

UNIVERSITY OF CINCINNATI

August 29, 19 70

I hereby recommend that the thesis prepared under my supervision by William Staton Leland

entitled Trends in the Exercise Literature of the Piano:

An Evaluation of Selected Works and Concepts.

be accepted as fulfilling this part of the requirements for the degree of DOCTOR OF MUSICAL ARTS

Approved by:

Donald H Foster

Scott Houston

Scott Houston

Jan. O'Leary

THESIS

TRENDS IN THE EXERCISE LITERATURE

OF THE PIANO:

AN EVALUATION OF SELECTED

WORKS AND CONCEPTS

William Leland

Candidate for the Degree of

DOCTOR OF MUSICAL ARTS

July, 1970

UNIVERSITY OF CINCINNATI LIBRARY

UMI Number: DP16177

INFORMATION TO USERS

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleed-through, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

UMI[®]

UMI Microform DP16177

Copyright 2009 by ProQuest LLC.

All rights reserved. This microform edition is protected against unauthorized copying under Title 17, United States Code.

ProQuest LLC
789 E. Eisenhower Parkway
PO Box 1346
Ann Arbor, MI 48106-1346

I. INTRODUCTION: THE PROBLEM

At no time in the history of the piano has there been a lack of written advice on how the human hand should contact a mechanical lever in such a manner as to cause it to descend a fraction of an inch and come back up again. The multifarious solutions offered to this seemingly simple problem over the years have resulted in arguments, insults, hero-worship, riches, world-wide fame, physical violence and even suicide. One well-known musician--Robert Schumann--crippled his hand permanently as a result of mistaken notions about how to practice. Another--Vladimir de Pachmann--insisted that milking cows was the most beneficial pianistic exercise that could be devised. Innumerable schools have flourished, countless methods propounded, and an inexhaustible supply of words and notes poured out on the mechanics of piano playing, reaching their high-water mark in the early part of this century when Tobias Matthay combined his findings into a fearsome system which comprises some fourteen volumes.

During the same two centuries or so, the subject has been indirectly studied from another viewpoint, that of medical science. Knowledge of muscle location and function, bone and joint structure, and the neurological conditions on which they depend have steadily accumulated, and the more recent discipline known as kinesiology--the study of organic movement--has thrown fresh light on the actions of the upper extremities. Even such matters as the effect of motivation and emotion on learning, and the ways in which different kinds and degrees of practice develop perceptual motor skills, are under intense investigation.

DEC 31 1970

Unfortunately, this growth of information concerning the neuro-physiological makeup has sometimes worked to the embarrassment of widely held conceptions by pianists and teachers of what happens, or should happen, inside the hands and arms when the piano is played. The unqualified use of the word "relaxation" is a good case in point. Some of the world's greatest pianists have insisted that they performed whole recitals in a state of complete relaxation from shoulder to finger, which amounts to saying that one can do something and nothing at the same time. The obvious lack here is of a sophisticated knowledge of such things as the degrees of relaxation available to a muscle, the difference between movement and stabilization, the speed with which tension and relaxation can be alternated, and so on.¹ Since so many of the hallowed precepts of piano technique were arrived at empirically, it is not difficult to understand why, in the course of attempting to verbalize their findings, many pedagogues occasionally expounded nonsense and prescribed anatomical impossibilities. Inasmuch as music is so highly subjective and personal, musicians often seem to have a tendency to treat the mechanical side of their art subjectively, even when objective information is readily available to them; this was often the case, at least, in the nineteenth century, when so much of the craft needed to cope with the modern piano was formulated.

An important part of this history has been the vast literature of technical studies and exercises it has produced, some of which have become fixtures in the repertoire. It is beyond the scope of this paper to enter into a detailed history of piano pedagogy; rather,

the purpose is to focus on the literature itself--to view it in the light of contemporary knowledge of what the hands and arms can do and how they may be most effectively trained to make the complicated series of movements involved in piano playing. How successful is each exercise in producing the desired result? Is the proper method of practice apparent from the notes themselves? How should individual exercises best be classified? Does the order of material follow the course of neuro-muscular development? Is it arranged in groups which consist of units calling for essentially the same or related movements? Are exercises necessary at all, or can technique best be developed by overcoming the difficulties of concert pieces? These are some of the questions to be explored.

II. MECHANISM AND ORGANISM

1. The Piano Action

It is hardly necessary to be a trained mechanic or to study engineering in order to play the piano well. There are, nevertheless, some basic facts about the mechanics of the instrument which should be understood prior to any intelligent discussion of technique, and they are here briefly summarized.

The modern grand action is a highly sensitive device capable of transmitting a wide range of pressures from finger to string. There are two main reasons for its efficiency. One is that the ratio of the respective distances traveled by key and hammer is 1:5--the key descends $\frac{3}{8}$ inch while the hammer moves upward $1\frac{7}{8}$ inches to the string--

and consequently the stroke of the finger is multiplied by five. The other is that the action transmits the force from key to hammer by means of an ingenious arrangement that permits great control over the speed with which the hammer moves. Five separate motions, each a small arc, occur almost simultaneously (see Appendix I).

The most important motion in the entire cycle is the escapement. This is the point at which, a fraction of an inch before the hammer contacts the string, the upright jack impelling it from below slides out from under the hammer knuckle, thus allowing it to rebound freely; the tail of the hammer is then caught by a back-check mounted on the key lever.

The hammer disengages from its check instantly as the key is released, and when the key is less than halfway back to its rest position the jack slips back under the knuckle and is ready for a new stroke. Thus, both the hammer and its impeller are back in place ahead of the key itself.

The volume of sound produced by a piano string is proportional to the speed with which the hammer strikes and rebounds. The quality, or timbre, exclusive of effects introduced by the pedals or extraneous noises added from other sources--such as the impact of finger on key--is governed solely by the quality and condition of the hammer, the string and the entire piano.

The implications of the above discussion can be summarized in a list of points which should be made a part of any evaluation of the technical repertoire of the piano:

1. The volume of a single tone varies according to the speed with which the key is depressed.
2. The quality of a single tone cannot be altered in any way by the player's finger.
3. The "purest" tone, i.e., that with the smallest amount of extraneous noise added, will be produced when the finger is in contact with the key before the key begins its descent.
4. In order for the action to complete its proper cycle of movements the key must be fully depressed.
5. The stroke of the hammer can be repeated before the key has fully returned.

2. The Human Organism

In any discussion of the purely manipulative side of piano playing it is usual to begin with a description of the muscles and joints involved--the so-called "playing mechanism." No such account will be rendered here, first, because the various parts of the hands and arms can be more conveniently mentioned as needed in connection with specific exercises; and, second, because there are some general facts about the workings of the neuro-muscular system which are far more relevant.

All too often, in elucidations of how the piano ought to be played, the human body is treated as a complicated mechanical device, each part of which occupies one place, assumes one position, and performs one function, like the parts of a machine. No concept could do more injustice to the marvel which is the living organism, and none has been more responsible for the profusion of misconceptions in the field of piano technique. The sciences of physiology, neurology and

psychology have unfolded a far more subtle and complex picture of willed movement and perceptual-motor learning.

Piano playing, like all other physical activities, demands coordinate movement. While it was recently demonstrated by electromyography that an individual can learn to control single motor nerve cells,¹ it is normally a movement rather than an individual muscle which is under the control of the will. This is made clear in Gray's

Anatomy:

It is seldom possible for a person to make a single muscle contract at will. In other words, the movements, not the muscles, are represented in the central nervous system. A muscle may be associated with one group for one action and a different group for another, possibly even antagonistic action.²

This interchangeability of muscle function is a frequent occurrence in piano playing. The biceps, for example, flexes the forearm at the elbow but also assists in forearm rotation, a completely different movement involving other muscles.

Equally important is the fact that a muscle may function differently depending on the angle of its joint, or even the position of another joint. The small hand muscles called the lumbricals give a baffling instance of this phenomenon: when the fingers are held straight and flexed at the main knuckle, the lumbricals do most of the work; but when the same knuckle is flexed with the forward joints curved, the lumbricals are inactive.³

Different parts of the same muscles may have separate and even antagonistic actions; for example, the deltoideus--the large triangular muscle which covers the shoulder joint--can flex, extend or

abduct the arm, depending on which portion of it is called into play.⁴ Separate parts of a single muscle may also be operative at different stages of a joint's range of motion. "The fact that different muscles or parts of muscles are active in different parts of the range of motion will dictate their use."⁵ Some of the long flexors and extensors in the forearm act in this manner.⁶

A muscle may be called upon to play one of several different roles. When it acts directly to bring about a desired movement it is called a prime mover; when it is stabilizing, or holding a part of the body in an appropriate position, it is a fixation muscle; and when it acts to offset an undesired action of a prime mover it is known as a synergist.⁷ The interchangeability of roles is one of the basic problems which hinders an understanding of relaxation in piano technique, because the same muscles may assume different roles at different times. The pianist, not knowing this, is likely to fall back on subjective terms such as "loose wrist," "dead weight," and so on, even though "all the muscles of the wrist are quite important for their synergistic use in stabilizing the wrist so that the fingers and fist work to best advantage."⁸

Many common terms have received precise medical definition. Strength, for instance, is defined simply as the ability to produce tension.⁹ Fatigue, the temporary loss of this ability, occurs when lactic acid, a by-product of muscle activity, accumulates in a muscle to an intolerable level; rest is needed to allow the muscle's circulatory system to carry off these wastes.

A muscle increases in size with training partly because of an increase in the number of capillaries available within it. Thus stamina, or work capacity, "is related more to the circulation and metabolic turnover than to the size and contactile strength of muscle."¹⁰ A muscle's tolerance to lactic acid levels also increases with its size. Extremes of unrelieved tension inhibit the proper action of a muscle because sustained contraction "is accompanied by less circulation than is rhythmic contraction. Rhythmic contraction also has the well-known milking action in deep veins with its enhancement of venous return."¹¹

O'Connell and Gardner have contributed some salient findings on the psychological aspects of fatigue and endurance:

For the average individual the psychological limit is quite far below his physiological capacity To develop endurance the act must be repeated beyond the time when discomfort becomes evident. Hence training for endurance₁₂ is quite different from training for strength alone.

The ~~excessive~~ practice schedules followed by some famous instrumentalists, such as Dreyschock and Paganini, who often worked up to eighteen hours a day, may perhaps be explained by a remarkably high level of tolerance to the pain of fatigue.

The role of practice in the acquisition of perceptual-motor skills has recently been investigated by K. D. Cross at Northwestern University Medical School. In defining the term "practice," Cross notes that it is frequently used interchangeably with "exercise." But exercise is "the repetitious performance of an already-learned act with the purpose of modifying in some way one's physical characteristics."¹³

True practice, on the other hand, is "the performance of any act one or more times with a view to fixating or improving the spatial and temporal organization of the same or any other act."¹⁴ Thus we may say that exercise causes changes primarily in the musculature, while practice is aimed at causing changes in the nervous system. Of course, practice and exercise frequently overlap in such activities as learning to play the piano, but the admixture is often accidental and the results haphazard.

How does practice lead to learning? One thing on which authorities seem to agree is that the changes in the nervous system occur during practice rather than after it. "That changes go on within a repetition rather than as a result of repetition is now recognized by practically all psychologists."¹⁵ There is still a variety of views, however, as to the nature of these changes. A widely held theory relevant to piano practice is that learning is really the result of a restructuring of the individual's way of perceiving. Thus, practice may be viewed as a series of exposures to situations that provide the individual with the opportunity to observe meaningful relationships between the different parts of a task and between these parts and the whole. "Learning occurs through practice because each repetition provides the opportunity to perceive a situation from a new angle. Practice is thus necessary for learning; but in order for practice to be effective it must be practice with a difference."¹⁶

Practice is classified into two types: whole-task, in which the activity is practiced from beginning to end, and part-task, in which the successive parts or components of the activity are practiced separately and only later integrated. The relative efficiency of each of these techniques has been the subject of controversy among educators and psychologists for over seventy years, and indeed the terms imply a continuous spectrum within which a virtually infinite number of tasks might be ranked according to their degree of complexity; there is no useful activity which is not made up of components. In any case, there is general agreement that, to be effectively practiced, the intricacy of a task will vary according to conditions, since

ability requirements are different at different stages of learning. Therefore, in evaluating the relative efficiency of one or another type of practice, one must consider not only the nature of the task being learned, but also the stage of practice or current level of skill of the individual. One variety of practice may prove quite effective at an early stage of skill development, yet turn out to be quite ineffective after skill has progressed beyond a certain stage.¹⁷

Although this assertion may seem quite obvious, it is ignored or forgotten by piano students and teachers with remarkable frequency, and its obverse--practice of a complexity above the current level of skill--is equally prevalent.

In evaluating the great number of experiments conducted since 1913, Cross puts forward certain conclusions, some of which may be summarized as follows:

1. As one becomes skilled at practice, the relative efficiency of the whole-task technique tends to increase.
2. Whole-task practice favors the older, more experienced and more intelligent individual.

3. Part-task practice is more efficient when practice is massed, whereas distributed practice favors the whole-task method.
4. Whole-task practice is most efficient when the component parts of a task are highly integrated.

In the early stages of practice the central nervous system invariably issues an excess of neural commands which result in muscular contractions in greater number and of a higher degree than needed for the desired activity. The result is the production of what neurologists call "parasitic movements."¹⁸ The acquisition of skill is in large measure the gradual elimination of these excess motions and the subsequent achievement of the greatest economy of effort. It will readily be seen that this is an area wherein judiciously chosen practice of the part-task variety can be of great benefit.

The practice of any motor activity is least effective when muscle tension is high. Darling has pointed out that a repetitive movement aimed at developing skill is most effective in the low-load range, if for no other reason than that high-load activity is much less practicable for comfortable repetition.¹⁹ Even where muscular development is the only goal it has been shown that a muscle is most effectively exercised (1) when its tension is less than half of maximum, and (2) when the work is prolonged sufficiently to develop a metabolic stress.²⁰

One other neurological phenomenon deserves mention, that of transference. It has been known since the late 19th century that unimanual training can augment the strength and skill of the unpracticed limb. Recent studies at the University of Wisconsin have confirmed the following observations:

1. Practice limited to the flexors and extensors of the fingers and hand of the preferred side affects the performance of both sides.
2. Significant indirect training occurs in the reciprocal muscle group of both sides.²¹

The above discussion is offered with a view to furnishing a base of up-to-date medical information concerning the neurological and physiological functions and capacities of the human organism that apply to piano playing. Many of the findings cited, of course, will be seen to support varieties of practice which are universally used and accepted, while a few would seem to suggest new methods or refinements of old ones. As a partial basis for the technical principles adhered to in evaluating the relative usefulness of individual studies and exercises, the following guidelines are suggested:

1. Practice and exercise requirements change and evolve constantly. Material must be varied regularly to accommodate new levels of strength and skill.
2. The number of task components usefully practiced at one time will vary according to ability, level of achievement and goal. In general, a gradual increase of complexity from part-task to whole-task types of practice will conveniently accompany technical growth and maturation.
3. The player's attention in motor learning should be directed at movements rather than individual muscles.
4. Economy of physical effort is a major goal. It consists of (1) selecting the most efficient type of movement, (2) reaching every location on the keyboard through the shortest practicable route, and (3) eliminating parasitic movements.
5. Since movement in different parts of a joint's range of motion may involve different muscles or parts of muscles, exaggerated movements, such as high finger or wrist exten-

sions, are useless and perhaps detrimental for exercise and for most types of skill practice.

6. The most useful mode of exercise for muscle development will involve low-load tensions repeated to fatigue in the normal playing positions.
7. Relaxation (1) is a selective rather than a general condition, (2) is a recurring rather than a continuous phenomenon, and (3) occurs in varying degrees, rarely to the point of flaccidity.
8. Moderate degrees of tension and relaxation can be made to alternate rapidly, as in vibratory movements.
9. Unimanual practice is useful for two reasons: (1) for isolation of attention, a part-task type of activity, and (2) for transference of strength and skill to the unpracticed limb.

III. EVALUATING THE REPERTOIRE

1. The Case for Technical Drill

Are formal drills really necessary? Many highly respected musicians have questioned the need for burdening pupils with such drudgery, pointing out the difficulties in concert pieces whose solution might yield the same benefits, the danger of dulling musical sensibilities, and the discrediting of the old theory that the "mental exercise" gained from one skill assists in the learning of another. William S. Newman is one who, while not advocating the abolition of all technical drills, is quite insistent that their value is rarely transferred to musical compositions:

The main fallacy in adhering to Czerny, *et al.* lies, it seems to me, in the illusion that piano practice means the development of the piano-playing muscles in general. But it does not. It means developing specific muscular coordinations to meet specific situations.

There are woodsmen and athletes who can squeeze any pianist's hand to a pulp. But their splendid strength means nothing at the piano, for, unless they have practiced the act, they can barely set down five fingers in a row. One learns only what he practices. Each technical feat must be learned separately. Technique does not generalize.¹

Newman manages to avoid the common habit of using "practice" and "exercise" interchangeably. But he denies the proven value of part-task learning, and--even more inexplicably--seems to reject the obvious fact that exercise of the playing muscles leads to their enlargement regardless of the name of the composer. One simply cannot deny that, given the proper movements, strength and skill improve with practice and exercise, and that this improvement is applicable to other activities. Yet Newman insists that

the practice of a Czerny study leads mainly to the perfection of that Czerny study rather than to Beethoven or Chopin or composers in general. The way to learn Beethoven is first of all to practice Beethoven. The practice of Czerny can help Beethoven only when an identical passage occurs in both.²

What Newman should have said is that the practice of Czerny can help Beethoven only when an identical type of movement occurs in both. After all, from the neuro-muscular standpoint there is no such thing as an "identical passage," even when exactly the same notes are repeated; minor adjustments are being made by the body constantly, and no two performances are ever alike. If, however, the learning of basic skills and the development of general muscular strength were not applicable to a host of specific situations we would be totally unable to function. Who has not, for instance, had the experience of climbing a peculiar flight of stairs whose configuration has never before been

encountered, or picking up an object of unfamiliar shape and texture? Yet the body adjusts to these new activities without a thought, because the basic climbing or grasping skills are already there and need only slight modifications. In the same way, it is possible to develop the habits and movements needed for most types of piano playing by using specialized material. It is of course true that every musical composition will have a residue of specific problems that no group of exercises, however thorough, can completely anticipate. But technique most certainly does generalize if--and this is the crucial point--the smaller practiced tasks are true components of the larger wholes, i.e., of the activities to be found in concert pieces. The ultimate criterion for any study or exercise, in fact, is its applicability.

The strongest case against technical drills, no doubt, is their lack of musical interest. Too much time spent on such material cannot help but dull the most important faculty any instrumentalist can have: attentive listening to his own playing. This tendency must be counterbalanced by judicious selection of material and continual variety, both of matter and method of practice--"practice with a difference." Many exercises, for example, can be advantageously subjected to changes of tempo, dynamics and rhythmic pattern, and some can profitably be transposed. Thus another criterion for a drill is what might be called its versatility.

The great advantage of drills over musical compositions is that problems can be isolated into part-task activities, and one can con-

trol the apportioning and balancing of them according to need.. If one were to develop a technique solely from practicing, say, the Etudes of Chopin, considerable facility would result, but it would be neither complete nor balanced. The right hand would be considerably more developed than the left, and there would be virtually no experience in playing scales, broken octaves, tremolos, or repeated notes. With drills, on the other hand, specific areas of technique can be encapsulated and focused, and practiced as required. How effectively a given study or exercise can be directed at a desired result, then, might be judged by a third criterion, its efficiency. It should be noted here that efficiency may or may not connote the degree to which problems are isolated, since the desired result may be the grouping of components into an activity of the whole-task type.

2. Classifications of Drill Materials

Although many examples of drill materials are difficult to categorize, the most useful distinction is that which divides drills into studies and exercises. A study, or etude, is a musical composition which embodies some specific technical problem or group of problems and which, though usually written for the primary purpose of technical improvement, is nevertheless a piece of music with meter, formal structure, harmonic progressions and cadences. An exercise, on the other hand, makes little or no attempt at musical expression of any kind; the sounds are wholly subordinate to the movements.

Yet there are many borderline cases even in this type of classification. Some of Brahms' Fifty-one Exercises, for example, though indubitably exercises, contain passages in which the consistency of the task is momentarily superseded by a musical effect, as if Brahms--being Brahms--could not resist an expressive modulation here or a satisfying cadence there. Even Hanon occasionally adds or changes something to relieve the monotony, as in No. 47 of The Virtuoso Pianist, where the deviations from the C Major scale pattern (m. 15 to the end) create problems for the right hand that do not occur in the left; as a matter of fact, Hanon's tremolo exercise, No. 60, is really an etude.

All of the works to be examined here are of the exercise type. While admitting the continued popularity of certain specimens of the etude literature--notably Czerny's School of Velocity and The Art of Finger Dexterity--it must be said that 20th-century piano pedagogy, following the general trend of our time toward capsulization and precision, has tended to avoid the circuitous etude in favor of the more efficient exercise. As early as 1929, Ernst von Dohnanyi wrote that

before all else the amount of studies ("Etudes") must be reduced, and this can be done without harm if they are replaced by such exercises which, in lesser time, bring forth the same benefits. Finger exercises are preferable to studies.³

The better etudes, such as those of Chopin and Schumann, belong to the category of concert pieces, and it has become increasingly apparent that the benefits derived from sterile, uninteresting ones can be more quickly gained from short, concentrated exercises.

This does not mean, of course, that exercises are new; over half of the works considered here were written in the 19th century. What is new is the shift of their role from that of supplementary material to that of the main--sometimes the sole--source of extra-musical drill. This trend is fortunate because the whole raison d'etre of technical drill lies in the fact that problems are susceptible to distillation. The above remarks concerning the advantage of drills over concert pieces are thus carried one step further.

Having opted for the exercise, in which neuro-muscular tasks or combinations of tasks are presented without excess baggage, one may proceed with their further classification. Exercises are commonly grouped in one of three ways:

1. According to musical pattern--scales, arpeggios, octaves, double thirds, double sixths and the like, with these categories further broken down into major and minor scales, three- and four-note arpeggios (triads and seventh chords), and so on.
2. According to general functional area--finger exercises, wrist exercises, arm weight exercises, etc.
3. According to difficulty--usually beginning with simple finger movements in the closed position and proceeding to more complex selection patterns, shifts, extensions, and eventually activities which involve progressively more of the arm and shoulder.

These areas frequently overlap and sometimes produce redundancy of task components or introduce additional components which are irrelevant to the stated purpose or may even subvert it. A common example of the former is the exercise embodying a series of white-

key sequences, each of which calls for the same finger movements. The latter may be illustrated by the use of the interval of the sixth or even the octave for early exercises in wrist flexion; this adds the problem of abduction fixation which--especially in small hands--invariably militates against the very freedom of movement the exercise is supposed to develop.

There is a general peculiarity of design common, it seems, to every volume of exercises, a peculiarity which intermittently subverts the author's own efforts at meaningful order and sometimes results in one or both of the disadvantages mentioned above. It is the composing and arranging of exercises according to musical and mathematical convenience, with the apparent assumption that variations such as sequences, transpositions, or inversions will not alter the neuro-muscular task to be performed. A universal example is the exercise which is presented in C major and followed by the instruction that it be repeated in all other keys. The transposition of an exercise, however, may result in varying degrees of ease or awkwardness of execution; it may introduce new elements, such as the problem of fitting fingers between black keys, or shift the hand in such a way as to alter the range of motion of certain fingers.

Another example is the five-finger exercise which places a gap of a third between adjoining fingers. Invariably, the same interval occurs in turn between each pair of fingers, even though they are utterly different in their range and strength of abduction. Most adults, for instance, can take in as much as an octave with their thumb and

forefinger, while their fourth and fifth fingers might have difficulty playing a minor third.

An even more common illustration is seen in exercises where the hands play the same notes an octave apart in parallel motion. Because the hands themselves are not parallel but constructed as opposites, it is far more comfortable to play in contrary motion, with the same fingers of each hand striking at the same time.

A fourth example is that of adding variants. Supposing an exercise consists of octaves played in diatonic scale patterns. It will often be followed immediately by a variant in which the same scales are played in broken octaves. The rotary movements of broken octaves, however, are utterly unlike the movements employed for unbroken ones; hence the variant is in the wrong place if the exercises are purported to be arranged in a progressive order.

There is no intention of denying the value of parallel motion, transposition, variation, or indeed any admixture of elements in exercises. These elements are extremely valuable as the materials of which concert pieces are made. If, however, they add unplanned components to part-task activities they may defeat their purpose, especially in elementary or preparatory exercises where part-task learning is most needed. The objection is to the frequency with which these elements occur accidentally; one must suspect that the composer employed them not realizing that they might introduce elements tending to complicate or subvert the basic design of the exercise.

Another criterion for any exercise is thus its clarity of goal: whether it is clearly directed at one of the two main goals, strength and skill, and precisely what kind and degree of each is desired. Two ingredients necessary for achieving this clarity are (1) control over the number of components in a given task, and (2) a general ordering of the exercises that have a common goal in such a manner that the number of task components is low at first and becomes progressively larger.

One more observation is offered concerning the exercise literature as a whole: exercises need to be accompanied by written directions as to their manner of performance. The one fully satisfactory situation, of course, is that they be learned in the company of a competent teacher. Taken by themselves, however, they must be considered incomplete without some instructions about the intended goal and the movements to be employed in reaching it. The clarity and relevance of these instructions is an important factor in evaluating them.

3. Evaluation of Selected Works

The works to be examined span virtually the entire history of the modern piano. By "modern" is meant the larger and more sonorous instrument which, beginning around 1800, began to develop rapidly and to supersede the five-octave Viennese piano that reached its state of perfection about 1780 in the hands of Andreas Stein.

The exercises, listed in order of discussion, are:

Schmitt: Preparatory Exercises
 Pischna: Technical Studies
 Hanon: The Virtuoso Pianist

Brahms: Fifty-one Exercises
 Dohnanyi: Essential Finger Exercises
 Barth: Technic, Book III
 Conus: Fundamentals of Piano Technique, Books I and II

Aloys Schmitt (1788-1866) was a German pianist and teacher whose short volume of finger exercises has been widely used for well over a century. He was a representative of the post-Viennese school which began with Clementi and featured primarily a finger technique, executed with quiet hands and arms.

There are two main sections to Schmitt's work. The first, Nos. 1-213, is made up of five-finger exercises in parallel motion, while the second consists of contrary-motion exercises devoted mainly to the passing under of the thumb. The first section shows the following patterns:

- 1-33: single notes played in five-finger position (c-g)
- 34-64: single notes played in five-finger position with one note held
- 65-110: single notes played in five-finger position with two notes held
- 111-115: single notes repeated in five-finger position with four notes held
- 116-118: two single notes alternately repeated four times each with three notes held
- 119-127: double notes (thirds) played in five-finger position
- 128-143: double and single notes alternated in five-finger position with one not held
- 144-151: double and single notes alternated in five-finger position with two notes held
- 152-157: two single notes alternated in five-finger position with three notes held
- 158-159: double and single notes alternated in five-finger position with two notes held

- 160-169: two (or three) notes repeated with three (or two) notes held
- 170-213: single-note groups ascending and descending diatonically "the whole extent of the keyboard,"⁴ The descending pattern is always an inversion of the ascending pattern.

It is at once obvious that the design and order of exercises is based far more on mathematical symmetry and convenience than on needs of the fingers. A basic hand position is set, with the right hand on middle C and the left an octave lower. The following instructions are given:

Repeat each Exercise at least ten or twenty times, but omit the closing note until the final repetition. At first, practice each hand separately, then both together, always keeping the hands steady and quiet. Practice each exercise slowly at first; increase the tempo gradually as the fingers acquire the necessary strength and flexibility. It is advisable to practice these exercises in the keys and without changing the fingering.⁵

There is no thought of the different degrees of strength and freedom in the fingers; all are treated exactly alike. What matters is that every arithmetical possibility of finger order is accounted for, beginning with 1-2 and proceeding to 1-3, 1-4, and so on. For the first several pages the exercises are arranged in pairs so that the even-numbered ones are inversions of the odd. Since inversions also exist within single exercises, however, it sometimes happens that pairs of exercises are exactly alike except for a shift of the note pattern to a different beat of the measure. This occurs with Exercises 1 and 2, 3 and 4, 15 and 16, 21 and 22, and 31 and 32. Many other patterns are so similar as to be virtual repetitions.

Beginning with Exercise 34 a new element is introduced, that of holding one or more fingers while the others play. This is a device which occurs again and again throughout the technical literature. How effective is it? Is the hand really doing anything different from what it does when the fingers simply alternate with one another? To answer this question it is necessary first to examine the activities involved in the exercises composed of individual finger movements.

The full title of Schmitt's volume is "Preparatory Exercises for acquiring the greatest possible independence and evenness of the fingers."⁶ "Evenness" is not a very precise term, but presumably it means equality of strength. Both major goals, then--skill and strength--are envisioned by the author.

In following the injunction to keep the hands "steady and quiet" it becomes clear that the skill to be won is that of using each finger as an independent lever. But the beginning student, for whom these exercises are intended, nearly always adds varying degrees of arm pressure to finger movements with the result that the main fulcrum--though its motion is so small as to be scarcely noticeable--becomes the elbow. Should this be avoided there is still the question of the shape and movement of the finger itself. Is it to be curved to such a degree that its tip strikes the key vertically, or should it be less curved so as to strike with the "cushion"? Are the fingers not in use to be held off the keys or rested on their surface? How high should each finger be raised?

It should be noted that all of these problems deal with movements, not muscles. Today we are beginning to understand the extent to which variations of movements, which to the eye appear quite minor, may bring different muscles or parts of muscles into play or cause them to assume different roles. It is precisely here, in the earliest stage of learning, that this problem is most critical. What to the author must have seemed the simplest kind of keyboard activity--the setting down of five fingers in a row--turns out to be a complex task susceptible of a host of missteps.

Holding down certain fingers while the others play is a device often used to insure that the keys are depressed by finger motions alone, but it usually has the opposite effect. Because of the increased difficulty of the coordination pattern, the unskilled player is far more apt to struggle to keep the proper keys depressed by pushing harder with the arm, resulting in an increase of parasitic movements and general tension. Even when the exercise is performed with finger movements alone, the held notes merely add one more stabilization to an already complex task. The point here is that five-finger exercises of the type under consideration are not composed of tasks which can be classed as preparatory. Schmitt compounds the problem by adding a number of the unplanned components discussed in the previous section: parallel motion, transpositions, and variants based on mathematical convenience instead of neuro-muscular requirements. As preparatory material, then, Exercises 1 through 213 must be classed as poor; and if the level of skill is such that they can

be played correctly, then they must still be given low grades because of their low degree of applicability and extremely high level of redundancy.

The remaining section of the volume is composed of exercises which are much more useful. Entitled "Exercises for passing the thumb under the fingers, preparatory to the practice of the Scales and Arpeggios", the section is truly preparatory in that it takes the major component (the special motion of the thumb) of a whole-task activity (scale or arpeggio playing) and deals with it separately.

The exercises consist for the most part of segments of scales and arpeggios on white keys, centering around those points where crossings occur. The arrangement is progressive, the thumb passing under only one finger (the forefinger) at first and eventually under several, with the intervals also becoming progressively wider. The hands, when performing together, now play in contrary motion.

As with the first group of exercises, however, there are some extraneous elements which complicate the basic motions. For example, both thumbs must often play middle C at the same time (Ex. 1), an unnecessary and annoying problem; or the hands may be placed so close together as to collide when the outer portion of the hand passes back over the thumb (Ex. 2). Occasionally the fingering becomes so awkward that the playing of fingers other than the thumb becomes the main task (Ex. 3). Several of the exercises consist of crossings so widely spaced that the thumb action must be superseded by a rotary forearm movement (Ex. 4).

There are several measures where Schmitt approaches the conciseness and efficiency which is the ideal of the modern exercise (Ex. 5). Attentive practice of these measures would reap most of the benefits to be found in the whole section; but, as before, explicit instructions are mandatory.

With the Technical Studies of Josef Pischna we are confronted with a totally different style. Pischna (1826-1896), a Bohemian pianist and pedagogue who taught for many years in Moscow and later at the Prague Conservatory, lived to see his work adopted all over Europe. It is subtitled, "Sixty Progressive Exercises, Containing Studies on Trills, Scales, Chords, Passages and Arpeggios." It is not, however, arranged in any progressive order so far as difficulty of coordination is concerned.

In contrast to Schmitt, Pischna clearly intends that the muscular activities be composed of contrasting tasks in combination. Most of the exercises are designed so that different patterns occur simultaneously in each hand and between the hands. The first fourteen involve finger movements in closed or nearly closed positions. Of these, the first six are made up of five-finger patterns in one hand, and trills on different pairs of fingers combined with held notes in the other (Ex. 6). Exercises 7 through 14 call for essentially the same movements, except that the intervals are somewhat extended and the held notes occur at different places in the measure. In some, an arpeggio figure (confined within the octave so that there are no crossings) is given with the instruction that all notes be held.

Presumably this means that each finger is to hold its note after playing, raising only immediately before its next turn.

There is no suggestion on the part of the composer that these are preparatory exercises; consequently the wish to combine different movements into complicated whole-task activities is perfectly acceptable in principle. But it would seem that, to meet the criterion of efficiency, the movements to be combined should be different enough so that their coordination calls for a genuine restructuring of the activities of the central nervous system. Such is not the case here; if the level of skill is already high enough to perform the basic movements separately, then the only problem posed by the first fourteen Pischna exercises is that of "learning the notes," something better reserved for concert pieces.

Different types of movements are combined in Nos. 15 and 16, which total four separate exercises (some of the numbered exercises are subdivided into as many as eight, and many have preparatory exercises as well). In this group, while one hand is continuing trill patterns while holding other notes, the other hand is occupied in performing broken octaves. Thus it is presumed that finger movements are to be combined with forearm rotation.

The notation, however, is confusing. Instead of being written as sixteenths, the broken octaves have their upper and lower notes scored as two separate voice lines, each in legato eighths (Ex. 7). A literal realization is impossible with one hand, and we are left with a classic example of an exercise which cries out for some sort

of written explanation. Only two directions are to be found throughout the entire volume: The frequent injunction to "hold down all the fingers" and the ubiquitous "practice in all keys."

The passing under of the thumb, with hand crossing in the inversions, is introduced beginning with Exercise 17. Instead of the brevity of Schmitt, Pischna offers lengthy and highly redundant diatonic patterns, in parallel motion or in combination with other finger patterns, which eventually culminate (in Exercises 39 and 40) in all the scales arranged in parallel octaves, thirds and sixths, and in contrary motion. Some of these exercises are as long as many of the Czerny etudes.

Interspersed along the way are a few octave and rotation exercises, the latter in broken octaves and sixths. Once again we are at a loss to know what movements are intended. Occasionally, a dynamic mark provides a clue: in No. 35, for instance, one gathers from the fortissimo that the left hand octaves are played with the whole forearm rather than from the wrist (Ex. 8).

In Exercises 42 and 43 the octaves become full chords, alternately solid and arpeggiated. The triplet broken octaves of Nos. 44 and 45 call for extra effort from the fourth and fifth fingers, as do the trills of No. 52. No. 57 (Ex. 9) is clearly a stretching exercise, but it is impossible of safe execution by anyone who cannot comfortably span a tenth already; and if he can do so, his hands are big enough. No. 54 is an exercise involving pairs of repeated notes, and again one asks, "How?" Should one employ flexion only (a "snapping" motion) or flexion and extension (as in finger staccato)?

Taken as a whole, the Pischna volume represents a case for which the type of criticism voiced by Newman would seem entirely apropos. It contains almost nothing of which the part-task components could not be far more efficiently learned in isolation. Conversely, most of the movements to be employed are combined into whole-task activities whose learning would be a waste of time; they simply combine already-mastered basic skills into activities which are the equivalent of those to be found in the concert repertoire.

The next work to be considered is, of course, the most famous of all. The Virtuoso Pianist, by the French pianist and teacher Charles-Louis Hanon, has enjoyed an unparalleled record of distribution and durability. It stands as an early effort at clarity, conciseness and genuine communication with the player. The volume begins with a lengthy preface, in which Hanon leaves us in no doubt as to his own opinion of his work:

For several years we have labored...to unite in one work special exercises which render possible a complete course of pianistic study in far less time.

To attain this end, it sufficed to find the solution of the following problem: If all five fingers of the hand were absolutely equally well trained, they would be ready to execute anything written for the instrument, and the only question remaining would be that of fingering, which could be readily solved.

We have found the solution to this problem in our work. . . . In this volume will be found the exercises necessary for the acquirement of agility, independence, strength and perfect evenness in the fingers, as well as suppleness of the wrists--all indispensable qualities. . . . Furthermore, these exercises are calculated to render the left hand equally skillful with the right.⁷

The next statement is truly remarkable:

These exercises are interesting, and do not fatigue the student like the generality of five-finger exercises, which are so dry that one requires the perseverance of a true artist to summon up courage to study them.

This paper is not concerned with the formulation of judgements concerning the musical worth of the works in question, nor with the musical taste of its authors. But to anyone who has studied Hanon, the above quotation is revealing, especially in company with the paragraph which immediately follows it:

These exercises are written in such a manner that, after having read them a few times, they can be played in quite a rapid movement; they thus become excellent practice for the fingers, and one loses no time in studying them. If desired, any of these exercises may be played on several pianos simultaneously, rousing a spirit of emulation among the students, and habituating them to ensemble playing.

What is revealed in these quotations, as in the exercises themselves, is the kernel of a whole philosophy of piano teaching which persists even today, namely, that the essence of good piano practice is relentless repetition. The chief characteristic of The Virtuoso Pianist is the endless reiteration of sequences in C major, a pattern ascending a step at a time for two octaves and its inversion coming back down. The exercises do not make use of transpositions; not a black key is touched until No. 39, where G-sharp is played as the seventh degree of the scale of A minor.

Hanon attempted to arrange the exercises in such a manner that the fingers which became most fatigued in each pattern would be somewhat relieved in the next, but as so many of the exercises are very

similar, and make use of all five fingers, it is difficult to see how this is accomplished. In the exercises which are designed to make extra use of certain fingers, such as the fourth and fifth, their relief comes at the beginning of the inversion, since at this point each hand takes over the finger sequences of the other (Ex. 10).

A few of Hanon's written instructions deserve comment. For the entire volume he directs, "Lift the fingers high and with precision, playing each note very distinctly." Here, of course, is the old fallacy that clarity is a function of range of motion. But clarity is the outcome of consistency in the timing, degree of pressure, and duration of key-descents, and is governed exclusively by the nervous system; it has nothing whatever to do with range of motion.

Exercise 44 consists of triplet repeated notes, fingered 3-2-1. Hanon's instructions are, "Lift the fingers high and with precision, without raising hand or wrist." Again, the motion is wasteful. In fact, rapid repeated notes with this fingering, as well as quadruplets fingered 4-3-2-1, are most efficiently played by snapping the fingers under the palm, since both the attack and release of the key take place in one direction.

Exercise 45 (Ex. 11) is made up of two-note slurs to be performed in turn by each pair of adjacent fingers as well as the combinations 2-4 and 1-3. Once more we encounter a design governed by mathematical combinations; the unequal fingers are to be made equal by giving each pair exactly the same task to do. And the only advice given for this exercise is that the first note of each pair be accented; there

are no clues as to the type of accent or any of the motions to be employed.

Thus, for all the composer's conscientiousness, the written directions which preface each exercise are not specific enough to tell the player much about his actual movements. Out of all sixty exercises there are three injunctions which deal explicitly with the type of motion envisioned: one is the already-quoted instruction to play with high fingers; another, preceding No. 58, which consists of sustained octaves accompanied by repeated notes in the inner fingers (Ex. 12), reads, "Strike the octaves vigorously without lifting the wrists, and hold them down while deftly executing the intermediate notes."⁹ This is quite specific, though one wonders how to get from octave to octave without lifting the wrists. The third charge deals with the execution of the tremolo, in Exercise 60: "By oscillations of the wrists, the rapidity is still further augmented."¹⁰ Here it is safe to assume that Hanon wants forearm rotation. There are a few other instructions which imply that all octaves are to be played using the wrist as the fulcrum, but usually they merely tell the player how the author wants the exercise to sound: "Execute this exercise very smoothly and evenly, striking each Third very clearly";¹¹ "play these scales legato, and very evenly";¹² or, "where the fingering is changed, be careful that not the slightest unevenness is apparent."¹³

Many instances of unplanned elements could be cited. Exercises 32, 33 and 34, for example, are made up of patterns which efficiently

isolate those portions of the C major scale where the thumb must pass under the hand. But by employing the familiar device of reiterating the pattern in diatonic sequences (Ex. 13), a repeated note is introduced once each measure which inevitably results, with unskilled players, in an extra movement of the arm. No. 37 (Ex. 14), in which only the thumb plays, is a much more efficient exercise if properly performed.

A major portion of the work consists of all the major and minor scales and the arpeggios on major and minor triads in root position, all with what have been universally accepted as the standard fingerings. The necessity of including these in any pianist's basic equipment can scarcely be gainsaid. It should also be noted that Hanon introduces wrist flexion with the hand in a comfortable closed position: No. 48, the first such exercise, begins with thirds on repeated notes, progresses to diatonic scales, and later repeats the same patterns in sixths. Finally, in No. 51, the hand is extended to the octave.

But for the most part, The Virtuoso Pianist must be accounted a work of limited usefulness. Its goal seems to be primarily the mechanical strumming of white keys at a single dynamic level, and its method of achieving it is the presentation of repetitious patterns which, in the absence of specific instructions, are subject to the employment of many kinds and degrees of parasitic movements.

But if building muscular strength, at least, can be done by repetition of muscle activity to the point of fatigue, why cannot Hanon

exercises serve the purpose? The answer is that they can--eventually. So, for that matter, can drumming on a table top. What the student needs, however, are exercises that can do this with the most efficiency, the least redundancy, and the greatest clarity of goal. Moreover, the constant search for drill materials which provide the greatest benefit in the most concentrated form is aimed not only at allowing the student more time for repertoire. It is also directed at avoiding, as much as possible, long periods of time spent in making sounds that are uninteresting, so as to checkmate the easy habit of playing without a steady, conscious attempt to influence the onward flow of a musical form.

The Brahms Fifty-one Exercises are definitely for students who have already mastered such basic skills as individual finger movements and simple scales. From the very first, one is struck by the fact that the whole volume is designed to stress the more sophisticated and subtle elements of technique; that is to say, those activities which are necessary for the control of the musical--as opposed to the merely digital--elements of concert pieces. Problems of tempo, rhythm, phrasing and dynamics abound, together with such problems as the intelligible rendering of separate and contrasting voice lines and the stressing of inner voices. In addition, some of the digital problems themselves are among the most ingenious to be found anywhere.

The exercises are not comprehensive in the sense that all the standard movements are covered; little attention, for example, is given to octaves, skips or repeated notes. On the other hand, many

tasks are dealt with which are not ordinarily found in exercise books but which often appear in the Romantic literature: crossings by fingers other than the thumb (Nos. 13, 34b, 34c); rapid changing of fingers on held notes (43a, 43b); broken chords in which two notes are struck together during the arpeggiation (31a, 31b); and the sliding of fingers from a black to a white key (25a, 25b, 25c).

Brahms does not provide written instructions concerning movements; even fingerings are often left to the player. What these exercises do is presuppose a musicality on the latter's part, as well as a certain minimal level of dexterity. It is often the musical effect which points the way to the proper movements. Yet a few of the exercises approach the ideal of being virtually impossible of execution except with the proper movements: Nos. 43a and 43b, for instance, cannot be performed as written without a flexible opening and closing of the hand; in the language of physiology, they are premier exercises for the abduction and adduction of the fingers. Similarly, Exercise 4, by its design, demands a freedom of movement at the wrist: the hand must turn in order to connect the tones of the legato voice, especially since the key is A-flat; and it must turn back to play the intervening notes a sixth below.

The first six exercises (1a through 1f) are basically scale patterns, but the main problem is rhythm: the player must learn to combine three notes with four, four with five, six with seven, and seven with eight (Ex. 15). Despite calling for a fairly complex whole-task activity these exercises point to a goal that is unmistakable: skill,

not strength, is the desired result, and the specific skill is the mastery of polyrhythms. It is absolutely impossible to play these exercises in a thoughtless, mechanical manner.

Nos. 2a and 2b (Ex. 16) provide a concise study in playing scales in double thirds. Only one key is used (A major), and the hands are alternated so that fatigue is avoided. The constant crossing of hands adds an additional task, albeit a purposeful one, and it would seem more convenient to begin with 2b, in triplets, rather than 2a, in sixteenths. Executed gracefully, however, the crossings of the hands automatically obviate fixation of either hand in a rigid posture; they also add musical interest.

No. 3 is an ingenious exercise for the weak fingers, far more efficient for this purpose than anything devised by Hanon. Nominally an exercise in thirds, it connects each sequence with a fingering in which the fifth finger must play three notes in a row while the third and fourth alternate (Ex. 17); moreover, the outer fingers must abduct at the same time. Since abduction, flexion, and extension at the main knuckle all involve the lumbricals and interossei, the exercise is excellent for bringing about an increase in strength where it is most needed; the weakest finger, in fact, plays the greatest number of times.

Exercises 5 and 6, each with a preparatory exercise, consist of broken octaves which shift an octave higher or lower with each pair of notes (Ex. 18). The time and effort demanded would not seem to be repaid in terms of rewards that could not be found in equally concise

form in many concert pieces--Brahms own concertos, for example.

The same may be said of many of the exercises which simply demand the coordination of already-mastered finger movements, such as 17 and 33a (Ex. 19). But the indications of dynamics or touch often imply a method of performance which add task-components that make the effort worthwhile. Nos. 32a and 32b provide an illustration: a legato inner voice in eighths is surrounded by an accompaniment of 32nds in the same hand (Ex. 20). But the indication "leggiero" for the 32nds implies that the notes of the legato voice must not merely be held--they must be played louder. We thus have an exercise not only in finger coordination, but coloring. Compare this with Hanon, where varieties of color and touch are utterly absent, and where the first dynamic mark occurs in the last exercise, No. 60. Hanon and Brahms are both consistent, but their goals are altogether different. Hanon's goal is clear enough: "Learn to push down levers." With Brahms it becomes: "Learn to make musical sounds."

By now it would seem to be more or less apparent that our criteria--applicability, versatility, and efficiency--are highly variable factors which depend in large measure on the level of development. The efficiency of a preparatory exercise, for instance, will be gauged in part by the degree of success with which it isolates certain tasks; on the other hand, an exercise of the whole-task type might be judged by its success in crowding a judicious combination of components into a short span of time. Similarly, an exercise may be applicable to one situation or level of skill and not another--this is why its placement in a group may be a factor in its evaluation. Again, the versa-

tility of an exercise will probably be a function of its design: a relatively simple, part-task type of exercise would tend to admit of more variations of touch, tempo and so forth, than a more complex one which has its versatility "built in." One criterion, however, remains invariable: clarity of goal. Our opinions of the goals themselves may vary, but the author's intentions must be clear.

In 1929 the eminent Hungarian composer, pianist, and teacher Ernst von Dohnanyi (1877-1960) published a collection of exercises which stands as an important landmark in the 20th century trend towards the elimination of redundancy and excess. In a lengthy preface to his Essential Finger Exercises, he argues the case for honing drill material down to its bare essentials:

In music schools piano tuition suffers mostly from far too much exercise material given for the purely technical development of the pupils, the many hours of daily practice spent on these not being in proportion to the results obtained. Musicality is hereby badly neglected and consequently shows many weak points. The fault lies on one side, that the pupils are not taught to practice properly, and on the other hand, that far too many studies and exercises are given from which only little value can be gained, whilst not enough time is left for the study of repertory pieces. . . . Finger exercises are preferable to studies (since) the whole attention can be concentrated on the proper execution, which is most important. . . . Even Czerny is superfluous; it does not contain anything of essential importance which might not be acquired through finger-exercises, or by conscientious practicing of appropriate passages of pieces.¹⁴

By way of general advice regarding movements, Dohnanyi has this to say:

The exercises have to be played forte with all possible strength, slowly and with well raised fingers, as well as piano in more rapid tempo. For training, the forte and slow practicing is more beneficial. To practice too slowly is a waste of time. The most rapid tempo in which the exercises can be played faultlessly gives best results.¹⁵

An opinion has already been rendered on the usefulness of exaggerated movements. Moreover, the final sentence in the quotation would seem to contradict the second, wherein slow, forte practicing is held to be most useful, since a gradual increment of skill would tend to increase the tempo and reduce the ranges of motion. It is not clear whether by the term "training" Dohnanyi envisions an increase in skill or strength, or both. One suspects the former, since earlier in the Preface the author is at pains to say:

The less time spent on purely technical studies, the more important it is to practice with fully concentrated thought. . . . When playing even the simplest of finger exercises, the full attention must be devoted to the finger-work, each note must be played consciously, in short: not to practice merely with the fingers, but through the fingers with the brain.¹⁶

What is quite clear is that Dohnanyi wishes to leave no doubt as to his impatience with the old method of mechanical repetition. It is not an exaggeration to say that his influence in furthering the cause of concentrated mental activity in piano practice was equal in importance to the ingenious capsulizing of many of the exercises themselves.

Dohnanyi uses the term "finger exercises" in the broadest sense, as his work covers virtually all phases of technique. The volume is divided into three sections, entitled: "Exercises for the independence and strengthening of the fingers"; "Scales and chords"; and "Double-stops." The sub-titles are not strictly accurate, since the first section includes a few exercises in repeated chords and tremolos, the second includes arpeggios, and the third, octaves and broken

octaves. The arrangement is not meant to be progressive; in the Preface the author provides a complete list of the exercises grouped into one of three levels of difficulty.

The first section relies heavily on the device of holding certain fingers while playing others, and most of the exercises exploit the convenient strategem of utilizing all possible arithmetical combinations. Yet they represent a significant advance in efficiency in several ways: for one thing, the patterns avoid the redundancy of repetitions and sequences; for another, the author consistently avoids the injunction that a C major exercise be practiced in all keys--if other keys are felt to be beneficial he lists those only, or else writes out the transpositions in full; furthermore, the exercises utilize either parallel or contrary motion according to a specific design.

Exercise 12 (Ex. 21) is a good case in point. It consists of simple diatonic patterns in five-finger position, each finger playing in numerical order. How is it more efficient than, say, the first exercise of Hanon? There are a number of ways:

1. It is written in contrary rather than parallel motion, making it easier to concentrate on individual movements when the hands are playing together.
2. The order in which the fingers play is reversed every three measures.
3. The first note of each beat is accented.
4. Because of the rhythmic design (quadruplets in 5/4 meter), the accent falls on a different finger each time.
5. The chordal pattern changes every measure in a regular sequence: major, minor, diminished.

Thus, several more skill components are added to an exercise which uses the same movements as the Hanon No. 1; the only additional movement is the accent, and, in contrast to the Hanon, there are no gaps between fingers.

All the major and minor scales, as well as the chromatic, are combined into one exercise (No. 18). It is rather long, but, unlike Pischna, Dohnanyi does not change from octaves to thirds and sixths, so that the exercise takes no longer to learn than the scales themselves. The following two exercises, however, may be open to the charge of redundancy: the same grouping of scales, except that the melodic minor replaces the harmonic, is given, first in sixths and then in tenths. No. 21 presents all major and minor scales and all diminished seventh and dominant seventh arpeggios in contrary motion. A more efficient exercise, of equal applicability, is No. 22, comprising all the major, minor, diminished-seventh and dominant-seventh arpeggios, all performed with the same fingering throughout. The retention of the C major fingering results, of course, in many awkward crossings; this illustrates another familiar device, that of exaggerating a difficulty on the assumption that it will thereby be made easier to master in its ordinary form. Whatever the merits of such a theory, it has the negative value in this case of rendering the exercise susceptible of quicker learning than it would be if the fingerings changed with each new key (Ex. 22).

The scales in double thirds, major and minor, are presented as a single exercise, in exactly the same musical pattern as the scales of No. 18. About scales in double sixths, Dohnanyi has this to say:

It is absolutely unnecessary to practice the very difficult scales in double sixths in all keys. The chromatic scale in major and minor sixths is sufficient.¹⁷

Thus, Exercise 34 offers double sixths in chromatic form only. But it might be argued that No. 32 (Ex. 23), an exercise in alternating double sixths in several positions, makes the chromatic sixths superfluous as well.

Many of the exercises which consist of double notes or chords in solid form are followed by variants in which the same notes are broken. As mentioned earlier, the variants call for totally different movements and would seem to be out of place and, on occasion, redundant. The variant of the four-note chords of No. 25a, for example, results in another arpeggio exercise (Ex. 24).

Unfortunately, Dohnanyi provides little in the way of specific instructions to the player. A rare exception precedes Exercise 38, in octaves:

This exercise is to be practiced forte from the arm and piano from the wrist; both ways with different fingering, i.e., once throughout with 1-5, and then alternating 1-5 with 1-4, whereby 1-5 come on the white keys and 1-4 on the black keys.¹⁸

The advantage of using the fourth finger on black keys, of course, is that the hand can be positioned so that the fourth and fifth fingers are always over black and white keys, respectively, and there is little motion lost in having to shift to and away from the fall-board; only the thumb must be slightly repositioned in transferring from one to the other.

Exercise 23 is unique among all the works under consideration. It consists of scale patterns, identical with No. 18, but executed with the

hands crossed, i.e., with the right hand one octave lower than the left. Cross-handed passages always cause a sense of disorientation, and it is difficult to decide whether the mastering of them really results in restructuring the nervous system in any significant way, but one advantage of them, provided the hands are playing the same patterns in parallel motion, is to bring the left--usually the weaker--hand into more prominence from the standpoint of the ear. One of the objections to the constant use of parallel motion in the regular positions is that it is easy for the left hand to "hide" behind the right, so to speak. It is one of the most common of faults for a student unconsciously to use a strong right hand to cover a weak left. That is why Hanon erred in assuming that exercises in parallel motion would automatically produce equality of strength and skill between the hands.

About six years after the publication of Dohnanyi's Essential Finger Exercises, Hans Barth's Technic, in three volumes, appeared. Barth (1897-1956) was for many years a judge for the Naumburg competitions in New York, and at the time of his untimely death was Dean of Judges of the National Guild of Piano Teachers. His lectures on piano technique, as well as his publications, attracted a wide following all over the United States.

Barth attempted to systematize the teaching of technique by dividing it into twenty-five separate categories or "branches" according to both musical pattern and functional area of the hands and arms. Thus, in addition to Scales, Arpeggios, Octaves, Repeated Notes, Thirds, Glissandos, etc., some of the branches include Fourth- and Fifth-finger

Exercises, Arm-drop Exercises, Wrist Exercises, Stretching Exercises and Thumb Exercises. The three volumes progress generally from elementary to advanced, but the exercises within each book are arranged in sets of four, each set with the heading "Daily Exercises" and applying four of the twenty-five categories. A daily regimen, characterized by controlled variety, is offered which gradually advances the student through all phases of technique. Volume III only is examined here.

The exercises themselves are, for the most part, disappointing. They consist in large measure of musical patterns which have been encountered over and over in the technical literature, and which could in many cases be replaced by similar patterns taken from concert pieces to be learned. Thus, instead of the octaves of Exercise 3 of Set 1 (Ex. 25), one might as well learn Liszt's Sixth Rhapsody, or substitute portions of Chopin's Etude in C minor, Opus 25, for the broken chord patterns of No. 4, Set 10 (Ex. 26). Yet a few of the exercises do encapsulate certain basic movements in highly efficient form. One of the best is No. 1 of Set 21, a preparatory exercise for scales in double thirds (Ex. 27). The patterns of diatonic thirds, of graduated difficulty, all focus on the sideways motion of the arm which must occur in complete scales as the hand shifts from position to position. Again, the exercise in legato octaves, No. 1 of Set 24 (Ex. 28), neatly isolates the individual movements and difficulties. All the exercises have the merit of brevity.

The real significance of Barth's Technic lies in the author's efforts to communicate a description of basic movements. At the begin-

ning of each volume in a page entitled "Suggestions for Practicing the Exercises in Books I, II and III." Here are several of these, quoted in full:

Scales: Keep hand in one position, avoid twisting at the wrist.

Broken Octaves: Turn hand from side to side from the elbow in a rocking motion, gradually lessening motion as speed increases.

Repeated Notes: Let fingers slide towards the palm of the hand, the arm making a slight outward (away from keys) motion as the 4th, 3rd, and 2nd fingers are played, then returning to first position as thumb plays.

Bringing Out Individual Notes in Chords: When bringing out an outer finger (the thumb and usually the 5th finger), lean the hand in the direction of the finger that is to bring out the tone. When a middle finger is to bring out a tone, extend that finger about an eighth of an inch further outward, keeping it firm, so that it hits the key a fraction of a second ahead, (not audible).

Glissandos: Whether you use the thumb or the 3rd and 4th fingers, the nail should at all times face the side of the key, and be as vertical as possible so that no part of the flesh touches the keys. Keep the hand very relaxed, although the fingers playing should be firm.²⁰

Many of the other suggestions are not so explicit, and none are as complete as the author would have liked. It is known, in fact, that Barth wished to publish a separate book of suggestions as a companion to the exercises.¹⁹ But for the first time in this study is encountered a consistent effort to present drill material in company with instructions that attempt to come to grips with the player's actual neuromuscular activities.

Leon Conus (1871-1944) among whose fellow students at the Moscow Imperial Conservatory were Rachmaninoff, Scriabin, Medtner, and

Josef Lhevinne, achieved international recognition as one of Russia's finest pedagogues. In 1924, in collaboration with his wife, Mme. Olga Conus, he founded the Russian Conservatory in Paris, later moving to the United States, where he joined the faculty of the Cincinnati College of Music. The Fundamentals of Piano Technique, in two volumes, is a joint effort, compiled and enlarged by Mme. Conus and first published in 1952.

A number of the exercises appear in both volumes. Book I, however, begins with the preparatory stages and progresses to exercises that are moderately advanced, while Book II presupposes an intermediate level of skill and proceeds to exercises of virtuoso caliber. Both volumes are rich in written guidelines; indeed, many of the exercises cannot be executed without specific instructions. The general goals envisioned are stated in the foreword to Book II:

In order to facilitate study and systematize these contents, I have divided the exercises into seven categories, first according to their classification, and second according to difficulty: Exercises for Extensions, Five-finger Exercises, The Passage of the Thumb, Exercises for the Trill, Scales and Arpeggios, Exercises for the Wrists, and Exercises in Double-Notes. Thus, each of these exercises has a special aim or purpose.²¹

Each category is then given a brief raison d'être. For example:

The Extension Exercises are designed to facilitate stretches, loosen the hand, strengthen the fingers and give them independence.

The Thumb must be specially trained, for its responsibility in piano playing is very great in so far as skillfulness in changing positions and maintaining legato are concerned.

Devotion to the concept of "practice with a difference"--variety instead of mere drudgery--is urged:

To obtain the best result in practicing exercises, one must vary the method of work. This can be accomplished by the following:

1. Play all exercises at different speeds and keys.
2. Use different touches and nuances.
3. Change all exercises by utilizing various rhythms and by displacing the accent.
4. Invent different fingerings in addition to the ones illustrated.
5. Memorize all exercises.

The chief value of these instructions lies in their flexibility. Rather than merely transpose each pattern to all keys, the player is asked to develop his own ingenuity and insight; he must decide for himself what variants are appropriate for each exercise, and not transpositions only but changes of rhythm, touch, nuance (which would include dynamics) and even fingering. These instructions, of course, are found in the Foreword to Book II; in the first volume such variations as are expected are usually included with each exercise itself.

Book I is divided into the same categories as Book II, with the addition, at the beginning, of a section entitled Preparatory Exercises. The first four exercises of this group deal with the basic movements of the fingers and wrist which are to be found in the entire volume, and are models of applicability, efficiency, clarity, and isolation of task-components. In Exercise 1 the player is instructed to make only simple extension movements:

Place the tips of five fingers on five keys, and WITHOUT PRESSING, slowly raise each finger four times silently.²²

The design of the exercise is such that parasitic movements are easily detected; if any unwanted flexion of either the fingers or the wrist takes place, a key will be at least partially depressed; if the wrist or any finger other than the one desired should be even slightly extended, one or more fingers will lose contact with the surface of the key; and if both flexor and extensor groups should tense together in synergy, the tension is detectable by the slightly spread, rigid posture of the hand and the increased prominence of the extensor tendons.

In Exercise 2, virtually no movements are made except at the wrist joint; the player is instructed to hold single notes of four counts each and alternately raise and lower the wrist with each beat. The goal is the establishment of possibly the most important coordination in piano playing; the simultaneous maintenance of stabilized finger joints and a flexible wrist.

Exercise 3 appears to be a simple row of quarter-notes in five-finger position; but the player is instructed to raise each finger before striking its key, while the previous note is still being held. The overlapping of movements thus produced--stabilized flexion in one finger and extension in the next--assures independence of finger movement.

The fourth exercise introduced the very difficult task of learning to play with passive, rather than active, movements. Pairs of adjacent fingers depress pairs of white keys utilizing the wrist movement learned in No. 2: the wrist lowers on the first note of each pair and raises on the second. The new element is the playing of the first note

by releasing the weight of the arm instead of by employing muscles as prime movers; in so-called "arm-weight" playing the muscle groups involved normally function only as fixation muscles.

It will be noticed that Exercises 1 and 3 call for exaggerated finger extensions. But in the Conus exercises high finger action is put to a wholly different use than in those of Hanon or even Dohnanyi. In the latter volumes the player is directed to play repetitious passages with exaggerated finger movements for the purpose of developing strength and clarity, a practice which appears to be based on misconceptions concerning neuro-muscular functions. In the exercises presently under consideration, high extensions are made for the sole purpose of isolating movements. Moreover, they invariably appear only on select notes within groups, and are performed slowly and without undue force. Exercise 5 of Book I offers an illustration (Ex. 29): The direction accompanying the exercise is, "In passing from one measure to the next the repeated note is to be played with raised finger action." One note out of eight is to be played in this fashion for the purpose of masking out the parasitic arm movement mentioned in connection with Hanon Nos. 33-35. Similar use of isolated high-finger movements is made throughout both books, although written directions concerning their employment are not always sufficient or even present.

A number of exercises are designed to develop relaxation as a recurring rather than a continuous condition, with the alternation of tension and release in appropriate muscle groups. Exercise 3a, Section VI, of Book II is virtually identical in note-pattern with Dohnanyi's

No. 9, but the goal is more subtle; in addition to independence of finger movement the exercise develops the all-important phenomenon of intermittent relaxation. Accompanying the notes is the injunction, "Slow; after the stretch the hand resumes its normal position." Thus the rests, during which the elastic--not rigid--hand automatically returns to a closed position because of the rhythmic relaxation of its abductors, are the most important parts of the exercise (Ex. 30).

The employment of the wrist and arm receive a lengthy and detailed commentary:

In practicing the so-called "heavy wrist" exercises the arm and shoulder are brought into play. The wrist is thus kept flexible while each note is attacked from the arm and shoulder. . . . the weight used is supported by the fingers alone, which remain relaxed but firm enough to support the weight employed. The "light wrist" exercise is the practice of the hand movement alone. The hand is used lightly and independently--as a finger--while the arm remains completely quiet.²³

The "heavy wrist" exercise goes Hanon one better by beginning with single notes, played by the third finger, and progressing to thirds and sixths. The movement is identical with that which Barth calls "Arm-drop."

Most of the exercises for scales and arpeggios, having been preceded by a whole section dealing with the passage of the thumb, are composed of portions of the scales themselves in a variety of rhythms and patterns. Exercise 1 of Section V (Book I) presents scales in different rhythms, with the task of making raised-finger accents on the first note of each group. Some of these are open to the charges of repetition and redundancy: a group of six, for example, is merely a multiple of three--the only difference is speed. But also included are the unusual rhythms of five and seven, and variants such as dotted rhythms and other

alternations of note value. The exercises which cluster groups of notes on different scale steps while retaining the scale fingering (Ex. 31) compel the player to concentrate without interruption; No. 8 of this group (Ex. 32), in which one note is added to the scale at a time, likewise fixates the attention on fingering, and also on retaining a mental picture of the next high note to be added. This group of exercises provides excellent opportunities for repeatedly perceiving the same situation from new angles.

Taken together, the Conus Fundamentals of Piano Technique must be judged a significant advance toward the ideals of intelligibility of instructions, distillation of, and control over, task-components, and presentation of non-redundant materials for extra-musical practice. They reflect a high degree of both physiological and psychological insight.

IV. CONCLUSION

In the course of evaluating examples of exercises it has been clearly impossible to give a full account of each volume. The intent has been rather to illustrate and evaluate various types of exercises, together with the general approach and method of representative composers. The evaluations are based on a practical knowledge of piano playing which has been leavened with some recent theories of medical science in the special disciplines of psychology, physiology, kinesiology and neurology, as well as basic facts concerning the piano itself.

It is easy to take advantage of the benefit of hindsight. The criticisms, both expressed and implied, of the technical repertoire

of the past are in no way calculated to demean the valuable efforts and dedication of those pedagogues who, working with the best knowledge then available, devoted themselves to bringing the highest ideals of piano technique within the reach of the average student. The primary goals of this paper have been to demonstrate, first, that a significant evolution has been taking place in the literature of technical drill materials for the piano; second, that the trend of this evolution has been toward conciseness, precision and better communication with the player; and, third, that the criteria offered in the first two sections of this chapter, based in turn on the guidelines presented at the end of Chapter II, represent a reasonable ideal for the design of such materials.

E N D

NOTES

I.

1. See the author's article "Relaxation in Piano Technique" for a more thorough discussion of relaxation.

II.

1. See Basmajian/Control, 480.
2. Gray, 415.
3. See Brown, Long, and Weiss, 458.
4. See Gray, 497.
5. Darling, 30.
6. See Gray, 503-514.
7. See Gray, 416.
8. Basmajian/Recent Advances, 173.
9. Darling, 27.
10. Darling, 28.
11. Darling, 30.
12. O'Connell and Gardner, 342, 344.
13. Cross, 458; italics added.
14. Cross, 488.
15. Cross, 488.
16. Cross, 489.
17. Cross, 489.
18. See O'Connell and Gardner, 355.
19. See Darling, 31.

20. See Darling, 30.
21. Hellebrandt and Waterland, 55.

III.

1. Newman, 35.
2. Newman, 34.
3. Dohnanyi, Preface, 2.
4. Schmitt, 13: direction for exercises 170-213.
5. Schmitt, 3.
6. Schmitt, 3; italics added.
7. Hanon, Preface, for this and the next two quotations.
8. Hanon, 2.
9. Hanon, 106.
10. Hanon, 110.
11. Hanon, 95.
12. Hanon, 87.
13. Hanon, 76.
14. Dohnanyi, Preface, 2, 3.
15. Dohnanyi, Preface, 5.
16. Dohnanyi, Preface, 4.
17. Dohnanyi, 43.
18. Dohnanyi, 46.
19. The writer was a private student of Hans Barth in 1956.
20. Barth, Foreword.
21. Conus, L., Foreword, for this and the next two quotations.
22. Conus, O., 3.
23. Conus, O., 23.

MUSICAL EXAMPLES

SCHMITT:

Ex. 1:

Ex. 2:

Ex. 3:

Ex. 4:

Ex. 5:

Five musical examples by Schmitt, each consisting of a treble and bass staff. Ex. 1: Treble staff has notes with fingerings 1 2 3 1 3 2; Bass staff has notes with fingerings 1 2 3 1 3 2. Ex. 2: Treble staff has notes with fingerings 4 1 5 1; Bass staff has notes with fingerings 4 1 5 1. Ex. 3: Treble staff has notes with fingerings 4 1 5 1; Bass staff has notes with fingerings 4 1 5 1. Ex. 4: Treble staff has notes with fingerings 2 1 5 1; Bass staff has notes with fingerings 2 1 5 1. Ex. 5: Treble staff has notes with fingerings 3 1 1 1 1 1 1; Bass staff has notes with fingerings 3 1 1 1 1 1 1.

PISCHNA:

Ex. 6:

Ex. 7:

Two musical examples by Pischna. Ex. 6: Treble staff has notes with fingerings 3 4; Bass staff has notes with fingerings 5 4 3 2 1. Ex. 7: Treble staff has notes with fingerings 5 3; Bass staff has notes with fingerings 5 3. Ex. 6 includes the instruction *f legato* and Ex. 7 includes *ff* and *(etc.)*.

Ex. 8:

Ex. 9:

Two musical examples. Ex. 8: Treble staff has notes with fingerings 4; Bass staff has notes with fingerings 4. Ex. 9: Treble staff has notes with fingerings 2; Bass staff has notes with fingerings 2. Ex. 8 includes the instruction *ff* and Ex. 9 includes *ten.* and *(etc.)*.

HANON:

Ex. 10:

Ex. 11:

Two musical examples by Hanon. Ex. 10: Treble staff has notes with fingerings 1 2 1 2 5; Bass staff has notes with fingerings 5 4 5 3 1. Ex. 11: Treble staff has notes with fingerings 5 4 5 2 1; Bass staff has notes with fingerings 1 2 1 3 5. Ex. 10 includes the instruction *(etc.)* and Ex. 11 includes *simile* and *(etc.)*.

Ex. 12: *ten.*

Ex. 13:

Ex. 14:

BRAHMS:

Ex. 15:

Ex. 16:

Ex. 17:

Ex. 18:

Ex. 19: (a) (b)

p 3 3 (etc.) *legato* (etc.)

3 4 5
1 2 3

DOHNANYI:

Ex. 20: *legato* Ex. 21:

legato *leggiero* (etc.) *legato* (etc.)

Ex. 22: Ex. 23:

(etc.) (etc.)

Ex. 24: (No. 25a) (No. 25b: Variant)

left hand two octaves lower

BARCELONA

Ex. 25:

First system of Ex. 25. Treble clef. The melody consists of eighth-note triplets. The first triplet is G4-A4-B4, the second is A4-B4-C5, the third is B4-A4-G4, and the fourth is A4-G4-F#4. The bass clef has a whole note G3. The word "(etc.)" is written below the bass line.

Ex. 26:

First system of Ex. 26. Treble clef. The melody consists of eighth-note groups with fingerings: 2 5 1 2, 5 2 1 5, 2 1 5, and 2. The bass clef has eighth-note groups with fingerings: 1 2 5 1, 2 1 5, 5 1, and 2 5 1 2. The word "(etc.)" is written at the end of the system.

Ex. 27:

First system of Ex. 27. Treble clef. The melody consists of eighth-note groups with fingerings: 3 4 3 1, 3 4 5 2 1, 5 4 3 2 1 3, and 5 4 3 2 1 3. The bass clef has eighth-note groups with fingerings: 1 2 3, 1 2 3 1, 3 2 1 3 5, and 3 2 1 1 3. The word "(etc.)" is written after each group. The instruction "(l.h. separately)" is written below the first bass line.

Ex. 28:

First system of Ex. 28. Treble clef. The melody consists of eighth-note groups with fingerings: 5 4 5 4 5, 4 5 4 5 4, 5 4 3 5 4 5 4 5, and 5 4 5 3. The bass clef has eighth-note groups with fingerings: 4 5 4 5 4, 5 4 5 4 5, 4 5 4 5 4 5 3 4, and 4 3 5 4. The word "(etc.)" is written after each group. The instruction "legato" is written above the first bass line.

Second system of Ex. 28. Treble clef. The melody consists of eighth-note groups with fingerings: 5, 5, 5, 5, 5, and 5. The bass clef has eighth-note groups with fingerings: 5, 5, 5, 5, 5, and 5. The word "(etc.)" is written after each group. The instruction "legato as possible" is written above the first bass line.

CONUS.

Ex. 29:

4 5

3 4

R.H. 2 3

1 2

4 5

3 4

2 3

1 2

sim.

sim.

L.H. 4 3 (one octave lower)
5 4

Ex. 30: (a: Conus)

(b: Dohnanyi)

Ex. 31: (a)

(b)

1 2 3 2 1 2 3 1 3 2 3 1 2 1 3

1 2 3 1 3 2 1 2 3 1 2 3 2

5 4 3 4 5 4 3 2 3 4 3 2 1 2 3

5 4 3 2 3 4 5 4 3 2 1 2 3 4

L.H. one octave lower

Ex. 32:

1 2 1 2 3 2 1 2 3 1 3 2 1 2 3 1 2 3

5 4 5 4 3 4 5 4 3 2 3 4 5 4 3 2 1 3

L.H. one octave lower

I.



BIBLIOGRAPHY

- Baker's Biographical Dictionary of Musicians. 5th ed., rev. N. Slonimsky. New York: G. Schirmer, 1958.
- Barth, Hans. Technic, Book III. New York: J. Fischer & Bro., 1935.
- Basmajian, John V. "Control of Individual Motor Units," American Journal of Physical Medicine, XLVI, No. 1 (February, 1967), 480-486.
- _____. "Recent Advances in the Functional Anatomy of the Upper Limb," American Journal of Physical Medicine, XLVIII, (August, 1969), 165-177.
- Brahms, Johannes. Fifty-one Exercises. New York: G. Schirmer, 1939.
- Conus, Leon. Fundamentals of Piano Technique, Book II. Evanston, Ill.: Summy-Birchard Co., 1953.
- Conus, Olga. Fundamentals of Piano Technique, Book I. Evanston, Ill.: Summy-Birchard Co., 1952.
- Cross, Kenneth D. "The Rule of Practice in Perpetual-Motor Learning," American Journal of Physical Medicine, XLVI, No. 1 (February, 1967), 487-510.
- Darling, Robert C. "Physiology of Exercise and Fatigue," Therapeutic Exercise, 2nd ed., ed. Sidney Licht. New Haven: Elizabeth Licht, 1961, 21-46.
- Dohnanyi, Ernst von. Essential Finger Exercises for Obtaining a Sure Piano Technique. New York: Edward B. Marks, 1942.
- Gray, Henry. Anatomy of the Human Body, 26th ed., ed. C. M. Goss. Philadelphia: Lea & Febiger, 1954.
- Hanon, C. L. The Virtuoso Pianist. New York: G. Schirmer, 1900.
- Harrison, Sidney. Piano Technique. London: Sir Isaac Pitman & Sons, 1953.
- Hellebrandt, F. A., and Waterland, Joan C. "Indirect Learning", American Journal of Physical Medicine, XLI, No. 2 (April, 1962), 45-55.
- Leland, William. "Relaxation in Piano Technique," Music Educators Journal, LV, No. 1 (September, 1968), 71-75.

Long, C., Brown, M. E. and Weiss, G. "Electromyographic Study of the Extrinsic-Intrinsic Kinesiology of the Hand," Archives of Physical Medicine and Rehabilitation, XLI (May, 1960), 453-472.

Matthay, Tobias. An Epitome of the Laws of Pianoforte Technique. New York: Oxford University Press, 1931.

Newman, William S. The Pianist's Problems. New York: Harper & Row, 1950.

O'Connell, Alice L., and Gardener, Elizabeth B. "Ingredients of Coordinate Movement," American Journal of Physical Medicine, XLVI, No. 1 (February, 1967), 334-361.

Ortmann, Otto. The Physiological Mechanics of Piano Technique. New York: E. P. Dutton & Co., 1962.

Pischna, J. Technical Studies. New York: G. Schirmer, 1904.

Schmitt, Aloys. Preparatory Exercises, Opus 16. New York: G. Schirmer, 1922.

Schultz, Arnold. The Riddle of the Pianist's Finger. New York: Carl Fischer, Inc., 1949.