

# Musical Aptitude Testing: From James McKeen Cattell to Carl Emil Seashore

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## Abstract

The purpose of this article is to describe the links between late nineteenth-century psychological research and the early musical aptitude research of Carl Emil Seashore (1866-1949). The primary link was the music-related research of the leader of the mental testing movement during the 1890s, Columbia University psychologist James McKeen Cattell (1860-1944). German psychologist Wilhelm Wundt instructed Cattell in the German scientific tradition, and English researcher Francis Galton encouraged Cattell's research on individual differences and introduced him to statistical methods. During the 1890s, Cattell conducted a longitudinal study, the hypothesis for which was that tests of sensory discrimination ability, including musical discrimination, would correlate with undergraduates' academic grades. After his study failed to produce the expected results, the mental testing movement followed Alfred Binet and Victor Henri of France, and Cattell turned to other activities. However, in the meantime, Cattell influenced many other important psychologists, including Edward W. Scripture, Carl Seashore's doctoral mentor at Yale University, and eventually Seashore himself. Despite the mental testing movement's shift to Binet and Henri's cognitive-type testing, Seashore continued his conservative, sensory approach to the testing of musical aptitude.

When psychologist Carl Emil Seashore (1866-1949) began the two decades of research that led to the development of his famous tests of musical aptitude,<sup>1</sup> he drew upon beliefs and research methods then prevalent in the field of psychology. Many of those beliefs and methods were examined in a previous article.<sup>2</sup> The purpose of this article is to describe the remaining major links between late nineteenth-century music-related psychological research and Seashore's early work: the music-related research of James McKeen Cattell (1860-1944), the leader of the mental testing movement during the 1890s.<sup>3</sup>

In the 1890s, European and American researchers in the new field of scientific, empirical, laboratory-based psychology (as opposed philosophical "armchair" psychology) focused their research on sensory perception, the first of the new psychology's three "great topics."<sup>4</sup> At about the same time, American psychologists assumed the leadership in mental testing research, which was part of the new psychology. Carl Seashore undertook his doctoral studies in the first half of the 1890s, a period that coincided with the birth of sensory psychology and mental testing research in the United States. Not long thereafter, he applied the methods of scientific psychology and mental testing to his research on musical aptitude.

## Perception Research

Speculation about sensory perception began in Ancient Greece. Empirical research on the same began during the Renaissance, including studies of the least discernible differences in musical pitch. Theoretical and empirical perception research by Ernst Heinrich Weber (1795-1878), Gustav Theodor Fechner (1801-1887), Hermann Ludwig Ferdinand von Helmholtz (1821-1894), and other physicists led to a fusion of philosophical speculation and physiological research on sensation, which in turn contributed significantly to the emergence of the field of modern psychology. Wilhelm Wundt (1832-1920) of the University of Leipzig, the world's first famous psychologist, borrowed testing ideas and research methods from these early researchers and helped develop the subfields of experimental psychology and psychophysics.<sup>5</sup>

Cambridge University researcher Francis Galton (1822-1911) borrowed sensory perception research methods from Wundt and others. An adherent of the long-standing belief that all knowledge is obtained through the five senses, Galton was also influenced by Charles Darwin's (1809-1882) theory of evolution, the natural selection properties of which implied individual differences between people;<sup>6</sup> the widespread belief in faculty psychology, whose adherents held that sensory faculties correspond to faculties of the brain; the emergence of atomistic chemistry, which encouraged psychologists to study the "psychological elements," or senses; and the development of the concept of the normal, or random, distribution curve.<sup>7</sup>

Eventually, Galton hypothesized that "a measure of sensory acuity would provide a crude measure of a person's level of intelligence," and that mental ability is normally, or randomly, distributed.<sup>8</sup> He also came to believe that mental abilities are related to each other, which led him to develop the rudiments of statistical correlation.<sup>9</sup> Unlike Wundt, who attempted to identify traits common to all (or most) people, Galton used Wundt's methods to measure individual differences in mental ability. Galton's research, which began in the 1870s, included tests of musical discrimination and perception.<sup>10</sup>

## James Cattell

Leadership of the mental testing movement passed from Galton in the 1880s to James Cattell in the 1890s. Cattell graduated from Lafayette College in Easton, Pennsylvania, where his father was president, in 1880. For the next several years, he divided his time between completing a master's degree at Lafayette, working on a Ph.D. in psychology under Wundt (granted in 1886), studying with Galton at Cambridge, and several other activities. One of those activities was a graduate fellowship at Johns Hopkins University (1882-83), where he and fellow graduate students (two of whom were John Dewey and Joseph Jastrow) helped G. Stanley Hall (1844-1924) establish one of the first American psychological laboratories.<sup>11</sup> He went to the University of Pennsylvania in the late 1880s, where he opened a psychological laboratory and held the first university faculty position in psychology in the United States. After moving to Columbia University in 1891, he provided leadership to the new experimental psychology movement for the next twenty-six years.<sup>12</sup>

Cattell seems to have begun his sensory perception studies while at Johns Hopkins in 1883.<sup>13</sup> He continued at least one of those experiments in Wundt's laboratory.<sup>14</sup> He also seems to have developed his keen interest in experimental apparatus at Leipzig, including those for music research:

We have in the [Wundt's] laboratory two excellent pieces of apparatus for testing the power of distinguishing notes. The one is an organ arrangement, which gives the notes at intervals of four vibrations from 32 to 1024 [Hz.] . . . The other apparatus is a set of tuning forks made up by König [*sic*], in Paris. Pairs of tuning forks are taken, one always gives the same note, the other (by means of weights) can be so regulated as to give a note a little lower or higher. Experiments on this subject are being made by three groups of students . . . In one case, memory of notes is being especially investigated.<sup>15</sup>

Similarly, in 1888, Cattell described "[c]areful experiments, not yet published," that had "been carried on for several years past in the Leipsic [*sic*] laboratory" on the least perceptible differences in loudness and pitch, and on the perception of musical intervals.<sup>16</sup>

Cattell also seems to have first become interested in individual differences during his time with Hall at Johns Hopkins.<sup>17</sup> He took that interest with him to Leipzig, where Wundt, himself uninterested in individual differences,<sup>18</sup> allowed Cattell to write a paper on the subject as early as 1885.<sup>19</sup>

Cattell's interest in individual differences intensified during his intermittent work with Galton at Cambridge over several years. For example, his letters from Cambridge tell of his "association experiments,"<sup>20</sup> which he employed in his mental testing efforts.

Cattell studied extensively with Wundt, the early leader in the psychological measurement of sensory perception, and Galton, the pioneering mental tester and the early leader in the measurement of individual differences in sensory perception. The fact that both men incorporated tests of musical perception in their research appears to have influenced Cattell to do the same.

## Cattell the Mental Tester

At the University of Pennsylvania, his first full-time position, Cattell gathered for the laboratory "a valuable collection of Koenig's [sic] apparatus for the study of hearing and the elements of music . . ." <sup>21</sup> Soon thereafter, in 1890, he published an article in a British journal that scholars believe was the first time the term "mental test" appeared in print. <sup>22</sup> In this article, a watershed in the history of mental measurement, <sup>23</sup> Cattell described a series of ten tests then in use at Pennsylvania. None of the ten tests involved music, although one measured "Reaction-time for Sound." However, Cattell listed an additional fifty tests still under development, "which I look on as the more important in order that attention may be drawn to them, and co-operation secured in choosing the best series of tests and the most accurate and convenient methods." Some of these were music tests. <sup>24</sup>

Upon his arrival at Columbia, he established the department of psychology and developed what became known as the "Freshman Tests," which he administered to at least fifty volunteer freshmen each year beginning in 1893. Cattell held great hope for these tests, which he predicted would correlate with each other and with academic grades. In an 1896 article, Cattell and a collaborator described their research methods in some detail and provided preliminary results from what may have been the first predictive study of academic success. Only two tests related to music. For one, a test of hearing (of tones), the researchers simply divided subjects from each year into "normal," "subnormal," and "abnormal" categories. The other music test measured the "accuracy of the perception of pitch." After subjects heard a pitch (F below middle C) played on a monochord, they attempted to match the pitch by adjusting the instrument's bridge. <sup>25</sup>

After several more years of data collection, one of Cattell's graduate students, Clark Wissler, reported more results from the study, including data collected from a small number of female students from Barnard College. Wissler correlated the test scores with each other and with senior grade-point averages using the technique of statistical correlation that had been discovered by Galton and developed by Galton's young associate, Karl Pearson. <sup>26</sup>

Most of the instruments in the battery were tests of sensory discrimination. In addition to the pitch perception test described above, Wissler discussed a music-related test of "Rhythm and Perception of Time" that measured subjects' abilities to continue tapping a steady beat on a telegraph key fifty times after hearing a stimulus of ten tapped beats, and two "Imagery" questions that required written responses. <sup>27</sup>

On the pitch perception test, the "average error" (monochord bridge distance from the "correct" placement) was 7.2 centimeters for freshmen and 3.7 centimeters for seniors. Wissler concluded that women were superior to men and seniors were superior to freshmen on that test, with a "certainty of results" of  $p < .01$  in each case. <sup>28</sup> He found no statistically significant differences in pitch perception between freshmen from different years. <sup>29</sup>

Unfortunately, with one exception, Wissler did not report correlation coefficients between the pitch perception test and the other variables. The exception was a coefficient of  $r = .01$  between pitch perception and reaction time ( $N = 100$ ). In general, he found only chance intercorrelations between the physical and mental tests, and moderate intercorrelations between grades for specific courses. Most disappointing of all, he found only chance correlations between individual tests taken as freshmen and overall grades as seniors. Among other things, Wissler complained about the inadequacy of

undergraduate grades as a representative measure of students' abilities to handle "life tasks," which he deemed "exceedingly complex." He concluded that Cattell's physical and mental tests promised little "from a practical point of view."<sup>30</sup>

## Other Mental Testers

European researchers were beginning to conduct similar studies of mental functions in the 1890s.<sup>31</sup> In the United States, where most of the work occurred, Frank Boas (1858-1942) related school children's test scores to their mental alertness as estimated by teachers; Joseph Jastrow (1863-1944) developed fifteen tests for college students; and James A. Gilbert (b. ?-d. ?) studied the mental and physical development of school children. Like Cattell and Wissler, Boas and Gilbert found only chance relationships between test scores and teacher ratings.<sup>32</sup>

More important than any of these mental testing efforts was the work of Alfred Binet (1857-1911) and Victor Henri (1872-1940) in France and Hugo Münsterberg (1863-1916) in the United States. These researchers experimented with a radically different type of mental test based on cognitive functioning rather than sensory perception.<sup>33</sup> Cattell seems to have recognized as early as 1896 the importance of these new tests:

of a strictly psychological character. For the psychologist these are, of course, the most interesting and important. But we are at present concerned with anthropometric work, and measurements of the body and of the senses come as completely within our scope as the higher mental processes.<sup>34</sup>

Indeed, the mental testing movement soon followed Binet and Henri's lead. Probably for that reason, Cattell, like Galton before him, turned to other interests.<sup>35</sup> He eventually became embittered, in part because "his major contribution to experimental psychology . . . [was] thoroughly discredited and replaced by the . . . tests of Alfred Binet."<sup>36</sup>

## Cattell and Seashore

Several pieces of evidence suggest that Cattell influenced Carl Seashore's work on musical aptitude testing. First, as a founding member and fourth president of the American Psychological Association, founding editor of the *American Journal of Psychology*, founding head of the psychology department at a leading university (Columbia), and leader of the mental testing movement during the 1890s, James Cattell was an extremely prominent psychologist.

Second, Cattell was a professional friend of Edward Wheeler Scripture (1864-1945), Seashore's doctoral mentor at Yale University who himself had taken his doctorate under Wundt in 1891. Scripture was a highly productive researcher, but because of his disagreeable personality, he "was largely estranged from his generation of American psychologists," except for Cattell, his "best friend among the American psychologists."<sup>37</sup> In addition to the personal relationship between Cattell and Scripture, both Scripture and Seashore adopted "an approach like Cattell's" to the study of sensation.<sup>38</sup>

A final set of clues to the link between Cattell and Seashore resides in the James McKeen Cattell Collection held by the Library of Congress. The author located more than seventy pieces of personal correspondence between the two men, the earliest dating from 1899.<sup>39</sup>

Seashore's doctoral dissertation, which he completed in 1895, was about neither mental testing nor music. Instead, his interest in mental testing may have come indirectly from the prominent Cattell, whose article on the Columbia "Freshman Tests" appeared after Seashore completed his dissertation but before he published his first article on a music-related study.<sup>40</sup> Cattell's work with music tests probably appealed to Seashore, a former singing school student, church organist and choir director, and college glee club director from an amateur musical family.<sup>41</sup>