Fingerprints of Marie Jaëll's students, 1897. Courtesy Bibliothèque Nationale et Universitaire de Strasbourg. Fonds Marie Jaëll, Mrs 560-1.
1. Introduction

Around 1900, musical performance became an object of scientific study. Physiologists and psychologists took an interest in the processes of performance, which had both a stable referent—the musical score—and great variability. However, the application of methods of visualization and recording first used in nineteenth-century experimental life sciences constantly reshaped the musical objects in question, transforming the concepts of individuality and even beauty.

In the mid-nineteenth century, experimental physiologists began to develop methods to register bodily functions. Experimenters hoped that visualizing, for instance, blood pressure, heartbeat, and the body’s movements would grant them repeated access to such ephemeral phenomena. By the end of the century, visualization was being applied to the investigation of musical performance. The study of performance processes depended on the possibility of recording them. The first attempt to register a performance was carried out by Étienne-Jules Marey, who played a key role in developing physiological registration apparatuses of all kinds. He registered the action of a reed organ while a musician played a melody.¹

In the history of visualizing musical performance, the piano is the main player. In the nineteenth century, it was the unrivaled favorite of musical culture. The most popular of concert instruments, it was the workbench of composers and teachers, and it allowed bourgeois households to become acquainted with the entire canon of eighteenth- and nineteenth-century music. In short, the piano was becoming a “medium”: a universal instrument and standard technical form through which all works and genres could be converted into audible sound. This career continued long after the 1870s, when sound recording was invented. Due to the poor sound quality and limited length of phonograph and gramophone recordings, the new technology could not yet rival piano reductions and transcriptions of works written for other instruments—whether symphonies or chamber music, opera or entertainment—as a means of reproducing them by a single player on a single instrument. Although the piano required supplementary
equipment, such as scores and skills, the imperfections of early sound recording sharpened the listeners’ awareness of the piano’s many advantages.

In the late nineteenth century, a number of technical innovations in piano building were supposed to make piano playing easier and the performance of piano reductions more efficient. However, the only commercially successful development along these lines was the player piano. A real boom in the use of the player piano occurred after 1900, when piano builders invented a mechanism that made possible the recording of piano performances that could then be played back on player pianos. In the 1920s, experimental psychologists tuned in, realizing that this new instrument was the perfect tool for visualizing piano performances. At this point, a shift in the concepts of beauty and individuality took place, driven by experimental research and its entanglement in the culture and media of music.

The story of this shift, traced in the following pages, begins with the idea of “beautiful piano playing.” While the first attempts to visualize piano performance were compatible with the idea of evenness that nineteenth-century piano teachers had promoted, the turn toward mechanical recording of performance brought forth an interest in the temporal aspects of piano playing: individual deviation from the written score emerged as a value indicating good performance.

Parallel to this shift from “beautiful” regularity to “individual” deviation, a curious episode in the history of visualizing performance occurred. Invited by the head of the Hospice de Bicêtre, a psychiatric hospital in the Kremlin-Bicêtre suburb of Paris, French pianist Marie Jaëll began to conduct experiments on sonority. In contrast to both earlier and later investigations of performance, Jaëll focused not on sound but on touch. For Jaëll, touch—that is, the pressing down of the keys—is the only moment when the player can influence the sound of the piano. Trying to understand the relation between beautiful sound and individual play, Jaëll took the performer’s fingerprints. Her attempt to visualize the magic moment of touch is unique in the history of visualizing piano performance. Although it points to later investigations of the piano’s sound, Jaëll’s attempt must be understood in the context of the intertwining means and media of visualizing performance between 1890 and 1930.

2. Regularity

In 1896, psychologists Alfred Binet and Jules Courtier introduced an apparatus to register piano playing. Their article “Recherches graphiques sur la musique” presented experiments they conducted with the new device at the Paris Laboratory for Psychology. Two features in their work were typical of the research program...
at this laboratory: by using the graphic method—in the tradition of Marey—they guaranteed the scientific validity of their investigation; and by turning to pianists as their experimental subjects, they aimed at a new level of complexity for their research.³

In the second half of the nineteenth century, Marey developed an apparatus for visualizing and measuring almost any function of the body. Its basic element was a kymograph, a device consisting of a rotating cylinder and a stylus. The stylus was connected to an interface, such as a tube or membrane, that transformed incoming pressure into a motion that was appropriate for registration. The cylinder’s surface was smoked or covered with a lamp-blackened sheet of paper, so the trace of the stylus would appear as a thin white line on a black ground. Such white-on-black curves became emblematic of the body’s traces as they were discussed in nineteenth-century experimental physiology.⁴

The graphic method spread into a new field with the emergence of experimental psychology in the second half of the nineteenth century. Psychologists set up complicated experiments in order to connect a research question about a function of the mind to some measurable feature of the body. This was a bone of contention for Binet and Courtier. Such experiments were based on situations that were completely artificial and alien to the experimental subjects, they argued.⁵ No one would act normally when subjected to these conditions; this research would therefore never provide any useful insights into human psychology. Their critical stance, however, did not prevent the two researchers from seeking an appropriate object of investigation that would fit both the generally accepted requirements for experimentation and their own exigencies for obtaining valid results.

Here, piano playing seemed promising. In fact, it combined many aspects of interest for psychological investigation. Part of a pianist’s training was devoted to playing in the presence of an audience. In this respect, the experiment was comparable to a musical performance. In addition, piano playing was a repeatable and well-described, but at the same time multifaceted, activity; it involved motor skills, coordination on various levels, emotion and expression, and cognitive aspects as diverse as learning, sight-reading, and memory.

Before even starting to sort out this complex interplay of factors, Binet and Courtier thought of a device that would provide a register for such an enterprise.⁶ Their idea was to record the movement of the instrument rather than to register yet another bodily function of the player. For this, a rubber tube was run beneath the keys of a piano. Both ends of the tube were connected to a membrane. When changes in the air pressure set the membrane in motion, it conveyed its movement
to a stylus, which in turn carved a line onto the lamp-blackened sheet of paper covering the obligatory rotating cylinder. To adjust this piano-kymograph to the needs of musicians, the authors recommended replacing the cylinder and stylus with an ink pen writing on a paper roll that was spooled between two reels.

Equipped with this device, Binet and Courtier tested the accuracy of various pianists. The ear might easily be deceived, they assumed. The visual traces of the apparatus, in contrast, were precise and unbiased. In order to work with the resulting inscriptions, however, a typology of possible traces was necessary. To get an understanding of the curves’ meaning, they systematically registered typical combinations of notes. An important part of their article was thus devoted to the translation of movements and sounds into curves. Five keys played one after the other would look like a sinusoidal wave, or like a sequence of steps, or like some combination of both, depending on how long each finger held the key.

From their work with this apparatus, the regularity of finger play emerged as a privileged object of investigation. The interest of this object was twofold. On the one hand, regularity was well-suited for observations of great psychological interest: it allowed, for example, comparisons between a listener’s perception of the music played and the physical trace of the performance. This involved observing the precision of auditory perception and its limits, as well as reevaluating pianists’ self-perceptions of their own accuracy and listeners’ expectations. Their research suggested that listeners accepted as a regular performance that which, when the registered curve was consulted, turned out to be full of inaccuracies. One of the invited subjects therefore called the apparatus a “pianists’ confessional”—no sloppiness could be hidden from it. On the other hand, the graphic method had been used already to observe regularity, as most of the movements it recorded were periodic. The patterns of reiteration and modification occurring in these types of curves would give the best measurement results. An example of this precision was in an experiment with one “very famous artist.” Binet and Courtier asked her to play a regular *decelerando* (a decrease in tempo over a few notes): to their surprise, they discovered that when the pianist played five notes in half a second, she managed to introduce between each pair of notes a retardation of one hundredth of a second.8

Their experiments thus implied that regularity was a desirable quality of piano playing. In their “confessional,” most pianists surrendered to the precision of the measuring device. Only those who excelled in technical mastery were able to
pass the test of visualization. In short, the researchers and their subjects shared the common attitude of the nineteenth century toward regularity, and the registration device in turn was well suited to corroborate this ideal. What had been commonplace in nineteenth-century piano pedagogy would soon change dramatically, however.

3. Nuance

After 1900, the first player pianos were marketed. The core of the player piano was a pneumatic mechanism that was controlled through paper rolls. Each hammer in the action of this instrument was connected to a tube rather than a key. When a hole in the paper passed one of the tubes, the corresponding hammer was set in motion. To produce the rolls, musical scores were translated into a sequence of dots that were then punched into the paper. In the first player pianos the patterns would be punched according to a geometrically exact temporal pattern. The player piano thus demonstrated the effect of flawless regularity—no human deficiency intervened in the execution of the written score. In reaction to this, regularity turned into a source of unease. The ideal of evenness, which had been current in piano pedagogy for almost a century, was challenged. Suddenly, an instrument was able to execute perfectly what piano pedagogues had posited as the highest aim of musical training. Although excessive technique had always been a target for critique, the critique now took on another shape. Any human virtuoso—however excessively they might display their technique—would be more interesting to listen to than the machine, the enemies of the player piano would argue.

Parallel to this unease with the former ideals of piano pedagogy, an interest grew in “individuality” as that which differentiates human beings from machines. The mastery of nuance was now found to be the decisive criterion for excellent human performance, in contrast to the mechanical instrument. Critics of the player piano stated that it lacked expression. More specifically, they noted that the player piano was unable to produce the shadings of sound required for musical expression. A mechanism to create such nuances was yet unknown. One of the proponents of the player piano, Russian music theorist Leonid Sabaneyev, admitted that the instruments would have to develop exactly this capacity if they were to enrich musical culture:

The “timbre”—or more precisely, the minimal nuances of timbre—can likewise be fixed, their mechanism grasped, and thus controlled according to the inspirations of artistic volition. When this condition is fulfilled, then the essentially justified accusations of emptiness and soullessness of the
timbre of mechanical instruments will fall away. This is not a matter of
soullessness, but of indifference and excessive uniformity, which precludes
the possibility of playing with the minimal nuances on which tone color
is based.  

Focusing on the “minimal nuances” of timbre, Sabaneyev recognized three aspects
of piano playing that only human beings could achieve: tone color, its variation,
and the degree of its variation (i.e., the minuteness of nuance).

A reviewer in the German Journal for Instrument Making (Zeitschrift für
Instrumentenbau) similarly praised the virtues of human musicianship:

The artistically intelligent interpreter knows how to tint the sound of the
piano in infinitely manifold ways, shading it or making it sparkle! All this
happens through the changing manner of touch. Sometimes the vehemence
of expression asks for the energetic unfolding of power, at other times the
poesy of an airy passage wants the key to be caressed and so forth. So far it
has not been possible to record this—divinatory, I should like to say—moment
anyhow. It rushed, passed by, faded, and was lost.  

Because the Journal of Instrument Making would generally take the side of instru-
ment makers, the reviewer had to have a reason for such a plea in favor of the
pianist. The occasion for this eulogy was a new development in the construction
of mechanical instruments. In 1905, the German company Welte began to demon-
strate to the public a new instrument, the “Welte-Mignon” piano, that could play
back pianists’ performances. “This instrument seems to be endowed with a soul,”
the reporter exulted.  

Much like the demonstrations of the phonograph and gramophone, these concerts juxtaposed pianists and piano roll reproductions.  

The most famous pianists of the time, such as Theodor Leschetizky, Josef
Hofmann, Ignacy Paderewski, and Sergey Rachmaninoff, soon agreed to be
recorded on such “reproducing piano” rolls.  

Other companies entered the market, such as the “artist rolls” (Künstlerrollen) from the Leipzig-based company Hupfeld and the Duo-Art-Piano from the Aeolian Company in the United States. Pianists had exclusive contracts with the companies, and the rolls were edited according to the desires of the artists, much as was done when electrical sound recording on tape took over the market. Yet, for the moment, the player piano was the only instrument that could not only produce music without the presence of a musician but reproduce an individual performance.

Just like Binet and Courtier in the late nineteenth century, psychologists real-
ized in the 1920s that piano playing offered them an excellent topic of study.
They regarded the rolls of the recording piano as visualizations of piano perfor-
manances. The paper roll, which encoded everything that was needed to play back a performance, was an integral part of the reproducing pianos. Thus, the recording device was readily available and needed but a few adjustments for the purpose of scientific experimentation. In exchange, the entire repertory that had been recorded for the reproducing piano could be taken into account and thus provided a vast material for investigation. The Journal for Instrument Making coined a term for this, calling the roll a phonologram. The term did not spread, however, because the player piano’s career was soon to end. Once sound recording technology made a decisive step forward in quality in the 1930s, enthusiasm dimmed for player pianos as a device to reproduce music. In the 1920s, however, that enthusiasm still persisted, and the most important argument made by the proponents of the player piano was that it conveyed the pianists’ individual nuances of style: “In a phonologram not even the slightest, acoustically barely perceptible variation remains concealed to the eye. But it is precisely in these variations that the character of personal style resides, which is so difficult to convey linguistically.”

Variation did not concern sound shades but the nuances of temporal differentiation, as the same author explained:

It is in these smallest individual shifts of the meter, which may not occur consciously, that the artist recognizes his own playing. This offers an exceptional stimulus to study the phonograms of one and the same piece played by various artists and to compare them purely visually in order to discover the nuances and differences that can never be expressed in ordinary musical notation.

As the quotation demonstrates, a shift had occurred between the late nineteenth century and the early twentieth century. Whereas the graphic method featured regularity as the decisive skill a player should master, the “phonologram” now pointed to nuance—and thus deviation—as what individuates a player. Nevertheless, both methods referred to musical notation and the necessity to complement it with some registration device; and in both cases the new device was considered superior to notation because of greater precision. In the late nineteenth century the use of these devices was considered an additional means for the composer to prevent individual performances from deviating from his or her intentions; in the twentieth century individual deviation was seen as the artistic value of musical performance. Because the use of the graphic method was restricted to the laboratory and no playback function was foreseen or intended, this method did not interfere with the means of diffusing and marketing music. In
fact, the two French psychologists thought of their method as a new notation; that
is, a visual addition to printed music.

In contrast, twentieth-century users of the piano roll discovered its value as a
visualization device only after it had been introduced as a medium for the prop-
agation of individual performance. The piano roll provided visual evidence of
temporal deviation as the factor that individuates a pianist’s performance. As
long as listeners compared human beings to machines, they heard human indi-
viduality as nuance in sound color. But when they audited several performances
on the same instrument, recorded by the same mechanisms, they found individ-
uality in the only factor that remained open to differentiation; namely, temporal
deviation. The concept of individuality was strengthened by the growing ease
and abstraction of the comparison. People did not see the pianist whose playing
was reproduced, and yet the difference of a single recorded performance from
other reproductions could be heard.

4. Deviation

In the 1920s, a first study using piano rolls as its basic material was published in
the Journal of Applied Psychology. The author, Guy Montrose Whipple, did not
think of individuality in terms of sound anymore. The tinges and shadings of
sound—formerly the most important characteristics of human play—had disap-
peared from descriptions. They were replaced by visible facts:

for the hard-hearted, matter-of-fact, man of science, subtle nuances, singing
tones, caressing legatos, restraints, brilliant temperaments, and sparkling
runs, so far as they relate to piano playing, must be simply differences in
time and intensity; and for our immediate purposes of analysis, they are, so
far as they exist at all, just so many holes punched at given distances in a
strip of brown paper!18

Whipple studied recordings of two bars from Franz Liszt’s Hungarian Rhapsody
no. 10, played by Arthur Friedheim and Ignacy Paderewski, and compared them
to a direct transcription of the printed notation into the paper roll system. He
found that both pianists differed from the notated time relations, but in distinct
ways. Paderewski, for instance, excelled in abundant use of rubato. He stretched
short grace notes and accelerated fast parallel octaves in the short sample. While
a listener could have noticed this feature without using visual aids, Whipple saw
great merit in his device’s ability to separate distinct parameters. Because of tech-
nical constraints in the recording and reproducing mechanisms, the control
of pitch and time, of intensity, and of damper pedal use were all cut separately
into the rolls, each line of punch holes addressing a different function of piano action. Recombining these parts and playing them back, one could experiment upon the recordings in ways previously unheard and unthought of: “The listener then hears, as we might say, Friedheim’s hands combined with Paderewski’s feet!”

Psychologist Carl Seashore further developed Whipple’s method and turned the piano into a device for photographic recording, using photographic paper instead of the paper rolls. The “Iowa piano camera,” a hybrid of piano and camera, registered the movement of every single hammer stroke in several steps. On the photographic medium these steps appeared as black bars on a grid. From the placement and length of the bars, the beginning and ending of each note could be determined. Also, the hammer’s impact could be calculated from the bars’ succession. Thus the point in time, duration, and loudness of every single note played could be inferred from the registered data. Eventually, the results were transcribed into a “performance score.”

To Seashore, it was a forgone conclusion that on a piano no differentiation of timbre, or sound color, was possible. He explained that “of the four factors in musical performance, pitch, intensity, timbre, and time, two, pitch and timbre, are determined by the piano. Therefore only intensity and time need to be recorded to obtain an adequate statement of piano playing.” The performance score thus contained all the information needed to understand a pianist’s individual style. “Such matters as phrasing, personal interpretation, the principles of art involved, errors, idiosyncrasies, and exhibitions of skill are embodied in such a piano-camera record.”

With the “Iowa piano camera,” the investigation of performance reached a new level. This device was not made for replaying, but exclusively served research purposes. To compare the performance score with the sound of the performance, a separate sound recording was necessary, but in the 1930s this was within reach. To understand what the specific characteristics of an individual performance might have been, listeners could always resort to the performance score.

5. Comparison
Comparison has always fueled the quest for individuality. Musicians such as Mozart and Bach are known to have competed against their rivals on keyboard instruments in head-to-head performances. So did the arguably best-known
piano virtuoso of the nineteenth century, Franz Liszt. Legend has it that the hostess of the famous duel of 1837 between Liszt and his major rival Sigismund Thalberg wisely but unmistakably decided the priority with this judgment: “Thalberg is the first of all pianists of the world. Liszt is the only one.” Generally, Liszt’s role as primus inter pares is explained by his technical skills and by his abilities as a composer for more than just the piano. But his artistic intelligence also extended to his understanding of the piano as a means to create his identity. If he wanted to succeed as a public figure, he had to employ the piano not just as his instrument but as a means to spread his fame.

In a letter published by the *Gazette musicale*, Liszt explained how the piano functions as a medium for the propagation of music:

> The piano holds the first rank in the hierarchy of instruments; it is the most widely cultivated one, the most popular of all; it owes this significance and this popularity partly to its power of harmony, which the piano alone possesses, and, due to this power, to its capacity to summarize in itself the entire art of music. Within the space of seven octaves, it embraces the range of an orchestra, and ten fingers of a single man suffice to render the harmonies produced by the assembly of a hundred musicians. By its mediation, works that remain unknown or little known to the many, due to the impossibility of gathering an orchestra at any place and time, become known. For orchestral composition the piano is what gravure is for the oil canvas; it multiplies it, and transmits it to everyone, and if it does not convey its colors, it conveys at least its lights and shadows.

The capacity to “mediate” music that was not originally composed for the piano gave it its prominent position among musical instruments. Liszt inferred the piano’s function as a mediator from its popularity and its capacity to express the harmonies composed for large ensembles of musicians. In combination, these two capacities of the instrument greatly helped the virtuoso to sharpen his profile. Piano reductions from orchestral and operatic music were standard items in the virtuoso concert. At the same time, simple versions of these pieces circulated among the broader public. Popular melodies from operas, such as the overture to Rossini’s *Guillaume Tell*, often performed by Liszt and others, thus guaranteed recognition: by playing their own signature versions, the virtuosi could set a reference point. When Liszt first heard about the growing fame of his rival Thalberg, he reacted with a harsh critique of the latter’s published piano reductions. By the same token—that is, published sheet music—piano aficionados could also have access to Liszt’s unique pianistic prowess. He published not only his own arrange-
ments and transcriptions of orchestral music but his additions to the piano music of others. Individuation was thus supported by print. Virtuosi such as Liszt could thus use musical notation to spread their fame. The difference between the virtuosi and run-of-the-mill pianists was visible in notated improvisation of well-known music. The sheer amount of notes on the pages caught the eye even of those with minimal or no musical training. More sophisticated amateur musicians could compare the styles of the arrangements and transcriptions—and perhaps try to play them.

6. Fingerprints

The French pianist Marie Jaëll included Liszt’s explanation of how the piano functions as a medium for the propagation of music in a piano manual from 1893, *Le toucher: Enseignement du piano basé sur la physiologie*. Liszt’s high mission, the author complained, was threatened by the fact that most piano students were learning to play without gaining an understanding of the music. Jaëll diagnosed an erroneous trend in piano teaching. While students might improve their dexterity, they lacked the capacity to produce a “beautiful sonority.” Instead, she remarked in her introduction to the piano manual, paraphrasing Beethoven, the acquisition of velocity came at the cost of their intelligence and sensitivity. For a definition of beautiful sonority, she turned to an authority in the field of acoustics. According to Hermann von Helmholtz, noise could be defined as a mixture of irregular auditory sensations. Musical sounds, in contrast, were due to a simple, homogeneous sensation. Guided by these prominent patrons—Liszt, Beethoven, and Helmholtz—Jaëll appealed to students of the piano not to lose time by practicing unnecessary movements but to reduce the hours of practice, never to play without consciousness of every single movement, and to use their ears to control the resulting sounds. Although she did not promise that this would turn the students into virtuosi, she claimed that even a student with clumsy hands and apparent lack of musical ability could profit from her method and develop a sense for beautiful sound.

Jaëll had started her career as a prodigy. Born in 1846 in the small Alsatian town of Steinseltz as Marie Trautmann, she showed an early, strong interest in music. The four-year-old girl ran away from home in order to listen to a gypsy band and a church choir. To prevent other incidents of this kind, her parents bought her a piano and took her to renowned teachers in Stuttgart and Paris. At the age of nine, she began touring France and Germany. Henri Herz, himself a former prodigy, became her teacher at the Paris Conservatory, where she was awarded a first prize as soon as she was old enough to be officially counted as a
student. After graduating from the Conservatory at the age of sixteen, a career as a concert pianist ensued. Together with the Austrian-born piano virtuoso Alfred Jaëll, whom she married in 1866, she played in the most famous concert halls and salons in Europe. After her husband’s death in 1882, Marie Jaëll began to compose and in 1887 was accepted as a member of the French society of composers, a rare honor for a woman at that time and long after. In the early 1890s, she was among the first to perform concert cycles of the complete Beethoven’s piano sonatas and the complete works for piano by Liszt and Robert Schumann. She was at the height of her fame when she published her piano manual in 1893. A book on music and psychophysiology, titled *La musique et la psychophysiologie*, followed in 1896.27

The publication of *La musique et la psychophysiologie* prompted Charles Féré, head of the Hospice de Bicêtre, to contact Jaëll. In an article published in 1896, Féré had postulated a relation between the development of intellectual capacities and the use of the hand. He had collected fingerprints of trained and untrained subjects whom he asked to grasp specific objects such as cylinders and spheres. He also recommended his method of taking and analyzing fingerprints as a useful tool for professional and artistic education. “The exact knowledge of [the hands’] attitudes and mechanisms would be of great service to a scientifically instructed refinement of movements as well as professional and artistic education.” 28 He had, however, lacked an occasion to verify his claims in collaboration with appropriate partners.29 Féré thus invited Jaëll to join his laboratory, and Jaëll accepted the invitation. She even stopped her career as a composer and concert pianist to work with Féré on questions of the physiology and psychology of music and perception. The collaboration continued until 1907, the year of Féré’s death.

Féré’s use of fingerprints differed from the established uses of that time. By the end of the nineteenth century, fingerprints were known to be a reliable way to identify individuals. Criminology had developed systematic means of collecting, filing, and comparing fingerprints. In 1892 a spectacular criminal case was solved in Argentina with the help of fingerprints.30 Francis Galton’s comprehensive study *Finger Prints* appeared the same year, laying the foundation for the present-day technique of dactyloscopy.31

While the idea that no two individuals have the same fingerprints was widespread by the 1890s, Féré was not interested in identification but in using fingerprints for experimentation. He was involved in a dispute with Galton over whether the design of the ridges and furrows pointed to something other than just their owners’ identity. The dispute concerned the role of fingerprints in human biological and cultural evolution. Galton stated that no correlation could be
found between the design of the ridges and furrows and an individual’s temperament, character, or ability. Galton was more optimistic, however, in hypothesizing about the function of the ridges as organs of tactile sensitivity. Although he deemed it unlikely that a direct correlation between tactile discrimination and the width of the interval between the ridges could be corroborated, he attributed to the surface of the fingertips the function of detecting the character of other surfaces. He contended that the sensation resulting from this action would be “analogous to a musical note,” and that the “characteristics to the sense of touch, of different surfaces when they are rubbed by the fingers, may be compared to different qualities of sound or noise.”

In contrast, Féré had argued for a direct correlation between physical, intellectual, and emotional strain in studies such as his Degeneration and Criminality (1888) and The Pathology of Emotions (1892). According to Féré, the movement of the hand was a peculiarly suitable object for the investigation of this correlation. He cited the comparison between the ape, whose hands were anatomically predestined to hold cylindrical objects, and the human, whose hands were most appropriate for holding a sphere. His own experimental verification of the human’s grip revealed that the ways in which human subjects held a spherical object differed strongly.

In man, the grip is not as uniform as one may believe. If we ask a group of subjects, whose fingertips have been coated with printing ink, to grasp two blank copper balls with both hands, we obtain traces that clearly show that grip in humans is not only different in every individual subject, but also differs in both hands.

Féré observed recurring patterns both in “cultivated individuals” and in individuals who were either less gifted or lacked training. Whereas the first placed their fingertips at more or less equal distance, among the latter the area of contact was large and the grouping of the fingers uneven. More specifically, the untrained individuals used a characteristic distribution of their fingers: they kept the three middle fingers closely together while thumb and little finger stayed more apart. That is, they grasped the ball as if it were a cylindrical object, thus alluding, Féré explained, to the apes’ use of their fingers.

In further experiments designed to observe the effect of training, Féré collected evidence for his hypothesis about the parallel development of physiology and intelligence. In his article “Education of Voluntarily Controlled Motility” from 1897, he argued that an increase in tactile sensitivity was accompanied by greater motility of the fingers and had a positive effect on the intellect. In the same article
he displayed the fingerprints he had collected from one individual during six months of training. Focusing on the patterns of grip, Féré did not observe his subjects’ identity or individuality. Rather, the data were correlated to state of health, social setting, and the overall motor abilities and tactile sensitivity of the subject. The fingerprints were thus detached from the individual and taken as evidence for some undiscovered law of nature.

7. Touch
In the second edition of her piano manual, Jaëll implemented the results of her collaboration with Féré. She now advised pupils to take the title of the manual—Le toucher, “touch”—literally by collecting their fingerprints. In the pedagogical literature for keyboard instruments, touch has had a prominent role since at least François Couperin’s L’art de toucher le clavecin (1716/1717). In the second half of the eighteenth century the discourse that linked the soul and the instrument via the notion of touch was in full bloom. Touch was associated with a fashion for the clavichord as the instrument that was most attuned to eighteenth-century ideals of sentiment. In a clavichord the sound production was, however, completely different than in its successor, the pianoforte. Pressing down a key on the clavichord established a contact between the lever and the string. As long as this contact subsisted, the note continued to be heard and, most important, could be influenced and its sound changed. The notion of touch as an extension of the performer’s soul found its material correlate in this mechanism.

Even after the clavichord had disappeared from musical culture, “touch” nevertheless continued to symbolize the contact between the player and the sound. Until the end of the nineteenth century, touch was placed among the most important criteria for good piano playing and was considered the means for achieving a beautiful sound. Although how pianists could influence the sound of a piano was unclear, it was perfectly clear that they had only one brief moment in which to do so.

The piano is constructed such that the player can no longer influence the sound once the key has been struck. Its action relies on a system of keys, hammers, and strings. Every key is connected to a hammer that strikes a string when the key is depressed. After doing so, the hammer must immediately bounce back to give way to the vibration of the string. If the hammer continued to touch the string, it would act like a damper, muting, muffling, or otherwise disturbing the sound. This could easily happen if the task of removing the hammer from the string were left to the player—that is, if the key were a simple lever. In order to avoid such problems, the hammer is tossed at the string and pursues its trajectory for a short moment in free flight. The player must therefore determine the approach of the
hammer before its trajectory takes its course; that is, when striking the key. In piano playing, the conspicuous and audible correlation between the player’s body and the tones produced by the clavichord ceased to exist, replaced by the ominous trajectory of the hammer, which defied description. Yet touch remained the key to sound.

Tracing touch, Jaëll hoped to grasp beautiful sonority. In a revised edition of her manual, fingerprints became the reference by which pupils were to judge their progress in the quest for beauty.\(^{37}\) Jaëll began to collect fingerprints herself and based her teaching on the new method of touch. For this, paper was cut into the shape of the keys and then fixed to them with elastic bands. The player’s fingertips were then blackened by rolling them lightly over a cotton ball coated with a thin layer of printing ink. A group of notes could then be played and the marks afterward investigated.\(^{38}\) In her books *Le mécanisme du toucher* (1897), *L’intelligence et le rythme dans les mouvements artistiques* (1904), and others, Jaëll provided a theoretical framework for this method.\(^{39}\)

The rethinking of fingerprint collection as an aid to piano pedagogy was in keeping with Jaëll’s idea of piano playing as a process that never comes to an end. For her, piano playing was a system in which the player had to operate with more than one variable. Physiology framed this enterprise, insofar as physiologists were often forced to speak about things they could not know anything about, to paraphrase nineteenth-century physiologist Emil du Bois-Reymond’s saying *ignorabimus*—“we will not know”—about the inherent limits to knowledge of nature.\(^{40}\) For Jaëll, to base her teaching on physiology did not simply mean to teach the correct movement from which beautiful sonority would necessarily result. Rather it required teachers and their pupils to find a way of dealing with unknowable elements. They could achieve this by understanding what they were doing as forming a coherent system linking touch, beautiful sound, individuality, and the mechanism of the piano, even though the production of beautiful sonority still defied thorough understanding. The systemic connection of physiology and beauty, movement and sound in Jaëll’s work produced a peculiar understanding of touch, one for which the fingerprint method seemed ideally fitted: her quest for beauty implied a concept of beautiful sonority that remained open to redefinition. Even though criteria for “beauty” could be given, beautiful
sonority was continually perfectible. Beauty could never reach an upper limit: although nothing could really guarantee that the next sound would come out as beautifully as the last one, the possibility was never excluded that the next sound would be even more beautiful than the most beautiful sound heard so far.

In *Music and Psychophysiology* Jaëll wrote, “As soon as we get a beautiful sonority from the instrument, a link between our own organism and the instrument is established, and via this link, another link to music.”\(^{41}\) In this description of sound production, no model of the beautiful sound was given beforehand. Rather, musicality was assumed to develop gradually. “Involuntarily, one becomes sensitive,” Jaëll continued, “one becomes a musician, for the sphere of musical life gradually expands via the perceptions that are constantly renewing.”\(^{42}\) This idea of education differed from nineteenth-century standards in one important respect. While pianists were usually expected to realize their ideas in sound, Jaëll’s program made no such assumption. Rather, musicality was supposed to grow as long as the circuit connecting one’s body to the instrument, and thus to music, remained closed.

By abstaining from precast ideas guiding musical expression, her approach opposed the standard account that all the steps of sound production were part of a sequence that had as its point of departure the player’s soul and found its end in the hermeneutic effort of the listener. In this account, such an effort consisted in moving backward in the presumed causal chain from the listener to the player’s soul. This model had a paradoxical appeal: To express one’s soul on the piano implied making all material obstacles disappear. For this, the students had to drill themselves in technique in order to overcome it, to master the instrument in order to forget it.

In Jaëll’s systemic model no one moment pertaining to playing could be separated from any of the others. More than one connection always existed between two elements. And the moment of contact was twofold: On the one hand, the circle of sound production closed, and this enabled players to widen their sense of musical beauty. On the other hand, the sensitivity of the fingertips could be observed and ameliorated with each touch. The desirable increase of sensitivity at the moment of touch required developing the ability to observe oneself or, as one would say in modern terms, the development of a certain kind of proprioception. Thus, from touch, the player obtained two kinds of feedback: the tactile sensation that occurred when a key was struck and the sound that resulted therefrom. For Jaëll, sound production was a circuit of “resonances” running through the body and reaching the ear after the actual sound had been produced. A second circuit involved increasing sensitivity. In her late writings, Jaëll turned
away from virtuosic piano playing. Instead, she considered the piano to be merely a device in an experimental setup in which the object was sensation and the experimental subject was Jaëll herself.

8. Conclusion

The fingerprints in the work of pianist Marie Jaëll trace touch as moment of contact. At no other moment can the sound production in piano playing be controlled, yet no specific requirements for this very moment could be convincingly postulated in Jaëll’s day. On the contrary, scientific investigation became disenchanted with the concept of touch shortly after Jaëll made her contribution to the discourse on piano playing. The fingerprints, however, made a different claim than the means of visualization that would eclipse the concept of touch a little later. They were meaningless without reference to audition and tactile sensation. Because of the systematic implications of sound production, the investigation of fingerprints had to fulfill certain requirements: no single fingerprint could provide information about sonority; the correlation of their shape and disposition required more data. Much like Féré, Jaëll observed patterns of prints rather than single prints. From Féré’s research she assumed that a certain disposition of fingerprints would point to a controlled movement. She did not relate the patterns obtained from her experiments to any global assumption about human beings, however. Instead, she stated, “While on every fingertip the apparatus of touch has been marvelously coordinated by nature, in the art of touch this marvelous coordination has to be re-constituted by the artist.” In contrast to Féré, for Jaëll the correlation between patterns of fingerprints and beautiful sonority prevented any simple correlation to issues such as evolution and degeneration. Because beautiful sonority itself remained open to redefinition, the fingerprints made no sense as a proof of any claim beyond their comparison with the next set of fingerprints.

As can be seen from the investigation of individuality in piano playing in the 1920s and 1930s, the notion of touch became empty when the resulting sound was traced back to discrete parameters. The idea of combining one pianist’s pedaling with another’s use of the hands is symptomatic here: if such a recombination were possible, then the crucial, individualizing role of touch could only be a misunderstanding. But the mechanism of the player piano had already replaced the pianist’s touch almost two decades before Whipple had the idea of recombining the parameters of performance.

Another theoretical explanation of sound production that stood in opposition to Jaëll’s systemic understanding was the conception of piano playing as a mechanism, a sequence of causally linked elements. In his study of the piano, acoustician
Otto Ortmann tried in the 1920s to establish the relation of touch and tone. He compared the visually enlarged vibrations that an eminent pianist produced on the piano’s strings to those resulting from lead weights dropped upon the keys, without detecting any difference.⁴⁴

Eventually, in the second half of the twentieth century, when the investigation of piano playing turned to the piano’s sound, the picture completely changed. The visualization devices developed during World War II, such as the sonogram, showed every sound to differ from every other sound, with one of the main characteristics of the sound of the piano being the components of instability and the absence of a constant pitch. In light of this, the recognizability of piano sounds as piano sounds became perhaps no less a riddle than their individuality. In any case, none of these findings shed light on the relation between playing and sound.⁴⁵

Around 1900, before these devices that led to the deconstruction of “touch” were available, this notion assumed a peculiarly important function, turning into a residual category for all those moments in piano playing that defied explanation. Yet, the notion of touch promised that an explanation was possible. During the nineteenth century and long before, touch was understood to be the most direct expression of the soul. Here, in the player’s inner feelings, was the ground of another causal chain: from this source—the soul—the music was supposed to take its departure and find its expression in the appropriate sound.

Against this background of symbolic notions and flawed concepts, Jaëll’s understanding of touch is surprisingly consistent. The “physiological disposition of contacts” that she investigated, and which became visible in the fingerprints, documented touch as an event. In each of the singular events of contact between fingers and keys, a system of sound production closed, establishing two intersecting circuits: the correlation of touch and audible sound, and the sensation of touch. By means of the fingerprints, the disposition of contacts could be studied and compared with the next set of traces collected. This method provided an object of reference for students because it enabled them, after the crucial moment of sound production was over, to better understand their own abilities through a material trace.
Notes
3. Binet and Courtier, 204.
6. In experimental physiology, the pianist’s body was subjected to registration between 1890 and 1930. This involved photographic recordings of pianists’ movements, myographic recordings taken from musicians (i.e., kymographic registration of their muscle movements), and even studies of their metabolism while playing various exercises. See, for example, Adolf Loewy and Hermann Schroetter, “Über den Energieverbrauch bei musikalischer Betätigung,” *Pflügers Archiv für die gesamte Physiologie des Menschen und der Tiere* 211 (1926): 1–63. Overviews of experiments involving piano playing are given in F.A. Steinhausen, *Die physiologischen Fehler und die Umgestaltung der Klaviertechnik* (Leipzig: Breitkopf and Härtel, 1905) (focusing on pedagogy); M. V. Ivanov-Boretsky, *Pyat’let nauchnoy raboty gosudarstvennogo instituta muzykal’noy nauki (GIMN’a)* 1921–1926 (Moscow: Muzykal’ny sektor gosudarstvennogo izdatel’stya, 1926) (focusing on muscle tension and on investigations carried out in early Soviet Russia); and Nikolai Bernstein and Tatiana Popowa, “Untersuchung zur Biodynamik des Klavieranschlags,” *Arbeitsphysiologie: Zeitschrift für die Physiologie des Menschen bei Arbeit und Sport* 1 (1929): 396–432 (providing a historical overview of photographic registration). On piano performance research during the twentieth century, see Reinhard Kopiez, “Aspekte der Performanceforschung,” in *Handbuch der Musikpsychologie*, ed. Helga de la Motte-Haber (Laaber, Germany: Laaber Verlag, 2002), 505–587.
12. [aehne], 10.
15. Hagmann traces the introduction of paper rolls into the player piano back to Welte’s earlier mechanical organs that preceded the first marketed player pianos without recording mechanism.
32. Galton, 197.
33. Galton, 63.