, are both fundamental principles behind the current study’s premise. Similarly, the aim of gaining muscular

182 Fielden, 34.
183 Ibid, 11.
184 Ibid, 15.
185 Ibid, 16.
186 Ibid, 44.
suppleness rather than enlargement resonates with the aims of the current study, specifically when treating the flexor-extensor co-contraction of the four fingers (excluding the thumb).

Yoshinori Hosaka, in his doctoral dissertation “Sumiko Mikimoto's Piano Method: A Modern Physiological Approach to Piano Technique in Historical Context,” treats Mikimoto’s work, The Correct Piano Technique (2004). Mikimoto’s approach is based on physiological and neurological studies, considering “anatomical-based awareness of localized muscle structures.” Mikimoto presents a progressive series of exercises to improve piano technique, addressing several technical challenges faced at many different levels of expertise, while preventing tension-related injuries. Her exercises are meant to be practiced away from the piano, at her patented “Finger-Board,” and at the instrument only at a later stage of training.

Hosaka considers Mikimoto’s work as a continuation of the work of Ortmann (in relation to physiological mechanics of piano technique), and that of Kochevitsky (in terms of incorporating neurological aspects of motor skills into pedagogy). He also highlights Mikimoto’s study of possible causes for weakness and tension with the purpose of preventing injuries or aiding to their rehabilitation.

In his dissertation, Hosaka offers a brief history of piano technique specifically tackling aspects as finger technique, arm weight and relaxation, scientific and physical approaches, psychological perspectives, and awareness of physical limitations and

188 Ibid.
189 Ibid.
injuries. Before describing Mikimoto’s exercises, Hosaka refers to the principles of Mikimoto’s perspective of piano technique, which centers on the role of the nervous system, relaxation and minimum contraction, tone production and weight transfer, and location of bones and muscles.

Hosaka also treats some routines to be applied at the “Finger-Board” patented by Mikimoto in 1980, which are designed to stretch tendons and train small muscles of hand and fingers. He then dedicates independent chapters to compare Mikimoto’s approach to other authors, to inform Mikimoto’s observations during her pedagogical career, and to address the role of piano technique in relation to injury prevention and rehabilitation.

Mikimoto believes that the comprehension of the physical structure followed by the isolated exercising of parts of hand and arm are essential steps to obtain coordination in movements, thus increasing kinesthetic sense. She also maintains that despite the fact individuals possess the same anatomical structure of muscles and bones, piano students develop their technique at different pace due to variations in length, strength, and shape of the muscles, tendons, and bones, as well as diverse sensitive responses of the nervous system. In relation to motor skill development in piano playing, Mikimoto proposes three different stages, focused on: 1) awareness of sensitivity and development of kinesthetic sense or coordination in various muscles, 2) speed control of fingers, and 3) tone production requiring muscle strength.

Mikimoto states that finger exercise routines should be applied away from the keyboard, with or without her patented “Finger-Board.” At a later phase, she also

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190 Hosaka, 45-46.

191 Ibid.

192 Ibid, 50.
suggests related exercises applied to actual piano playing. She conceives five stages for the training of finger control: 1) developing a sense of independence of fingers; 2) developing agility and instantaneous power in individual finger movement; 3) developing agility in alternating finger movement; 4) stabilizing the finger joints; and 5) combining finger movements.

Hosaka’s dissertation is valuable in offering a review of Mikimoto’s book, which, due to language limitation, is not available as a primary source. Mikimoto’s practical approach on improving piano technique stands as an updated source which considers anatomical awareness of muscular structures from physiological and neurological perspectives. It also informs Mikimoto’s pedagogical experiences related to excessive finger tension.

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193 Hosaka, 60.

194 Ibid.
CHAPTER THREE
METHODOLOGY

The present study will select finger gymnastic exercises based on a comprehensive review of literature regarding gymnastics for fingers and hands, as a supplemental method of retraining muscular control for more refined and efficient technique among experienced adult pianists. It will also include some original exercises developed by Dr. Naoko Takao and this author along the process of the present research.

The retraining process will focus on solving excessive and continuous contraction of finger-controlling muscles (excepting the thumb), as well as on adapting the thumb for its peculiar usage at the keyboard, which act as the necessary support mechanism for the remaining fingers. Both objectives serve as beneficial factors to combat rigidity and stiffness in piano playing.

The retraining process consists of learning to release habitual constant tension in order to apply muscular contraction voluntarily and at an appropriate timing in correspondence to mental command. The process centered on the thumb may be applied separately, since it implies a new positioning and coordination of a very specific group of muscles, unrelated to the constant tension of flexor and extensor muscles in other fingers. The exercises to be selected will be classified into different stages with specific targeted outcomes, using manageable and concrete physical movements. The exercises will be described using the original authors’ explanations, complemented by the researcher’s commentary. The latter serves as additional clarification of the purpose, goals, and proper usage of each exercise within the specific application parameters of this study, based on a thorough examination of correlating factors as reviewed in the literature review. Each
stage of the exercises will therefore encompass explanations to ensure cognitive understanding of the intended outcomes as well as practical suggestions for the exercise practice, including those related to metacognitive aspects. This will be followed by recommended follow-up notions to gradually return back to healthy repertoire study.
CHAPTER FOUR

EXERCISES

Flexor-extensor coordination

Stagnation and stiffness in piano playing are logically related to an inadequate balance of tension in levers of the *upper apparatus*. Although there exist several areas where this unbalance can be located, when it does locate at the finger’s tensor-extensor level it manifests in specific manners. As Mark explains, regardless of the shape and size of the hand, fingers in quietude follow a natural curve as a product of the absence of tension in both tensor and extensor muscle sets.\(^{195}\) When co-contraction has been acquired, this natural curve transforms into a very pronounced curve or into a straight line, produced by the predominance of tensor or extensors muscles respectively.

Such unnatural but permanent state of tension, besides provoking the described extra curled or straightened positioning of fingers while resting, interferes with and impedes the normal usage of the opposite set of muscles. Such unbalance could be noticed at the instrument through the following signs: 1) height of the bridge is pronouncedly high or extremely low; 2) engagement of finger tips is compromised and difficult; and 3) coordination of immediate releasing and lowering of keys is difficult.

The case of the thumb

In the specific case of the thumb, its usage in piano playing requires particular muscular ways of coordination depending on the repertoire particularities. For example,
in basic five fingers position and related scale patterns, the thumb should create a trajectory parallel to the one the other fingers trace, avoiding its natural function of adduction through flexors’ contraction. Contrary enough to the undesired predominance of flexor or extensor muscles in the other four fingers, in this context the prevalence of thumb’s extensor muscles to keep it abducted at the carpometacarpal (CMC) and metacarpophalangeal (MCP)196 joints may be beneficial or even essential.

In his paper “Educative Approach to the Functions of the Thumb in Piano Playing,” Ozgur Mert explains that flexing the interphalangeal joint of the thumb (keeping the tip flexed or contracted) causes unnecessary tension and blocks the finger vertical trajectory towards the keyboard.197 In the case of the other four fingers, the vertical trajectory towards the keyboard coincide with their natural movement of adduction; consequently the constant flexion at the distal interphalangeal joint (fingertip), does not have the same effect as in the thumb’s action at the keyboard. Mert explains:

“In piano playing the thumb acts in an opposite way muscually to the other fingers. Flexion from the interphalangeal joint stretches the flexor pollicis longus and obstructs the upward movement of the thumb. Stretching the flexor pollicis longus, loosens the flexor pollicis brevis, and causes too much loss of control in the downward movement of the thumb. This reflexive flexion of the interphalangeal joint of the thumb is also the most common and indiscriminable mistake that hinders most of the movements of the thumb in piano playing.”198

Based on the natural functionality of the hand, the act of flexing the four fingers influences simultaneously the flexion of the thumb, thus impeding the vertical stroke of

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196 The carpometacarpal joint (CMC) is located at the wrist level. The metacarpophalangeal (MCP) joint links the fingers to the palm, normally known as knuckles.


198 Ibid, 272.
the thumb on the keyboard and affecting the overall position of the hand at the
instrument. As Mert explains, gaining independence of the thumb from this natural
tendency is beneficial for the development of proper piano technique. For such purpose,
Brancart’s proposition is to stretch the adductor pollicis muscle as the default muscular
positioning, helped by the enhancement of the extensor pollicis longus. Such process
would ease the avoidance of the natural tendency of flexing the thumb at the CMC and
MCP, and the stretching of the adductor pollicis muscle, while also help to strengthen the
support of the hand known as bridge. Such repositioning of this specific muscle would aid
in maintaining this finger more open and relaxed, while synchronizing several related
muscles.

Exercises

The retraining process of the present work is divided into different phases with
specific targeted outcomes, focusing on: 1) releasing relentless muscular tension in
fingers, 2) controlling and regulating muscle contraction, 3) finding muscular
coordination and balance and 4) thumb’s muscular coordination and repositioning. The
order of the sections responds to a logical training progression, with the exception of
some of the exercises of the fourth section which can be applied simultaneously with any
of the others.

The exercises were selected from the following works for the specific purpose of
the current study: David Kempff’s “Automatic Finger Control,” Tobias Matthay’s
“Relaxation Studies,” and Paolo Steinberg Griakis’s doctoral Essay about Evelyne

\[^{199}\text{Grikis, 18.}\]
Brancart’s method “The Pianist’s Support: the Development of the Palm of the Hand and its Relation to Fingers, Wrist, and Arm.” It also includes some exercises created by Dr. Naoko Takao and this author, consolidated after a few experimental sessions on the topic along the process of writing this essay.

The exercises are presented in a logical progression, if not otherwise stated in the “Suggestions” for their practice. As mentioned before, the training of the thumb has an independent treatment in Section IV, thus its employment along the other three sections will be reduced to its minimum. If any exercise that includes the use of the thumb prove challenging, first mastering those exercises described in Section IV is recommended.
Section I: Releasing Relentless Muscular Tension in Fingers

Exercise 1

Kempff: n.1

Figure 4.3: Kempff’s exercise n.1

Description:

“Hold your right hand before you, double up your fist tightly, thumb on the outside of the fingers. The hand turned with the palm side facing you. Open the hand briskly and with considerable effort, letting it turn around, so that the back of the hand is now turned toward you. Be sure to get this point and turn the hand around as you open the fingers. As you open the hand, be sure to keep the fingers stiff and bend them back from the wrist as far as possible. Repeat this exercise twenty times.”

Purpose and goal:

- To learn to simultaneously and briskly release extensors and engage tensors combined with pronation of the forearm.

Suggestions: Complete the exercise avoiding the flexion of the thumb, keeping it aside from the palm at all times. This would prevent the natural tendency of this finger’s flexion to engage in reaction to other fingers’ flexion.

The manner Kempff describes the exercise for fingers and hand is most often in closed position, the palm facing the body. This process focuses predominantly in

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200 Kempff, 31.

201 Ibid.
activating flexors, and briskly and momentarily tensing the extensors, with help of the rotation of the forearm (pronation).\textsuperscript{202} In order to employ these muscular sets inversely, the process could be reversed: starting in the open position of the hand, back of the palm facing the body, briskly turn the hand around until the fist is momentarily tightly closed, while supinating the forearm. This should be easier, for most, than Kempff’s original form.

**Commentary:** Practicing this exercise in its original form and in its variant as proposed would train the sudden and precise deactivation of one muscular set while its opposite is active (extensors and flexors respectively). It is important to note that the angle of the wrist does not inadvertently change along the process. If such change is happening, it may be helpful to do the exercise a little slower and less forcibly at first.

**Exercise 2**

Kempff: n. 7

![Figure 4.4: Kempff’s exercise n.7\textsuperscript{203}](image)

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\textsuperscript{202} In anatomically neutral position (arms straight, palms facing forward) pronation implies the rotation of the forearm toward the body (palm ends facing the body); supination implies its rotation away from the body (palm ends facing forward).

\textsuperscript{203} Kempff, 36.
Description:

“Bring the fingertips of the right hand together with the tip of the thumb, spreading the fingers at the middle knuckle and rounding the whole back of the hand. From this position snap the whole hand out flat, with the fingers spread wide apart. Do this forcibly. Quickly return to the original position and repeat the exercise twelve times.”

Purpose and goal:

- To engage the extensor muscles from a flexed position; simultaneously stretching (abducting action) the *interossei* muscles sets, without rotation of the forearm (pronation/supination).

Suggestions: For the purpose of the study, maintain the thumb on the side of the palm. Practice the exercise as described but also inversely: starting with the fingers spread out, forcibly bending them, and quickly returning to the original spread position.

Commentary: the original version of the exercise trains the effortful engagement of extensors (“forcibly spreading out of fingers”) from a starting position with flexed fingers. The author’s modification of the exercise focuses inversely in the active flexion of fingers starting in an extended position. If the modified version feels helpful, practicing both versions of the exercise would benefit the balanced use of both muscular sets. The first two exercises of the study are very similar; they differ in the use of forearm rotation in coordination with finger action (Exercise n.1).

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204 Kempff, 36.
Exercise 3
Mattahy: Set I; Balancing or Freeing Exercises, Form b (for finger-freedom)

![Figure 4.1: Matthay’s Balancing or Freeing Exercises, Form B](image)

Figure 4.1: Matthay’s Balancing or Freeing Exercises, Form B

**Description:** Place the hand lying loosely upon a table or other flat surface. Gently and continuously roll and unroll the fingers upon themselves. The weight of the hand must remain constantly in the same lightness, and the fingertips must remain on the same spot at all times. The height of the arm must remain invariable.

**Purpose and goal:** (As explained by Matthay)
- To acquire and retain freedom during the required exertions of the finger, by eliminating all contrary exertions form the required exertions.
- To teach and remind us how to use the down-exertions (flexors) of the finger unimpeded by any exertion of the corresponding up-muscles (extensors).

(As understood by the author)
- To engage the flexor (especially short flexors and lumbricals) and extensor muscles in passive motion while retaining the fingertip pressure (continuous engagement of long/deep flexors).

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Matthay, 5.
Suggestions: Matthay talks about practicing the exercise in continuous movement. I would suggest staying a while in the “rolled” position. This pause from the rolling-unrolling continuous movement could increase gradually from 3 to 10 seconds, and it will assure that unnecessary muscular tension of flexors and extensors disappears.

Although Matthay also suggests that this exercise could be practiced at the piano, in order to avoid automatic remembrance of old habits as he warns against in the Introduction of his book, it would be advisable to practice it away from the instrument for retraining purposes.

Commentary: Matthay pursues to achieve “freedom during the required exertions by eliminating all contrary exertions.” This implies gaining muscular control, in terms of releasing the tension of the muscular set that is not required for a determined action. In the specific case of this study, this means to learn not to tense the extensors at the moment of depressing the key; and simultaneously, to do tense them at the moment of releasing the key. The use of flexors must happen inversely.

The exercise targets the flexor (most likely short flexors and lumbricals) and extensor muscles to balance in passive motion while retaining the fingertip pressure, with the latter implying continuously engaging the deep flexors at different angles. Such balance of finger muscles (in the arm and in the hand) is also combined with the proper engagement of other supportive muscles (again, in the arm and in the hand) to counteract their resistance against the table. Keeping the pressure and retaining arm’s height supply a constant reference point for the muscles to be exercised.

The continuous rolling-unrolling of the fingers assures the attainment of the simultaneous tension-release coordination of both opposite finger muscle sets. The suggested pause at the “rolled” position reinforces the inaction of the flexors and
extensors at the relatively outer edge of the range of motion, thus contributing to cancel
the habit of constant tension by helping to learn to relax them. Matthay labels as “Act of
Resting” to the absence of fingers’ muscular exertions, and maintains that only under
such state muscular forces can be applied with accuracy in relationship to any utmost
musical expression and intention.

**Exercise 4**

Matthay: Set I; Balancing or Freeing Exercises, Form A (for wrist freedom)

![Figure 4.2: Matthay’s Balancing or Freeing Exercises, Form A](image)

**Description:** Place the hand lying loosely upon a table or other flat surface,
supported by all five fingers. Slowly, gently and continuously, sway the hand up-and-
down at the wrist joint. The weight of the hand must remain constantly in the same
lightness, and the fingertips must remain on the same spot at all times.

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206 Matthay, 4.
**Purpose and goal:** (As explained by Matthay)

- To acquire and retain freedom during the required exertions of the hand, by eliminating all contrary exertions form the required exertions.

- To teach and remind us how to use the down-exertions of the hand unimpeded by any exertion of the corresponding up-muscles.

(As understood by the author)

- To coordinate and balance flexor (*short flexors* and *lumbricals*) and extensor muscles while retaining the fingertip pressure (continuous engagement of *long/deep flexors*); in coordination with the forearm, upper arm, and shoulder.

**Suggestions:** Matthay does not specify if the “Balancing or Freeing Exercises” should be practiced in the order presented in his book, although this may be implied by their appearance. In reality, both exercises (Exercises 1 and 2) supplement each other and could follow any sequence. Depending on the individual, they may respectively help to develop different unfamiliar manners of coordination.

At an early stage, it would be advisable to only exercise the more difficult one for each person (coincidentally, the one which is more helpful for that specific case), in order to focus and improve a specific balance and coordination at first. The exercises are presented here in the inverse order as Matthay does, solely for the sake of logical explanation of the muscular coordination involved from the author’s perspective for the study.

This exercise could also be practiced fragmenting the constant up-down movement of the hand into several pauses of 3-10 seconds each, with the purpose of reaffirming the balance and coordination at definite angles and positions. Such fragmentation would be relative to each individual, but generally could include 3 pauses
within the main up-down motion. Every aspect of Matthay’s description of the exercise must be met in order to fulfill its objective, the weight of the hand must remain constantly at the same lightness, and the fingertips must remain on the same spot at all times.

**Commentary:** This “Freeing Exercise Form A” by Matthay focuses on balancing and coordinating the same set of muscles as “Exercise Form B” within the types of motions required for playing the piano. In this case, the position of the fingertip will be a constant variable since the wrist is now allowed to move up and down, considering the coordination of the palm, forearm, and upper arm, in conjunction. This would require learning to adjust the engagement of the *deep flexors* (fingertip) while continuously adapting the other muscles at different positions: in other words, acquiring a relative relaxation and coordination of the muscles involved, while adjusting and coordinating them as the angles change. The constant swaying of the hand up and down at the wrist level, would allow for finding a relative tension-relaxation of the involved muscles alongside the different positions created.

Similarly to seeing each scene of a movie separately, each set of coordinating muscles at each position in the continuum along the range of motion need to be mastered separately, until the gradual change in the angles can be achieved continuously. For this reason, converting the constant motion into a “momentary paused” positioning progression (3-10 seconds for each phase) may be a helpful tool at the earlier stages of practice. The brisk motions embraced by Kempff in the first two exercises of this study contrast to Matthay’s suggestion for gradual movement; the latter may be more difficult to achieve for some and require more mental power and concentration.
Section II: Controlling and Regulating Muscle Contraction

Exercise 5

Kempff: n. 3

Figure 4.5: Kempff’s exercise n.3

Description:

“Open the left hand out flat with the fingers loosely apart. Grasp the little finger with the thumb and fingers of the right hand. Very gently bend it backward, as far as it will go without straining. You must be careful not to overdo this at first. Now bend it forward to the palm; back again and to the right and left.

Do this six times, allowing the little finger to move freely. (…) Now repeat the exercise, only instead of allowing the little finger to move freely, try to hold it rigid and immovable. Go through this entire process with each of the other fingers and the thumb of the left hand. Then take up the exercise with each of the fingers of the right hand, moving them with your left.”

Purpose and goal:

- To learn to change a state of tension to relaxation, in each finger individually.

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207 Kempff, 33.

208 Ibid.
**Suggestions:** Kempff asks for moving the fingers freely 6 times, and against will 14 times. I would suggest repeating the moving freely phase of the exercise for each finger, after having completed the portion against resistance.

**Commentary:** In this exercise three different processes take place: 1) moving the fingers in a passive state ("moving freely" phase, that of concentric or eccentric nature), 2) moving the fingers with muscular engagement against resistance ("moving against will" phase, that of isometric nature, and 3) distinguishing the different sensations of relaxed and tensed muscular states. The inclusion of the second passive phase (no. 3 above) would enforce the absence of tension, benefitting the control of acquired co-contraction; Kempff did not intend to regulate constant tension per se nor to retrain specific psychomotor habits or conditions.

**Exercise 6 (a)**

Kempff: n.18

Figure 4.6: Kempff’s exercise n.18 209

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209 Kempff, 47.
Description:

“Hold the right hand before you, the fingers relaxed, and slightly curved, palm facing you. Grasp the second, third and little fingers gently with your left hand, and bend the forefinger down to the palm from the second joint. Use considerable pressure each time you bring the finger down to the palm and repeat the exercise eight times, allowing the finger to become fully relaxed between each motion. Repeat this exercise for the middle finger ten times. For the ring finger, do this exercise twelve times. For the little finger, do this exercise ten times. Proceed with the same series of exercises for the left hand.”

Purpose and goal:

- To learn to control the tension and relaxation of the flexor digitorum superficialis muscle (proximal interphalangeal joint) in each finger independently.

Suggestions: independence of fingers and their muscular action is strongly dependent of level of concentration. Exercising the fourth finger is especially hard but can improve after constant practice.

Each finger will comfortably reach certain strengthen position. This aiming position could increase progressively with constant practice.

Commentary: Besides the fact Kempff numbers this exercise as no. 18, it could be actually considered as a preparation for no. 16. Thus, it consists in a previous stage of the same muscular action, because it uses extra help form the other hand to prevent the passive three fingers from moving.

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210 Kempff, 47.
Exercise 6 (b)

Kempff, exercise 16

Figure 4.7: Kempff’s exercise n.16\textsuperscript{211}

Description:

“Extend the left hand and close the fingers down to the palm, keeping the knuckle joints straight and bending only the two outer joints. Holding the other fingers motionless, straighten out the index finger. You must be careful throughout the entire exercise, never to move the knuckle joint. Repeat five times without muscular resistance, then go through the exercise with the muscles tense, so that one set resists the motion of the other.”

Purpose and goal:

- To learn to control the tension and relaxation of the flexor digitorum superficialis muscle (proximal interphalangeal joint) in each finger independently, and separately from the lumbricals (which would move the knuckle joint).

Suggestions: same suggestions as “Exercise 6 (a).”

Commentary: this exercise removes any help from the other hand as used in “Exercise 18,” which makes it harder to complete. It would prove especially difficult for

\textsuperscript{211} Kempff, 46.
the ring finger; its final position would be much less straightened out than the other fingers.

Exercise 6 (c)

Kempff: n.19

![Figure 4.8: Kempff's exercise n.19](image)

Description:

“Hold your left hand before you, the fingers bent down to the palm, and reaching as far toward the wrist as possible. Extend the first finger. Open gradually so as not to move the others. Do this five times without muscular resistance and five times with. Go through the same exercise with each of the other fingers.” 213 (Resistance implies performing the exercise with the muscles tense, so one set of muscles resists the motion of the other).

Purpose and goal:

- To learn to control the tension and relaxation of the *lumbrical* muscles in each finger independently.

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212 Kempff, 48.

213 Ibid.
- To actively engage extensor muscles of a specific finger, simultaneously but independently from other fingers.
- To stretch the muscles around the MCP joint (knuckle) of each finger separately.

Suggestions: the process of opening each finger must starts at the lumbrical level; the degree in which each finger extends will be variable depending on their respective physiology. The exercise would be difficult for the ring finger, thus an extra help could be used, especially at the beginning of its practice. While exercising this finger, maintain the fifth finger very flexed, almost pressing it slightly with its nail against the flesh of the palm.

Commentary: This exercise is similar to “Exercise 6 (b), but focuses the movement from the knuckle joint.

Exercise 7

Kempff: n. 23

Figure 4.9: Kempff’s exercise n.23\textsuperscript{214}

\textsuperscript{214} Kempff, 52.
Description:

“Extend the fingers of the left hand, with the little finger away from you and the thumb opened and pointing away from the palm, that is toward your right. Bring the index finger down until it is at right angles to the palm, bending only at the knuckle joint. Let the knuckle joint straighten up again and at the same time bend the other two joints of the finger, so that the fingertip goes down to the palm of your hand. Repeat this exercise five times without resistance, and then five times with resistance.”^{215} Do this with every finger (excepting the thumb) of both hands.

Purpose and goal:

- To learn to engage the *lumbrical* flexor in each finger independently.

- To actively engage flexor muscles of a specific finger, simultaneously but independently from other fingers.

Suggestions: This exercise is certainly complicated, since it implies several aspects of muscular coordination. It would be advisable to practice it with help of the other hand, during the first days of practice. The other hand could hold the fingers not being exercised, as well as guide the fingers’ movement, especially for the fifth finger.

Commentary: This exercise consists on the progressive engagement of finger flexors, starting at the proximal phalange and finishing at the fingertip level (distal phalange). It is an advanced routine of muscular coordination, thus its practice could be delayed for several days if necessary.

^{215} Kempff, 52.
Exercise 8
Kempff: n. 21

Figure 4.10: Kempff’s exercise n.21

Description:
“Place the hand on a flat surface with the fingers curved so that just the tips and the base of the palm touch the table. Raise and lower the fingers one after the other slowly and with muscular resistance. Bring the fingers down with considerable pressure each time. Repeat twenty times with each hand. With the fingers in the same position raise the thumb as high as possible, and bring it down sharply to the table. Repeat twenty times with each thumb.”

Purpose and goal:
- To coordinate muscular tension and relaxation in each finger while maintaining a stable resting position of fingers and hand.
- To coordinate muscular tension and relaxation of fingers in succession while maintaining a stable resting position of fingers and hand.

Suggestions: avoid the practice of the thumb as suggested by Kempff and only exercise the rest of the fingers. The practice of the thumb could be added at a later stage if

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216 Kempff, 51.

217 Ibid.
desired. Before raising and lowering slowly one finger after the other, raise and lower each finger twenty times, engaging the fingertip of all fingers at all times.

**Commentary:** this exercise implies the application of several muscular exertions practiced in the previous exercises, so it should be practiced only after all others have been mastered. It includes: a) the engagement of fingertips, b) the stabilization of a “resting position” for fingers and hand, c) the coordinated tension and relaxation of *lumbrical* flexors and extensors, among others. Keeping the thumb aside and extended reinforces its independence from the action of flexion of the other fingers.
Section III: Finding Muscular Coordination and Balance

Exercise 9 (a)

Takao: n. 1

Figure 4.11: Takao’s exercise n.1

Description:

Phase 1: engage the fingertips grabbing the square edge of a table, without engaging any other muscles, especially not the lumbrical muscles (those which flex the fingers from the metacarpo-phalangeal joint (MCP)).\textsuperscript{218} The picture shown has all fingertips engaged, but each individual finger could be exercised in a similar fashion, as needed.

Phase 2: translate the acquired muscular coordination and hand position over to a flat surface. It is important to feel the slight friction at the fingertip against the table surface as it tries to “grab,” but without letting it overcome the friction and curling. This process could be done with all fingers at once, with only one finger at a time, or in various combinations of fingers.

\textsuperscript{218} The metacarpophalangeal (MCP) joint links the fingers to the palm, normally known as knuckles.
**Purpose and goal:**

- To learn to engage the fingertips while the rest of flexor and extensor muscles of the fingers are inactive.

**Suggestions:** The engagement of the tip must be constant while the rest of the muscles are released. While practicing “Phase 1” of this exercise, fingers should lie on the square edge of the table, with the fingertips actively grasping its edge as trying to pull it towards the body. It would be advisable to pass onto “Phase 2” of the exercise once the coordination of previous phase feels stable and conquered. Time needed in achieving this state may be uncertain in duration, depending on the level of concentration and capacity of adaptation of the individual. It should also be noted that the level of engagement should lesson with degree of mastery: start with full engagement and shift towards slight engagement.

**Commentary:** Learning how to release certain muscles that are not necessary at a definite time could be reinforced by engaging other muscles that were not used to work or were overshadowed by the excessive engagement of the ones targeted for release. In other words, making certain neuronal connections stronger may concomitantly weaken others previously acquired and automatized.\(^{219}\)

On the same topic, Kochevitsky states that learning to control specific muscles needed for fulfilling a complex action could be achieved by reinforcing and repeating a definite stimulus, combined with the avoidance of reinforcement of other stimuli. This practice would allow the organism to differentiate the more specialized stimulus (those

\(^{219}\) L. Sian Beilock et al.
reinforced) and to respond only to them.\textsuperscript{220} Excitation (discharge of impulses) and inhibition (suppression of excitation) are fundamental processes or nervous activity, and are mutually connected processes of reciprocal induction; one process induces the opposite.\textsuperscript{221}

Both processes happen in a definite area of the cortex, which, with practice, could become narrower, stronger, and thus more concentrated and specialized. This specialization of neural connections would allow the individual to eliminate unnecessary muscle contractions and perform freer movements. Additionally, the concentration of excitation and inhibition in a definite area would simultaneously hinder other weaker processes happening in its surroundings.\textsuperscript{222}

\textbf{Exercise 9 (b)}

Takao: n. 2

Figure 4.12: Takao’s exercise n.2

\textsuperscript{220} Kochevitsky, 26.

\textsuperscript{221} Ibid.

\textsuperscript{222} Ibid, 27.
**Description:** proceed similarly to “Phase 1” of Exercise 9 (a), engaging this time the other two phalangeal areas of the fingers (intermediate and proximal).

**Purpose and goal:**
- To learn to engage the *proximal interphalangeal* and *metacarpo-phalangeal* joints of the fingers (intermediate and proximal phalanges respectively).

**Exercise 10**

Takao: n. 3

![Figure 4.13: Takao’s exercise n.3](image)

**Description:** place hands against each other, fingers meeting at the fingertips and at the base of thumbs for proprioceptive reference. To avoid an excessively extended position of the wrist, it is advisable to place forearms in front of the body so that the elbows are touching or nearly touching each other. While engaging and pressing fingertips to each other straighten and bend fingers slowly. When finding a new position, make sure both hands imitate exactly of each other. Start the process with independent fingers, then in pairs and so on, as well as in various combinations of fingers, including the thumb.
**Purpose and goal:**
- To learn to mirror muscular engagement, positioning, and balance between both hands while visually monitoring.

**Suggestions:** The practice of individual fingers (middle against middle, etc.) is especially recommendable for those fingers with focalized constant tension in one hand. The mirroring should also be to the fingers not being pressed (exercised).

**Commentary:** when erroneous muscular habits are focalized in only hand, imitating the other hand’s correct coordination could positively influence to acquire novel muscular settings.²²³ Thus, the assumption here is that one hand is in better condition than the other, factoring in handedness as well as acquired maladaptive muscular coordination.

**Exercise 11**

Kempff: n. 24

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²²³ This is based on the same principle behind why contrary-motion 5-finger exercises should proceed before parallel-motion 5-finger exercises.

²²⁴ Kempff, 54.
Description:
“Lay the right hand flat on a table or other hard plane surface, fingers and thumb far out-spread. Press firmly with the whole hand on the table. Continuing this downward pressure, exert an upward pressure against it with the finger tips, and raise the body of the hand about 1½ inches from the table top. Throughout this entire exercise try to keep the back of the hand parallel with the table. After you have reached the desired height, press the hand down to the table top again against muscular resistance. Repeat this exercise ten times.” 225

Purpose and goal:
- To exercise the formation of the bridge: engaging the supporting muscles inside the hand (intrinsic muscles) including the four supporting the thumb, in coordination with flexor, extensor, and interossei muscle sets.
- To reinforce the correct balance and coordination of the intrinsic muscles in relation to extrinsic muscles. 226

Suggestions: this exercise requires higher levels of muscular control and coordination, so it should be practiced after mastering previous routines as well as the thumb exercises (separately covered below) if needed.

Commentary: this exercise focuses on forming a standing position of the hand over a flat surface (ultimately the keyboard), using the active exertion of fingers’ flexors, in coordination with the engagement of all the muscles inside the hand. Such engagement reinforces the development of the hand’s bridge, and emphasizes its coordination with fingertips’ flexion, control of fingers’ extensors, relative engagement of the four intrinsic muscles controlling the thumb, and the use of interossei muscles.

225 Kempff, 54.

226 Intrinsic muscles of the hand are those originated and present in hand (inside the structure); extrinsic muscles locate in the forearm (outside the structure) and insert into the hand through tendons. Both are responsible for hand movements.
Section IV: Thumb’s Muscular Coordination and Repositioning

Exercise 12 (a)

Brancart-Grikis: 1c) thumb muscle

Figure 4.15: Brancart-Grikis’ exercise 1c) \(^{227}\)

Figure 4.16: Author’s version of Brancart’s exercise. Grikis’ version lacks the use of thumb and index holding thumb’s tip.

Description:

“With fingers 3 and 4 of your left hand, feel the muscle in the palm of your right hand (the muscle is located between the bottom of the "hill" of your

\(^{227}\) Grikis, 21.
palm and the middle finger). Massage this inner side of your right palm. While still having left fingers 3 and 4 under your right palm, use fingers 1 and 2 of your left hand to hold the last articulation of your thumb, then bring your right thumb knuckle "out." Check how the thumb changes its position slightly (the thumb moves slightly back, towards your body). This "lift" (an action of a thumb extensor on the inside of the forearm below the wrist) eventually should be done without the help from your other hand.228

**Purpose and goal:** (as stated by Grikis)

- To stretch the *adductor pollicis* and work the *extensor pollicis longus*.

**Suggestions:** while practicing this exercise keep the rest of the fingers relaxed.

The help of fingers 1 and 2 of the other hand will be necessary at all times, especially during the beginning days of practice. Make sure to really achieve 1) putting the thumb knuckle “out,” and 2) moving the whole thumb slightly back towards the body.

**Exercise 12 (b)**

Brancart: thumb action by itself/self-repositioning

**Description:** follow the same description of “Exercise 12 (a),” and after 5 seconds of employing the left hand to achieve the aimed position, release its help maintaining the position achieved with the right hand alone. Maintain this position five seconds and relax afterwards. Repeat ten times.

**Purpose and goal:**

- To train to maintain the thumb stretched and abducted by itself.

**Suggestions:** after several days of practice, achieve the positioning of the thumb (knuckle “out” and finger slightly back towards the body) without any help from the other hand.

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228 Grikis, 20.
Both exercises “12 (a) and (b)” can be practiced simultaneously with the previous three sections of gymnastics.

**Commentary:** this variant of “Exercise 12 (a)” is only suggested by Grikis but not explicitly stated as an actual routine. Rather, it was taught directly to the author by Prof. Brancart.

**Exercise 13**

Kempff: n.13

![Hand drawing](image.png)

Figure 4.17: Kempff’s exercise n.13

**Description:**

“Hold the right hand edgewise before you, the thumb towards the chest. Have the fingers closed tightly together and bring the thumb firmly against the first finger. With a sharp, quick action, open the thumb away from the finger, so that it points over your shoulder; at the same time bending the entire hand sideways at the wrist, bringing the thumb still nearer the shoulder. The movement must be quite snappy to get the desired effect. Repeat twelve times.”

229 Kempff, 43.

230 Ibid.
**Purpose and goal:**
- To train to stretch the extended thumb away from the palm, while the rest of the fingers perform a flexion motion.

**Suggestions:** practice the exercise as recommended by Kempff. At a later stage, also start from positioning the thumb separated from the index; thus the ending position will be even more separated, going from open to more open.

**Commentary:** this exercise is very useful for the independence of the extended thumb in relation to the rest of fingers flexion. The practice suggested by Kempff starts with an engagement (adducted position) that first needs to be released and coordinated with the engagement of the opposite muscle (abduction action).

**Exercise 14**

Encalada: n.1

![Figure 4.18: Encalada’s exercise n.1](image)

**Description:** This exercise is based on Kempff’s exercise n.24. It starts with the hand flat on a table, fingers and thumb far out-spread. Without pressure of any kind, flex
the four fingers making the palm arise. The thumb must remain at the same spot maintaining the same distance in relation with the index finger at all times. Stay in the risen position for 3-10 seconds (progressively increasing the length) in a relaxed but firm position with fingertips engaged.

**Purpose and goal:**
- To reinforce the flexion of the fingers in a stabilized resting position, while keeping the thumb extended and independent from the rest of the hand.

**Commentary:** this exercise will 1) emphasize the resting position at the keyboard mentioned by Matthay, 2) reinforce the bridge and strengthen the stretching of the thumb, and 3) practice the simultaneous flexion of the other fingers while keeping the thumb extended.

**Exercise 15**

Takao: n. 4

**Figure 4.19: Takao’s exercise n.4**

**Description:**

Phase 1: engage the tip of the thumb, grabbing a square object or against a resistance provided by a fingertip of the other hand, without engaging any other muscle (intrinsic or extrinsic) controlling the fingers.
Phase 2: Apply the acquired muscular coordination position over a flat surface.

**Purpose and goal:**
- To learn to engage the thumb’s fingertip in support of the hand position and the action of the other fingers.

**Suggestions:** When applying the muscular coordination of the thumb in “Phase 2,” the thumb must be felt as standing on a definite and specific point of the finger, rather than resting on an ample lateral side of the finger. Visualizing a specific point could be helpful for this purpose, as well as for maintaining activeness and engagement of the tip. The grabbing sensation should be slight, just enough to sense the friction with the flat surface.

**Commentary:** This exercise is important for improving the hand position and fortifying the bridge as it engages the extrinsic muscles which are stronger than their intrinsic counterpart in supporting weight, and also to prevent using the thumb as an inert limb. The engagement of thumb’s fingertip also benefits the action of other fingers, especially the engagement of their respective tips.
Refining Acquired Sensorimotor Skills

Understanding the transformation process of habitual factors in automatized motor skills would offer an important and complemental perspective to the practical application of this compilation of gymnastics. The functioning of sensorimotor high-level skills is neurologically dependent and certainly complex. Skills, such as piano playing, are characterized by necessary reliance on proceduralized and automated knowledge, acquired only after frequent and deliberate practice over an extended period of time.

In early stages of skill practice, one-by-one and step-by-step attention is essential for integrating control structures held in working memory, as well as for supporting skill performance. Consequently, automating the skill decreases attention to specific task components while developing procedural knowledge, implying that the awareness of separate task components dissipate. After task components are procedurally encoded, skill-focused attention, which was necessary at earlier stages of learning, could even be harmful for skill performance.

Conversely, using skill-focused attention may be beneficial to explicitly alter unproductive or maladaptive specific components of performance, aiding to refine control strategies. Although this process implies fragmenting an automated skill into its diverse

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231 L. Sian Beilock et al., 6

232 Ibid, 7.
components, and initially affecting its real-time performance, this would benefit in re-adapting and re-proceduralizing new sets of executional habits in the long term.\textsuperscript{233}

Consequently, when using sets of gymnastics with the purpose of re-setting specific physiological and psychomotor aspects related to piano playing, probabilities exist that performing the instrument as a whole could be affected at some level. Also, since the refinement sought relates only to specific components of this skill in a non-musical and neutral context, applying very detailed step-by-step attention along the process will be essential.

Another important consideration when refining sensorimotor skills is to identify and avoid environmental circumstances that could stimulate undesired habitual settings. In this perspective, Matthay states that “the mere sight of a keyboard is often found sufficient, irresistibly to summon up the acquired but totally wrong muscular-conditions.”\textsuperscript{234} Therefore, the author suggests practicing the exercises selected away from the keyboard for an initial period; after acquiring novel physiological and psychomotor settings, they could be applied progressively at the instrument. Patience required for this process is certainly much more than what one is likely accustomed to, even among and especially for the most disciplined individuals with a long history of training at the instrument.

\textsuperscript{233} L. Sian Beilock et al., 15.

\textsuperscript{234} Matthay, iv.
Bidirectional links between decision making, perception and motor action

As already stated, the refinement sought through gymnastics relates to specific physiological and muscular aspects in a non-musical and neutral context. Consequently, the application of renovated settings in a musical context would be highly dependent on a dynamic process between decision making, perception, and motor action.

Feedback among decision making, perception, and action embeds a complete description of human behavior, and has been mostly studied in sportive situations. Such links are characterized by being: 1) bidirectional: reciprocal nature of their interactions; 2) nonconsecutive: can follow any direction of interaction; 3) dynamic: how they develop over time; and 4) strongly constrained by characteristics of the person, task, and environment.

The bidirectional nature of these links implies that collecting information from the environment is an active process in which both action and perception are equally important to each other. Consequently, while interacting with the environment, “action implementation brings about relevant perceptions,” and “perceptual information can directly guide actions.” In the case of piano playing, this implies that audio and visual perception in evaluating performance outcome as well as, perhaps more importantly, in imagining and planning for the intended motion to match the musical context would be

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236 Ibid, 87.

237 Ibid, 89.

238 Ibid.
influenced by and determinant to the implementation of restored physical and muscular action at the keyboard.

Decision making, perception, and action are dependent processes, but not in a determined consecutive way.\(^{239}\) Thus, a decision-making process often defines an action, but the link between decision and action could be interrupted by new perceptions; likewise, this process could also be suddenly terminated after perceiving new action possibilities.\(^{240}\) In short, contrary to still-pervasive belief that mind controls the body in a unidirectional manner, feedback from action and perception is equally important in informing and modifying future mental processes. This notion will be essential for the immediate assessment and application of physical movement within a musical context.

Information resultant from the interplay of these processes could allow the individual to calibrate the link between perception and action, benefitting performative decisions-making in a short-term scale.\(^{241}\) Over a long-term span, and after continual and constant practice, specific links are strengthened allowing learning, enhancing performance through changes in cortical organization.\(^{242}\) The short-term dimension allows the immediate feedback and adjustment during a determined practice session\(^{243}\) at the piano, while the long-term scope endorses selected processes as permanent and habitual.

\(^{239}\) De Oliveira et al., 89.

\(^{240}\) Ibid.

\(^{241}\) Ibid.

\(^{242}\) Ibid.

\(^{243}\) Equivalent to “deliberate practice session”; a highly systematized and concentrated form of practice appropriate for modification of skills as discussed here as found among “experts,” conceptualized and researched in detail by Anders Ericsson.
The influence of constraints in the interaction among decision making, perception, and action is decisive and superlative: “person’s goal, physiologic state, and emotions all influence the way he/she sees and interacts with the world.”\textsuperscript{244} Constraints’ role is relevant since they can influence each one of the processes as well as the links between them.\textsuperscript{245} They can be: 1) organismic: referring to the person’s characteristics (relatively stable as the properties of musculoskeletal system), or transient (as anxiety); 2) task related: referring to the task’s goal, rules, and equipment if needed; and 3) environmental: referring to factors external to the person and not specific to the task (temperature, presence of public, instrument characteristics).\textsuperscript{246}

The nature and characteristics of the interaction of decision making, perception, and action will be fundamental at the moment of including new muscular coordination and conditioning in actual piano repertoire. Their reciprocal dimension, nonconsecutive interaction, and dynamic development over time are all determinant scopes for refining a high-level skill as piano playing. Their dependency on task, environmental, and individuals’ constraints would also be highly influential for avoiding recurrence of previous habitual settings while invigorating those innovated.

\textsuperscript{244} De Oliveira et al., 89.
\textsuperscript{245} Ibid.
\textsuperscript{246} Ibid, 90.
CHAPTER VI
CONCLUSIONS AND RECOMMENDATIONS

The process of retraining physiological and psychomotor aspects related to the art of piano playing could become necessary, whether distinctly or indistinctly at any point of the performing career. Regardless of passion and dedication, musical talent, and commitment for practice, erroneous habits and derived inconvenient technical settings are always a plausible risk.

The present research has intended to find support in the medical and biomechanical fields with the purpose of comprehending and delineating reasoned and practical manners to overcome specific inadequate conditions of the hand and fingers. The central proposition has been to suggest the constant practice of routines and actions known as finger and hand gymnastics, based on scientifically informed principles of human physiology and kinesiology.

The specific motor aspects here treated (excessive and/or permanent stress of fingers at the flexor/extensor muscles, and the under development of thumb’s functionality, and its coordination), stand as common reasons for impeding free and fluent movements at the keyboard, although they do not represent the only causes for stiffness and stagnation. Other possible aspects related to this tendency that may need specific training could be associated with the muscular control of longer muscles through the *lumbricals*, and the relative capability of angling the hand and fingers at various degrees besides the neutral position, which would involve other muscles like the sets of *interossei*.

Excessive or permanent tension at the flexor/extensor level of fingers causing co-contraction or active muscular opposition stands as an obstacle for moving fingers fast.
and freely, at the same time as inhibiting the proper use of fingers’ deep flexor muscles, which control the adequate use of fingertips and allowing for strength. Such conditioning could also tighten the wrist and even provoke injuries due to extra stress on tendons. 247

Due to its morphological differences with other fingers, the thumb has determined motion capacities and specific manners to achieve muscular coordination at the keyboard. The predominance of an abducted positioning of the thumb sought in some of the exercises does not necessarily imply that no other positioning or action would be eventually applied under specific requirements of repertoire. Nevertheless, it would be highly beneficial in most frequent technical demands, as well as crucial in building a stronger “bridge,” offering muscular support for fingers action. More abducted positioning of thumb as described above does not deny either the engagement of its finger tip at the keyboard. Rather, the coordination of both actions constitutes an ultimate goal for many mechanical necessities, like passages based on individual finger activity.

The exercises and routines here proposed are intended to directly tackle these specific physiological aspects, yet they could be combined with other gymnastics focusing on bigger limbs and structures. 248 Therefore, the intended retraining process possibly will be influenced by the physical condition of the rest of the upper apparatus. If the case is given that muscular rehabilitation is needed somewhere else, the present research could serve as a pattern to find informed conceptual and practical means to their respective treatment.

247 Mark, 108.

248 In fact, the commonly accepted recommendation among any work that deals with a systematic physical training is to start work on large, supportive muscular sets before working on smaller (such as hands and fingers).
Based on the extensive literature reviewed, it could be inferred that a retraining process of this type is uncertain in duration (could last several weeks or months), depending on many factors and variables related to the individual’s health, muscular, and physiological conditions, habitual characteristics, among others. However, medical, scientific, and pedagogical findings here treated agree that: 1) acquiring new settings of physiology and coordination is possible over time; 2) practicing gymnastics and similar exercises must be constant and frequent, following specific schedules during the day; 3) they should be practiced with reasoned understanding of the action and purpose, under full mental concentration and engagement; and 4) they could be completed away from the keyboard, which would be beneficial for creating new neurological connections while not recalling old ones.

Piano playing stands as one of the most demanding high-level performance skills, and as such it comprises multiple components of neurological, artistic, creative, psychomotor, and sensitive realms functioning simultaneously in diverse manners and combinations. When a component works inconveniently and is of psychomotor nature, focalized attention to its specific range of action through step-by-step attention could be beneficial for improvement. Thus, the practice of exercises comprising definite and concise movements could be used as a valuable tool in order to develop physiological settings that could serve as a base to apply novel and improved neurological commands for muscular action and coordination.

Contrary to common belief, the neural connection and feedback between the controlling mechanism of the brain and the physical movement is not unidirectional but bidirectional. Improved physical conditioning, which goes hand in hand with accurate neural representation of the precise mechanical necessities for the desired movement, do
and can improve mental conception and listening. Such dynamic bidirectional process is based on the interaction and mutual profit of decision and action, and will be an essential matter when applying retrained physical conditions at the keyboard. Applying retrained psychomotor practices and new muscular coordination at the keyboard could be an intricate process, reason for which the pianist must follow general guidelines: 1) slowly and purposefully employing new positioning and coordination, hands separate at first; 2) carefully aiming to achieve them under specific circumstances; 3) sensibly associating them with sound production and general motions of hand and arm; and 4) thoughtfully using acoustic and visual perception and feedback, with the purpose of developing the skill of decision and action making.

Before starting to practice repertoire by itself, it would be advisable to: 1) execute the gymnastic exercises here suggested on the actual keyboard (at least those suitable to do so); 2) practice basic exercises of individualized fingers patterns as those by Hanon, hands separate, slowly, and with full muscular awareness; and 3) slowly play scales and scale-related patterns in contrary motion mirroring both hands in shape, muscular action, and general motion. During the mentioned stage of progressively returning to the keyboard, the practice of gymnastics should remain as part of the daily routine of the pianist to ensure the constant engraving and conservation of the retrained settings. It shouldn’t be assumed that inconvenient habits and conditions will not return, in reality that would be likely to happen sooner or later.

The present research could be followed up by several empirical studies focused on, but not limited to measure: 1) the benefits of finger-gymnastic practice; 2) the effect

\[249\text{ At first repertoire should be simpler and less dense, where technical and musical demands are moderate and feedback is clearer.}\]
of avoiding regular piano practice while practicing the exercises; 3) the influence of diverse variables such as level of concentration, regularity of practice, grade of co-contraction or under development, among others; and 4) the recommended average periods for practice each stage or exercise, as well as approximate time lengths for acquiring new muscular and physiological settings.

Besides accepting the eventual necessity of a pianist to retrain mechanical aspects, it always results compulsory to base the pedagogic process at any age, but especially during infancy and adolescence on well informed mechanical fundamentals in order to develop adequate muscular coordination and control. Such informed approach would prevent, to a minimum scale, the appearance of prejudicial and inconvenient habits. Certainly, our customary aversion today towards physiological approaches in piano pedagogy is reactionary in nature. The memory of excessive significance placed upon mechanical aspects, at the exclusion of larger musical and psychological contextualization, among the “physiological school” of piano playing is still fresh among us. This should not deter us from leaping the benefits of mindful application of approaches such as finger gymnastics. The inclusion of biomechanical conceptions should be an essential part of the educative background of the piano teacher, performer and student.
WORKS CITED


